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Is anyone looking at me? Direct gaze detection in children with and without autism

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Abstract

Atypical processing of eye contact is one of the significant characteristics of individuals with autism, but the mechanism underlying atypical direct gaze processing is still unclear. This study used a visual search paradigm to examine whether the facial context would affect direct gaze detection in children with autism. Participants were asked to detect target gazes presented among distracters with different gaze directions. The target gazes were either direct gaze or averted gaze, which were either presented alone (Experiment 1) or within facial context (Experiment 2). As with the typically developing children, the children with autism, were faster and more efficient to detect direct gaze than averted gaze, whether or not the eyes were presented alone or within faces. In addition, face inversion distorted efficient direct gaze detection in typically developing children, but not in children with autism. These results suggest that children with autism use featural information to detect direct gaze, whereas typically developing children use configural information to detect direct gaze.

Keywords: Autism; Autism spectrum disorder; Gaze; Direct gaze; Face processing; Visual search; Search asymmetry; Face inversion effect

1. Introduction

Information gained from another person's eyes plays a crucial role in human social communication. Among various functions of gaze processing, detection of direct gaze or eye contact is essential in social interaction and communication. Direct gaze signals the intention of the gazer towards the perceiver. Eye contact also plays a major role in communication and affective bonding (Kleinke, 1986; Robson, 1967; Robson, Pedersen, & Moss, 1969). Csibra and Gergely (2006) argue that perceived eye contact signals communicative ostention, and initiates referential communication.

Experimental studies have found that direct gaze affects perception, cognition and attention. For example, in visual search, target faces with direct eye gaze are detected faster and more efficiently than those with averted eye gaze (Conty, Tijus, Hugueville, Coelho, & George, 2006; von Grünau & Anston, 1995; Senju et al., 2005a; Senju & Hasegawa, 2006). In addition, when the gaze direction of others is ambiguous and difficult to perceive, people are biased to judge the gaze as "looking at me" (Martin & Jones, 1982; Martin & Rovira, 1981,1982). Direct gaze also holds attention and makes it difficult to disengage from the face (Senju & Hasegawa, 2005). In addition, faces with direct gaze were remembered better than faces with averted gaze (Hood, Macrae, Cole-Davies, & Dias, 2003; Mason, Hood, & Macrae, 2004; Smith, Hood, & Hector, 2006; Vuilleumier, George, Lister, Armony, & Driver, 2005). It is also known that a stranger gazing directly at the perceiver increases autonomic arousal in adults (Gale, Kingsley, Brookes, & Smith, 1978; Gale, Spratt, Chapman, & Smallbone, 1975; Nichols & Champness, 1971).

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Failure to develop typical mutual gaze behavior is one of the core symptoms of severe social and communicative disorders, and of autism (American Psychiatric Association, 1994; Baron-Cohen, 1995). Retrospective home video analyses found that from the first year of life, infants who were later diagnosed with Autism Spectrum Disorders (ASD) orient less to faces than typically developing infants (Baranek, 1999; Clifford, Young, & Williamson, 2007; Maestro et al., 2005; Osterling & Dawson, 1994; Osterling, Dawson, & Munson, 2002; Werner & Dawson, 2005). Hobson and Lee (1998) also reported that older children and adolescents with ASD make eye contact less in a communicative context (greeting) than those without ASD. Studies with eye-tracking techniques confirm these observations and revealed that individuals with ASD fixate less to eyes compared to typically developing individuals (Dalton et al., 2005; Klin, Jones, Schultz, Volkmar, & Cohen, 2002; Neumann, Spezio, Piven, & Adolphs, 2006; Pelphrey et al., 2002; Spezio, Adolphs, Hurley, & Piven, 2007, but see also van der Geest, Kemner, Verbaten, & van Engeland, 2002).

Although these observation studies are very informative for spontaneous behaviour, they do not clarify how individuals with ASD process direct gaze, or whether perceived direct gaze affects cognition in individuals with ASD. Moreover, there are few studies which have empirically examined the cognitive and neural basis of eye contact processing in ASD. Furthermore, of these experimental studies that investigate eye contact processing in ASD, the findings are inconsistent. A series of experimental studies byour group found that individuals with ASD failed to show the facilitated behavioural (Senju, Yaguchi, Tojo, & Hasegawa, 2003) and event-related potential (ERP) (Senju, Tojo, Yaguchi, & Hasegawa, 2005b) responses associated with direct gaze. On the other hand, other neurophysiological studies reported that individuals with ASD elicited large ERP or magnetoencephalography signals in response to direct gaze, whereas this was not apparent in typically developing individuals (Grice et al., 2005; Kylliäinen, Braeutigam, Hietanen, Swithenby, & Bailey, 2006). In addition, Kylliäinen and Hietanen (2006) presented looming faces with direct or averted gaze, and found that looming faces with either gaze direction, elicited a similar skin conductance response (SCR) in typically developing individuals. However, individuals with ASD, elicited a larger SCR in response to a looming face with direct gaze than one with averted gaze. It is difficult to interpret the cognitive and/or affective basis of the SCR response because the looming feature of the stimuli differed from other studies, and because the SCR response was smaller in individuals with ASD compared to typically developing individuals. However, at least, the differential response to gaze suggests that individuals with ASD possess a sensitivity to others' direct gaze.

Interestingly, one of our previous studies (Senju, Hasegawa, & Tojo, 2005a) found conflicting results about direct gaze detection in autism. This study adopted a visual search paradigm initially used by von Grünau and Anston (1995), in which eye stimuli with various gaze directions were presented. Participants were instructed to detect targets of a particular eye direction, i.e. direct gaze, within a set of distracters of a different eye direction, i.e. averted gaze (Fig. 1). There were two versions of the task, in the first we used schematic eyes (Fig. 1a) as used by von Grünau and Anston (1995), and in the second we used photographs (Fig. 1b). In the first experiment, children with autism, as well as typically developing children, showed the 'stare-in-the-crowd' effect (or asymmetry in search performance), performing better for the detection of direct gaze than the detection of averted gaze. In contrast, when the gazes were presented in photographs of laterally oriented faces, typically developing children were faster to detect direct gaze than averted gaze, but gaze direction did not affect search performance in children with autism. In addition, the faster detection of direct gaze in typically developing children was limited within the context of an

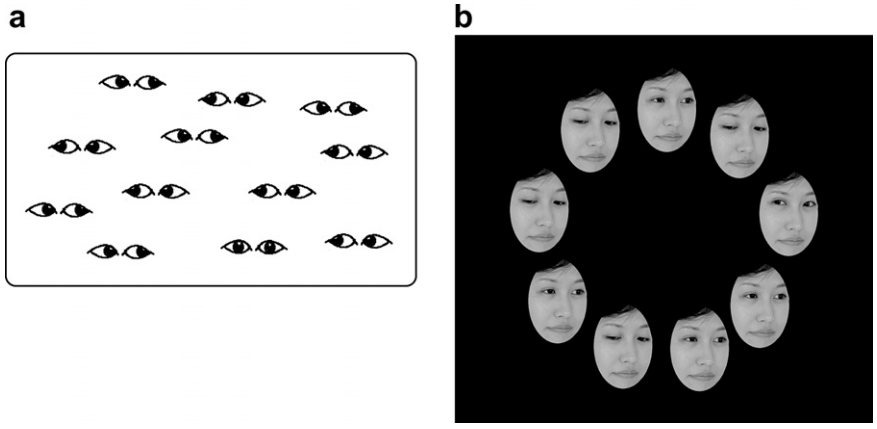

Fig. 1. Examples of the stimulus display used in Senju et al. (2005a). (a) An example of schematic eye stimuli. This figure depicts a direct gaze condition with a target (direct gaze, appeared to the lower right) present among distracters (rightward- and leftward-gaze). (b) An example of laterally oriented face stimuli. This figure depicts a direct gaze condition with a target (direct gaze, appeared to the right position of the stimulus array) present among distracters (rightward-gaze and downward-gaze).