Brief Report: Faces Cause Less Distraction in Autism

Running Head: Face Distraction in Autism

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Abstract

Individuals with autism have difficulties interpreting face cues that contribute to deficits of social communication. When faces need to be processed for meaning they fail to capture and hold the attention of individuals with autism. In the current study we illustrate that faces fail to capture attention in a typical manner even when they are non-functional to task completion. In a visual search task with a present butterfly target, an irrelevant face distracter significantly slows performance of typical individuals. However, participants with autism (n=28; mean 10 years 4 months) of comparable non-verbal ability are not distracted by the faces. Interestingly, there is a significant relationship between level of functioning on the autism spectrum and degree of face capture or distraction.

Keywords: Face perception, social attention, autism

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Faces Cause Less Distraction in Autism

The human face has a ‘special’ capacity to attract attention. At any given time, we must prioritise information to engage our visual attention while ignoring information of less relevance, or risk flooding our limited resources with information too rich to be processed simultaneously (see Broadbent, 1958). For individuals who are developing atypically, the process of selective attention may occur in an atypical manner; this is highly likely to be the case for autism. Research suggests that individuals who are functioning on the autism spectrum give attentional priority to information that would not necessarily capture the attention of typically developing individuals.

The neuro-developmental disorder autism is characterised by complex impairments of social interactions, communication and imagination (APA, 1994). Atypicalities of attention have been suggested to play a central role in atypical processing associated with the disorder. Furthermore, atypicalities of attention to social information are particularly evident for individuals on the autism spectrum. A failure to attend to socially relevant information in a typical manner will impact upon the development of sophisticated social expertise (Klin, Jones, Schultz, & Volkmar, 2003); for example, socio-cognitive skills such as theory of mind (Baron-Cohen et al, 1997). In typical development an attention bias to faces is said to be present from birth (Farroni et al., 2005) and is believed to be sub-served by a number of cortical structures (e.g. amygdala, superior colliculus) that guide cortical specialisation for face perception (Johnson, 2005). However, a lack of attention allocation to faces has been widely found across the developmental spectrum of autism, especially where there may be competition for attentional resources from non-social information (Klin et al., 2002; Speer et
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al., 2007; Riby & Hancock, 2008, 2009a; Kikuchi, Senju, Tojo, Osanai, & Hasegawa, 2009; but see also Fletcher-Watson, Leekam, Turner, & Moxon, 2006; Freeth, Ropar, Chapman, & Mitchell, 2010). So while research on typical development suggests that faces capture attention because of their social significance (Vuilleumier, 2000) the failure of faces to capture attention in autism may be due to both a lack of social priority and atypicalities of selective attention (e.g. Allen & Courchesne, 2001; Remington, Swettenham, Campbell, & Coleman, 2009).

For typical adults faces engage attention more than objects (Hershler & Hochstein, 2005; Lewis & Edmonds, 2003; Theeuwes & Van der Stigchel, 2006). Furthermore, once a face has captured attention it is likely to delay responses to other stimuli (Bindemann, Burton, Hooge, Jenkins, & de Haan, 2005). This delay may occur even if the face is not functional to task completion. Langton, Law, Burton and Schweinberger (2008) used a visual search task with typical adults to show that when searching for a butterfly target participants were slowed by the presence of an upright face distracter (compared to non-face distracters or inverted faces). The authors operationalised stimulus-driven attention capture as the “performance decrement produced by a task-irrelevant face” (page 331). Langton and colleagues (2008) suggested that faces captured attention and directed processing resources to their location, slowing task completion in the search for the real target. The fact that the same participants showed a lack of attention capture when the same faces were presented under inversion illustrated that the effect was face-specific, possibly socially relevant, and that it was not driven by low-level image-based stimulus properties.

In the current experiment we explored whether individuals with autism were susceptible to face distraction when a face was non-functional to task completion. This is an important
extension of previous research, which unlike the current study, has focused on attention capture by faces when the face is required for task completion (e.g. Kikuchi et al., 2009). Langton et al. (2008) found that faces caused interference during the search for a present target for typical adults. We propose that the critical condition in the current study is the target present condition. We predicted that whilst reaction times to detect a present target (a butterfly) would be slowed by face presence in typical development (replicating Langton et al., 2008); reaction times would show no effect of face presence in autism.

Method

Participants

Twenty-eight individuals with autism were recruited from 3 schools for pupils with special educational needs, including autism spectrum disorders. All pupils had a full statement of special educational needs. Participants were aged 10 years 2 months to 16 years 6 months (mean 12 year 11 months; 24 male). Functioning level was confirmed by teacher completion of the Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Rocher Renner, 1988). Participants ranged from ‘mild-moderate autism’ to ‘severe autism’ and all scored above the cut off (> 30; range 31 - 50).

Each participant with autism was matched to a typically developing individual of comparable nonverbal ability using the Ravens Coloured Progressive Matrices (RCPM; Raven, Court, & Raven, 1990; max 36). Typically developing participants were aged 8 years 8 months to 14 year 3 months (mean 10 year 4 months; 22 male). There was no significant group difference in RCPM scores (Autism mean 17, typically development mean 17; p=.74), although the
typically developing participants were chronologically younger \((p<.01)\). In the typically developing group the absence of developmental and social difficulties was confirmed by teacher completion of the Strengths & Difficulties Questionnaire (SDQ; Goodman, 2001). All participants scored within the ‘normal’ behaviour range \(<11\).

Parental consent was received prior to participation and where deemed appropriate (by ability level), participant assent was also provided.

*Stimuli*

The task was based on Langton et al. (2008; experiment 1a). Participants were required to detect whether a butterfly target was present / absent from a visual array. Participants were presented with an empty grid of 3x3 squares on screen for 500ms. The grid measured 600 x 600 pixels with each square of the grid measuring 200 x 200 pixels. Stimuli randomly appeared in 3, 6, or 9 squares of the grid to manipulate cognitive load and to maintain task engagement (rather than for the purposes of an independent variable; see Figure 1 for an example of the stimuli). The stimuli measured 150 x 150 pixels so as to appear inside the squares of the grid. The target was present in half the trials of which there were 18 at each set size (total 54 trials). The distracters in the array were non-butterfly items, which may or may not have included a face. The stimuli remained on screen until participants made their response by pressing a pre-determined key (the rest of the keyboard was covered with an acetate sheet). Participants were required to press one pre-determined key if the target was present and a different key if the target was absent. Participants were told to respond as fast and as accurately as possible. A 1000ms inter-stimulus blank screen separated trials.
Six butterfly images were used as the target and six non-face objects were the distracter items (conch shell, flower, plant, house, globe, fruit). Each object appeared equally often in target present and absent conditions. In 14 butterfly-present and 13 butterfly-absent trials one object distracter was replaced by a neutral upright face (there was an uneven number due to 27 trials in each of the butterfly present / absent conditions created by one appearance in each cell for the grid in each condition possible). Five face identities were used randomly (3 male, 2 female) and were cropped (to the size indicated previously) neutrally expressive faces of the Ekman and Friesen (1976) series (Figure 1).

All testing took place on a Dell Latitude D820 laptop computer (screen size 15 inches). E-Prime software was used for programming, stimuli presentation and data recording.

**Procedure**

Participants were tested individually in a quiet environment at school. The participant was told that they were going to play a game on a laptop computer where they had to spot whether a butterfly was present or absent from a picture. Participants were shown the response keys and asked if they had any questions. They kept their fingers on the two response keys throughout the task. Each participant successfully completed three practice trials followed by the experimental trials. Participants were not provided with feedback but were provided with encouragement to maintain their task engagement. Analyses focused on reaction time data for correctly answered trials (median RT) as accuracy measures would fail to detect subtle but informative group differences.
Results

An ANOVA with the within-subject factors of Face Distracter (present, absent) and Target (present, absent) and the between-subject factor Group (Autism, typical development) revealed a significant effect of Target $F(1,54)=5.77, p<.05; \eta^2=.10$; faster RT for target present than absent trials (present 1726ms, absent 1836ms$^1$). There was also a significant effect of Face Distracter $F(1,54)=11.23, p<.01, \eta^2=.18$; faster RT for face absent than face present trials (face distracter absent 1714ms, present 1848ms). Overall, there was no significant effect of Group ($p=.92$).

The interaction between Target x Group did not reach significance ($p=.35$) but there was a significant interaction between Face Distracter x Group $F(1,54)=12.41, p<.01, \eta^2=.19$ and Target x Face $F(1,54)=9.20, p<.01, \eta^2=.15$. These interactions were consolidated further by the three-way interaction between Face Distracter x Target x Group $F(1,54)=7.40, p<.01, \eta^2=.12$. We take each group in turn to explain this three-way interaction. Individuals who were developing typically were significantly slower for face present than face absent trials in the target present condition $t(27)=6.61, p<.001$ (target present: face present 1941ms, face absent 1460ms). See Figure 2), however, they were not affected by face presence in the target absent condition (target absent: face present 1885ms, absent 1824ms). Individuals with autism showed no significant effect of face presence for target present trials ($p=.92$; target

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$^1$ Note that the reaction times may seem relatively slow compared to other studies of a similar nature, however this is due to the nature of the child participants and the inclusion of individuals with intellectual difficulties.
present: face present 1755ms, face absent 1748ms. See Figure 2) or target absent trials (p=85; target absent: face present 1811ms, face absent 1825ms).

[insert Figure 2 about here]

An index of face distraction

We calculated a ‘face distraction’ index for each participant in the target present condition (due to a theoretically driven interest in this condition; Langton et al., 2008). The ‘face distraction’ measure was calculated by the difference in reaction times in the target present-face present condition and the target present-face absent condition. A positive index indicated slower reaction times for the face present than face absent trials. An independent samples t test on ‘face distraction’ with the factor Group (Autism, typical development) indicated that typically developing participants were significantly more affected by face presence than those with autism t(54)=4.53, p<.001 (autism mean 8.04, typical development mean 480.34).

In typical development there was no significant relationship between chronological age (p=.73) or nonverbal ability (RCPM score; p=.85) and degree of face distraction. This pattern was mirrored for chronological age (p=.86) and nonverbal ability (p=.55) in autism. However, there was a significant correlation between CARS score (the indicator of level of autistic functioning) and the measure of face distraction. Pearson correlation indicated a significant negative correlation between CARS score and the index of face distraction (r=-.59, p<.05; see Figure 3). Participants with autism who scored higher on the CARS showed more severe autistic functioning and this was related to less face distraction.

[insert Figure 3 about here]
Discussion

While the human face has special social relevance to typically developing individuals and captures attention when competing for restricted resources (e.g. Theeuwes & Van der Stigchel, 2006), this is not the case for individuals with autism. Previous research has reported a lack of spontaneous attention allocation to faces (Klin et al., 2002; Speer et al., 2007; Riby & Hancock, 2008) and a lack of attention capture by faces when they are functional to task completion (Kikuchi et al., 2009). In the current study we extend this finding to illustrate that even when faces are non-functional to task completion (and are not tapping into a previously noted deficient processing domain), distraction by faces remains atypical. This is a novel addition to the previous literature that has relied on exploration of face distraction when those faces need to be processed for meaning and thus rely on a processing domain known to be problematic for this population. Typically developing participants were slowed significantly in their task completion when a face distracter captured their attention (replicating typical adults, Langton et al., 2008). However, for individuals with autism there was no significant effect of the face distracter on reaction times. The face did not distract participants with autism.

Providing further insight, we have shown that level of face distraction was significantly related to the participants’ level of functioning on the autism spectrum. This finding may elucidate the cause of discrepancies in the existing literature. A similar finding has been noted in eye tracking research, whereby lower functioning individuals spontaneously attended to faces for shorter periods than higher functioning individuals (Riby & Hancock, 2009a). The correlation analysis in the current study (care required for relatively small
sample size, see Figure 3) indicated that individuals who were lower functioning on the autism spectrum showed less face distraction than those participants who were higher functioning. We should bear in mind that these individuals were able to comply with task demands and therefore while they were participants who had the higher CARS scores they were by no means ‘low functioning’ in terms of the full autism spectrum (CARS ranged 31-50).

We could question whether the pattern seen here for individuals with autism is syndrome-specific or relevant to any individual with a disorder of development that impacts upon social functioning or attentional control. In recent research we showed that when completing the task used here, individuals with the genetic disorder Williams syndrome show a ‘typical’ pattern of face distraction (Riby et al., in press). Therefore, evidence from another disorder of development that impacts upon social expertise (but in a very different way to functioning on the autism spectrum) and attention modulation indicates that in autism the atypical allocation of attention to faces is related to social ability, but not lower IQ. This argument is strengthened further by use of a typical comparison group matched on non-verbal ability.

To consider how the current research may be used to guide future investigations, it is worth noting that more experimental work is required to elucidate whether the pattern seen here for individuals with autism is due to general visual perception and attention atypicalities, rather than being ‘face-specific’. At this point the possibility cannot be ruled out. Individuals with autism show various atypicalities in the modulation of their attention (e.g. Remington et al., 2009) and components of basic visual perception (e.g. Dakin & Frith, 2005). Although recent reports suggest that low level visual saliency may not guide attention atypically in individuals who are high functioning on the autism spectrum (see Freeth, Foulsham, & Chapman, 2010),
other aspects such as atypical perceptual style (e.g. the balance between global and local strategies) may play a role in all types of visual tasks. Equally interesting, Langton et al. (2008) found that typical adults only showed face interference by upright, as opposed to inverted, faces. It would be useful to extend the current study with various task manipulations, such as stimulus orientation and target item properties, to explore the effect in typically developing children as well as individuals with autism. Therefore, there are several ways to extend the investigation reported here, or to test other properties of visual perception in the same participants alongside this type of task, in individuals developing either typically or atypically.

To conclude, individuals with autism show significantly less face distraction than individuals who are developing typically, even when those faces do not need to be processed for functional reasons. Thus, any atypicality of attention allocation to faces is unlikely to be driven by problems processing or interpreting information from faces and is more likely to relate to reduced social priorities or atypicalities of basic visual perception.
References


Figure Captions

*Figure 1.* Two trials with the target present and distracter present (a) or absent (b)

*Figure 2.* The effect of face presence on reaction times in the target present condition across groups

*Figure 3.* The relationship between score on the Childhood Autism Rating Scale (CARS) score and the level of face distraction for participants with autism ($r=-.59$, $p<.05$)
Figure 1.
Figure 2.
Figure 3.