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BRIEF REPORT

Brief Report: Seeing the Man in the Moon: Do Children with Autism Perceive Pareidolic Faces? A Pilot Study

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Abstract Faces are one of the most socially significant visual stimuli encountered in the environment, whereas pareidolias are illusions of faces arising from ambiguous stimuli in the environment. Autism spectrum disorder (ASD) is characterised by deficits in response to social stimuli. We found that children with ASD ($n=60$) identify significantly fewer pareidolic faces in a sequence of ambiguous stimuli than typically developing peers. The two groups did not differ in the number of objects identified, indicating that the children with ASD had a specific lack of attention to faces. Pareidolia have considerable potential as naturalistic and easy-to-create materials for the investigation of spontaneous attention to social stimuli in children with ASD.

Keywords Autism spectrum disorder · Face perception · Social attention · Protofacial stimuli · Pareidolia

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Introduction

Pareidolias are illusions of faces arising from ambiguous stimuli in the environment. We might see a face in the moon or an image of Jesus on a piece of toast (Liu et al. 2014). The impression that a face is present occurs in the context of a particular object and in this way pareidolia is a misperception, rather than a hallucination which is a perception without an object being present. Maranhão-Filho and Vincent (2009) suggests that pareidolia may explain certain religious visions and apparitions, where the perceiver is primed to see culturally salient phenomena.

Faces are considered to be one of the most biologically and socially significant visual stimuli that we encounter in the human environment (Palermo and Rhodes 2007). Typically developing (TD) adults readily detect faces in the environment, even in the absence of human faces. Seeing faces is a form of over-responding that one would expect of an intact social system attuned to detect all and every important social stimuli in the environment. As Takashashi and Watanabe (2013) point out, the triggering threshold for attention to face-like stimuli may be low to increase an individual's chances of avoiding potentially dangerous situations. Faces, and their attendant easily distinguishable emotions (Ekman et al. 1987) likely constituted the most salient and urgent predictors of local threats and opportunities to humans over evolved time. False positives are likely if the threshold is set very low and pareidolia may represent this very phenomenon: seeing faces that are not there. Pareidolia results in a strong phenomenological experience of a face being present and Hadjikhani et al. (2009) have shown that this first-person experience is accompanied by specific face-related brain activity.

Autism spectrum disorder (ASD) has two key features; qualitative impairments in social interaction and communication, and restricted and repetitive activities (American Psychiatric Association 2013; World Health Organisation 1992). Social impairment in ASD is characterised by abnormalities in eye contact, failure to initiate or respond to social interactions, difficulties developing and maintaining relationships (APA 2013), all of which require a person to orient and respond to the faces of others.

For TD individuals, attention to faces in the environment has been shown to occur very early on in development. While illustrating that new-born infants turn their eyes and heads to follow a series of moving stimuli, Goren et al. (1975) found that new born babies were significantly more responsive to a proper face pattern than to either a scrambled face pattern or a blank stimulus. This responsiveness to faces has been shown to increase across development. Frank et al. (2009) used eye tracking data from infants' viewing of social video clips to show significant increases in fixation time to faces between 3 and 9 months of age. Behavioural research carried out on older children and adults has found that faces 'pop out' as distractors in tasks when competing with other non-face objects (Hershler and Hochstein 2005; Langton et al. 2008).

There is emerging evidence that children with ASD do not show special attention to faces (Kikuch, Senju et al. 2009; Chawarska et al. 2010; Guillon et al. 2016). Face processing deficits have been highlighted in a number of studies of children with ASD (Klin et al. 1999; Wolf et al. 2008). However there have been some contradictory findings have been reported for adults with ASD (Shah et al. 2013). A recent study conducted by Akechi et al. (2014) reported that adolescents with ASD perceive faces similarly to TD adolescents when asked to rate the 'face-likeness' of face-like objects. Although the sample size was quite small (ASD group: $n=16$), these results suggest that adolescents perceive faces in face-like objects similarly to TD adolescents. However, this study did not assess whether face-like objects were spontaneously perceived by individuals with ASD as readily as TD individuals. Guillon et al. (2016) assessed spontaneous attention to face-like objects in preschool children using a preferential looking task. They found that TD children were more likely to orient to the upright face-like object than to the inverted face-like object, when compared to children with ASD.

The current study uses pareidolic images to investigate if children with ASD are less responsive to face-like stimuli than TD peers. It attempts to capture "spontaneous responses" to face-like objects. Based on the findings of Akechi et al. (2015) and Hadjikhani et al. (2009), we expect that both groups will perceive pareidolic faces, but that the children with ASD will be less sensitive to the face-like patterns and will report perceiving fewer faces than the TD children. To establish that the differences between the groups is not due to a general lack of attention to the stimuli we will compare the number of objects identified in the pictures between the two groups, and the number of real faces identified, predicting that there will be no significant difference between the groups on these two measures.

Method

Participants

Sixty children with ASD (46 male, 14 female) between the ages of 8–18 were recruited from a public health disability service. All the children had a diagnosis of Childhood Autism (WHO, ICD-10 1992) or Asperger Syndrome (WHO, ICD-10 1992). They had received a diagnosis through a multidisciplinary assessment using both the ADOS-G (Lord et al. 2000) and either the Autism Diagnosis Interview-Revised (ADI-R: Lord et al. 1994) or the Diagnostic Interview for Social and Communication Disorders schedule (DISCO-10, Wing et al. 2002), direct observation of the child and information from other sources such as teachers and therapists. Individual scores on these measures were not available to the research group. Thirty-three TD children (17 male, 16 female) aged 8–18 were recruited through invitations to the staff of the disability service and the university.

Ethical research committee approval was obtained and the young people and parents gave informed consent through the instructions page of the online protocol. All procedures performed were in accordance with the 1964 Helsinki declaration and its later amendments.

Materials

Each participant viewed 25 images presented on screen for 5 s followed by a multiple choice question asking 'what did you see?' Each randomly ordered set of response choices included the names of three objects present in the image, 'face' and one option naming an object that was not present in the image. The latter was included in order to monitor the attention of the participant. The response page used checkboxes in a multiple selection format; that is, participants could response with as many of the choices as they wished to each image. Eighteen of the images were chosen from a google search entitled 'face-like objects' (see online appendix A for an example image). Images had to have at least the basic pattern of two elements above one element in the spatial configuration of the regular human face (Maurer et al. 2002). The face-like pattern had to be made up of one or more structures that could be identified as or part of some object. Images had to contain other identifiable objects, as well as the objects making up the face-like pattern. A further two images containing real human faces were selected and five control images with no faces present, real or pareidolic. The twenty-five images were preceded with a trial image that did not contain a face-like pattern to familiarise the participant with the format.

The first few images included in the task were neutral stimuli with no known face-like patterns. The remaining images contained face-like patterns ordered according to the authors' judgement of least face-like to most face-like image.

Results

Task Engagement with Objects

Task engagement was assessed by examining item recognition accuracy rates for objects in the images. This was done using the hit rate and false alarm responses to objects presented. The 25 images contained 75 non-face objects which could be endorsed in the response selection. In addition, as each response set included one foil (a label for an object not contained in the picture) there was a potential 25 false alarms. Accuracy rates were very high for both TD participants and participants with ASD (mean detection over 80% for both groups). Using the procedure outlined by Macmillan and Creelman (2005) a measure of signal detection ability was calculated for each participant: d prime (*d'*). A standard correction was applied in which zero counts of false alarms were replaced with a count of 1/n (where n = maximum number of false alarms: 25). As can be seen from Table 1. there was no significant difference between the groups in relation to accuracy in detecting objects ($t = -1.76$, n.s.).

Attention to Real Faces

Two images contained real faces. The first was identified by 98% of participants with ASD and the second by 92%. Similar levels were recorded for TD participants (97 and 94%). All participants responded to at least one of the two real faces.

Group Comparisons

Given the difference in samples sizes between the ASD group and TD group, we tested for homogeneity of variance on the total number of pareidolia faces identified. The assumption of homogeneity of variance was rejected ($p = .036$), therefore we used the Welch ANOVA which has been described as the optimal procedure under variance heterogeneity and is favoured over the non-parametric alternative of Kruskal–Wallis (Tomarken and Serlin 1986) (Fig. 1).

We established that there was no difference in the total number of pareidolic faces identified by the male ($M = 9.50$, $SD = 6.22$) and female ($M = 8.52$, $SD = 6.66$) participants (*Welch's* $F(1, 56.56) = .47$, n.s.) in the study, to rule out the possible confounding influence of gender. However there was a significant difference between the ASD and TD groups (*Welch's* $F(1, 77.90) = 15.51$, $p = .0002$) with children in the TD group identifying more pareidolic faces ($M = 12.24$, $SD = 5.34$) than the children in the ASD group ($M = 7.41$, $SD = 6.25$).

Spontaneity

A key aim of this study was to assess the degree to which children with ASD spontaneously respond to pareidolic faces. This pattern may change as the experiment proceeds. We graphed the percentage of participants in each group who identified pareidolic faces in each of the images, according to the order of presentation. As can be seen in the Fig. 2, the percentage of participants in each group who identified the pareidolic faces increased gradually across the presentation of images. However, the percentage of the ASD group always trailed behind that of the TD group.

Discussion

This study provides evidence that children with ASD show less spontaneous sensitivity to pareidolia than TD children. When shown a sequence of images containing pareidolic

Table 1 Mean and Standard Deviation of accuracy (d') for item response to objects

	d'
ASD	2.61 (.53)
TD	2.56 (.49)

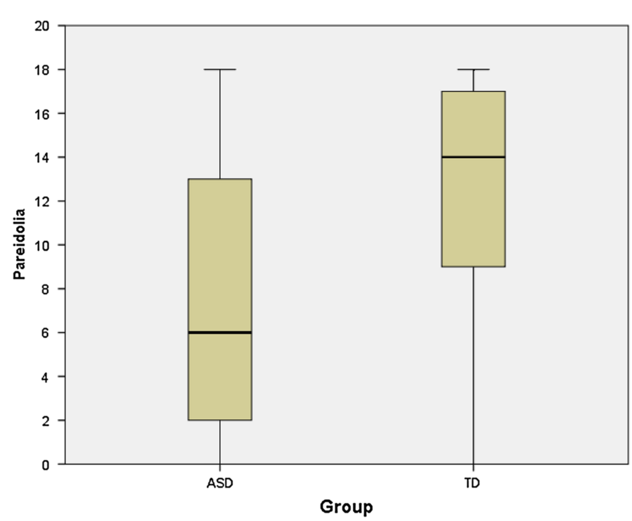

Fig. 1 Mean number of pareidolic faces identified by group

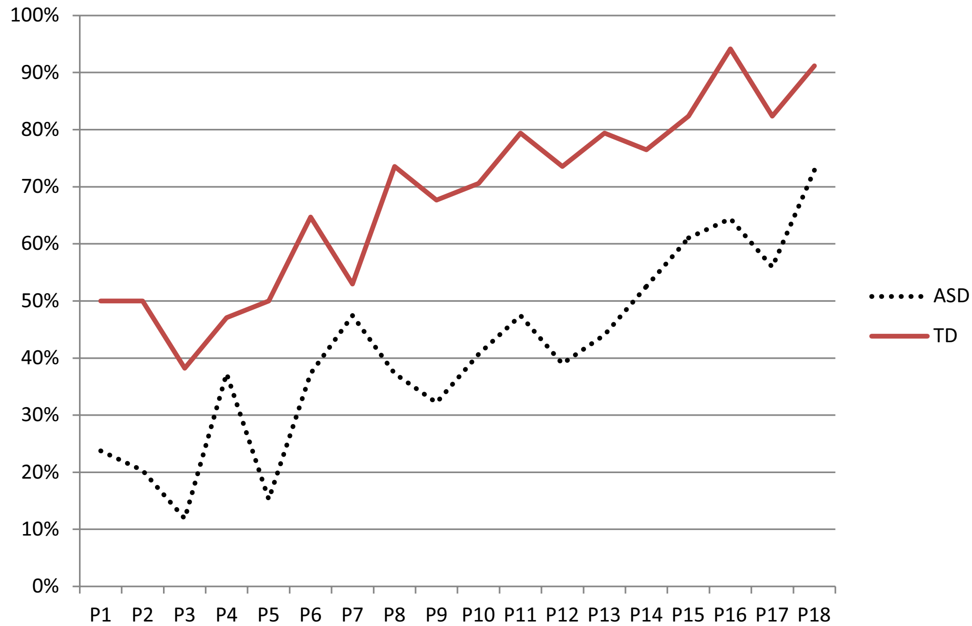

Fig. 2 Percentage of participants correctly identifying pareidolia in each of the 18 images containing pareidolia by group, in order of presentation

faces, children with ASD gradually improved in their ability to identify the faces, but always did so at a rate lower than their TD peers. Previous research has demonstrated that social stimuli are more salient for TD children than for children with ASD (Chevallier et al. 2012; Kikuchi et al. 2009; Riby and Hancock 2009). This study expands that insight by showing that spontaneous attention to naturally occurring face-like images is reduced in ASD.

An alternative explanation of these results could be that TD participants began to realize that the option 'face' appeared in most response sets, and were able to infer that the real intention of the task was to detect faces. Additionally, TD participants may have been more motivated to do well and please the experimenter and therefore attend more successfully to the presence of pareidolic faces. However, the graph in Fig. 2 does not provide strong support for this alternative explanation. No sudden change in performance occurs after a number of presentations of the option 'face' in the response set, as one would expect from a sudden correct inference about the true purpose of the study. In fact, both groups show a remarkably similar profile in gradually identifying more faces as the task proceeded. This change likely reflects the ordering of the images from least face-like to most face-like.

Many previous studies using face-like objects have relied on designs in which participants are instructed to look for a target stimuli (Akechi et al. 2015) or utilized faces in whole or part combinations (Annaz et al. 2009). Few studies have attempted to detect spontaneous attention to face-like stimuli in the presence of other objects that might compete for attention in the visual field. As Weigelt et al. (2012) point out, very few studies utilising face recognition tests with children with ASD compare their performance with object recognition. Objects were included in this experiment as both a potential distractor and as elements to be reported in the response sets. No difference in attention to objects was noted between the two groups.

The results of our study show a pattern of reduced awareness of pareidolic faces by the children with ASD when compared with TD peers. This is similar to Guillon et al. (2016) who, when investigating spontaneous orienting and gaze duration toward face-like objects in preschool children with ASD, showed that children with ASD had an intact perception of face-like objects but showed diminished orienting responses toward those objects. We do not know why children with ASD are orientating less to face-like objects, but a range of differences in responses to parts of faces, particularly the eye region have been identified in the literature. These include reduced social motivation (Chevallier et al. 2012), aversion due to anxiety associated with eye contact (Dalton et al. 2005), atypical modulation of arousal in response to eye contact (Kylliäinen et al. 2012), differences in the salience of direct gaze (Pitskel et al. 2011), and the possibility of random face scanning patterns (Pelphrey et al. 2002). It is possible that one of these processes may be linked to the reduced face orientation detected in this study.

The study has a number of limitations. The small sample size limits the generalizability of the findings. We do not know what impact intellectual functioning may have had on the results; however the high accuracy of responses to objects by the ASD group does offer some reassurance that cognitive difficulties are an unlikely explanation for the difference between the two groups on the pareidolic faces. We sourced pareidolia from the internet, and did not control for the distractor objects present in the image: an improved design could use the same images manipulated into both pareidolic and non-pareidolic versions. However, this study demonstrates that pareidolia have considerable potential as a method of investigating spontaneous attention to social stimuli in children with ASD.

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Author Contributions The study was conceived by MS, in discussion with RK and CR. MS designed the study and collected the data. Data analysis was done by CR and MS. CR coordinated and drafted the manuscript with contributions from both RK and MS. All authors read and approved of the final manuscript.

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Compliance with Ethical Standards

Conflict of Interest All authors declares that they have no conflict of interest.

Ethical Approval All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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