cortex 75 (2016) 113–119

Available online at www.sciencedirect.com

ScienceDirect

Journal homepage: www.elsevier.com/locate/cortex

Note

# Face processing in autism: Reduced integration of cross-feature dynamics

Punit Shah [a], Geoffrey Bird [a,b] and Richard Cook [c,*]

[a] MRC Social, Genetic and Developmental Psychiatry Centre, Institute of Psychiatry, Psychology, and Neuroscience, King's College London, University of London, London, UK
[b] Institute of Cognitive Neuroscience, University College London, University of London, London, UK
[c] Department of Psychology, City University London, London, UK

ARTICLE INFO

*Article history:*
Received 13 June 2015
Reviewed 10 October 2015
Revised 25 October 2015
Accepted 17 November 2015
Action editor Jason Barton
Published online 17 December 2015

*Keywords:*
Face perception
Facial motion
Cross-feature integration
Dynamic elements
Autism spectrum disorder

ABSTRACT

Characteristic problems with social interaction have prompted considerable interest in the face processing of individuals with Autism Spectrum Disorder (ASD). Studies suggest that reduced integration of information from disparate facial regions likely contributes to difficulties recognizing static faces in this population. Recent work also indicates that observers with ASD have problems using patterns of facial motion to judge identity and gender, and may be less able to derive global motion percepts. These findings raise the possibility that feature integration deficits also impact the perception of moving faces. To test this hypothesis, we examined whether observers with ASD exhibit susceptibility to a new dynamic face illusion, thought to index integration of moving facial features. When typical observers view eye-opening and -closing in the presence of asynchronous mouth-opening and -closing, the concurrent mouth movements induce a strong illusory slowing of the eye transitions. However, we find that observers with ASD are not susceptible to this illusion, suggestive of weaker integration of cross-feature dynamics. Nevertheless, observers with ASD and typical controls were equally able to detect the physical differences between comparison eye transitions. Importantly, this confirms that observers with ASD were able to fixate the eye-region, indicating that the striking group difference has a perceptual, not attentional origin. The clarity of the present results contrasts starkly with the modest effect sizes and equivocal findings seen throughout the literature on static face perception in ASD. We speculate that differences in the perception of facial motion may be a more reliable feature of this condition.



## 1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by social-communicative atypicalities, and a restrictive and rigid repertoire of behaviours (American Psychiatric Association, 2013). Characteristic problems with social interaction have prompted considerable interest in the face processing of individuals with ASD. Where

* *Corresponding author*. Department of Psychology, City University London, Whiskin Street, London, EC1R 0JD, UK.
E-mail address: Richard.Cook.1@city.ac.uk (R. Cook).
http://dx.doi.org/10.1016/j.cortex.2015.11.019

observed, deficits of face perception may hamper social interaction, contributing to the emergence of wider socio-cognitive features of ASD (Klin, Schultz, & Jones, 2015; Schultz, 2005). Although the literature is somewhat mixed, many studies have found evidence of atypical processing of facial identity or expression in this population (Harms, Martin, & Wallace, 2010; Jemel, Mottron, & Dawson, 2006; Morin et al., 2015; Weigelt, Koldewyn, & Kanwisher, 2012). Most recently, it has been reported that observers with ASD are less able to recognize faces from their characteristic patterns of motion (O'Brien, Spencer, Girges, Johnston, & Hill, 2014). Previous work suggests that a failure to integrate information from different facial regions may contribute to *static* face recognition difficulties experienced by observers with ASD (Behrmann, Thomas, & Humphreys, 2006; Gauthier, Klaiman, & Schultz, 2009; Teunisse & de Gelder, 2003). The present study is, to our knowledge, the first to examine whether reduced integration of information from *dynamic* features underlies the poor recognition and interpretation of facial motion in this population.

### 1.1. *Feature integration – static faces*

When presented upright, the individual features of static faces are thought to be integrated into coherent representations of the whole for interpretation and analysis. Within a laboratory context, feature-integration has been studied using the composite face paradigm. When upper and lower regions from different faces are aligned to form a facial composite, observers exhibit a tendency to 'fuse' the two halves together. The resulting illusory interference hinders performance when participants are asked to judge the identity (Young, Hellawell, & Hay, 1987), expression (Calder, Young, Keane, & Dean, 2000) or attractiveness (Abbas & Duchaine, 2008) of one face half, while disregarding the other. The composite-face effect reveals a tendency to integrate feature information from disparate regions of upright static faces – possibly mediated by the fusiform gyrus (Schiltz, Dricot, Goebel, & Rossion, 2010) – consistent with theories of holistic face processing (Maurer, Le Grand, & Mondloch, 2002; Young et al., 1987).

Sensitivity to orientation inversion is widely regarded as a hallmark of holistic representation, i.e., the feature integration processes recruited by static faces (Maurer et al., 2002; Tanaka & Farah, 1993). For example, composite interference is greatly reduced when stimulus arrangements are shown upside-down (Abbas & Duchaine, 2008; Calder et al., 2000; Susilo, Rezlescu, & Duchaine, 2013; Young et al., 1987). Disrupted holistic processing forms the rationale for a popular account of the well-known face inversion effect, whereby the recognition of faces is disproportionately impaired by orientation inversion compared to other objects (Yin, 1969). Whereas the perception of upright faces may benefit from the efficient, accurate analysis afforded by holistic representation, inverted faces may be subject to a slower, effortful, piecemeal analysis (e.g., Maurer et al., 2002; Piepers & Robbins, 2013).

Diminished integration of static features may contribute to difficulties recognizing faces from photographic images experienced by some individuals with ASD (Simmons et al., 2009; Weigelt et al., 2012). Observers with ASD often focus on local features and may therefore experience problems forming integrated global representations (Behrmann et al., 2006; Happe & Frith, 2006). Moreover, it has been argued that extensive visual experience of a stimulus class is necessary to acquire holistic representation (Diamond & Carey, 1986; Richler, Mack, Palmeri, & Gauthier, 2011). Should individuals with ASD attend less to social stimuli (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012; Riby & Hancock, 2008; Swettenham et al., 1998), members of this population may exhibit problems acquiring holistic face representation. Although findings have been mixed (Nishimura, Rutherford, & Maurer, 2008; Watson, 2013), some observers with ASD do appear to show reduced susceptibility to the composite-face illusion (Gauthier et al., 2009; Teunisse & de Gelder, 2003), indicative of weaker integration of static facial features.

### 1.2. *Feature integration – dynamic faces*

While the overwhelming majority of face perception research conducted to date has addressed the perception of static faces, the faces we typically encounter outside of the lab are *moving*. It is therefore essential that we develop our understanding of dynamic face perception, both in typically and atypically developing populations (O'Toole, Roark, & Abdi, 2002). Motion cues are thought to play a valuable role in face recognition. For example, when avatar faces are animated using facial motion captured from human actors, observers can recognize the identity and gender of the actor from their 'motion signature' (Cook, Johnston, & Heyes, 2012; Hill & Johnston, 2001; Knappmeyer, Thornton, & Bulthoff, 2003). Motion cues may be particularly valuable when we encounter faces under impoverished viewing conditions, such as those created by negation (Knight & Johnston, 1997), or pixilation and blurring (Lander, Bruce, & Hill, 2001) and have been shown to aid face recognition in individuals who exhibit poor face perception (Bennetts, Butcher, Lander, Udale, & Bate, 2015; Longmore & Tree, 2013). Moreover, responding appropriately during social interactions, often challenging for individuals with ASD, depends on the accurate perception of correlated feature changes over time (Jack, Garrod, & Schyns, 2014).

The ability of typical observers to recognize identity and gender from facial motion cues is sensitive to orientation (Cook et al., 2012; Hill & Johnston, 2001; O'Brien et al., 2014), a finding that suggests that moving faces also recruit feature integration processes (see also, Favelle, Tobin, Piepers, Burke, & Robbins, 2015). Recently, this possibility was confirmed by a novel dynamic face illusion reported by Cook and colleagues (Cook, Aichelburg, & Johnston, 2015). Adopting a similar logic to the composite face paradigm, observers were asked to judge the speed of eye-opening and -closing, whilst ignoring asynchronous mouth-opening and -closing. The presence of the concurrent mouth movements altered how observers perceived the eye-opening and -closing. The motion of the eyelids was subject to illusory slowing; transitions (from eyes-open to eyes-closed and *vice versa*) with a physical duration of 140 msec, were judged to take ~180 msec. Interestingly, illusory feature slowing was observed only when stimulus arrangements were shown upright, suggesting that dynamic and static feature-integration processes behave in similar ways. Feature slowing may reflect the adjustment of feature dynamics, whereby transitions are delayed to match the