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Exploring factors related to the anger superiority effect in children with Autism Spectrum Disorder

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ABSTRACT

Despite face and emotion recognition deficits, individuals with Autism Spectrum Disorder (ASD) appear to experience the anger superiority effect, where an angry face in a crowd is detected faster than a neutral face. This study extended past research to examine the impacts of ecologically valid photographic stimuli, gender and anxiety symptoms on the anger superiority effect in children with and without ASD. Participants were 81, 7–12 year old children, 42 with ASD matched on age, gender and perceptual IQ to 39 typically developing (TYP) children. The photographic stimuli did not impact on task performance in ASD with both groups exhibiting the anger superiority effect. There were no gender differences and no associations with anxiety. Age was associated with the effect in the TYP but not ASD group. These findings confirm a robust effect of speeded detection of threat in ASD which does not appear to be confounded by gender or anxiety, but may have different underlying age-associated mechanisms.

1. Introduction

Identifying emotional faces is an important social skill that allows people to identify the mental states of others and respond appropriately during social interactions. Individuals with Autism Spectrum Disorder (ASD), a neurodevelopmental condition affecting 1% of the population, have a core deficit in their ability to function socially (American Psychiatric Association, 2013). They experience deficits in the way they process faces and impairment in understanding the mental states and intentions of others, often referred to as Theory of Mind. Atypical face processing in ASD is marked by paying more attention to the mouth rather than eyes when processing faces (Baron-Cohen, Wheelwright, & Jolliffe, 1997; Dalton et al., 2005). Although primary facial expressions such as happy and sad often appear intact in ASD, the recognition of subtle emotions, such as guilt, fear and anger, may be impaired (Harms, Martin, & Wallace, 2010; Kuusikko et al., 2009). It has been proposed that because individuals with ASD do not recognize emotions in a typical way, they compensate use more time consuming processes.

In typically developing individuals, an angry face in a crowd is detected faster than a happy face in a crowd (Hansen & Hansen, 1988), a phenomenon known as the anger superiority effect (ASE). Angry or threatening faces provide early warning signs of possible danger, hence, the ability to rapidly identify an angry or threatening face at the pre-attentive level may be underpinned by a neural network evolved for this purpose (Krysko & Rutherford, 2009; Vuilleumier & Schwartz, 2001). Given the face processing deficits in ASD, atypical performance on this type of task, which requires differentiation of facial expressions could be indicated. However, it has also been suggested that the ASE being at the pre-attentive or implicit processing level, may involve more basic brain areas than those required for identifying faces or Theory of Mind, with these basic areas intact in ASD (Krysko & Rutherford, 2009). The amygdala is thought to be involved in the ASE given its well established role in processing faces and threatening stimuli. The amygdala may underpin the neural circuitry of an "emotional attention" network, with this type of attention potentially resulting in the "pop out" effect found in the ASE. This emotional attention may be different to the other types of executive functioning attention components such as sustained and selective attention. In ASD, the executive functionings are often impaired. However, the amygdala is also implicated.

To date, five past studies, three focusing on children and adolescents and two on adults have examined the ASE in ASD, Table 1. Ashwin, Wheelwright, and Baron-Cohen (2006) found a threat detection over friendly face advantage in adult males with ASD

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Table 1
Summary of past studies of the anger superiority effect in Autism Spectrum Disorder.

Authors	Age, N & gender	Diagnosis	Stimuli	Findings
Ashwin et al. (2006)	ASD N = 18 TD N = 18 All Male Adults	DSM-IV or ICD 10 criteria	Schematic faces	No difference in RTs; TD fewer errors but trend only
Krysko and Rutherford (2009)	ASD N = 19 TD N = 19 All Male 20–54 years	Not specified (ADOS confirmed)	Schematic faces	No difference in RTs; TD had fewer errors
Rosset et al. (2011)	7–17 years ASD N = 30 25M, 5F TD N = 30 25M, 5F	DSM-IV Autism	Schematized coloured line drawings	No difference in errors; RT not reported
Isomura, Ogawa, et al. (2014)	ASD N = 19 15M and 4F Age 8:6–12:2 TD N = 18 14M and 4F Age 8:5–12:0	DSM-IV or ICD 10 PDD, Autism Spectrum Disorder, Asperger's syndrome, High functioning Autism, PDD-Not Otherwise Specified	Schematic pictures	No difference in RT; Errors not reported
Isomura, Ito, et al. (2014)	ASD N = 20 15M and 5F Age 7–10 TD N = 23 12M and 11F Age 7–11	DSM-IV or ICD 10 PDD, Autism Spectrum Disorder, Asperger's syndrome, High functioning Autism, PDD-Not Otherwise Specified	Schematic pictures	ASE present in TD but not ASD in RTs; No group difference in errors Age significant covariate in analysis with ASE but not IQ or autism symptoms (correlations not reported)

TD, Typically Developing; ASD, Autism Spectrum Disorder; PDD, Pervasive Developmental Disorder; M, Male; F, Female; ADOS, Autism Diagnostic Observation Schedule; ASE, Anger Superiority Effect; RT, Response Time.

similar to a comparison group. Krysko and Rutherford (2009) examined a group of adult males with ASD and similarly found them to be as fast as comparison adults in identifying a threatening face in a group of faces; although adults with ASD made more errors, indicating some atypical processing. Children with ASD (N = 30) aged 7–17 years were found by Rosset et al. (2011) to experience a similar ASE to typically developing children. This was also the case in Isomura and colleagues (Isomura, Ogawa, Yamada, Shibasaki, & Masataka, 2014) in one study of children aged 7–17 years, but not in their second study of younger children aged 7–10 years (Isomura, Ito, Ogawa, & Masataka, 2014). Isomura (Isomura, Ito, et al., 2014) suggest this contradictory finding might indicate that there is a developmental effect of the ASE. However potentially the small sample of these studies may have produced the inconsistency. Past studies of normally developing individuals have found that the ASE is present in infants and 5 year old children, as well as adults, with faster detection in adults compared to children (LoBue, 2009; LoBue & DeLoache, 2010).

Overall, these studies suggest the ASE is present in ASD, thus supporting the notion of an intact implicit threat detection system. However, there were a number of limitations in these studies. Firstly, all of the studies have employed schematic faces. Schematic faces lack ecological validity and may have provided a way to for individuals with ASD to compensate for emotion recognition difficulties and potentially even provide them with an advantage given their local feature biases (Isomura, Ogawa, et al., 2014). In fact, children with ASD have been found to process cartoon faces but not photographic faces similar to typically developing children (Rosset et al., 2008). The need for replication of the findings using ecologically valid photographic faces may therefore be important.

Secondly, the adult studies have only examining *males* with ASD, and the child studies have had too few females to examine gender differences. A gender difference in attention bias has been found, such that anxious females show threat bias, whereas anxious males do not (Tran, Lamplmayr, Pintzinger, & Pfabigan, 2013). Meta-analytic reviews suggest that females have a face emotion processing advantage over males which may relate to socialisation or neurological maturation differences between the genders (McClure, 2000). Males with ASD outnumber females by on average 4:1, with the cause of this gender discrepancy much debated and still unclear (American Psychiatric Association, 2013). It has been proposed that females may have better superficial social skills which results in subthreshold symptoms of ASD (American Psychiatric Association, 2013). Whether gender plays a role in the anger superiority effect and how this might interact with ASD is unknown.

Thirdly, studies of the anger superiority effect show that anxious individuals exhibit an enhanced effect over non anxious controls (Ashwin et al., 2012; Byrne & Eysenck, 1995; Fox, Derakshan, & Shoker, 2008). This enhanced threat bias is thought to maintain and potentially cause anxiety (Mathews, 1990; Mathews & Mackintosh, 1998). Given extremely high levels of anxiety in ASD (White, Oswald, Ollendick, & Scahill, 2009), anxiety symptoms may potentially be a confounding factor and may resulted in an enhanced effect in ASD resulting in apparent similar performance to controls.

This study aimed to extend past research in threat detection in ASD to address these three potentially confounding factors. Firstly, the studied employed a similar number of males and females to enable the exploration of gender differences. Secondly, the study used colour photographs to examine the ASE using ecologically valid stimuli rather than schematic faces which could confer an advantage to individuals with ASD. Thirdly, anxiety symptoms were measured to determine if these were associated with the ASE in ASD. Finally, given the proposal by Isomura, Ito, et al. (2014) that there may be an age effect in ASD such that attainment of the ASE is delayed put may 'catch up' by adolescence, age was also investigated.

Predictions were as follows. Firstly, if photographic faces resulted in more complex processing for children with ASD, they should exhibit slower and less accurate performance than typically developing children on the anger superiority task. Secondly, if females are more likely to show threat bias than males, females, with and without ASD, would be expected to show an enhanced ASE compared to males. Thirdly if anxiety symptoms are driving the 'intact' anger superiority performance in ASD, there should be a positive association between anxiety symptoms and the anger superiority in individuals with ASD. Finally, if the effect is related