International Journal of Psychophysiology 87 (2013) 88–94

Contents lists available at SciVerse ScienceDirect

International Journal of Psychophysiology

journal homepage: www.elsevier.com/locate/ijpsycho

Psychophysiological correlates of social judgement in high-functioning adults with autism spectrum disorder

Danielle Mathersul *, Skye McDonald, Jacqueline A. Rushby

School of Psychology, University of New South Wales, Sydney, NSW 2052, Australia

ARTICLE INFO

Article history:
Received 7 August 2012
Received in revised form 9 November 2012
Accepted 12 November 2012
Available online 23 November 2012

Keywords:
Autism
Asperger's
Trust
Approachability
Skin conductance
Arousal

ABSTRACT

Neural structures involved in social cognition (e.g., amygdala, orbitofrontal cortex) have been implicated in judgements of trustworthiness. These regions are also functionally atypical in individuals with autism spectrum disorders (ASDs). Studies investigating judgements of trustworthiness in ASDs have suggested possible disruptions in the allocation of significance to social stimuli. Concurrent measures of autonomic responses provide further insight into these deficits, given their role in the direction of attention and allocation of significance. Thirty high-functioning adults with ASDs and 31 non-clinical controls viewed neutral images piloted as most "positive" and "negative." Skin conductance (SCR, SCL) and evoked cardiac deceleration (ECD) were recorded. Adults with ASDs did not differ from controls in ratings of trustworthiness. However, they displayed atypical SCRs, providing further support for a disruption in the allocation of emotional significance.

1. Introduction

Social cognition refers to the thought processes that represent our interactions with those around us and how they subsequently affect our behaviour (Adolphs, 2001). Emotion processing and recognition, as well as emotional awareness and self-regulation in general, are key components of social cognition (Adolphs, 2002; Lane and Schwartz, 1987). So too is Theory of Mind (ToM), the ability to interpret the meanings inherent in intrapersonal and social interactions and thus infer the beliefs, desires and intentions of others (Baron-Cohen, 1988; Frith, 1989). Neurobiological models generally propose that social cognition is mediated by a neural network involving the amygdala, orbitofrontal cortex (OFC), prefrontal cortex (PFC), anterior cingulate cortex (ACC), insula, and hypothalamus (Adolphs, 2001; Phillips et al., 2003; Rolls, 1999). In the past decade, there has been an increasing interest in the social cognitive concept of "trust"; how and why individuals make judgements of trustworthiness and their motivations related to approachability. Several lesion and imaging studies have confirmed that judgements of trustworthiness also involve the social cognitive structures of the amygdala, ventrolateral PFC, and insula, as well as the superior temporal sulcus (STS; e.g., Adolphs et al., 1998; Pinkham et al., 2008; Winston et al., 2002). These studies help to understand the mechanisms underpinning the social cognitive deficits seen in a range of clinical disorders, including autism spectrum disorders.

Autism spectrum disorders (ASDs), including autism and Asperger's Syndrome, are pervasive developmental disorders characterised by severe impairments in the development of a broad range of social and psychological functions, usually apparent before the age of 3 years (APA, 2000). Core diagnostic criteria of autism spectrum disorders according to the DSM-IV-TR (*Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, text revision*) include marked impairment in social interaction (particularly social-emotional reciprocity and the use of non-verbal behaviours such as eye-gaze and facial expression) and the presence of repetitive and stereotyped behaviours (APA, 2000). Where lower functioning individuals typically demonstrate marked deficits in communication, higher functioning individuals (e.g., Asperger's, high-functioning autism (HFA)) show no clinically significant delay in language and usually have an IQ within the normal range (APA, 2000). Proposed changes to diagnostic criteria in the upcoming *DSM-5* recommend the removal of the distinction between autism and Asperger's (APA, 2011), suggesting instead the use of high versus low functioning. Therefore, for the purpose of this study, individuals with HFA or Asperger's will be referred to as individuals with high functioning ASDs.

Consistent with diagnostic criteria of marked impairments in social behaviour and interaction, individuals with ASDs generally have poor social cognition (e.g., Baron-Cohen, 1989; Couture et al., 2010; Di Martino et al., 2009). Furthermore, several neural structures known to play a role in social cognition have been shown to be functionally atypical in high-functioning individuals with ASDs, including the amygdala (Ashwin et al., 2007; Baron-Cohen et al., 1999b; Critchley et al., 2000; Di Martino et al., 2009; Pinkham et al., 2008), OFC (Ashwin et al., 2007; Loveland et al., 2008), medial PFC (Di

* Corresponding author. Tel.: +61 2 9385 3041; fax: +61 2 9385 3641.
E-mail address: dmathersul@psy.unsw.edu.au (D. Mathersul).

0167-8760/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.ijpsycho.2012.11.005

Martino et al., 2009; Loveland et al., 2008; Ohnishi et al., 2000), ACC (Ashwin et al., 2007; Di Martino et al., 2009; Ohnishi et al., 2000), insula (Critchley et al., 2000; Di Martino et al., 2009), and superior temporal gyrus (STG; Ashwin et al., 2007; Baron-Cohen et al., 1999b; Critchley et al., 2000; Loveland et al., 2008). Research also suggests that high-functioning individuals with ASDs have selective impairments in higher-order aspects of social cognition, such as the perception and comprehension of social blunders (Baron-Cohen et al., 1999a) and recognition of higher-order emotional/mental states from faces (Baron-Cohen et al., 1999b) or voices (Rutherford et al., 2002), whilst their basic emotion recognition abilities remain intact (Adolphs et al., 2001). Given these subtle impairments in social appraisals in individuals with ASDs, impairments in the judgement of trustworthiness would also be expected.

Only a handful of studies have investigated judgements of trustworthiness in individuals with ASDs, with mixed results. One behavioural study demonstrated that high-functioning adults with ASDs rated faces as more trustworthy and more approachable than controls (Adolphs et al., 2001). As this behavioural profile was similar to that seen in bilateral amygdala lesion patients (Adolphs et al., 1998), this was proposed as further evidence for an amygdala deficit in individuals with ASDs. Similarly, a very recent study demonstrated that high-functioning ASDs rated the most untrustworthy/negative faces as more trustworthy than controls (Couture et al., 2010). While a recent imaging study failed to find differences in judgements of trustworthiness between high-functioning ASDs and controls, they did demonstrate significantly reduced activation in the right amygdala and left ventrolateral PFC in the clinical group (Pinkham et al., 2008).

The amygdala plays an important role in associating perceptual stimuli as reinforcers and may be involved in allocating and directing attention and/or significance to environmental stimuli especially threat-related stimuli (e.g., Davis, 1997; Rolls, 1999). Consequently, Pinkham et al. (2008) suggested ASDs may be associated with a disruption in the allocation of emotional significance to facial stimuli when making complex social judgements. While this differential brain activation is suggestive that the ASD group were responding differently to controls, the nature of this difference is ambiguous, especially in light of an absence of group differences on the behavioural measure. Using psychophysiological measures to supplement subjective behavioural ratings is an alternative approach to examining whether judgements of trustworthiness is impaired in individuals with ASDs.

Environmental stimuli such as faces typically elicit an orienting response (OR) that serves to generate action and approach within an organism (Barry, 1990). ORs involve a combination of behavioural and physiological changes, and are affected by the novelty, significance and intensity of the evoking stimulus (Barry, 1990). Standard physiological markers of the OR include changes in electrodermal activity (skin conductance response; SCR), heart rate (HR), respiration rate, and pupillary dilation. SCRs may reflect the arousal or intensity of motivationally significant stimuli (e.g., Lang et al., 1990), as well as the allocation of attention to stimuli over time (e.g., Barry, 1990; Maltzman, 1977; Sokolov, 1990). Sustained, initial evoked cardiac deceleration (ECD) is typically proposed to reflect orientation to, and continued interest in, a stimulus (e.g., Graham and Clifton, 1966; Turpin, 1983). Conversely, skin conductance levels (SCL) provide an objective measure of slower, more longer lasting changes in arousal in response to novel stimuli and stimulus repetition (Barry, 2004; Rushby and Barry, 2007). Given that the amygdala is involved in the generation of physiological ORs and arousal in general (i.e., including SCR, ECD, SCL; Davis, 1997; LeDoux, 1993; Rolls, 1999), these measures provide further insight into possible disruptions in the allocation of emotional significance to facial stimuli in individuals with ASDs.

Thus, the aim of the present study was to investigate social judgements of trustworthiness in high-functioning individuals with ASDs and their relationship with concurrent measurements of skin conductance and cardiac responses. As with prior research, it was hypothesised they would be less able to judge the trustworthiness of strangers. In an effort to increase the sensitivity of this measure, we expanded on prior research by including three questions to address this judgement: (i) would you be prepared to meet this person for a drink; (ii) would you be interested in attempting a friendship with this person; and (iii) how trustworthy do you think this person is. It was also hypothesised that a disruption in the allocation of emotional significance to facial stimuli when making these complex social judgements would be reflected in atypical SCRs and SCL over time and atypical initial ECD.

2. Materials and methods

2.1. Participants

Thirty-one high-functioning adults with ASDs and 36 non-clinical control individuals were recruited from Sydney and surrounding regions in New South Wales, Australia, via advertisements, support groups, clinicians, Aspect (Autism Spectrum Australia)[1] and undergraduate university populations. Individuals were reimbursed for their time or received course credit for participation. Participants gave written informed consent in accordance with the University of New South Wales Human Research Ethics Committee (UNSW HREC).

All individuals in the clinical group met *DSM-IV-TR* (APA, 2000) diagnostic criteria for an ASD, as assessed by experienced clinicians independent of the present study. The Autism Quotient (AQ; $\geq$32; Baron-Cohen et al., 2001) and/or Ritvo Autism Asperger's Diagnostic Scale (RAADS; $\geq$77; Ritvo et al., 2008) were used to support diagnosis. The AQ has been shown to produce good test-retest reliability (r=.70) and good internal consistency (Cronbach's α=.63–.77; Baron-Cohen et al., 2001). The RAADS has been shown to produce reliable clinical discrimination (97–100% sensitivity, 100% specificity), high test-retest reliability (r=.99), and good internal consistency (Cronbach's α=.65–.92; Ritvo et al., 2011, 2008). Exclusion criteria were a self-reported personal history of physical brain injury, neurological or developmental disorder (other than an ASD in the clinical group), psychiatric illness, or any other serious medical condition (information on medication status was not available). In addition, control participants were excluded if they had a score above the recommended clinical cut-off on the AQ and/or RAADS. Four control participants were subsequently excluded and the data from an additional control participant was lost due to equipment problems. One ASD participant was excluded due to smoking immediately prior to arriving. The final sample consisted of 30 high-functioning adults with ASDs (aged 18–73 years; 24 males) and 31 non-clinical control individuals (aged 18–72 years; 24 males)[2].

2.2. Materials and measures

2.2.1. Wechsler Abbreviated Scale of Intelligence

The Wechsler Abbreviated Scale of Intelligence (WASI) is a brief, standardised measure of general intellectual functioning that demonstrates good reliability and validity (Wechsler, 1999). All participants were administered the two-subtest format (that is, vocabulary and matrix reasoning).

2.2.2. Photographic stimuli

The photographic stimuli were grey-scale, frontal images of male and female faces displaying neutral, closed-mouth expressions.

[1] Australia's largest not-for-profit provider of services related to ASDs, including access to information, support groups, blogs, research participation and relevant media releases.

[2] Within the final sample, SCR from 1 control individual, and both SCR and HR from 1 ASD individual were also lost due to equipment problems.