Cognition 171 (2018) 1–9

Contents lists available at ScienceDirect

Cognition

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

Original Articles

Decreased reward value of biological motion among individuals with autistic traits

Elin H. Williams[a], Emily S. Cross[a,b,c,*]

[a] Social Brain in Action Laboratory, Wales Institute for Cognitive Neuroscience, School of Psychology, Bangor University, Wales, United Kingdom
[b] Institute of Neuroscience and Psychology, University of Glasgow, Scotland, United Kingdom
[c] School of Psychology, University of Glasgow, Scotland, United Kingdom

ARTICLE INFO

Keywords:
Biological motion
Human motion
Autism spectrum disorders
Autistic traits
Reward value
Social motivation

ABSTRACT

The Social Motivation Theory posits that a reduced sensitivity to the value of social stimuli, specifically faces, can account for social impairments in Autism Spectrum Disorders (ASD). Research has demonstrated that typically developing (TD) individuals preferentially orient towards another type of salient social stimulus, namely biological motion. Individuals with ASD, however, do not show this preference. While the reward value of faces to both TD and ASD individuals has been well-established, the extent to which individuals from these populations also find human motion to be rewarding remains poorly understood. The present study investigated the value assigned to biological motion by TD participants in an effort task, and further examined whether these values differed among individuals with more autistic traits. The results suggest that TD participants value natural human motion more than rigid, machine-like motion or non-human control motion, but this preference is attenuated among individuals reporting more autistic traits. This study provides the first evidence to suggest that individuals with more autistic traits find a broader conceptualisation of social stimuli less rewarding compared to individuals with fewer autistic traits. By quantifying the social reward value of human motion, the present findings contribute an important piece to our understanding of social motivation in individuals with and without social impairments.

1. Introduction

Humans naturally find certain types of stimuli more rewarding than others. A well-established literature documents the high reward value of food and money (Berridge, 1996; Breiter, Aharon, Kahneman, Dale, & Shizgal, 2001), as well as social stimuli, such as human faces (Aharon et al., 2001; Kampe, Frith, Dolan, & Frith, 2001). When we view such stimuli, whether material or social in nature, brain regions associated with reward processing, including the ventromedial prefrontal cortex, the striatum, and the orbitofrontal cortex, are reliably engaged (Lin, Adolphs, & Rangel, 2012; Sescousse, Redouté, & Dreher, 2010; Spreckelmeyer et al., 2009).

Stimuli such as faces are suggested to be rewarding because they provide an abundance of information about another individual's mood, feelings and intentions, thus providing rich social cues (Kampe et al., 2001). Further, faces may predict social outcomes. For example, smiles may lead one to anticipate positive social outcomes, while frowns may predict negative social outcomes (Kringelbach & Rolls, 2003). Research into the reward value of faces demonstrates that faces with genuine smiles are valued more than faces with polite smiles, as demonstrated by participants' willingness to forgo higher monetary rewards to view faces with genuine compared to polite smiles (Shore & Heerey, 2011). Male heterosexual participants also work harder, or exert more effort, to view images of attractive, rather than average, female faces (Hayden, Parikh, Deaner, & Platt, 2007).

However, it has become apparent that the value assigned to social stimuli is subject to individual differences. For example, research has demonstrated that individuals with an autism diagnosis, or individuals without a clinical diagnosis of autism, but who report more autistic traits, show a reduced response to social, but not non-social, rewards (Carter Leno, Naples, Cox, Rutherford, & McPartland, 2016; Cox et al., 2015; Gossen et al., 2014; Zeeland et al., 2010). This reduced sensitivity to social rewards has been observed in a number of different tasks, including incentive delay (Cox et al., 2015; Gossen et al., 2014), reward learning (Zeeland et al., 2010), and effort tasks (Dubey, Ropar, & Hamilton, 2015). Furthermore, modulating the reward value of social stimuli, such as faces (Sims, VanReekum, Johnstone, & Chakrabarti, 2012) and hands (Haffey, Press, O'Connell, & Chakrabarti, 2013) in conditioning paradigms increases spontaneous mimicry and prosocial behaviour (Panasiti,

* Corresponding author at: School of Psychology, Bangor University, Bangor, Gwynedd, LL57 2AS Wales, United Kingdom.
E-mail address: e.cross@bangor.ac.uk (E.S. Cross).

http://dx.doi.org/10.1016/j.cognition.2017.10.017
Received 14 March 2017; Received in revised form 19 October 2017; Accepted 21 October 2017

Puzzo, & Chakrabarti, 2016) in individuals with fewer autistic traits, but not in those with more autistic traits. Together, these findings provide support for the idea that a deficit in sensitivity to social rewards exists in individuals with autism as well as in those reporting high numbers of autistic traits.

The Social Motivation Theory of Autism (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012) suggests that individuals with autism spectrum disorders (ASD) fail to form a representation of the reward value of social stimuli, and therefore place less value on these types of stimuli. It is thought that the reduced reward value associated with social stimuli consequently leads individuals with ASD to differ in their motivation to engage socially (Dawson et al., 2004). In a recent attempt to test this theory, Dubey et al. (2015) conducted an elegant behavioural experiment to measure the reward value of social stimuli based on the number of autistic-like traits participants reported, and whether or not they had a clinical diagnosis of ASD. Specifically, the authors investigated the value of dynamic smiling faces with direct and averted gaze via an innovative task that used participant effort to gauge the reward value of each stimulus type. The results demonstrated that participants exerted more effort to watch videos of smiling faces with direct gaze, compared to videos of smiling faces with averted gaze or videos of moving objects (a non-social control condition). However, this preference for social stimuli was reduced in participants who reported more autistic traits or had a clinical ASD diagnosis. These results support the notion that individuals with ASD, as well as individuals without a clinical ASD diagnosis who report more autistic traits, assign a reduced reward value to social stimuli relative to typically developing individuals.

Although many studies have suggested that individuals assign a high value to faces as they may predict social outcomes (Fridlund, 1991; Hooker, Germine, Knight, & D'Esposito, 2006) and provide a wealth of other social cues (Kampe et al., 2001), faces are rarely encountered independently from other types of social information, such as bodies. Moreover, in a social world, faces and bodies move together. Biological motion, defined as motion produced by an animate agent, is another type of social stimulus that provides rich social information about others we encounter in our environment (Grossman et al., 2000). During social interactions, we receive valuable information from bodies as they gesture and signal emotions, ideas and intentions (Atkinson, Dittrich, Gemmell, & Young, 2004; Johansson, 1973; Pollick, Kay, Heim, & Stringer, 2005).

Biological motion is suggested to be of great value for adaptive social behaviour, and sensitivity to this type of motion is thought to be a precursor to social development (Klin, Lin, Gorrindo, Ramsay, & Jones, 2009). Seminal research documents how the human visual system is sensitively tuned to recognise biological motion even in minimal circumstances, such as point-light displays (Johansson, 1973). Preferentially orienting to biological motion is suggested to be an evolutionarily important behaviour – protecting us from predators and ensuring filial attachment (Atkinson et al., 2004). This natural orientation towards other animate agents is manifest in a range of species, from humans to birds (Simion, Regolin, & Bulf, 2008; Vallortigara, Regolin, & Marconato, 2005), and is demonstrated in human infants as young as two days old (Simion et al., 2008). However, these aforementioned behaviours seem to be impaired in infants with ASD, and these individuals appear to, instead, preferentially orient to non-biological, or non-social motion (Klin et al., 2009). Research has suggested that these behaviours point to a disruption in an innate predisposition to attend to biological motion, which may have negative downstream consequences for the processing of social cues (Blake, Turner, Smoski, Pozdol, & Stone, 2003; Clarke, Bradshaw, Field, Hampson, & Rose, 2005; Grossmann & Johnson, 2007; Toth, Munson, Meltzoff, & Dawson, 2006).

To summarise, copious research has demonstrated that typically developing individuals assign high reward value to social stimuli, such as human faces, and that the value of social stimuli may differ in individuals who report more autistic traits or who have an ASD diagnosis (Chevallier et al., 2012; Dubey et al., 2015; Sepeta et al., 2012; Zeeland et al., 2010). Research has also demonstrated that typically developing individuals preferentially orient to biological motion compared to other types of motion, but this same preference is not shown among individuals with ASD. However, it remains unknown whether individuals from these two populations assign different *reward value* to biological, or human-like, motion compared to less or non-biological motion, in a manner similar to what has been demonstrated for faces. Therefore, it is important to determine the extent to which familiar, human-like motion is perceived as a rewarding social stimulus among individuals with and without ASD, as well as among those reporting greater or fewer autistic-like traits, in order to advance our understanding of social motivation in typically developing individuals and those with social impairments.

The aim of the present study is to investigate the value individuals assign to biological, natural human motion, and how these assigned values differ depending on the number of autistic traits reported by each individual. In this study, we operationalise reward value by measuring the amount of effort participants are willing to exert in order to view a particular stimulus (Aharon et al., 2001), as we predict that certain stimuli should lead to higher positive affect in the viewer than others. A modified version of the Choose-a-Movie paradigm (CAM), originally developed by Dubey et al. (2015), enables us to measure the effort participants are willing to exert to watch different types of videos. On each trial of the CAM task, participants choose to open one of two boxes, based on their knowledge of the videos that are associated with those boxes (e.g., a green box is always associated with human motion), and the number of locks on each box (a box with 3 locks requires more key presses, and therefore more effort to open, compared to a box with 1 lock). Participants must choose between opening boxes containing videos of natural human motion, machine-like motion or non-human control motion. We hypothesised that participants with fewer autistic traits should find natural human motion most rewarding, and will thus choose to open more of these boxes and exert more effort to watch them relative to the other two video categories. However, if participants with more autistic traits value social stimuli less, we predict that these individuals should open fewer boxes containing human motion, and exert less effort to view these types of videos. This would manifest as an interaction between autistic traits and stimulus category, or a three-way interaction between autistic traits, effort and stimulus category.

2. Materials and methods

2.1. Participants

Participants were 105 Bangor University students and individuals from the local community, who received either course credits or £7 per hour for their participation. Five participants were excluded from the sample due to not following task instructions, leaving a final sample for data analysis of 100 participants (77 females; M_{age} = 21.45 years, *SD* = 3.46). Due to the complexity of conducting power analyses for experiments employing mixed effects models (Kain, Bolker, & McCoy, 2015), the sample size for the present study was chosen based on a sample size used in a similar experiment by Dubey et al. (2015). All participants provided written informed consent, and the Research Ethics Committee of the School of Psychology at Bangor University, provided ethical approval for all aspects of this study (Ethical Approval Code: 2015-15400).

2.2. Stimuli

Stimuli included three kinds of videos. The first category of videos featured a human actor performing simple, natural, human-like motion (such as moving his arms or legs from side to side smoothly; see Supplementary Video 1). This motion was used as a proxy for biological