Research in Developmental Disabilities 47 (2015) 393–404

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Morphing technique reveals intact perception of object motion and disturbed perception of emotional expressions by low-functioning adolescents with Autism Spectrum Disorder

Bora Han [a,*], Charles Tijus [a], Florence Le Barillier [b], Jacqueline Nadel [a,c,**]

[a] CHArt—LUTIN Cognitions Humaine et Artificielle, University of Paris 8, 2 rue de la Liberté, 93526 Saint Denis Cedex 02, France
[b] La Maison pour les Personnes Autistes du département d'Eure et Loir, Les Hôpitaux de Chartres, 1 rue Saint Martin au Val, 28000 Chartres, France
[c] CNRS UMR 7225, INSERM U 11-27, UPMC UnivParis06, ICM, Social and Affective Neurosciences Laboratory, CHU-Pitié-Salpêtrière, 47 bd de l'Hôpital, 759013 Paris, France

ARTICLE INFO

Article history:
Received 5 September 2014
Received in revised form 13 September 2015
Accepted 16 September 2015
Available online 27 October 2015

Keywords:
Autism
Morphing
Emotional expressions
Objects
Robot
Eye tracking

ABSTRACT

A morphing procedure has been designed to compare directly the perception of emotional expressions and of moving objects. Morphing tasks were presented to 12 low-functioning teenagers with Autism Spectrum Disorder (LF ASD) compared to 12 developmental age-matched typical children and a group presenting ceiling performance. In a first study, when presented with morphed stimuli of objects and emotional faces, LF ASD showed an intact perception of object change of state together with an impaired perception of emotional facial change of state. In a second study, an eye-tracker recorded visual exploration of morphed emotional stimuli displayed by a human face and a robotic set-up. Facing the morphed robotic stimuli, LF ASD displayed equal duration of fixations toward emotional regions and toward mechanical sources of motion, while the typical groups tracked the emotional regions only. Altogether the findings of the two studies suggest that individuals with ASD process motion rather than emotional signals when facing facial expressions.

1. Introduction

Capturing dynamic changes in a visual scene is of paramount importance for our adaptation to physical and social environment. Although it involves complex computation encompassing perceptual and representational aspects of changes, the capture is incredibly fast. The human face is a spectacular example of this fast computation of dynamic changes. Incessantly moving to express emotions or intentions, it is the most powerful, natural and spontaneous way for a human to detect within a few milliseconds the information necessary to interact with others (Bartlett et al., 2005). Humans can also recognize an object within a fraction of a second. Among objects, man-made artefacts are a special category of stimulus in that their structure is purpose-oriented, and that they can be hand-propelled to perform actions on other objects (Bloom, 1996; Grèzes & Decety, 2002; Malt & Johnson, 1992).

* Corresponding author. Tel.: +33 1 49 40 64 89/+33 01 49 40 64 79; fax: +33 1 49 40 67 54.
** Corresponding author at: CNRS Center Emotion, ICM, Université Pierre & Marie Curie, Hôpital de La Salpêtrière, 47 bd de l'Hôpital, 75013 Paris, France. Tel.: +33 1 42 16 17 39.

http://dx.doi.org/10.1016/j.ridd.2015.09.025
0891-4222/

Whether the perceptual processes in play are similar or different when we perceive dynamical change in a face or in a graspable object remains largely an unexplored matter, though an important matter to deal with in the case of Autism Spectrum Disorder (ASD). Indeed visual peculiarities are described as part of ASD and often assumed to be at the origin of the impaired adaptation of individuals with ASD to the social world (Dawson, Webb, & McPartland, 2005; Klin, Jones, Schultz, Volkmar, & Cohen, 2002; Senju & Johnson, 2009). Numerous clinical observations of children with ASD have reported early reduced attention to faces and lack of use of eye contact to regulate social interaction (Dawson et al., 2002; Maestro et al., 2001; Osterling & Dawson, 1994). Such descriptions have led many researchers to focus on perceptual processing in autism. In particular emotional face processing, which is a key element of social interaction, has generated a large number of experimental studies aimed at questioning the origin of the socio-emotional deficits in this population (for a review see Harms, Martin, & Wallace, 2010). As a first way to document the question, a large number of behavioural studies have focused on the exploration of static stimuli.

1.1. Static stimuli

There is contradictory evidence of an impaired recognition of static emotional faces in ASD. For instance, eye-tracking studies allowing free exploration of the stimuli (Corden, Chilvers, & Scuse, 2008; Howard et al., 2000; Pelphrey et al., 2002) as well as some matching studies (Gross, 2004; Ozonoff, Pennington, & Rogers, 1990; Wallace, Coleman, & Bailey, 2008) have reported impaired recognition of emotional faces. Yet other matching studies have not found such deficit (Adolphs, Sears, & Piven, 2001; Castelli, 2005; Rutherford & Towns, 2008). The heterogeneity of participants' age, severity of autism and cognitive efficiency, along with the impact of experiment-related factors may account for divergent results (Behrmann, Thomas, & Humphreys, 2006; see Falck-Ytter & von Hofsten, 2011, for a review).

In contrast, individuals with ASD are often described as presenting high competence in visual tasks involving object detection or manipulation. A meta-analysis examining face, object, and word processing found no between-group difference for object perception (Samson, Mottron, Soulières, & Zeffiro, 2012). Several face and object studies have reported intact performance in static object recognition in contrast to an impaired face recognition (Deruelle & Rondan, 2004; McPartland, Webb, Keehn, & Dawson, 2011; Teunisse & de Gelder, 2003; Wallace et al., 2008). Dawson et al. (2005) postulate that individuals with ASD use a similar strategy for both kinds of stimuli, which would lead to successful processing for objects and impaired processing for faces.

An explanation of the phenomenon may require the contribution of brain studies. For example, during face processing, functional imaging studies of individuals with ASD have found a weak activation of the fusiform gyrus (Critchley et al., 2000; Grelotti et al., 2005; Hubl et al., 2003; Pierce, Muller, Ambrose, Allen, & Courchesne, 2001; Schultz et al., 2000), a brain region known to respond preferentially to the perceptual analysis of structural properties of face. Some studies report in the same subjects an increased activity in the nearby inferior temporal gyrus, a region known to respond preferentially to object perception (Schultz et al., 2000). Yet, a normal activation of the fusiform gyrus has been shown under certain conditions such as a special object of interest (Grelotti et al., 2005), thus suggesting that specialization for faces in the fusiform gyrus area is an example of a more general phenomenon related to experience and expertise (Tarr & Gauthier, 2000). Noticeably, several studies have compared gaze behaviour during the presentation of cartoons (van der Geest, Kemner, Camfferman, Verbaten, & van Engeland, 2002) or picture arrays (Sasson, Turner-Brown, Holtzclaw, Lam, & Bodfish, 2008) of social stimuli or objects. Results showed no between-group differences in the exploration of the two kinds of stimuli, which suggests that the abnormal social gaze behaviour reported in everyday life would be related to factors such as social interaction or detail-oriented attention rather than to the nature of the visual stimuli. Studying the perception of the variant aspects of facial expression or object properties through the use of dynamic stimuli may help test this suggestion.

1.2. Dynamic stimuli

Introducing motion via the use of dynamic stimuli provides a more ecological way to study the perceptual processing of an ever-changing world. Naturalistic and semi-naturalistic studies offer an important contribution to this point (Noris, Nadel, Baxter, Hadjikhani, & Billard, 2012). Several studies have shown that dynamic displays enhance the discrimination of emotion in typical subjects (Kamachi et al., 2001; Lander & Bruce, 2003) and increases the activity of the key components of the emotional face processing system, when compared to a static presentation (Kilts, Egan, Gideon, Ely, & Hoffman, 2003; LaBar, Crupain, Voyvodic, & McCarthy, 2003; Trautmann, Fehr, & Hermann, 2009). How this brain modulation operates in ASD is of particular interest to test the hypothesis of a specific impairment of emotion processing.

Using the Representational Momentum paradigm, Uono, Sato and Toichi (2010) have found that the dynamic presentation of stimuli (200 ms) enhances the perception of emotions also in individuals with ASD. Authors speculate that the poor emotion recognition observed in ASD might be due to an impaired high level processing of emotional reaction rather than to a low processing level. Similarly Speer, Cook, McMahon, and Clarck (2007) have designed static and dynamic social stimuli presented either isolated or in an interactive context. They found differences between ASD and controls only for social dynamic stimuli in an interactive context. Back, Ropar, and Mitchell (2007) have shown equal mental states recognition for dynamic and static emotional faces presented during 5 s. Using a morphing procedure (15–33 s), Bal et al. (2010) have also reported similar recognition scores of dynamic faces in high functioning children with ASD compared to typically developing children, though with a significantly longer response time in the ASD group. Whether the intact