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Perception of emotions from facial expressions in high-functioning adults with autism

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ABSTRACT

Impairment in social communication is one of the diagnostic hallmarks of autism spectrum disorders, and a large body of research has documented aspects of impaired social cognition in autism, both at the level of the processes and the neural structures involved. Yet one of the most common social communicative abilities in everyday life, the ability to judge somebody's emotion from their facial expression, has yielded conflicting findings. To investigate this issue, we used a sensitive task that has been used to assess facial emotion perception in a number of neurological and psychiatric populations. Fifteen high-functioning adults with autism and 19 control participants rated the emotional intensity of 36 faces displaying basic emotions. Every face was rated 6 times—once for each emotion category. The autism group gave ratings that were significantly less sensitive to a given emotion, and less reliable across repeated testing, resulting in overall decreased specificity in emotion perception. We thus demonstrate a subtle but specific pattern of impairments in facial emotion perception in people with autism.

1. Introduction

Impaired social communication is one of the hallmarks of autism spectrum disorders (ASD). It is commonly thought that people with ASD are impaired also in a specific aspect of social communication, the recognition of basic emotions from facial expressions (i.e., happiness, surprise, fear, anger, disgust, sadness). However, the literature on this topic offers highly conflicting findings to date: whereas some studies find clear impairments in facial affect recognition in autism (Ashwin, Wheelwright & Baron-Cohen, 2006; Corden, Chilvers & Skuse, 2008; Dziobek, Bahnemann, Convit & Heekeren, 2010; Law Smith, Montagne, Perrett, Gill, & Gallagher, 2010; Philip et al., 2010; Wallace et al., 2011), others do not (Adolphs, Sears & Piven, 2001; Baron-Cohen, Jolliffe, Mortimore & Robertson, 1997; Neumann, Spezio, Piven & Adolphs, 2006; Rutherford & Towns, 2008). Part of this discrepancy may be traced to the known heterogeneity of ASD, together with differences in the stimuli and tasks used in the various studies; and part may derive from the specific aspects of facial emotion perception that were analyzed in the studies.

A recent and comprehensive review attempted to make sense of this mixed literature (Harms, Martin & Wallace, 2010). The authors suggest that the ability of individuals with an ASD to identify facial expressions depends, in large part, upon several factors and their interactions, including demographics (i.e., subjects' age and level of functioning), the stimuli and experimental task demands, and the dependent measures of interest (e.g., emotion labeling accuracy, reaction times, etc.). Other factors, such as ceiling effects or the use of compensatory strategies by individuals with an ASD, might also obscure true group differences that would have been otherwise found. The authors further make the interesting point that other behaviorally- or biologically-based measures almost invariably demonstrate that individuals with ASDs process faces differently, so perhaps previous studies of facial affect recognition which failed to find group differences used tasks and/or measures that are simply not sensitive enough to detect group differences. Difficult or unfamiliar tasks are more likely to reveal impairment, since they are better able to avoid ceiling effects and, in some cases, are less well-rehearsed and preclude compensatory strategies.

Two distinct methodological approaches have been used to achieve these goals of providing sensitive measures of facial affect recognition. One approach has been to manipulate the stimuli in some way, such as with facial morphing (e.g., Humphreys, Minshew, Leonard & Behrmann, 2007; Law Smith et al., 2010; Wallace et al., 2011). This approach gives the experimenter parametric control of the intensity of the stimuli, and so can assess emotion discrimination at a fine-grained level, but with the important caveat that the morphs

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are artificially generated and not necessarily the same as the subtle expressions that one would encounter in the real world. The second main approach is to modify the task demands (e.g., changing task instructions, reducing the length of stimulus presentation, etc.), rather than manipulating the stimuli in any way. By doing so, the experimenter can increase the task difficulty and reduce the likelihood that an explicit, well-rehearsed cognitive strategy is used for decoding the expression, while still using naturalistic stimuli. Here, we took this latter approach. We used a well-validated and widely used set of facial emotion stimuli (Paul Ekman's Pictures of Facial Affect; Ekman, 1976) and obtained detailed ratings of emotion. An additional motivation for using these stimuli is that they provide continuity with a number of prior studies in a wide variety of populations including ASD (Adolphs et al., 2001), patients with brain lesions (Adolphs, Tranel, Damasio & Damasio, 1995; Adolphs, Damasio, Tranel, Cooper & Damasio, 2000), frontotemporal dementia (Diehl-Schmid et al., 2007), Parkinson's disease (Sprengelmeyer et al., 2003), and depression (Persad & Polivy, 1993).

Given that facial expressions are complex and are often comprised of varying degrees of two or more emotions in the real world, participants were asked to determine the intensity levels of each of the 6 basic emotions for every emotional face they were shown (e.g., rate a surprised face on it is intensity (i.e., degree) of happiness, surprise, fear, anger, disgust, and sadness, etc.). In keeping with previous descriptions of this task (e.g., Adolphs et al., 1994,1995), we refer to it as an emotion recognition task, since it requires one to recognize (and rate) the level of a particular emotion displayed by a face. For instance, for one to rate a surprised face as exhibiting a particular intensity of fear requires recognizing that emotion, fear, in the first place. Given that participants are unlikely to have practiced this task during any sort of behavioral intervention they may have been exposed to, we expected this task to reveal group differences, particularly in the overall intensity ratings and the degree of response selectivity (i.e., tuning or sharpness) for particular emotional facial expressions. We also assessed test-retest reliability in a subset of our study sample, to explore whether a less stable representation of emotional expression would be reflected in increased response variability across these testing sessions.

2. Methods

2.1. Participants

Seventeen high-functioning male adults with an ASD and 19 age-, gender- and IQ-matched control participants took part in this experiment. Two ASD participants were excluded because their scores exceeded at least 3 standard deviations (SD), calculated across both groups together, for one or more of their facial expression-emotion judgment categories, resulting in a final sample size of 15 ASD and 19 control participants. Control and ASD groups were well matched on age and verbal, performance, and full-scale IQ (see Table 1a). IQ scores were not available for 3 control participants and 1 ASD participant. DSM-IV diagnosis of an ASD was made by a clinical psychologist following administration of the Autism Diagnostic Observation Scale (ADOS) and the Autism Diagnostic Interview-Revised (ADI-R; when a parent was available; for 12 of 15 participants total; see Table 1b). In order to ensure that our findings could not be explained by possible group differences in facial identity recognition, we also tested participants on the Benton Facial Recognition Test (14/15 ASD participants and 12/19 controls). There were no significant differences between groups [$t(24)=4.39$, $p=0.70$; ASD=46.5 (4.7); control=45.8 (4.1)]. However, two participants with an ASD scored below the cutoff for "Normal" on Benton Facial Recognition (1 scored in the "Borderline" range and 1 scored in the "Moderate Impairment" range), and 1 control participant scored in the "Borderline" range. The main effects reported below remained significant even after re-running the analyses with these 3 participants excluded.

2.2. Stimuli

Each participant rated the emotional intensity of 36 Ekman faces, each displaying 1 of the 6 basic emotions (i.e., happiness, surprise, fear, anger, disgust, sadness; Ekman, 1976). All images were black and white, and were forward facing.

Table 1
(a) Mean age and IQ scores (verbal, performance, and full-scale) were not significantly different between control and autism groups. Standard deviations are given in the parentheses. (b) Means, standard deviations, and ranges for the autism group on clinical measures (*ADOS*=Autism Diagnostic Observation Schedule; *ADI-R*=Autism Diagnostic Interview-Revised; *RSB*=restricted and stereotyped behaviors).

	Control group ($n=19$)*	Autism group ($n=15$)*	*T*-test
Age	31.9 years (11.9)	30.5 years (11.5)	$t(32)=0.36$, $p=0.72$
Verbal IQ	111.5 (10.9)	109.0 (16.8)	$t(28)=0.49$, $p=0.63$
Performance IQ	107.2 (12.8)	104.9 (12.3)	$t(28)=0.49$, $p=0.63$
Full scale IQ	110.2 (10.2)	107.1 (11.7)	$t(28)=0.78$, $p=0.44$
		Mean (SD)	Range
ADOS: communication		3.7 (1.3)	2–6
ADOS: social		7.7 (3.0)	5–14
ADOS: RSB		1.3 (1.3)	0–4
ADI-R A: social		20.8 (5.0)	12–28
ADI-R B: communication		15.8 (3.6)	10–22
ADI-R C: RSB		6.3 (2.9)	2–12

* IQ scores were not available from 3 control participants and 1 ASD participant.

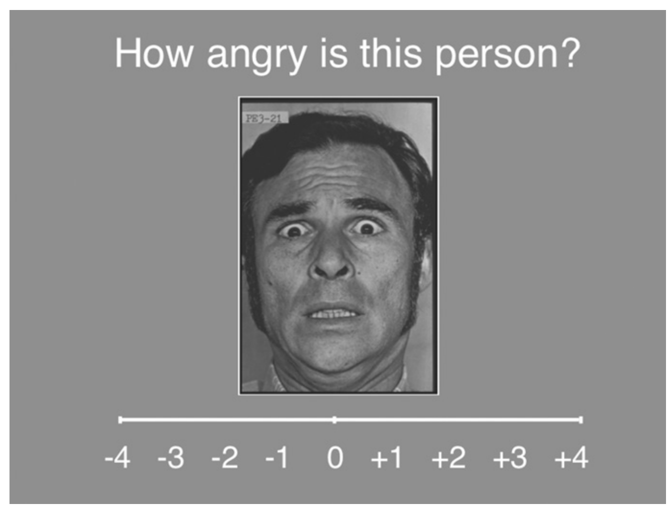

Fig. 1. An example of a trial. Participants were asked to rate the intensity of a particular emotion (in this example, anger) for all 36 emotional faces used in the experiment, each representing 1 of the 6 basic emotions (in this case, fear). The emotion of the rating category and face could be concordant (e.g., rate a happy face on how happy it is) or discordant (such as in the current example). Every face was rated 6 times—once for each emotion category.

An additional 3 faces displaying neutral expressions were also included, but these are considered separately from the other emotional stimuli. The specific images were identical to those used in (Adolphs et al., 1995, 2001), and were chosen on the basis of an independent group of control participants rating these faces as exemplars of each particular emotion category (Ekman, 1976). Stimuli were 336×500 pixels (width × height) and displayed on an LCD monitor with a resolution of 1024 by 768 pixels.

2.3. Task

Subjects viewed and rated the emotional intensity of the 36 emotional faces and 3 neutral faces, presented in randomized order, a total of 6 times- once for each emotion category (e.g., rating the intensity of happiness in all 39 faces; then rating the intensity of surprised, etc.; see Fig. 1). Therefore, ratings could either be concordant (i.e., the rating category and the primary/intended facial expression are the same emotion) or discordant (i.e., the rating category and primary facial expression are different emotions). Intensity was rated on a Likert scale from -4 to $+4$, with a $+4$ indicating that the face very strongly displayed the emotion of the rating category, while a -4 indicated that the face very strongly displayed an emotion opposite to the rating category (a rating of 0 indicated that the face was