Differences in Neural Activity when Processing Emotional Arousal and Valence in Autism Spectrum Disorders

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Introduction

Autism Spectrum Disorders (ASD) are a set of complex neurodevelopmental disabilities that cause lifelong impairments in social ability, communication, and behavioral flexibility (American Psychiatric Association, 2000).

Individuals with ASD often have difficulty recognizing and interpreting facial emotions, which may impair their ability to understand the intentionality and minds of others, a capacity needed for successful social communication (Grether et al., 2003; Golan et al., 2006).

Numerous studies have provided evidence for the existence of distinct neural systems that subserve the experience of emotional valence (the extent to which emotions are pleasant or unpleasant) and arousal (the extent to which emotions are associated with high or low energy) (Gerber et al., 2006; Posner et al., 2005; Colibazzi et al., 2010).

The Circumplex Model of Affect posits that the subjective experience of all affect arises from cognitive interpretations of neuropsychiological changes in valence and arousal in relation to the experiential context of the eliciting stimuli and memories of prior experiences when similar sensations of valence and arousal are elicited (Russell, 2002; Posner et al., 2005).

We sought to identify similarities and differences in neural activity when participants with ASD and typically-developing (TD) participants viewed and rated these experiences of facial emotions (Russell et al., 1989; Gerber et al., 2006).

To our knowledge, this is the first study to assess whether neural activity in circuits that subserve processing of the two dimensions of facial emotions differ between individuals with ASD and their TD counterparts.

Methods

Behavioral Data

- ASD group performed nearly as well as, and in a similar pattern to, the TD group when participants were asked to rate emotional faces for arousal and valence (Tseng et al., 2014).
- Typical-level behavioral performance on emotion-processing tasks does not explain the possibility of atypical neurocognitive processing of emotional information.

MRI Data

- Imaging was performed on a GE Sigma 3T whole body scanner (Milwaukee, WI) using a single channel quadrature head-coil.
- MRI data was preprocessed (including slice timing correction, motion correction, spatial smoothing) using SPM (http://www.fil.ion.ucl.ac.uk/spm, run under MATLAB2006b).
- Participants for whom motion affected more than 15% of their data were excluded from further analyses (eliminated 1 TD and 4 ASD).
- A parametric experimental design was used to identify brain regions in which neural activity correlated with arousal and valence ratings in a broad range of facial emotions.
- BOLD-signal intensity was used to index neural activity as participants viewed photographs depicting emotional faces.
- Brain regions were identified in which BOLD-signal systematically covaried with ratings of arousal or valence in ASD and TD groups.
- Regions in which these correlations differed statistically across emotional dimensions and diagnostic groups, indicating the differential associations of these regions with processing arousal or valence within each group.
- Post-hoc analyses covared for FSID in all participants and ADOS scores in analyses involving only participants with ASD. Analyses also conducted using only the adult participants (18-51yrs) in order to whether including child participants (7-18yrs) change our findings. No significant differences from our original findings were detected in these additional analyses.

Valence Results

- BOLD-signal correlated with ratings of linear valence similarly for both diagnostic groups.
- In both TD and ASD participants, valence ratings correlated positively with BOLD-signal in ACC, PC, ST, and S1 (Tseng et al., 2014). Positive correlations of BOLD-signal with valence ratings did not differ significantly between diagnostic groups.

Arousal Results

- TD: BOLD-signal correlated inversely with arousal ratings in IFG, PC, ACC, DLPFC, dorsal PC, interparietal PC, CN, and PUT.
- ASD: BOLD-signal correlated positively with arousal ratings in posterior temporal and interior PC, the mesial wall (pregenual and dorsal portions of anterior frontal and anterior CO), PreHC and supplementary motor cortices, Cu, PCs, basal ganglia nuclei, THAL, dorsal Cb.
- Correlations of BOLD-signal with arousal ratings differed significantly across ASD and TD participants (ASD>TD) in AMYG, HIPP, CN, ACC, and SFG.

Discussion

- BOLD-signal correlated linearly with ratings of emotional arousal, but in opposite directions and in differing locations for the two groups.
- BOLD-signal in TD participants correlated inversely with ratings of arousal in regions associated primarily with attentional functions, whereas BOLD-signal in ASD participants correlated positively with arousal ratings in regions most commonly associated with impulse control and invariance in sensorimotor regions.
- Neither did the correlation of BOLD-signal with valence ratings differ significantly across groups.
- Our findings provide unique insight into the emotional experiences of individuals with ASD. TD individuals and persons with ASD seem to find differing aspects of emotional stimuli to be salient and relevant. Studying these differences may help us to understand the origins of atypical interpersonal emotional experiences in individuals with ASD.

References


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