Brain function in Asperger syndrome during natural viewing


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Introduction

Autistic behavior is neither well captured by any simplified behavioral measure (Golan et al. Soc Neurosci. 2008), nor strictly localized to a specific brain region or network (Minshew & Keller Curr Opin Neurol. 2010). According to behavioral studies, conditions that are in their complexity close to neurotypical are useful in capturing temporarily fine-grained changes in multiple interdependent social cognitive functions associated with autistic behavior (e.g. Kim et al. Arch Gen Psychiatry 2002, Golan et al. 2006). Here we studied atypical real-life neurocognitive functions in Asperger syndrome (AS) by collecting fMRI during natural viewing of a narrative film. To analyze the data, we used intersubject correlation approach that requires no a priori assumptions about affected brain regions or modeling of task/stimulus contents. Therefore, this viewing of a narrative film. To analyze the data, we used intersubject correlation approach that requires no a priori assumptions about affected brain regions or modeling of task/stimulus contents. Therefore, this approach may be useful in describing the relative role of multiple affected social cognitive functions, such as facial processing (Critchley et al. Brain 2000), mentalization (Happe et al. Nat. Neurosci. 2006).

Materials and Methods

Participants: 14 males (age 20-41 years, mean 29 years) diagnosed (DSM-IV) with Asperger syndrome and 14 neurotypical males (age 19-47 years, mean 28 years). None of the participants had comorbid psychiatric diagnoses (structured clinical interview for DSM-IV Axis I) and they were not under psychoactive medication. Each participant also had normal or corrected-to-normal vision, and normal hearing. Stimulus and task: free viewing of the feature film: The Match Factory Girl (Aki Kaurismäki, 1990). Onsets and durations of the episodes containing social interaction, human hand action, and faces were annotated from the film and then used as regressors in GLM analysis (see Fig 2).

fMRI data acquisition:
- General linear model analysis across all participants using social interaction, human hand action (Hands), facial perception (Reading the Mind in the Eyes test, and Benton facial recognition test).
- Interindividual differences analysis (ISCs) showed a network of areas showing significant ISC values in individuals with higher autistic traits as compared to lower autistic traits, when viewing realistic and naturalistic social interactions, human hand actions, and facial expressions. The ISC analysis encompasses all brain areas (Fig 1).

Conclusions - spatial differences between NT and AS

- Highest interindividual correlations (ISCs) were observed in the low-level visual areas (VT-3), dorsal visual stream (VS), IPS/SPL, and STS (Fig 1a). ISCs in NT were more distributed over larger brain areas in NT (Fig 1a).
- ISCs peak were highly similar in NT and AS (Fig 1a).
- ISCs showed prominent differences between the two groups in distributed occipital, temporal, frontal, parietal, and insular cortex areas (Fig 1b).
- Model-based analysis showed that this network associated with episodes containing social interaction network (Fig 2).

Conclusions - classifying individual participants

- Network showing significant ISC values in individuals with higher autistic traits as compared to lower autistic traits, when viewing realistic and naturalistic social interactions, human hand actions, and facial expressions. The ISC analysis encompasses all brain areas (Fig 1).

Acknowledgements

aivoALTO project, Aalto University, Finland; the Academy of Finland.

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Fig 1. a) Intersubject correlation over the whole film in neurotypical (NT) and Asperger (AS) participants (P < 0.0005) showed a network of areas showing differences between NT and AS. Black lines outline the areas showing significant ISC differences (Fig 2).

Fig 2. General linear model analysis across all participants using social interaction, human hand action (Hands), facial perception (Reading the Mind in the Eyes test, and Benton facial recognition test).

Fig 3. Linear discriminant analysis using the relative ISC values of individual subjects (see Fig 1b).

Fig 4. MANOVA using average time series in brain regions showing different ISCs in NT vs. AS across all areas (a), blue, and in each individual region (a, red). The group differences across all areas were associated (P < 0.05) with episodes containing hand actions.

Conclusions - temporal differences between NT and AS

- A network of areas showing differences between NT vs. AS (Fig 1b) differed in repeated events, while individual regions differed only in a few points.
- The differences across the network were associated with hand actions.

Summary

Our results propose that natural viewing of realistically complex episodes of socially relevant stimuli induces highly consistent differences between NT and AS (Figs 1b, 3; see also Hasson et al. Autism Res. 2009).

ISC proved to be useful in detecting these differences, as they were not observed in signal amplitudes across the experiment, or when specific types of episodes were modeled (Fig 2).

Our findings (Figs 1b, 2) propose that multiple social brain functions are affected in AS (see Minshew & Keller 2010).

Our results (Figs 3, 4) emphasize the role of impaired ability to imitate others’ actions in autism (Nishitani et al. Ann Neural. 2004).

High discrimination rates of individual participants (Fig 3) encourage to further develop naturalistic paradigms in order to support diagnostics of autism spectrum disorders.