Tract-based statistical analyzes in dMRI in autism spectrum disorder

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Tract-based statistical analyzes in dMRI in autism spectrum disorder

Submission No:

3854

Introduction:

Abnormal face processing is one of the hallmark features of social impairments in autism spectrum disorder (ASD). Previous neuroimaging studies showed that the fusiform gyrus is involved in face perception and is not or abnormally activated in autistic subjects [1][5]. The aim of this study was to quantify potential anatomical differences in the white matter tracts that traverse the fusiform gyrus, the prefrontal cortex and the superior temporal gyrus, and correlate them with ADOS scores in ASD subjects. We used Diffusion Tensor MRI (DT) images to assess the integrity of automatically segmented white matter bundles connecting these brain areas. Then, we perform statistical analysis on these fiber bundles using diffusivity measures calculated from DT to characterize tissue microstructure changes and correlate these changes with ADOS scores.

Methods:

Participants. 7 adults with high functioning autism or Asperger syndrome and 11 typical adults participated in the study.
Data acquisition and preparation. For each participant, diffusion-weighted images were acquired with 1×1×1.3mm voxel size using 80 non-collinear directions at b=1000s/mm2 and 1 image with b=0s/mm2. We started preparation by generating an unbiased template of the DT images and registering non-linearly all of the images to it. Then, we computed full brain tractography for every subject. Finally, we used the tools developed by Wassermann et al. [2] to cluster fiber bundles and identify the bundles traversing the fusiform gyrus. This gyrus was identified using the gyri parcellation of the JHU atlas. We clustered these bundles across subjects extracting a set of population-obtained bundles.
Data analysis. We applied the statistical analysis of Wassermann et al. [3] for each population-obtained bundle, we calculated its tract-probability map (TPM) and skeletonized this map to obtain a bidimensional representation of each bundle. For each patient, we projected the measures of diffusivity (FA, axial and radial diffusivity) around the tract to their closest points on the skeleton and averaged them with a weight according to the TPM. This produced two populations (one for patients and one for controls) of projected functions on the skeleton. For each tract and each measure, we used a cluster-based permutation hypothesis testing approach [4] to detect dissimilarities between populations. For significant clusters, we calculated correlation between the mean diffusivity measure and ADOS scores.

Results:

We found several clusters with dissimilarities between ASD and control subjects in FA measures on tracts traversing the fusiform gyrus in both hemispheres of the brain (Fig.1). We observed a significant reduction of FA values in a cluster on a bundle joining the superior temporal gyrus to the prefrontal

cortex (Fig.2). In this cluster, the mean FA was strongly correlated with the ADOS scores (correlation coefficient < - 0.96, $p<0.004$) (Fig.3).

Conclusions:

Results revealing difference between controls and ASD subjects in clusters on fiber bundle traversing the fusiform gyrus are in agreement with current literature suggesting abnormal FFA function in ASD. The localization of the cluster where we found a correlation with ADOS social interaction scores is in agreement with current anatomical literature, the superior temporal gyrus being a classical area of face features recognition and the prefrontal cortex an area know to be involved in social information processing. This is reinforced by the strong inverse correlation (Fig. 3) showing that in this linking cluster a drop of FA value is strongly correlated with a rise of the intensity of ASD. Disruption of white matter tracts between regions implicated in social functioning and face perception may contribute to the social impairments that characterize ASD.

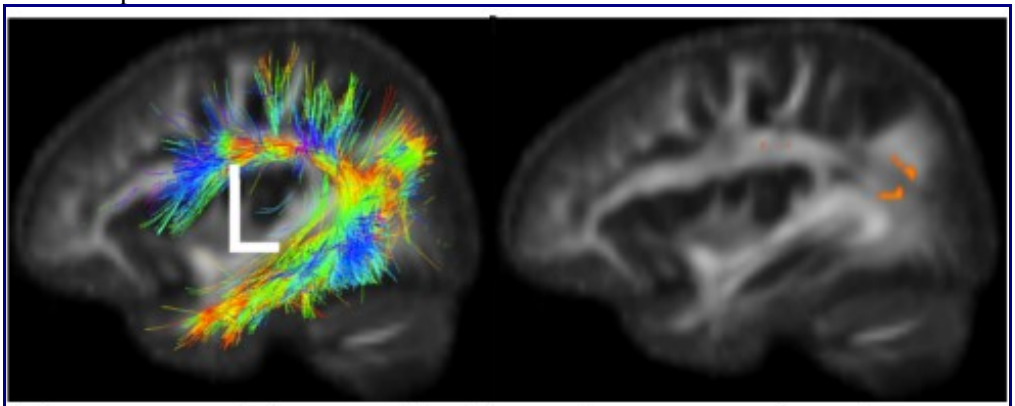

Fig1. One of the studied bundle traversing the fusiform gyrus. In orange significant clusters of difference between autists and controls on this bundle.

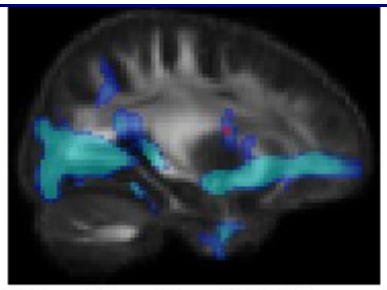

Fig2. Studied TPM and significant cluster (red voxels)

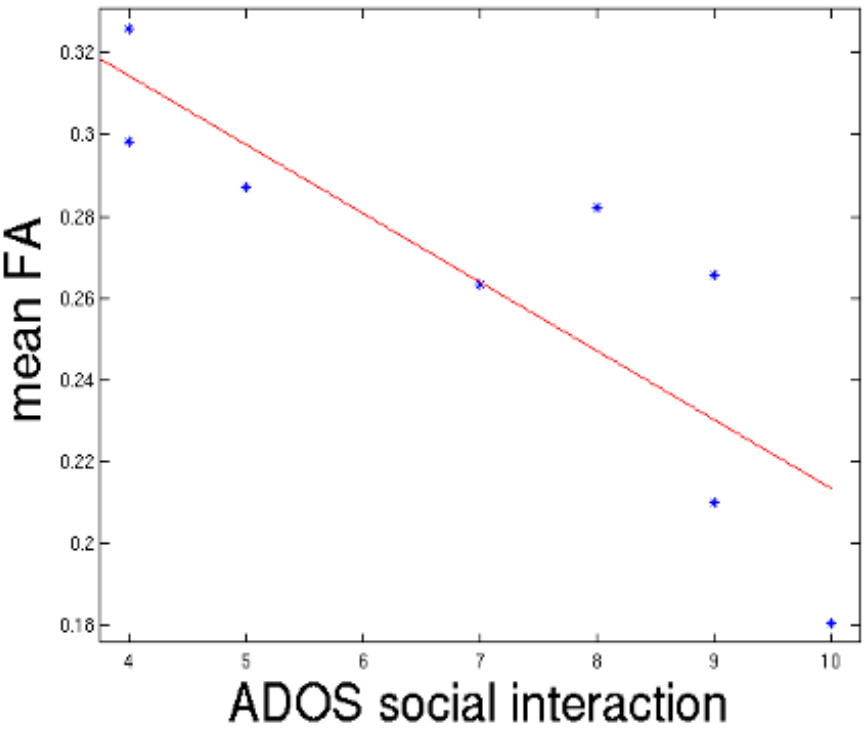

Fig3. Correlation between ADOS social interaction and mean FA in the cluster for 8 autists.

Imaging Methods

Diffusion MRI

Abstract Information

References

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