Distracted *'from'* their surroundings: excessive functional coupling between salience and default-mode networks in ASD

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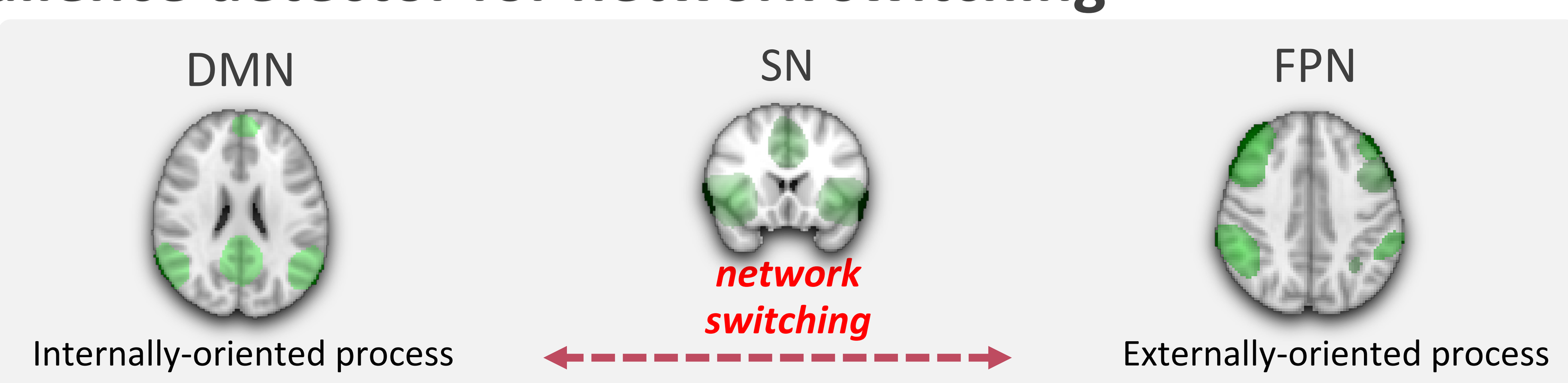
BACKGROUND

- Autism spectrum disorder (ASD): the more well-known characteristics is that affected individuals exhibit extreme self-focus (e.g., self-absorbed, internally-oriented, and mind wandering)
- Atypical activities in the ***salience network*** and ***default-mode network*** have been reported in individuals with ASD.
- However, no study has investigated how these two networks dynamically interact in the affected brains

Salience detector for network switching [1,2]



- ***Salience network (SN)*** is implicated *in modulating the switch* between DMN and FPN, moving network configurations away from deep internal self state to give attention to the outside or vice versa. The switching is spontaneous over time regardless the external sensory inputs[3,4]
- ***Default mode network (DMN)*** is active when individual is at rest and plays a role in self-related processing (e.g., self-oriented attention, self-awareness, and mind wandering)
- ***Frontoparietal executive network (FPN)*** is a cognitive control and executive system in the brain

Hypothesis

- The self-oriented characteristic in ASD derived from the excessive functional coupling between DMN-SN, reflecting a hyperactive DMN mode in the brain, compared to the typical development (TD) group.

METHOD

Pre-existed dataset

- The present study was carried out using resting-state fMRI (rs-fMRI) data from the Autism Imaging Data Exchange (ABIDE)[5]

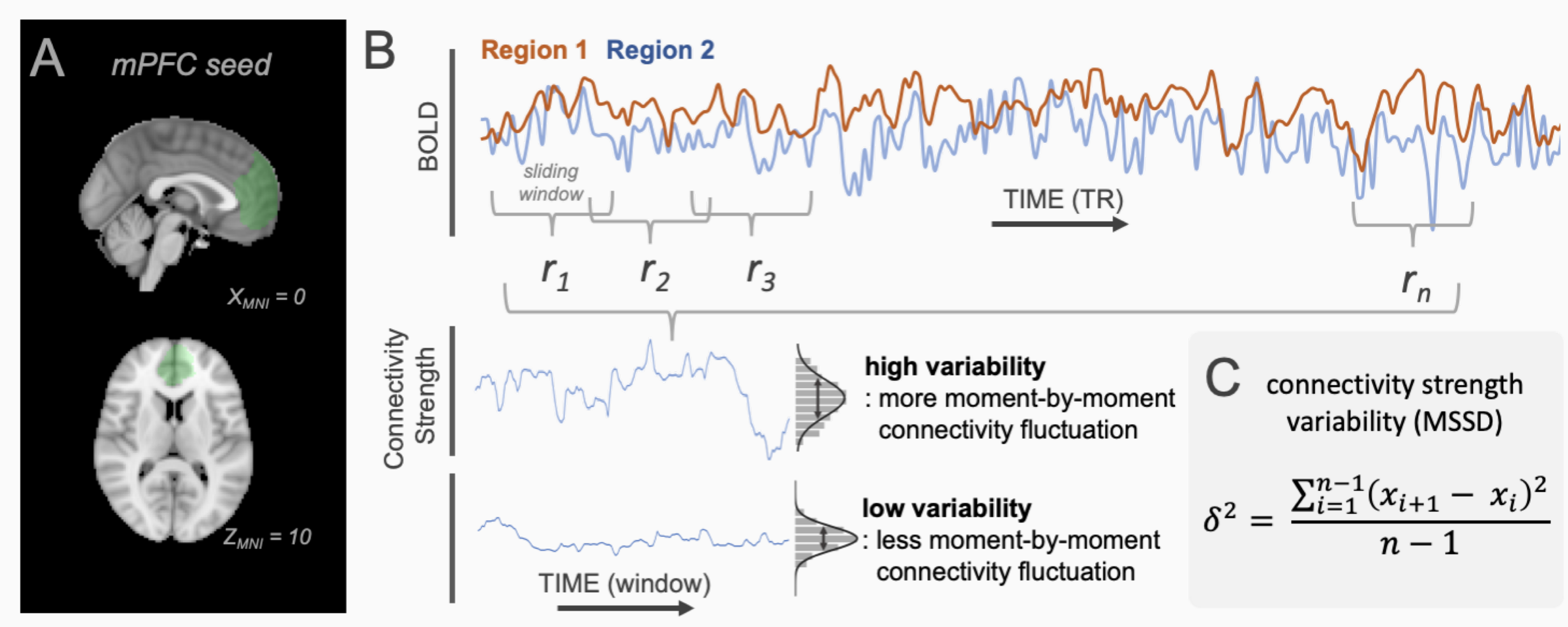
Participants

- ASD: N = 325, M_{age} = 16.07 years, age range = 7 – 58; 12.54% females
- TD: N = 356, M_{age} = 16.22 years, age range = 6 – 48; 18.01% females

Preprocessing

- 0.001 – 0.08 Hz Bandpass
- ICA-AROMA denoising
- 5-mm smoothing
- Slice timing and motion correction
- Registration to 2mm MNI using ANTs
- Regressing out WM/CSF nuisance signal

Connectivity analysis



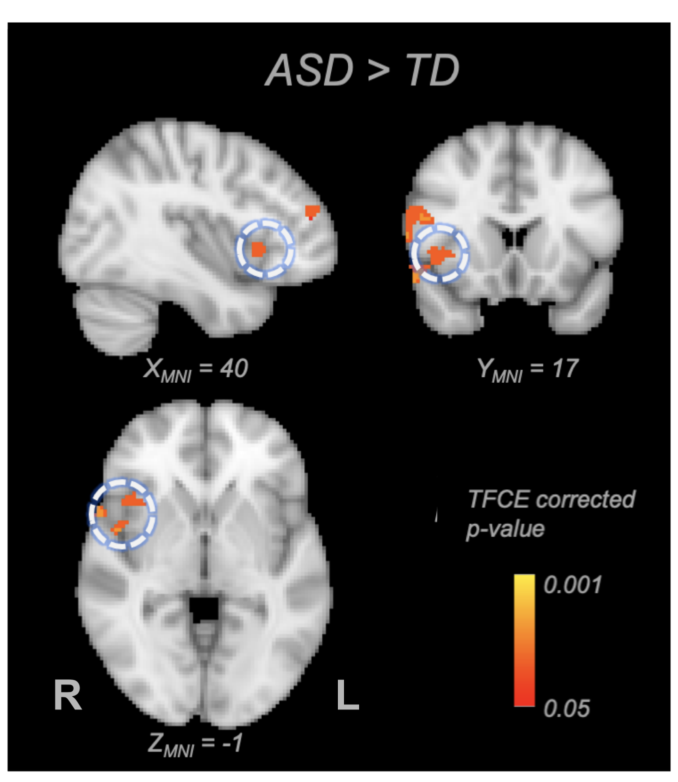
(A) Medial prefrontal cortex (MPFC, a core region of DMN) seed mask for the seed-based static functional connectivity analysis

(B) Schematic figure of connectivity variability estimation. Using dynamic functional connectivity with 50 TR window size, the connectivity strength value between regions were computed for each sliding-window[6]

(C) The mean square successive difference (MSSD) equation for connectivity strength variability estimation

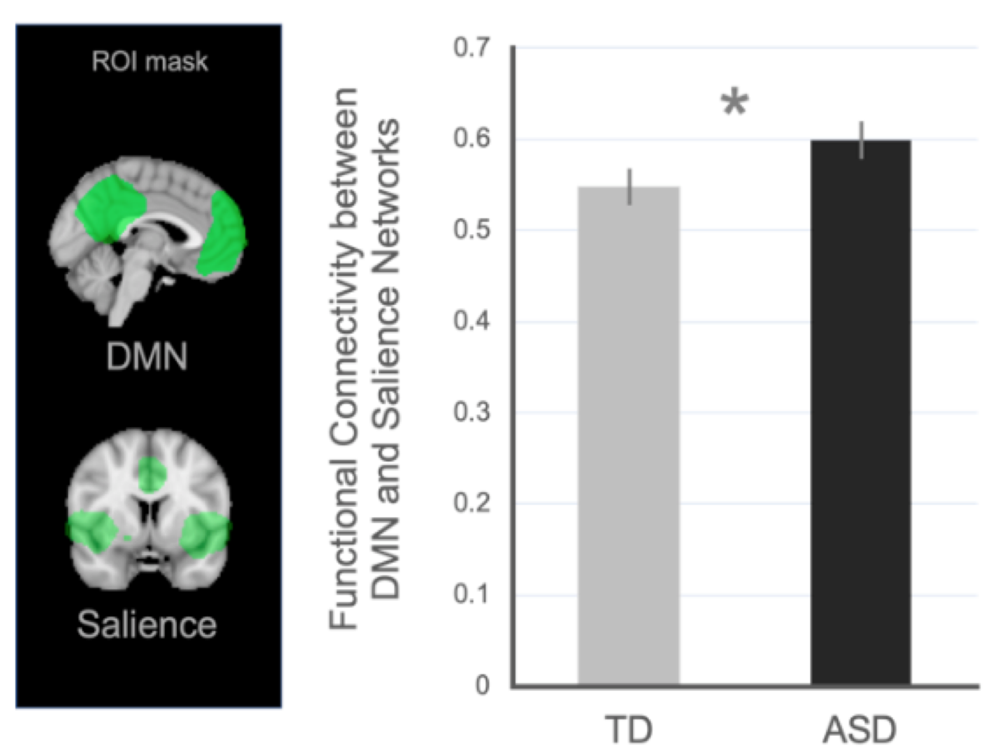
RESULTS and DISCUSSION

MPFC seed functional connectivity



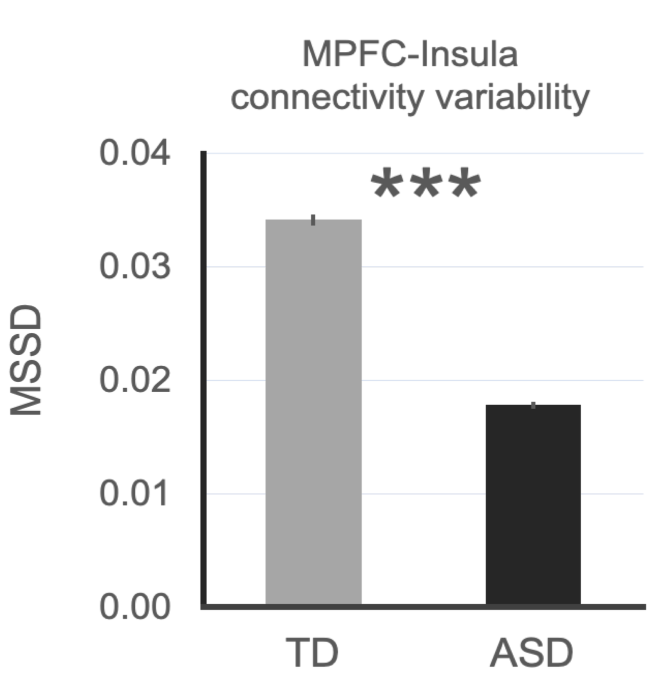
- The static functional connectivity analysis shows a stronger coupling between the MPFC and the insular, as a core region of the salience network, in the ASD group compared to the TD group.

Functional connectivity ROI between DMN and SN

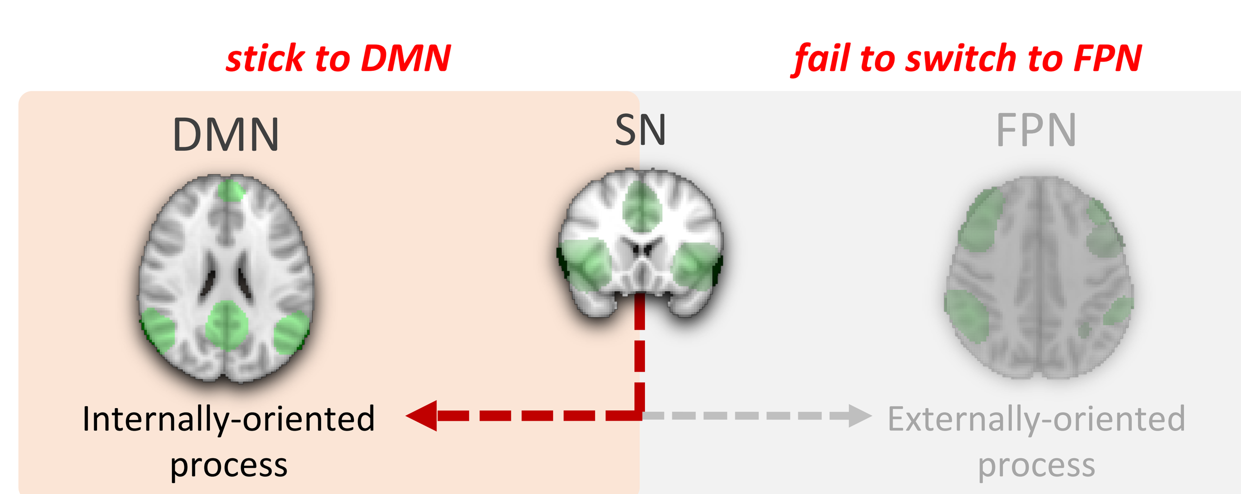


- Additional connectivity analysis using intrinsic meta-analysis template masks[7] confirms our interpretation that the increased MPFC-Insula connectivity is based on the connectivity between the DMN and SN.
- ASD group shows more coupled DMN-SN connectivity compared to TD group.

Dynamic Functional Connectivity between MPFC-Insula



- The MPFC-Insula coupling was significantly more rigid over time in the ASD group (i.e., low MSSD; less variability in connectivity changes).
- These findings suggest that the over-internally-oriented characteristics of ASD may be due to the excessive coupling between the DMN and SN.



The current study provides the fundamental neural mechanism underlying the deficit of switching attention to the outer social world from a self-oriented mind in ASD.

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