

Regional brain connectivity patterns distinguish males from females

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Introduction

- Connectivity patterns of specific brain regions during resting state (RS) have been shown to allow sex classification with high accuracy by use of machine learning approaches ([1]).
- Sex-specific classification accuracies can further help to characterize sex-specific connectivity patterns and differences.

Aims of the present study:

- Identification of key brain regions underlying sex differences in functional brain organization by comparing sex-specific accuracies in classification based on regionally specific connectivity patterns.

Methods

Sample:

- Human Connectome Project Sample (HCP S1200 release; [2]),
- 744 subjects (372 males, age range: 22-37, mean age: 28.5 years),
- Matched age, education, twin-status.

Functional imaging data:

- Resting state: 1200 volumes,
- Siemens Sykra 3T: TR=720ms,
- FSL-FIX denoising ([3]),
- RS connectomes extracted for 436 ROIs ([4,5]): Pearson correlations between each ROI's time course and the rest of the brain.

Sex Classification:

- RBF-SVM:** *LibSVM toolbox* ([6]), independently for each ROI,
- 10 repetitions /10-fold CV.

Sex Specific Accuracy:

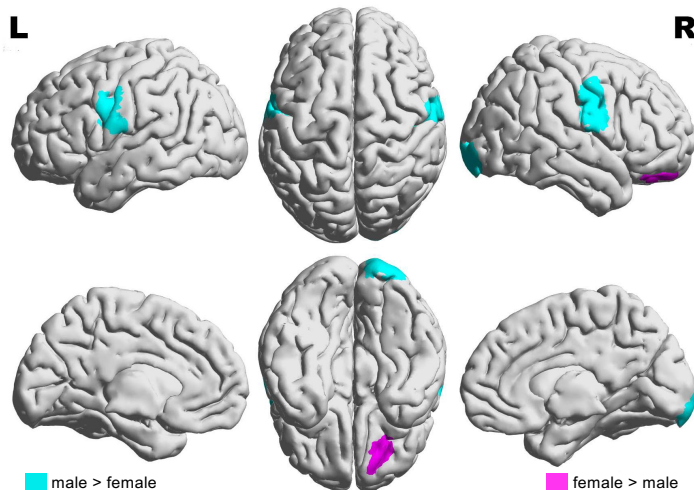
- Accuracies for males and females were computed as the number of correctly classified males / females divided by the total number of males / females for each parcel,
- χ^2 -Test for differences between sexes ($\chi^2(1) > 7.75$, $p < 0.005$).

Functional Decoding:

- Meta-analyses based on ([7]).

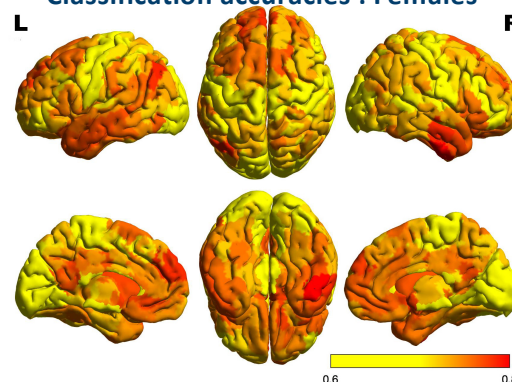
Results

Significant differences in classification accuracies between the sexes

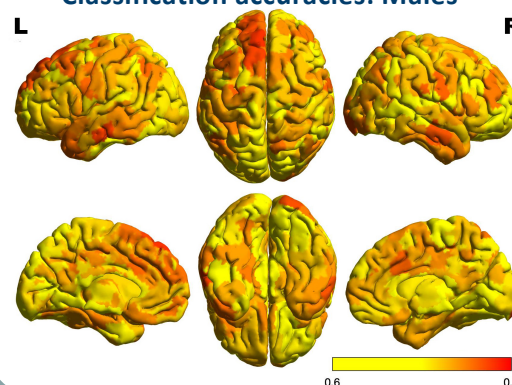


- All classification accuracies above chance for males and females: mAcc: 65.6% - 79.0%, fAcc 61.7% - 82.1%.
- No significant difference between the sexes on average: mAcc: 72.8%, S.D. 2.5%; fAcc: 73.1%, S.D. 3.5%; $t = 1.26$; $p > 0.05$.
- Significantly higher classification accuracies for males: L + R pre- and postcentral gyri, R occipital lobe, associated with language functions and speech execution.
- Significantly higher accuracy for females: R superior and medial orbital gyrus, associated with emotional processing of reward.

Classification accuracies : Females



Classification accuracies: Males



Discussion

- Similar classification accuracy for both sexes across most of the brain indicate that connectivity patterns are both typical within sex and for the majority of brain regions.
- Relatively lower classification accuracy in one sex as opposed to the other implies more varied connectivity patterns across that sex group.
- Similarly, higher accuracy for one sex implies a more typical connectivity pattern within that sex.
- Significantly lower classification accuracies for females as compared to males were found in specific speech and language related brain regions, possibly implicating more varied connectivity patterns in females.
- Possibly related to a larger variety of cognitive strategies and the female advantage in verbal processing ([8]).
- Areas associated with emotional processing of reward show a more typical connectivity pattern in females and might indicate more efficient emotion regulation strategies in females than in males ([9]).

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