Alterations in hemispheric integration and segregation in clinical (schizophrenia) and non-clinical (bilingual) populations

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Introduction

Functional Brain Lateralisation

- Fundamental principle of brain organization
- Commonly quantified as the difference of overall magnitude or extent of brain activation or connectivity in the left and right hemisphere
- Alternative [1] :
  - functional integration: integrative interaction with both hemispheres
  - functional segregation: preferential interaction of one hemisphere with itself

Aim:

Examine differences in functional integration and functional segregation between
- monolingual and bilingual subjects
- schizophrenic patients and healthy controls

Methods

- Dataset 1: OpenNeuro ds001747 (monolingual and bilingual participants, [2])
  - 59 Bilinguals (27 male), 33 Monolinguals (13 male), age: 18-29y, right handed
  - Resting state fMRI data: 823 volumes (TR: 875ms, TE: 43.6ms, 100x100, 72 slices, voxel size 1.8x1.8x1.8mm³), Siemens TRIO Tim 3T
- Datasets 2: COBRE (The Center for Biomedical Research Excellence)
  - 60 schizophrenic patients (48 male); 69 healthy control (49 male), age: 18-65y, right handed
  - Resting state fMRI data: 150 volumes (TR: 2000ms, TE: 29ms, 64x64, 32 slices, voxel size: 3x3x4 mm³), Siemens TRIO Tim 3T
- Standard pre-processing using fMRIPrep (https://fmriprep.org/en/stable/)
- Extraction of mean time course from each parcel of the AICHA atlas [3] and computation of whole brain parcel-wise connectome (Pearson's correlations).
- Functional integration and functional segregation of each parcel computed as [1]

$$\text{Integration left} = LL + LR;\quad \text{Integration right} = RR + RL$$
$$\text{Segregation left} = LL - LR;\quad \text{Segregation right} = RR - RL$$

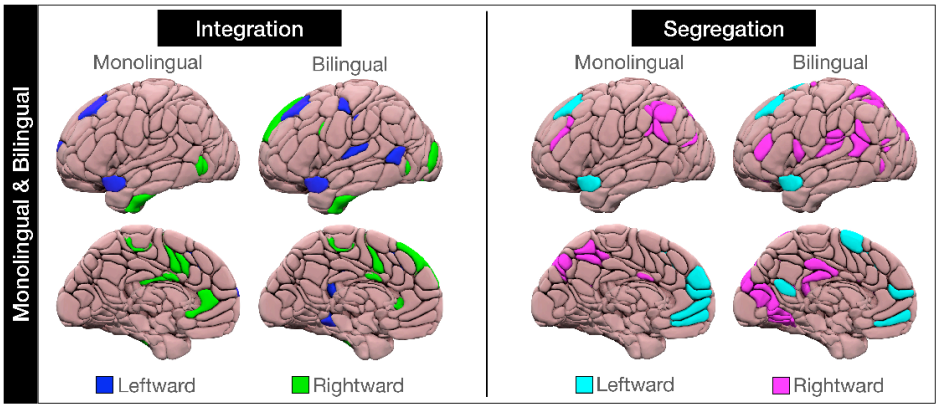
- Functional Decoding (http://brainmap.org/scribe/, [4])

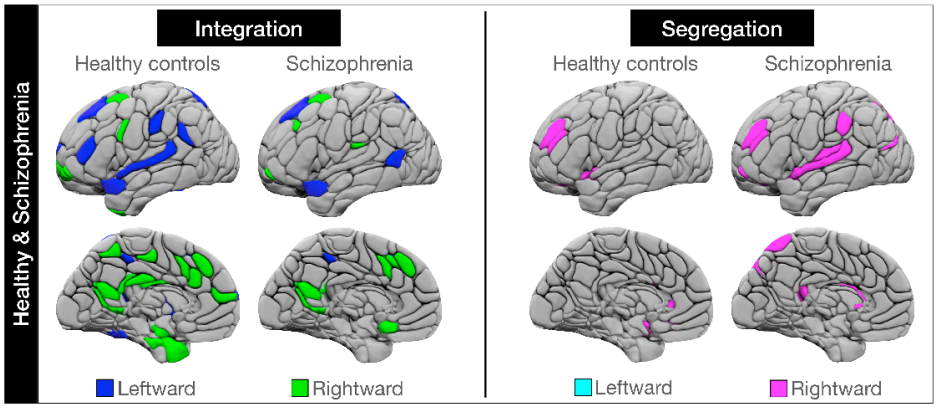
Results

Monolinguals vs. Bilinguals

Integration
- Both monolinguals and bilinguals display more pronounced rightward (mainly medial) than leftward integration (mainly lateral).
- Leftward integration is (non-significantly) more pronounced in bilinguals than monolinguals.

Segregation
- Both monolinguals and bilinguals display more pronounced rightward (mainly posterior lateral) than leftward (mainly medial frontal) segregation.
- Rightward segregation is (non-significantly) more pronounced in bilinguals, while leftward segregation is more pronounced in monolinguals, especially in medial brain areas.





Controls vs. Schizophrenic Patients

Integration
- Both controls and patients display more pronounced rightward (mainly medial) than leftward (mainly lateral) integration.
- Both leftward and rightward integration is more pronounced in controls vs. patients, particularly in lateral temporal cortex (leftward) and temporal pole (rightward).

Segregation
- Both controls and schizophrenic patients display more pronounced rightward than leftward segregation, with patients displaying stronger segregation in superior temporal and temporo-parietal cortex as compared to controls.

Discussion

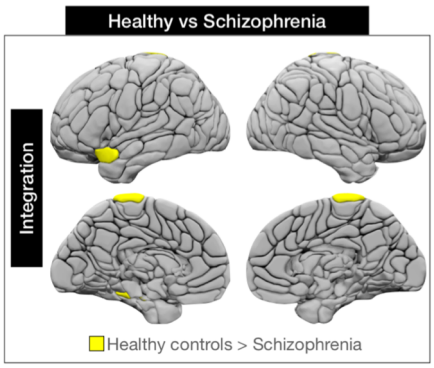
Monolinguals vs. Bilinguals

- Stronger leftward integration and rightward segregation in bilinguals vs. monolinguals might reflect specific patterns of intra- and inter-hemispheric brain connectivity that is connected to acquisition of a second language [5,6].
- Reduced medial frontal leftward segregation in bilingual as compared to monolingual subjects might indicate stronger language-related inter-hemispheric interaction in bilinguals [5].

Controls vs. Schizophrenic Patients

- Within lateral temporal cortex, stronger leftward integration in healthy controls and stronger rightward segregation in patients might reflect often reported abnormal brain asymmetries in schizophrenic patients [7,8].
- Functional decoding shows that group differences are most pronounced in brain areas related to emotion, memory and language, reflecting core symptoms in schizophrenia.

-> Examination of functional integration and segregation might offer more detailed insights into clinical and non-clinical group differences over what can be achieved by comparing left and right brain activity.



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