LANGUAGE LATERALIZATION AND DTI METRICS OF THE CORPUS CALLOSUM

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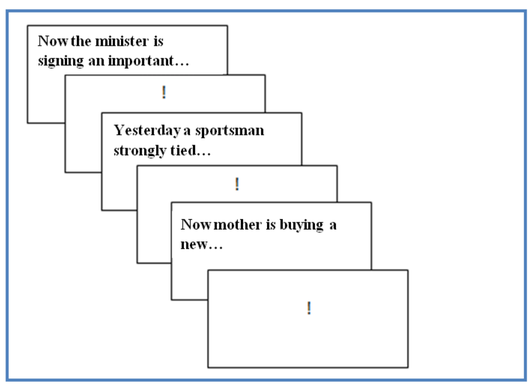
INTRODUCTION

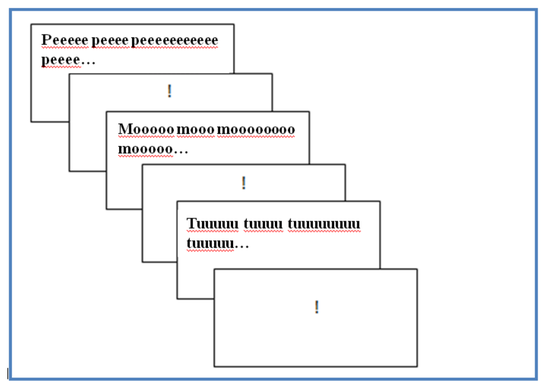
- **Language lateralization**: typically left-hemispheric
- Why right-hemispheric or bilateral in some people?
  - Personal left-handedness
  - Familial left-handedness?
  - Structural correlates?
- **Corpus callosum** (CC):
  - Josse et al. 2009: larger CC volume → greater left lateralization. But: indirect measure of CC volume (midsagittal surface area).
- **Our goal**:
  - To test the relation between language lateralization and direct tractographic metrics of corpus callosum

METHOD

fMRI

- Siemens 3T scanner; sparse sampling, TR = 7 sec
- 120 experimental and 120 control stimuli; in blocks of 3 stimuli





- Analysis in SPM and Lateralization Index toolbox (Wilke & Lidzba, 2007)
- Lateralization index:
  - Based on number and intensity of activated voxels in each hemisphere
  - From +1 (left) to 0 (bilateral) to -1 (right)

DTI

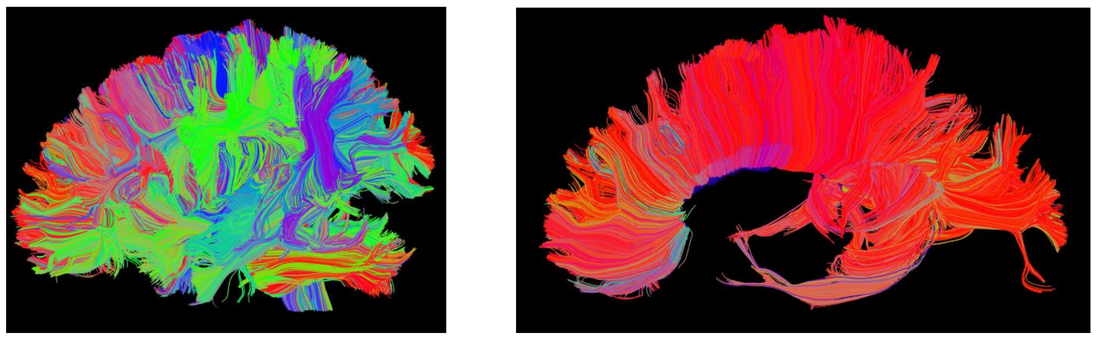
- Two repetitions with opposite phase encoding directions (64 directions, b=1500, voxel size 2x2x2 mm)
- Preprocessing in FSL and ExploreDTI (tensor model)
- CC reconstruction in TrackVis. Metrics:
  - Fractional anisotropy
  - Mean diffusivity
  - Volume
  - Track count

Participants

- 50 neurologically healthy Russian speakers (mean age 24 y.o.; 32 females)
- Edinburgh Inventory (Oldfield, 1971) to assess handedness

RESULTS

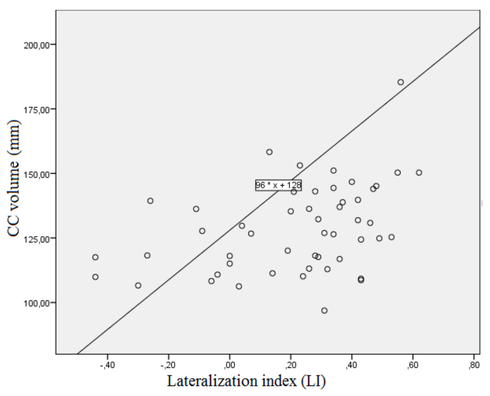
Group	n	Handedness score	Lateralization index
Right-handed	20	+45 to +100	+0.30 to +0.55
Left-handed	20	-100 to -45	-0.44 to +0.53
Ambidextrous	10	-18 to +23	-0.44 to +0.62

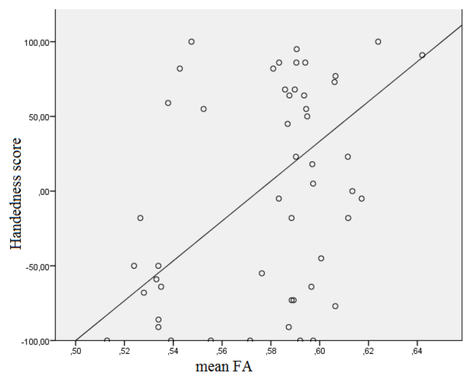


Whole-brain tensor model and corpus callosum reconstruction in one right-handed participant

Significant correlations (Bonferroni-corrected for multiple comparisons):

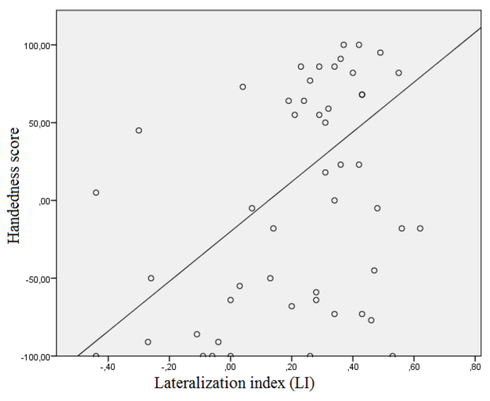
1) Larger volume of corpus callosum - stronger left lateralization of language
r =0.384, p = 0.006





2) Greater fractional anisotropy in corpus callosum - stronger right-hand preference
r = 0.397, p = 0.007

3) Greater right-hand preference - stronger left lateralization of language
r = 0.334, p = 0.018



No other significant relations, including those with age and gender

DISCUSSION

- Larger CC volume – stronger left lateralization of language processing
  - Consistent with Josse et al. (2009) but this study is the first to provide direct tractographic evidence
- Why? Possible mechanisms:
  - Larger CC – better transfer of language-related information from right to left hemisphere
  - Larger CC – better suppression of excessive language-related activation in the right hemisphere
  - Stronger left lateralization – more intensive transfer between language-related information in left hemisphere and non-language-related information in right hemisphere
- Future directions: what about other tracts?