Foreign Language Learning Experience Enhances Inter-hemispheric Functional Connectivity

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Introduction

- Foreign language learning is one of the most challenging educational activities during adulthood.
- Native language processing is typically lateralized in the left hemisphere, regardless of type of language, language user's handedness, or functional language lateralization (Vernooij et al., 2007).
- However, the extent of left laterlization decreases with
  - second-language proficiency (Hull & Vaid, 2007)
  - multilingualism (Hosoda et al., 2013)
  - language-specific features such as tonal properties and logographic writing system (Wong et al., 2007; Nelson et al., 2009)

Question: How does language-learning experience modulate the organization of the functional language network?

Methods

One-month Mandarin training in classroom

- 3.5 in-class hours per day, for 5 days per week, over 4 weeks.
- 11 assignments and 10 quizzes (an average of 2.7 after-class hours per day).

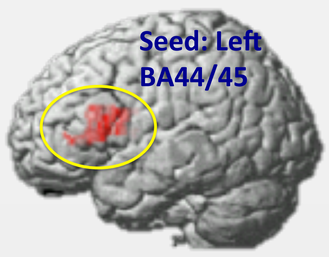
Resting-state functional MRI before and after training

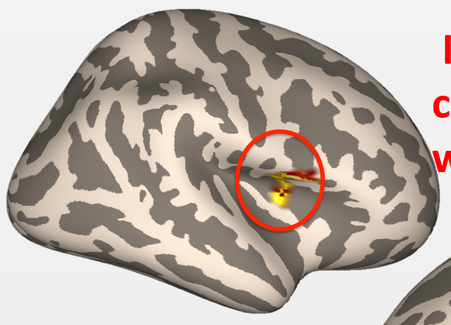
- 6.2-min scan
- TR: 2.5 sec. 37 slices with 3.5 x 3.5 x 3.5 mm voxels

Participants

- 23 native English speakers (8 females and 15 males)
- Age: 18 -33 Mean: 23.1
- Handedness: 19 right-handers and 4 left-handers
- Final exam to test holistic usage of the language (Mean: 76.9; range: 55.9 – 93.1, out of 100).

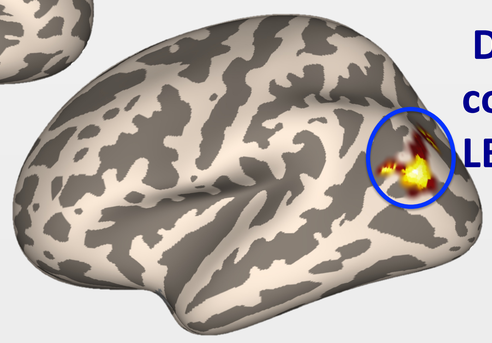
Results





Voxel-level threshold: $p < 0.01$
Cluster-level threshold: $p < 0.05$

Increased connectivity with RIGHT IFG



Decreased connectivity with LEFT MT/ V5

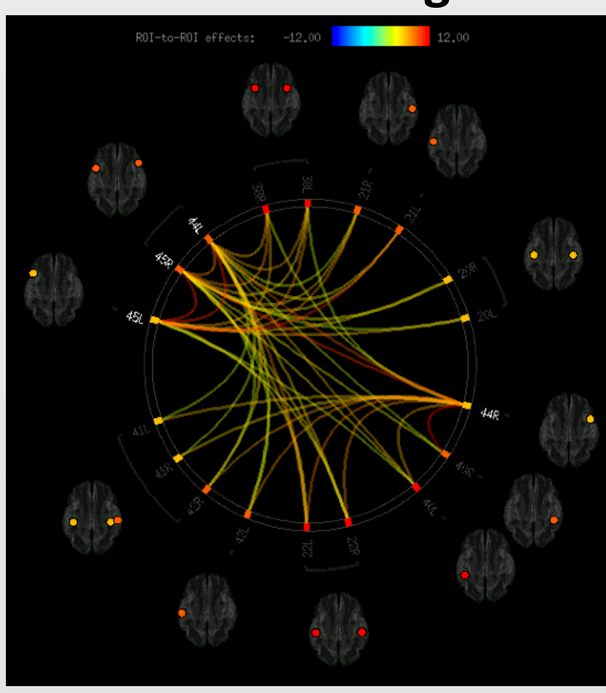
Participants with higher final exam scores showed greater increase in the connectivity between the left and right IFG

Voxel-level threshold: $p < 0.05$
Cluster-level threshold: $p < 0.05$

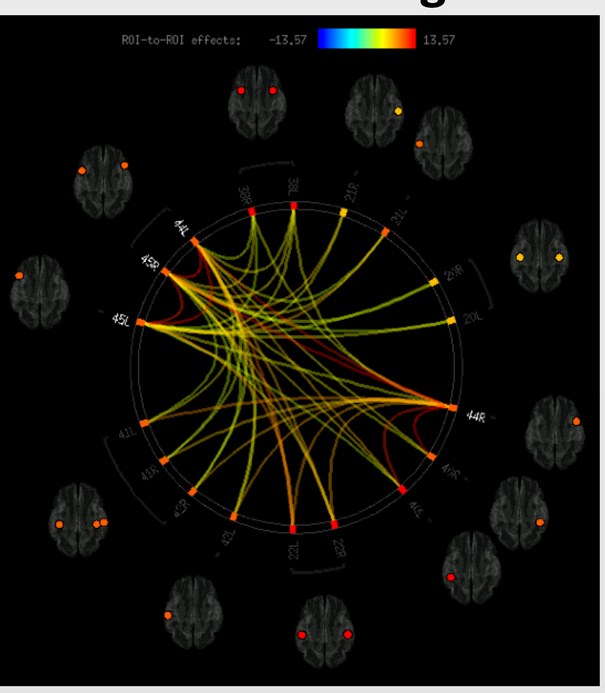
Altered connectivity pattern within the language network

Connection-level **p-FDR (seed-level) = .05,** Seed-level **F-test p-FDR = .05**

Pre-training

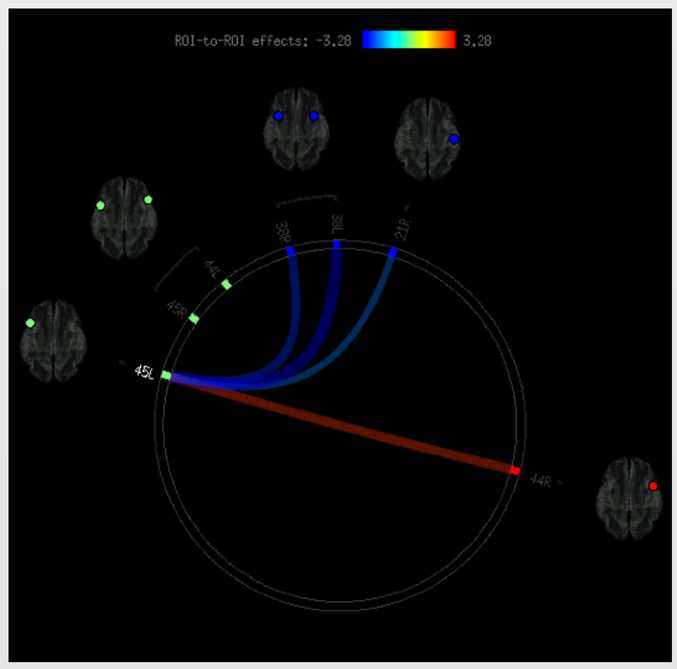


Post-training



Connection-level **p-uncorrected = .1,**
Seed-level **F-test p-FDR = .05**

Post > Pre



Conclusion

- Inter-hemispheric functional connectivity plays a critical role in foreign language learning during adulthood.
- Processing the tonal feature and orthographic complexity of Mandarin Chinese might rely on right hemisphere and its effective communication with left hemisphere at the early stage of learning.

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