Speech Processing and Plasticity in the Right Hemisphere Predict Real-world Foreign Language Learning In Adults
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Introduction

- Despite the fundamental role of speech perception in first language acquisition, the role of speech perception in foreign language learning outcomes remains unknown.
- Nonnative in adults varies substantially across individuals [1].
- Better behavioral performance and stronger neural responses discriminating non-native speech sounds are related to greater success learning foreign language vocabulary and phonology [2-5].

Research Questions

How does the interplay between speech perception and language learning – and particularly the neural mechanisms underlying these processes – determine the long-term retention of holistic, real-world foreign language skills?

Neuroimaging Methods

- **Tone discrimination fMRI task**
  - 96 pairs of Mandarin single words
  - Different syllables; Different speakers
  - 96 pairs of corresponding sinewave tones
  - TR = 2.7 s, TA = 0.5 s, design

- **Task fMRI analysis**
  - FSL v5.0.9 Nipype v0.8
  - Speech vs. Sinewave
  - Randomise function, 5000 permutations

- **Resting fMRI**
  - Scan time: 6 min 15 sec
  - TR = 2.5 s, 37 slices (3.5 mm thick)

- **Resting functional connectivity analysis**
  - SPM v8, ART, CONN v13.p
  - aCompCor for non-neuronal noise sources
  - Anatomically defined seed in left and right IFG

Participants

- 24 native English speakers (8 females and 16 males)
  - Age: 18 - 33, Mean: 23.1

- 3.5 hours every day
  - Highly-interactive classroom with 12-13 students
  - 10 in-class quizzes, 11 assignments
  - Mid-term and Final exams

**Behavioral and Neural Predictors**

a) Immediate attainment is best predicted by pre-training lexical tone discrimination accuracy.

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<tr>
<th>Proficiency</th>
<th>Pre-training (N = 24)</th>
<th>Post training (N = 24)</th>
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<tbody>
<tr>
<td>Speech</td>
<td>r = 0.63, p = 0.001</td>
<td>r = 0.39, p = 0.060</td>
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<tr>
<td>Sinewave</td>
<td>r = 0.53, p = 0.008</td>
<td>r = 0.47, p = 0.020</td>
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Cross-validation analysis of prediction models

- All Learners

b) Long-term retention is best predicted by pre-training right IFG engagement in lexical tone discrimination.

c) Long-term retention is best predicted by plasticity of right IFG (disengagement) in lexical tone discrimination.

Summary:

- The present study demonstrated how the brain organization of speech perception, a fundamental linguistic ability, has a long-lasting effect on adults' holistic acquisition of foreign language.
- Successful whole-language learning hinged on both initial engagement and subsequent disengagement of right IFG for foreign speech processing.
- Enhanced cross-hemispheric connectivity might support transition from initial right-to-left IFG engagement in speech perception.

Reference:


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