



# Neural Underpinnings of Lexical Tone Learning

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## Background

### Introduction

- Second language (L2) learning is difficult when the L2 has elements absent from the native language
- Mandarin, for example, is a tonal language while English is atonal
- Metaphorical gestures representing pitch are effective in helping differentiate between meaning of Mandarin words (Morett and Chang, 2015)

### Posterior Superior Temporal Sulcus (pSTS)

- Implicated in multimodal processing (auditory and visual; Krönke, K. M et al., 2013)

### Laterality Shift

- Pitch gesture facilitates right-to-left shift in brain activity for L2 lexical tone processing in atonal language speakers

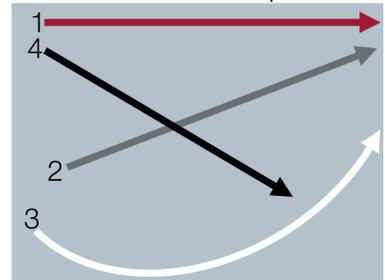


Figure 1. Schematic of the four tones in Mandarin; 1- high flat; 2- rising; 3- low dipping; 4- falling.



Figure 2. Brain with pSTS highlighted

## Aims

Understand the neural and cognitive mechanisms subserving pitch gesture processing in L2 learning

Examine whether pitch gesture facilitates the right-to-left shift in brain activity during L2 lexical tone processing

Determine whether pitch gesture's facilitation of L2 lexical tone acquisition is due to embodiment or conceptual metaphor.

## Participants



Native English Speakers



Undergraduate Students



No Prior Exposure to Tonal Languages

## Method

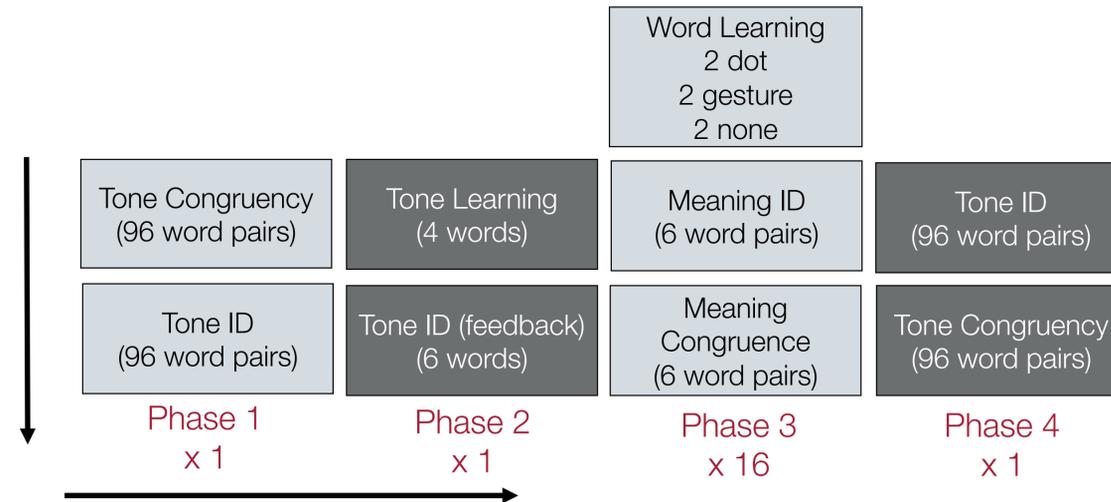


Figure 2. Schematic showing the study design. Note that only Phase 3 is repeated multiple times, as each of the word pairs are divided into sixteen blocks to minimize cognitive overload.

Figure 3. Images from study paradigm phases.

## fNIRS

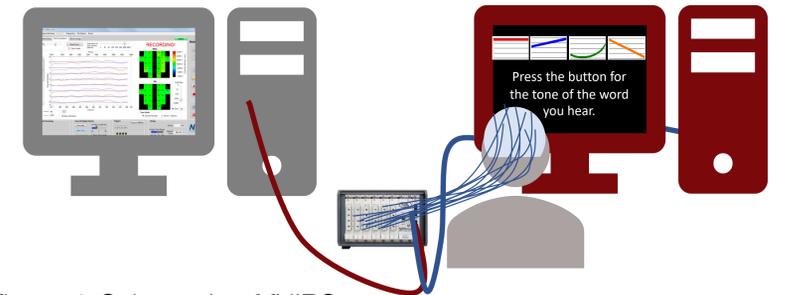


Figure 4. Schematic of fNIRS setup



Figure 5. Brief overview of functional near-infrared spectroscopy.

## Hypotheses

Increased activity in pSTS during pitch gesture condition because of pSTS involvement in iconic gesture processing.

Facilitation of right-to-left shift in brain activity during Mandarin lexical tone learning in pitch gesture condition.

## Implications

Knowledge about how the brain uses gesture to enhance L2 speech sound acquisition

Importance of pedagogical use of pitch gesture in L2 lexical tone and intonation learning

## Acknowledgements

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## References

1. Krönke, K.-M., Mueller, K., Friederici, A. D., & Obrig, H. (2013). Learning by doing? The effect of gestures on implicit retrieval of newly acquired words. *Cortex*, 49(9), 2553-2568.
2. Morett, L. M., & Chang, L. Y. (2015). Emphasizing sound and meaning in tonal language acquisition: A gesture training study. *Language, Cognition and Neuroscience*, 30, 347-353.2.