

探討人腦聽覺系統處理中文聲調的神經機制

Tracking lexical tone processing in the human auditory pathway

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The acoustic realization of Mandarin lexical tones is susceptible to the preceding context [1]. Among these variations, Tone 3 sandhi is an extreme case that results in phonological neutralization. When two underlying Tone 3 occur consecutively, the first one bears a rising fundamental frequency (f₀) contour that is perceptually identical to Tone 2 [2]. This phonological process renders the sequence of two low tones, i.e., the canonical form of Tone 3 in isolation, phonotactically illegal in some domains. However, the sequence of two low tones does exist in the language, as in the short sentence *da la* ‘hit s^FP.’ Thus, it is unclear whether listeners automatically detect the irregularity if Tone 3 sandhi is violated in the speech.

This study aims to examine the phonotactic processing of lexical tones and how it is influenced by attention. We compared listeners’ event-related potential (ERP) responses to two types of auditory stimuli in two tasks. The **Norm** stimuli were disyllabic words with two underlying Tone 3 and the legal rising-low f₀ contour. The **Odd** stimuli were created by substituting the low f₀ for the rising f₀ of the first syllable in the Norm stimuli. Other possible combinations of two tones, such as /Tone 1-Tone 2/ and /Tone 3-neutral tone/, served as fillers. A phonetically trained male native speaker produced these stimuli. Finally, 20% of the stimuli were made to resemble a female voice. In the **Attended** condition, participants pressed a button when they heard a target female voice. In the **Unattended** condition, they were told to ignore the sounds (See Figure 1 for more details.).

Figure 2 and Figure 3 illustrate the ERP results from five representative electrodes in the Attended and Unattended conditions, respectively. The ERP data were analyzed using the Mass Univariate ERP toolbox [3]. In the Attended condition, the ERP for the Odd stimuli differed from the Norm stimuli at the Oz electrode between 494–513 ms. Thus, listeners are sensitive to the violation of Tone 3 sandhi even when they are not engaged in lexical processing. Interestingly, no significant difference was found in the Unattended condition, suggesting that attention plays a critical role in detecting phonotactic violations.

Figure 1. Experimental procedures. In the Attended condition, participants stared at the fixation cross on the screen. They had to pay attention to the sounds to identify the target. In the Unattended condition, they watched a subtitled silent movie of their interest. The auditory stimuli were the same in both conditions. ERPs were recorded during the experiment.

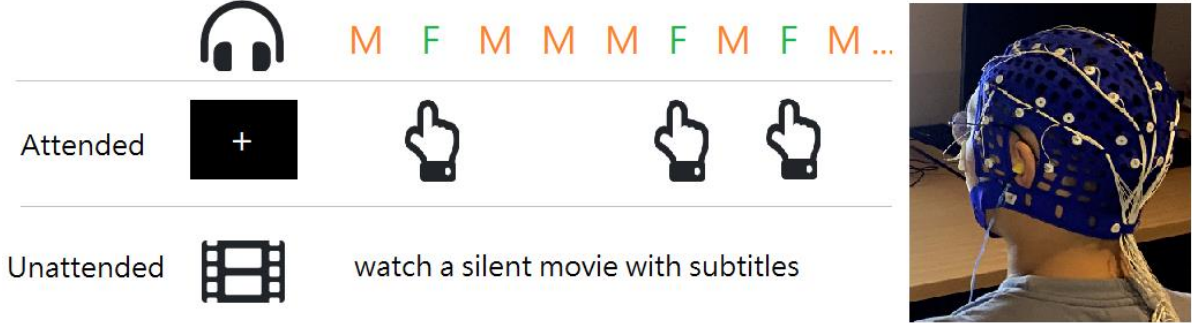


Figure 2. The grand average ERP of data from 22 participants in the Attended condition.

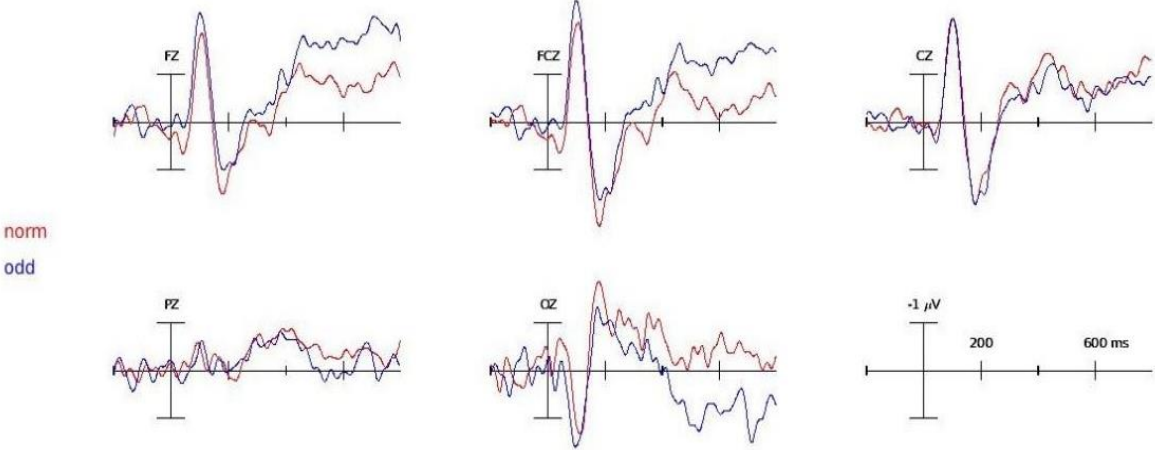
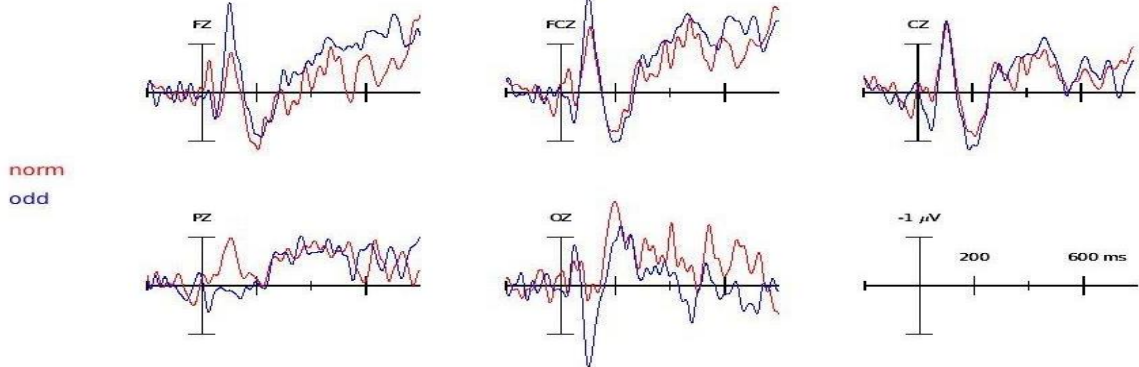


Figure 3. The grand average ERP of data from 12 participants in the Attended condition.



References

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