

Investigating MMN Responses to Pitch Contrasts in Monolingual and Bilingual Speakers of Tonal Languages

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Among the myriad aspects of language processes, correctly perceiving suprasegmental information is vitally important. However, the majority of the studies of language process assumes a monolingual mindset. Some researchers have highlighted that there are needs to improve the understanding of language processes in multilingual speakers, because working with different languages in everyday lives might require special needs[1]. To contribute to this lack, the present study explored whether lexical tone contrasts of syllables would be processed in the same way regardless of the language background of participants?

In the present study, participants' pitch perception was evaluated in an event-related potentials (ERP) experiment. One group of participants was Mandarin Chinese speakers, and the other one was Hailu Hakka-Mandarin Chinese bilinguals. We measured the mismatch negativity (MMN) which is a unique ERP activity to index discernible changes of acoustic features in a streams of sound and is not influenced by attention[2, 3]. Kuo et al.[4] have noted that there were theoretical explanations for the influence of bilingual experiences on speech perception, such as , such as the cross-language transfer theory and the structural sensitivity theory. Both theories would expect that owing to the simpler phonological structure of Mandarin Chinese than Hailu Hakka, Mandarin speakers may be less sensitive to the phonemic features of Hakka syllables. Therefore, Mandarin speakers may exhibit reduced or insignificant MMN response to the T1/T3 contrast in Hakka syllables.

Seventeen native Mandarin speakers and sixteen Hakka-Mandarin bilinguals were recruited to participate in MMN experiments. Two lexical tones utilized here were the high level tone (T1) the low falling-rising contour tone (T3). One set of speech stimuli were two Mandarin syllables /zu/ with T1 and T3, and they are not real morphemes or words in Hailu Hakka. The other set were Hakka syllable /so/ with T1 and T3, and they are not real morphemes or words in Mandarin. There were four experimental blocks, and each block had five hundreds trials. In each trial, a syllable was presented over two loudspeakers at 70 dB. The stimuli lasted 350 ms with a 400 ms inter-trial interval. The four blocks were orthogonally assigned to one of two languages, and one of two conditions, including the MMN condition and the probability control condition. In the MMN condition, the T1 and T3 syllables were presented 100 and 400 times, respectively. In the control condition, the T1 and T3 syllables were presented with equal probability. During the experiment, participants were watching a movie without its sounds and subtitles, and their EEG signals were simultaneously recorded from 32 scalp electrodes.

A repeated-measure ANOVA model including the condition of probability (control and MMN conditions), language types (Mandarin syllables and Hakka syllables) and electrodes (six electrodes in the frontal scalp) as independent variables was applied to the data of each group. The dependent variable was the mean amplitude of ERPs to T1 syllables. In Hakka-Mandarin bilingual speakers, the main effect of conditions was significant, $F(1, 15) = 15.45$, $p = .001$, suggesting that syllables in MMN blocks yielded more negative activity than in control blocks. The interaction between conditions and language types was not significant, $F(1, 15) = .07$, $p = .796$, suggesting that the difference between MMN and control blocks did not vary across language types. In Mandarin speakers, the results yielded a significant main effect of conditions, $F(1, 16) = 22.01$, $p < .001$, and a significant interaction between conditions and language types, $F(1, 16) = 6.74$, $p = .019$, suggesting that the condition effects differed in terms of language types. Post-hoc tests with Bonferroni-Holm adjustments showed that Mandarin speakers' ERP activity to the syllable /zu1/ in the MMN block was significantly more negative than that in the control block (adjusted $p < .001$).

Finally, there was no condition effect on Mandarin speakers' ERPs to the Hakka syllable /so/ (adjusted $p = .283$).

In conclusion, the present study demonstrates that monolingual speakers might store a bank of phonological exemplars to perceive the tonal information of native syllables, whereas bilinguals have a more generalized representation of pitch height that allows them to process tonal information from different tonal languages. This study highlights the importance of considering the linguistic background of the participants when studying speech perception in tonal languages, and underscores the need for more research to better understand how linguistic experience can be used to improve language learning.

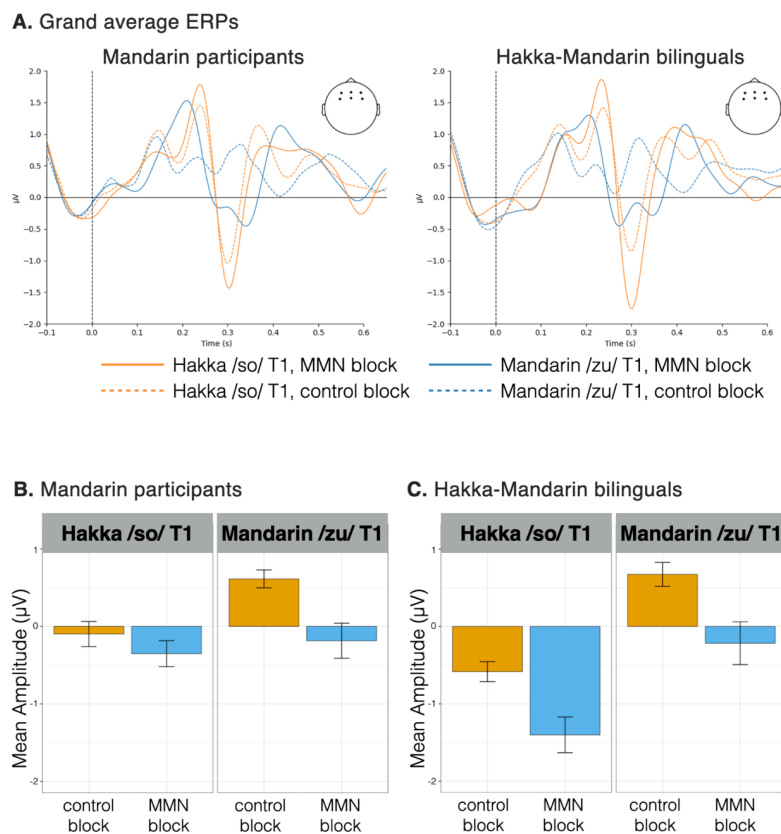


Figure 1. (A) Grand average ERPs elicited by syllables in MMN and control blocks within each participant group at electrodes of interest. (B) Bar plots of the mean amplitudes as a function of the condition of probability (control and MMN conditions), language type (Mandarin syllables and Hakka syllables) within Mandarin participants. The error bars show standard errors. (C) Bar plots of the mean amplitudes within Hakka-Mandarin bilingual participants.

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