No word-specific mismatch negativity effect in Mandarin speakers

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A key feature of the architecture of language processing is presumably that words of a language are represented and processed differently than nonwords. One piece of evidence for this comes from the mismatch negativity, a component of brain activity which is larger when hearing real words than when hearing nonwords, and which is not due to low-level physical differences between them. This lexicality effect on the mismatch negativity has been observed in English [1,2], Finnish [3-5], and Thai [6]. These effects suggest that the mismatch negativity can serve as a bio-marker for determining whether a stimulus is processed like a word or not like a word (e.g., if it activates long-term memory traces or initiates computations associated with linguistic processing of morphologically meaningful units). The present study aimed to take advantage of this fact to examine the brain-level processing of Mandarin words, nonwords, and allomorph stimuli: sounds that do not exist as citation forms of real words but that are frequently produced (and heard) as outputs of a phonological alternation (like rising-tone [kʰaˊ], which native speakers will generally say is not a word, but which is an allomorph of the low-tone real word [kʰaˬ] 卡 when it appears in certain contexts).

The mismatch negativity is measured by presenting sounds in an oddball paradigm, where participants hear one category of sounds frequently and another category of sounds rarely. The mismatch negativity is the brain response to the rarely presented sounds, minus the response to the frequently presented sounds. Low-level physical differences between words and nonwords can thus be controlled by including those differences in both the frequently-presented and rarely-presented sounds, so they will be "subtracted out" of the mismatch negativity response. The mismatch negativity response itself reflects the detection of the change between the frequent and rare stimuli, rather than the exogeneous response to purely physical aspects of the sound; since the mismatch negativity for words is often bigger than that for nonwords, it may also reflect the activation of long-term memory representations associated with the rare stimulus.

In the present study, 48 native speakers of Mandarin (pre-tested to ensure that they did not believe they know any characters with pronunciations corresponding to the sounds that we are treating as nonwords) participated in a passive oddball paradigm in which they heard the following types of blocks (the stimuli before the ellipse represent the frequently-presented sounds and the stimuli after represent the rarely-presented sounds):

- **Word stimulus as rarely-presented sound:** [kʰaiˬ] [kʰaiˬ] [kʰaiˬ] … **[kʰaˬ]**
- **Nonword stimulus as rarely-presented sound:** [pʰaiˬ] [pʰaiˬ] [pʰaiˬ] … **[pʰaˬ]**
- **Word stimulus as rarely-presented sound:** [pʰaiˊ] [pʰaiˊ] [pʰaiˊ] … **[pʰaˊ]**
- **Allomorph stimulus as rarely-presented sound:** [kʰaiˊ] [kʰaiˊ] [kʰaiˊ] … **[kʰaˊ]**

In each block, they heard 20 of the frequently-presented stimuli in a row, and then heard 330 stimuli pseudorandomly mixed such that 85% of the sounds (290 trials) were the frequently-presented stimulus and 15% (50 trials) were the rarely-presented stimulus; each block occurred three times, so there were 150 trials of each type of rare stimulus. The acoustic difference between the frequent and rare stimuli was always the same (the frequently-presented stimuli had a diphthong rime [ai] and the rarely-presented stimuli a monophthong rime [a]) and the sounds were cross-spliced to ensure the same rimes were used across rarely-presented stimuli that would be compared. This design ensures that differences observed between the mismatch negativity waves cannot be due to physical differences in the stimuli or to easier-to-detect vs. harder-to-detect changes between the frequent and rare stimuli. (It also would not be due to differences in the lexicality of the frequently-presented stimulus, as previous studies have shown this to not have an impact on the mismatch negativity [1].) We predicted that real-word [kʰaˬ] would elicit a larger (more negative) mismatch

negativity than nonword [pʰaɻ], whereas the difference between real-word [pʰaɭ] and allomorph token [kʰaɭ] (not a real word, but a possible allomorph of one) would depend on whether or not the latter is processed like a real word.

Results (from electrode Fz) from our 48 speakers are shown in the figure below, with solid blue lines for real words and dashed or dotted red lines for nonwords and allomorph stimuli. Contrary to expectation, real words did not elicit larger mismatch negativity than nonwords. These results challenge previous understanding of the nature of apparent lexicality effects in the mismatch negativity. While there are many other paradigms showing that words and nonwords are processed differently (such as the prime lexicality effect [7]), the present results suggest that either mismatch negativity is not a reliable biomarker of this difference, or that lexicality in Mandarin has different properties than it does in other languages where this effect has been shown.

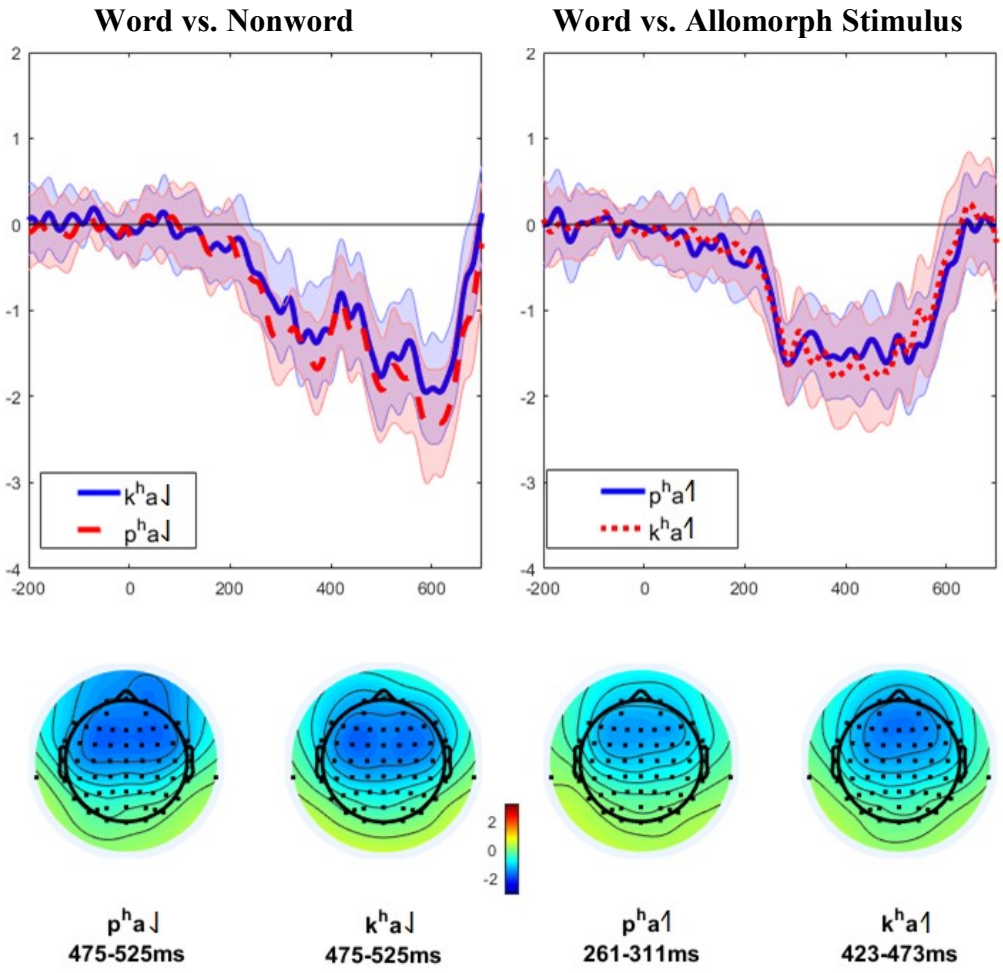

Fig.1 Mismatch negativity waves (deviant minus corresponding standard) for each deviant. Blue lines represent real word stimuli, red dashed lines represent the unambiguous nonword stimulus, and red dotted lines represent the allomorph stimulus.

References

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