

## Cross-category effects and prime-target frequency interactions in reading aloud lexical tones: a mixed effects model of ERPs

**Introduction** The phonetic realisation of speech sounds depends on their context. For example, /t/ is aspirated in ‘top’, but unaspirated in ‘stop’. Yet how such phonetic variation is processed online during reading and speech production is not yet well understood. Does processing involve activation of the speech category (e.g. the phoneme /t/) or the context-specific form (e.g. unaspirated [t])? The present study investigates how context-dependent phonetic variation is processed by measuring ERP amplitude during reading aloud with masked priming. The study also investigates whether processing involves *cross-category priming*; that is, whether there is an effect of phonetically similar, but phonologically different visually-presented primes.

In Beijing Mandarin, Tone 3 (T3) usually has a low contour (low T3), but preceding another Tone 3 syllable, it has a rising contour (T3 sandhi). Importantly, Tone 2 (T2) also has a rising contour. So, T2 and T3 sandhi are phonetically similar (both have a rising contour), despite belonging to different tone categories.

**Method** ERPs were recorded from 24 native Beijing Mandarin speakers as they read aloud words preceded by brief (48 ms) masked primes. All critical targets were T2 words (e.g. 鱼缸, yu2gang1, ‘fish tank’). All primes were T3 words, so there was no overlap in tone category. However, primes either matched the target in tonal contour (T3 sandhi words, *Contour-match condition*; e.g. 雨水, yu3shui3, ‘rain’) or mismatched (low-T3 words, *mismatch condition*; 雨衣, yu3yi1 ‘raincoat’). Initial characters were identical between conditions. Any difference between conditions indicates activation of the context-specific tonal contour, determined by the second character.

**Results** ERPs were analysed using Generalised Additive Mixed Modelling, a non-linear model with random effects for subjects and items. To avoid possible speech artefacts, only data preceding 500ms were analysed. Divergences emerged around 100ms and at around 300-400ms after target presentation. ERP amplitude varied as a function prime type (contour-match vs. mismatch) and interacted with prime and target word frequency. In the contour-match condition, negativity was reduced when target frequency was relatively high and prime frequency low. However, when prime and target frequency were both high or both low, there was increased negativity, suggesting competition between prime and target. In the mismatch condition, there was relatively little effect of item frequencies.

**Discussion** These results suggest that when tonal contour no longer discriminates between prime and target (contour-match condition), the a priori probabilities of the prime and target come into play. The conflict that arises between prime and target requires increased processing effort as reflected in greater ERP amplitudes. This difference in the pattern of effects between the contour-match and mismatch primes provides evidence for top-down effects of context on phonological processing of masked primes during reading aloud.

In summary, the present results show that even for briefly presented masked primes, the context-specific phonetic form is processed. Moreover, activation of this context-specific variant influences processing of targets from a different tone category, demonstrating cross-category phonological effects.