Activation of phonological speech variants in visual word recognition: Evidence from Chinese tonal allophones

Jessie Nixon, Yiya Chen and Niels Schiller
University of Leiden
Contact: j.s.nixon@hum.leidenuniv.nl

During speech, the constituent sound units (phonemes) that make up words often have two or more realizations (allophones), determined by context. For example, in English, voiceless stops, such as /t/, are aspirated in the canonical form ('top'), but unaspirated following /s/ ('stop'). Such variation is ubiquitous in language. Yet many current psycholinguistic models fail to account for how context-specific realisations are processed in language use.

A number of recent studies have investigated the question of specificity with regard to speech production and perception. McQueen *et al.* (2006) found that training with ambiguous [f-s] fricative sounds led to retuning of phoneme perception, which, critically, generalized to words not in the original training set. They argue that lexical processing must employ sublexical phonological abstraction. On the other hand, Nielsen (2011), using an adaptation of the imitation priming paradigm (Goldinger, 1998), found evidence not only for phoneme-level representations, but also for non-discrete, gradient, subphonemic representations of voice onset time. These studies provide evidence for both abstract and specific representations, at least in speech production and perception. To the best of our knowledge, the present study is the first to investigate specificity of phonological representations in visual word recognition (VWR).

Moreover, this study extends the debate with evidence from a tonal language. Beijing Mandarin has four lexical tones. Tone 3 (T3) has two realizations ('allotones'). In most contexts, T3 characters (=syllables) are realised with a *low* contour. However, when followed by another T3 character, the first has a *rising* contour, known as tone Sandhi. Moreover, Tone 2 (T2) is also pronounced with a rising contour, making the Sandhi allotone ambiguous with T2. The aim of this study was to determine whether retrieval of Sandhi words involves activation of the 'underlying' low allotone, the 'surface' rising allotone, or both.

This study used the picture-word interference (PWI) task to investigate activation of phonological variants of sandhi words. In this task, pictures are presented on screen, with phonologically related distractor words superimposed over them; participants ignore the words and name the pictures. Targets were pictures of T2 or T3 words; distractors were sandhi words or Controls (tone 1 or 4). If recognition of Sandhi words activates the rising allotone, we expect naming latencies for T2 pictures to be shorter with Sandhi distractors, compared to controls. If recognition of Sandhi words activates the low allotone, we would expect T3 naming latencies to be shorter with Sandhi distractors.

The data were analysed using linear mixed effects regression modeling (Baayen, 2008). The best fit model revealed a main effect of distractor type, with faster RTs for sandhi words compared to controls, and no effect of target type (see Figure 1). This suggests that both variant representations are activated during recognition of Sandhi words.

Figure 1: Response latencies for T2 and T3 pictures as a function of distractor type
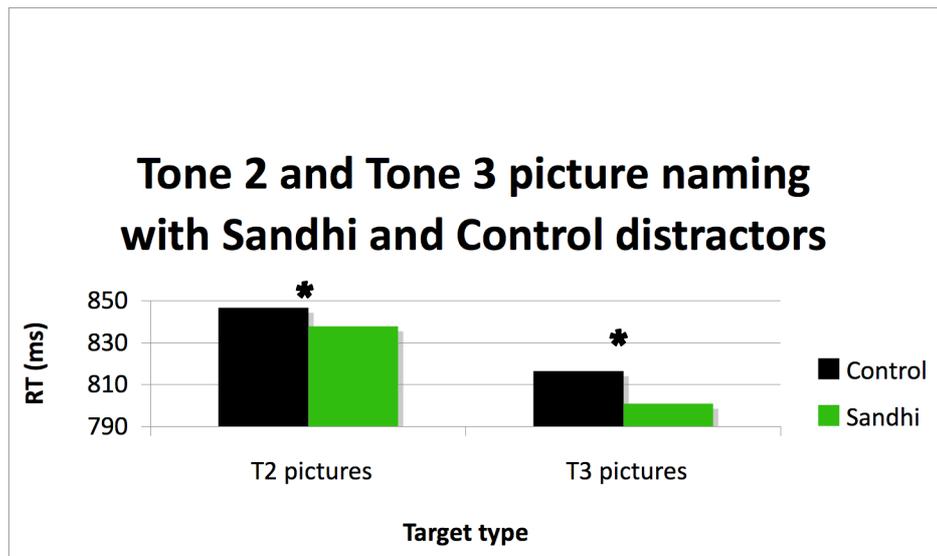
This has implications for both VWR and language production research. Language production models need to account for the subphonemic nature of phonological representations, not only in terms of segmental phonemes, but also at the level of lexical prosody (tones). In addition, the results provide evidence that visual processing of words involves activation of both the context-specific and the (superfluous) 'underlying' form.

References:
Goldinger, S. D. (1998). Echoes of echoes? An episodic theory of lexical access. *Psychological Review*, 105, 251–279
McQueen, J., Cutler, A. & Norris, D. (2006). Phonological Abstraction in the Mental Lexicon. *Cognitive Science*, 30, 1113–1126
Nielsen, K. (2011), Specificity and abstractness of VOT imitation. *Journal of Phonetics*, 39, 132-142.