**Lexical competition in Mandarin Chinese spoken word recognition**

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In the canonical Neighborhood Activation Model (Luce and Pisoni, 1998), words greater in phonological neighborhood density (PND) showed greater errors in perceptual identification and were competitive, i.e., slowed reaction times, in auditory word repetition (a.k.a. shadowing) and auditory lexical decision. Evidence of lexical competition has been replicated in French (Ziegler, Muneaux and Grainger, 2003; Dufour and Frauenfelder, 2010), yet showed facilitative effects, i.e., faster reaction times to words greater in PND, in both Spanish (Vitevitch and Rodríguez, 2004) and Russian (Arutiunian and Lopukhina, 2020).

A recent focus has turned towards Mandarin Chinese to ask whether phonological neighbors facilitate or inhibit spoken word recognition in a tonal language. Due to the added complexity of tonality within the lexicon, the studies that have investigated neighborhood activation in Mandarin have had to simultaneously face the long-standing question of segmentation of the Mandarin syllable (for review, see: Neergaard and Huang, 2021). Exploratory studies that compared multiple models, each representing PND values based on differing segmentation schemas, found that spoken monosyllables (Neergaard and Huang, 2016) and bound morphemes (Yao and Sharma, 2017) were slowed by higher PND values within segmentation schemas that are tonal and segmented. Yet, a third study that used the tonal fully segmented schema (C_G_V_X_T), with controlled stimuli of both monosyllables and disyllables, found a facilitative effect (Neergaard, Britton and Huang, 2019). This contradiction poses the question of whether syllable length affects how activation spreads among words in long-term memory.

Under the assumption that lexical tone binds segmental units, leading to a first-syllable influence on the recognition of disyllables, we created a novel metric. Syllable degree (SyDegree) combines the phonological neighbors of the first syllable with those of the disyllable. This calculation also allows for a SyDegree recalculation of lexical frequency (SyFreq) and phonological clustering coefficient (syCC: i.e., the interconnectedness of a word's phonological neighbors). In two experiments we sought to 1) implement the methods found in Sadat *et al.* (2014), who used large stimuli sets, 2) contrast effects of neighborhood activation between SyDegree and the segmented PND metric used in the above-mentioned studies, and 3) provide the first experimental evidence of the effect of PND on spoken errors.

In Experiment 1, 34 native-Mandarin speakers repeated 503 spoken words (239 monosyllables, 264 disyllables). The PND model contained lexical frequency (Freq), clustering coefficient (CC), phonotactic probability (PP) and a Syllable:PND interaction. Only the inhibitory effect of monosyllables from the Syllable:PND interaction was significant ($t=3.14$; $p<.01$). The SyDegree model contained SyFreq, SyCC, PP and a Syllable:SyDegree interaction. Both monosyllable:SyDegree ($t=4.05$; $p<.01$), and disyllable:SyDegree ($t=2.245$; $p=0.025$) slowed reaction times, while SyFreq was facilitative ($t=-2.24$; $p<.01$). In Experiment 2, 27 participants shadowed the same words embedded in noise, such that the dependent effect was the number of errors produced by the participants. In the PND model, higher Freq led to fewer errors ($t=-3.55$; $p<.01$), higher CC led to more errors ($t=2.10$; $p<.05$), and only monosyllable:PND ($t=3.01$; $p<.01$) led to more errors. In the SyDegree model, higher SyFreq led to fewer errors ($t=-3.50$; $p<.01$), while higher SyDegree for both monosyllables ($t=3.41$; $p<.01$) and disyllables ($t=2.37$; $p=.02$) led to more errors.

Our results show that words with greater numbers of phonological neighbors in the Mandarin mental lexicon lead to competitive effects in spoken word recognition, however, effects with disyllables is contingent on accounting for the effect of the first-syllable's phonological neighbors.

**References**


Arutiunian, V. and Lopukhina, A. (2020) 'The effects of phonological neighborhood density in childhood word production and recognition in Russian is opposite to English', *Journal of Child Language*, pp. 1–19. doi: 10.1017/S0305000920000112.

Dufour, S. and Frauenfelder, U. H. (2010) 'Phonological neighbourhood effects in French spoken-word recognition', *Quarterly Journal of Experimental Psychology*, 63(2), pp. 226–238. doi: 10.1080/17470210903308336.

Luce, P. A. and Pisoni, D. B. (1998) 'Recognizing Spoken Words: The Neighborhood Activation Model', *Ear and hearing*, 19(1), pp. 1–36. doi: 10.1097/MPG.0b013e3181a15ae8.Screening.

Neergaard, K. D. *et al.* (2021) 'Database of Word-Level Statistics for Mandarin Chinese (DoWLS-MAN)', *Behavior Research Methods*.

Neergaard, K. D., Britton, J. and Huang, C.-R. (2019) 'Neighborhood in Decay: Working Memory Modulates Effect of Phonological Similarity on Lexical Access', in Goel, A. K., Seifert, C. M., and Freksa, C. (eds) *Proceedings of the 41st Annual Conference of the Cognitive Science Society*. Montreal: Cognitive Science Society, pp. 2447–2453. Available at: https://mindmodeling.org/cogsci2019/papers/0423/0423.pdf.

Neergaard, K. D. and Huang, C.-R. (2016) 'Graph theoretic approach to Mandarin syllable segmentation', in *Proceedings of The 15th International Symposium on Chinese Languages and Linguistics (IsCLL-15)*. Taipei, Taiwan.

Neergaard, K. D. and Huang, C.-R. (2021) 'Mandarin Chinese syllable structure and phonological similarity: Perception and production studies', in Lin, Y. H. and Huang, C.-R. (eds) *Cambridge Handbook of Chinese Linguistics*. Cambridge University Press.

Sadat, J. *et al.* (2014) 'Reconciling phonological neighborhood effects in speech production through single trial analysis', *Cognitive Psychology*, 68, pp. 33–58. doi: 10.1016/j.cogpsych.2013.10.001.

Vitevitch, M. S. and Rodríguez, E. (2004) 'Neighborhood density effects in spoken word recognition in Spanish', *Journal of Multilingual Communication Disorders*, 3(1), pp. 64–73. doi: 10.1080/14769670400027332.Neighborhood.

Yao, Y. and Sharma, B. (2017) 'What is in the neighborhood of a tonal syllable? Evidence from auditory lexical decision in Mandarin Chinese', in *Proceedings of the Linguistic Society of America*. Austin, Texas, pp. 1–14. doi: 10.3765/plsa.v2i0.4090.

Ziegler, J. C., Muneaux, M. and Grainger, J. (2003) 'Neighborhood effects in auditory word recognition: Phonological competition and orthographic facilitation', *Journal of Memory and Language*, 48(4), pp. 779–793. doi: 10.1016/S0749-596X(03)00006-8.