Probabilistic Selection of Input in Diachronic Mandarin Tone 3 Reduction This paper demonstrates ongoing tonal reduction in Standard Chinese (SC) from a full concave Tone 3 (T3; 214) to its shortened 'half-tone' allomorph (21) and proposes an account based on Probabilistic Selection of Input (PSI; e.g. Chen 2014; Guy 2007, 2014). PSI assumes a rich lexicon that stores all surface allomorphs of a morpheme and probabilistically selects the allomorphs as the phonological input of the morpheme. The 'half-tone' allomorph has a higher chance to be selected as the input of T3 words due to its high token frequency, which then surfaces faithfully to replace the full concave tone in the output. The half-tone output eventually becomes the learning target of T3 words and thus initiates the tonal change. This account will be verified with similar experiment and simulation results elaborated below.

The full concave citation tone of T3 words in SC (i.e. 214) only occurs in a phrase-final position and has been commonly assumed as their tonal UR. An input full concave tone undergoes two tone sandhi processes as illustrated in (1): Before any word with a non-third tone (1a; i.e. in any non-phrase-final positions), 214 is reduced as a 'half-tone' 21 (e.g. Zhang & Lai 2010). Before another 21(4), a T3 word is produced with a rising tone 24 (1a; i.e. Third Tone Sandhi). The half-tone allomorph 21 should have a higher token frequency than the other two allomorphs; in every long sentence, there is only one phrase-final position for the 214 allomorph to surface, and T3+T3 sequences for the 24 allomorph to surface are outnumbered by T3+Non-T3 sequences.

(1) Tone sandhi processes of Tone 3: a. 214→21/__T b. 21(4)→24/__21(4)

If learners store all T3 allomorphs for every T3 word in a rich lexicon and probabilistically determine the input of each T3 word, a frequency bias toward the half-tone allomorph 21 then largely increases its chance to be selected as the input. Consequently, the half-tone output may emerge to replace the full concave production of T3 words in the isolated and phrase-final contexts. In addition, PSI also predicts a slower change for T3 words that appear in phrase-final positions more frequently given a weaker frequency bias toward their 21 allomorph; given a lower chance for the half-tone allomorph to serve as the input and surface as a half-tone output, it takes longer for these T3 words to be completely realized as a half-tone.

The above predictions were tested by an elicitation task that required native SC speakers produce eighteen Tone 3 words in the phrase-final position. The probability of full concave tone productions of each T3 word was analyzed using Linear Mixed-Effect Regression, and the token frequency of each word in non-final and final positions were calculated as a Non-Final:Final Ratio to be the main predictor. The results in Figure 1 suggest that (1) T3 is undergoing the shortening process in SC with a free variation between the half and full concave tone, and (2) T3 words that appear in phrase-final positions more frequently (i.e. higher ratio) has a higher chance to be produced as a full concave tone. Both match the predictions based on PSI.

We further attempted to verify the PSI account by simulating the experiment results with a training corpus of the same eighteen T3 words with their frequency information. The PSI-based algorithm repeats cycles of calculating input probabilities with allomorph frequencies, producing the surface variation of T3 words, and acquiring new input probabilities of T3 words. The simulation results in Figure 2 indicate similar percentages of full concave outputs for T3 words whose Ratio is higher than 0.178, suggesting that a rich lexicon storing all surface allomorphs is crucial in modeling morphophonological acquisition and predicting morphophonological changes triggered by an unbalanced allomorph distribution in the learning inputs.

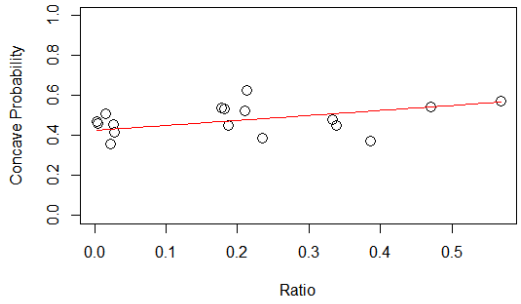

Figure 1. Probabilities of full concave tone output (y-axis) of Tone 3 words with different Final:Non-Final ratio (x-axis) in the real elicitation task

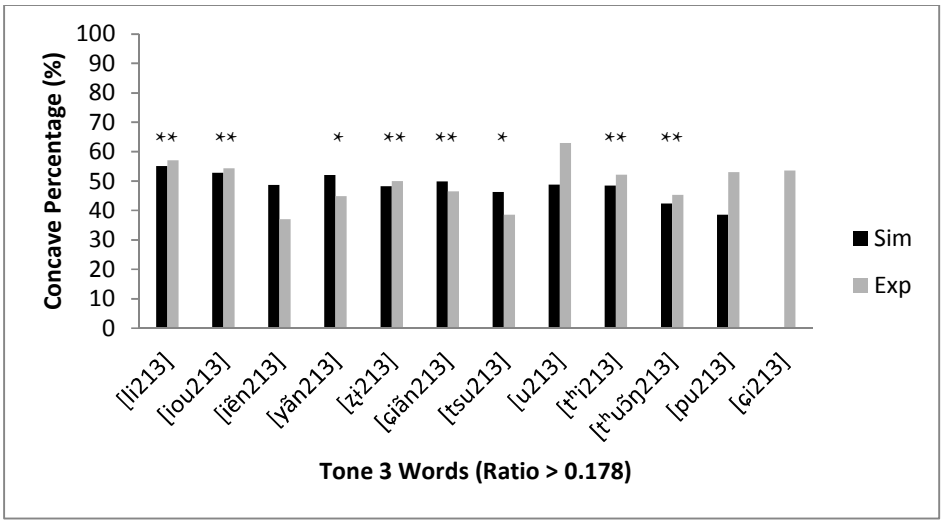

Figure 2. Concave percentages of twelve Tone 3 words with a ratio higher than 0.178

Sim = Simulation
Exp = Experiment

* difference ≤ 10%
** difference ≤ 5%.

References Chen (2014). Probabilistic Selection of Input in morphophonological acquisition. Doctoral dissertation, University of Alberta. Guy (2007). Lexical exceptions in variable phonology. *PWPL* 13(2), 109–120. Guy (2014). Linking usage and grammar: Generative phonology, exemplar theory, and variable rules. *Lingua* 142, 57–65. Zhang & Lai (2010). Testing the role of phonetic knowledge in Mandarin tone sandhi. *Phonology* 27(1), 153–201. Fon et al. (2004). Production and perception of the two dipping tones (Tone 2 and Tone 3) in Taiwan Mandarin. *JCL* 32(2), 249–280.