Tone sequences in lexical processing of Beijing Mandarin

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An observation: In Mandarin, [ma] with a dipping tone (tone 3) can mean 'horse' 马, 'number, code'码, 'amethyst'玛, or 'ant' 蚂: for a listener, identifying a given syllable, even with tone, does not select a single word, but merely an array of homophones. In reality, most content words in Mandarin are disyllabic, where one syllable acts as a bound morpheme. With the addition of a second syllable, segmental content alone will often suffice to select a unique lexical item: the only lexicalized item corresponding to the segments [manao] is 玛瑙 'amethyst' (tones 33), similarly [mayi] is 蚂蚁 'ant' (tones 33) (Lin, 2016).

The problem: To what extent do tone representations contribute to Mandarin word processing, given that tone information is so often unnecessary to identify a word? Most previous studies use monosyllabic words (Lee, 2007, Sereno and Li, 2015), but monosyllables only represent a small part of the lexicon; furthermore, as said earlier, tone is uninformative there: even with tone, identification is usually not unique.

Our hypothesis: When there are segmental homophones, as in the two pairs below, tone is involved in lexical selection, and the word with the more-frequent tone sequence has an advantage. Below are two such pairs of items:

	segments	tones		tones	
(1)	[tɕyli]	42	距离 'distance'	34	举例 'to give an example'
(2)	[huli]	43	护理 'to take care of'	25	狐狸 'fox

The study: We presented native speakers of Mandarin with disyllabic sequences (audio) that were tonally ambiguous between two words, such as (1) and (2). The stimuli were manipulated so that the pitch contour was an average between the two possible tone sequences (Figure 1). Participants were primed with an unrelated disyllabic word that bore either the same tone sequence as one of the word candidates or an unrelated tone sequence. They were then asked to identify the tonally ambiguous token. We tested for effects of word frequency and tone sequence frequency (how likely it is to encounter a given sequence of two tones in the language).

Results: All else being equal, participants tended to choose the more-frequent word and the more-frequent tone sequence.

We show that tone sequence frequency interferes with word frequency information during the processing of disyllables in Mandarin. When word frequency and tone frequency did not favour the same candidate, participants were less likely to pick the word with the same tones as the prime (Figure 2). Such inhibitory effects of tone priming have been observed previously (Poss, Hung and Will, 2008).

Additionally, according to our preliminary results, "tone frequency" is better modeled as frequency in running speech (regardless of word boundaries) rather than frequency in words. This suggests that tone sequences and their frequency are represented at the disyllabic level, and these representations influences lexical selection when segmental information is ambiguous.
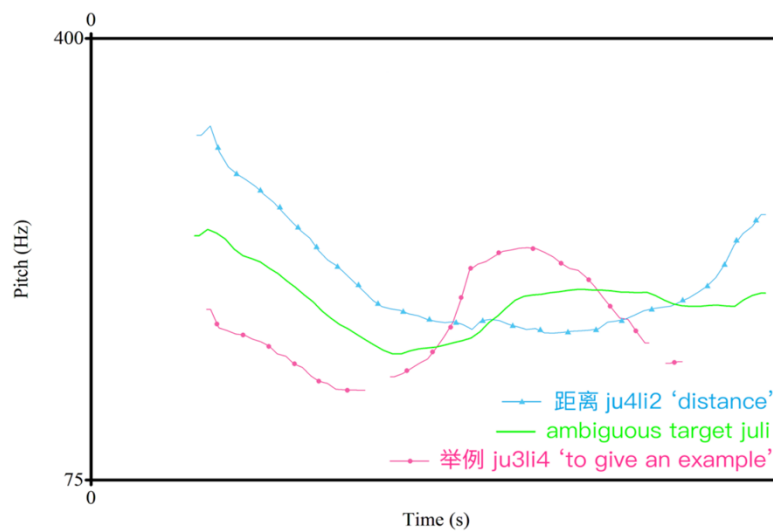
Figure 1. Pitch contours involved in creating the target stimulus for tɕyli: 42 'distance' in blue, 34 'to give an example' in magenta, and the resulting averaged contour in green. Durations were normalized. The green contour replaced the pitch contour on a nonce tɕyli 11 item, produced with level tones.
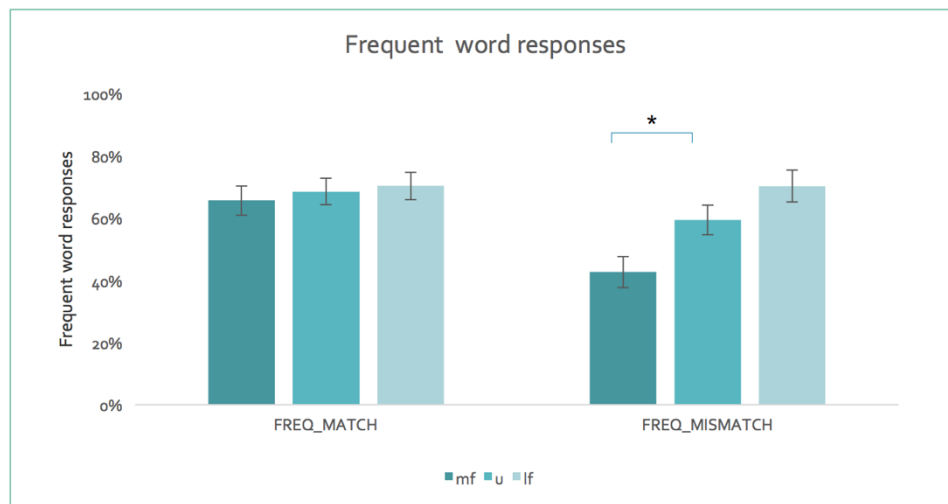

Figure 2. Rates of responding with the more-frequent word. Priming conditions are: prime matches tones on the more frequent word alternative (mf), prime bears tones unrelated to either word alternative (u), prime matches tones on the less frequent word alternative (lf). Frequency conditions are: the more frequent word alternative bears the more frequent tone sequence (FREQ_MATCH), the more frequent word alternative bears the less frequent tone sequence (FREQ_MISMATCH). Error bars are standard error to the mean.

References

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