Tonal Variants in the Bilingual Mental Lexicon

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Abstract

Bilinguals of Jinan Mandarin and Standard Chinese (SC) produce different tonal variants of the same Jinan word. These words typically share the same segmental composition as their SC counterparts. Among the tonal variants, usually only one variant is identical to the tonal contour of the SC counterpart (variant_id). The word-wise probability of variant_id varies between 0 and 1. Naming latency data were elicited for 400 Jinan words from 42 speakers to test how speakers of Jinan store the tonal variants, in particular, whether those who produce the variant_id might also store the tonally non-identical variant (variant_ni) which they do not produce. We hypothesize that if a speaker who produces the variant_id does not store the unproduced variant_ni, the naming latency should only depend on the speaker’s choice of variant_id (yes/no) and not on the word-wise probability of variant_id. On the other hand, if a speaker who produces the variant_id does store the unproduced variant_ni, the naming latency should depend on the word-wise probability of the speaker’s chosen variant. Our results provide support to the latter storage account.

Index Terms: tone, production, mental lexicon

1. Introduction

Etymologically related words between dialects are usually translation equivalents which are similar in sound. They are either inherited from the common ancestor as cognates or borrowed across languages as loan words.

The phonological similarity between a pair of etymologically related words varies along a continuum and etymologically related words can be practically distinguished as identical and non-identical. For instance, the Dutch “computer” and the English “computer” are more similar than the Dutch “neus” and the English “nose”. Experimental evidence suggests that etymologically related words with different degrees of phonological similarity may have different statuses in lexical representation and lexical access. For instance, only identical cognates showed cognate facilitation effect in eye-tracked reading, while non-identical cognates did not [1]. However, the effect of phonological similarity is inconsistent within and across studies [1-4]. Several reasons may be responsible for the unstable effects. First, the phonological similarity co-varies and interacts with the orthographic similarity. Second, etymologically related words can be non-identical in different ways. For instance, some have different vowels and the others have different consonants. However, one problem for most studies on bilingualism is that there are not enough cases for studying each sub-type separately.

The degree of phonological similarity becomes an even more important variable when it comes to bilingual speakers of tonal languages/dialects. Take bilingual speakers of Jinan Mandarin and standard Chinese (SC) as an example. First, unlike in the previous studies, the etymologically related words are the majority in the vocabulary of bilinguals who speak these two closely related dialects. As a result, the majority of translation equivalents are phonologically similar, providing much more cases for studying the effect of phonological similarity. Second, both Jinan and standard Chinese are written with the same pictographic Chinese writing system. Thus all Jinan-SC etymologically related words are orthographically identical, providing another level of strict control which could stem from the influence of orthography. Third, the segmental differences between the etymologically related words are almost reduced to annihilation in the youngest generation. As a consequence, the tonal similarity between a Jinan word and its counterpart in standard Chinese determines the phonological similarity between them. As a result, most pairs of etymologically related words are only different in tone. This then provides us with a great testing case to examine the role of tone in the bilingual lexical representation and access.

On the other hand, earlier studies on spoken word variants, such as the study on the flapping and non-flapping variants of American English variants /t/, have shown variant frequency effect [5, 6]. Under the exemplar-based storage assumption, the results indicated that the reduced variants are also stored in lexical representation [5, 6].

What makes our test case even more interesting is that some Jinan words are produced with different tonal variants by different speakers, some of which are identical and some non-identical to their SC counterparts. As shown in Figure 1, in our Jinan corpus, some Jinan words were produced with two or more tonal patterns, (hereafter, we will refer to these words as multi-pattern words). Such words usually have a variant almost identical to the word’s counterpart in SC (variant_id), in addition to one or more variant(s) which is/are not identical to the words SC counterparts (variant_ni). Note that the segmental structure of both variant_id and variant_ni are almost always identical to that in SC and their only difference is in the tonal contour.

The Jinan case is different from the flapping variation of English /t/ in two aspects. First, although a few speakers produced both variants for some of the multi-pattern words when asked to produce the same word twice, whether they were simply code-mixing is still an open question. Second, the Jinan tonal pattern variation is potentially contrastive in some other words and the contrastive Jinan tonal minimal pairs showed a different priming pattern compared with different variants of multi-pattern words. Thus simple under-specification accounts cannot explain the storage of the variants [7].
The interesting question that arises here is whether speakers who did not produce variant_id also store it in an integrated lexicon together with variant_ni. The answer to this question is contingent upon how we should interpret the effect of word-wise probability of variant_id. The status of variant_id in the bilingual mental lexicon yields different predictions for the following experimental questions. Does the word-wise probability of variant_id affect the naming latency of the word, no matter which variant is produced in the actual rendition? Does a speaker's choice of variant_id affect the naming latency of the word, no matter how low or high the word-wise probability of variant_id is for this word?

Assuming that lexical representations made up of different phonemes (including tone) are also different [2], variant_id and variant_ni should have different lexical representations. As shown in Figure 3, one possibility is that different variants are stored by different speakers. The speakers who produce variant_ni store variant_ni and those who produce variant_id store variant_id as the phonological representation for the same Jinan word. The former speakers have both variant_ni and variant_id and the latter speakers only have variant_id. Under this hypothesis, the word-wise probability of variant_id only reflects the distribution of individual difference of phonological representation in the language system and should not affect the naming latency of the multi-pattern word. Instead, the speaker's choice of variant_id should show effects. Assuming an integrated bilingual lexicon [8], speakers who produce variant_ni should be generally slower than speakers who produce variant_id because the former speaker's variant_ni (Jinan) receives extra competition from variant_id.

An alternative possibility, as illustrated in Figure 4, is that all speakers store both the variant_id and the variant_ni in an integrated lexicon. Under this hypothesis, the word-wise probability of variant_id reflects the likelihood of variant_id being selected in Jinan lexical access. In this case, the more likely the produced variant is, the shorter the naming latency should become, regardless whether it is variant_id or
variant_id. We expect that a higher word-wise probability of variant_id should reduce the naming latency of variant_id and increase the naming latency of variant_ni, since the condition implies a relatively lower likelihood of variant_ni. Correspondingly, a lower word-wise probability of variant_id should increase the naming latency of variant_id and reduce the naming latency of variant_ni, since the condition implies a relatively higher word-wise probability of variant_ni. Thus an interaction of speaker’s choice of variant_id and word-wise probability of variant_id should be observed.

2. The Experiment

2.1. Data preparation

2.1.1. Participant

The speech data used in the present study were collected from 42 Jinan native speakers in 2012. The speakers’ age ranged between 23 and 76. The largest two groups of speakers were in their 20s and 50s. Most speakers (except one) received formal education, of which 57% reached college level and the rest reached middle school level. Regarding the literacy education, 24% speakers received it in Jinan, 55% received it in SC, and 19% received it in a combination of Jinan and SC.

2.1.2. Stimuli

Each speaker read 400 disyllabic Chinese words in Jinan. Two lists of written words were selected from a corpus of Chinese film subtitles [9]. One list consisted of 200 high-frequency words, 10% of the total disyllabic Chinese words with the highest word frequency. In a similar way, we selected the other list of 200 low-frequency words. In each list, each of the 20 disyllabic tonal combinations of standard Chinese (including neutral tone syllables) contributes 10 words.

2.1.3. Procedure

The high and low frequency lists were presented to the speakers in two blocks with a self-paced rest break in between. The words in each list were presented in a different random order for each speaker. After the speaker finished producing a word, they pressed a key to see the next word.

A trained phonetician listened to each recording, looked at the spectrogram, and manually marked the beginning and the rhyme of the production. Also In this process, recordings with speech and/or recording errors were excluded from the corpus. Then naming latencies and pitch contours on the rhymes were extracted. To further remove pitch contour outliers, we calculated Local Outlier Factors (LOF) for each speaker’s z-normalized pitch contours on the rhyme. Any pitch contour with a LOF greater than 1.5 [10] and belongs to the 2.5% of the highest integral density were eliminated from the corpus. The naming latency outliers were excluded using a distribution based approach (method I) [11] on the log transformed naming latency.

Whether the Jinan word was produced almost identical to its counterpart in standard Chinese was judged by a phonetician with Putonghua Proficiency Test Certificates-Level1B. The probability of variant_id can be measured for each word, by calculating the percentage of speakers who produced variant_id for the word.

2.2. Model fitting

Only renditions of multi-pattern words (N = 3368) were taken into consideration in the following analysis. Linear mixed effects analyses were performed on the naming latency data, using R[12], lme4[13], and lmerTest [14] in the following way. A full model was built first, including the fixed effects of the speaker’s choice of variant_id, the word-wise probability of variant_id, the Chinese word frequency, the tonal categories of the words’ SC counterpart, and their two-way and three-way interactions, as well as the random intercept of the word and the speaker as predictors. (The random intercept model was proven to be better than alternative random slope models via model comparisons). When there were unrealized combinations of the nominal predictors, the corresponding interaction terms were removed. A backward elimination was then performed to remove non-significant effects, using p-values calculated from F test based on Sattethwaite’s method [14].

In the final model, the main effect of Chinese word frequency was the only significant main effect, F = 15.61, p < 0.05. A higher Chinese word frequency reduces the Jinan naming latency. The main effect of the speaker’s choice of variant_id, F = 0.92, n.s., and the word-wise probability of variant_id, F = 0.10, n.s., were both insignificant. However, their interaction was significant, F = 4.00, p < 0.05. As shown in Figure 5, for a word with higher word-wise probability of variant_id, the variant_id was named faster than the variant_ni; for a word with lower word-wise probability of variant_id, the variant_id was named slower than the variant_ni. All the other fixed terms were insignificant and removed in the model trimming.

3. Discussion and Conclusion

Our current results suggest that no matter which variant is chosen (i.e. tonally identical or non-identical to the word’s SC counterpart), the higher the word-wise probability of the variant is, the shorter the naming latency is. The results thus support the possibility that speakers who produce the tonal variant identical to their SC counterpart also store the unproduced variant which is not tonally identical to the words’ SC counterpart.
The results support the hypothesis that all the speakers store both the variant_id and the variant_ni in an integrated lexicon (Figure 4), which divides the effect of Chinese word frequency. The result is also in-line with the data from a smaller corpus where each word was produced twice by each speaker in different random orders. We have observed both variant_ni and variant_id in the two renditions by the same speaker. Furthermore, results of a lexical decision task show that the priming effect of such two variants spoken by the same speaker is similar (but reduced) compared to the identity priming effect of the same variant in median-term auditory priming [7].

Note that the LME modeling assumed that each speaker has a constant adjustment on the reaction time across conditions and excluded the individual variations in the final estimates of fixed effects. It is still possible that a small number of speakers only store one variant in their mental lexicon, although the results support that at least it is a general trend in the population that both variants are stored.

There has been accumulating evidence that the bilingual mental lexicon is integrated and words from different languages are co-activated. Nevertheless, individual differences in the bilinguals’ language production and their implication for a more general theory of bilingual lexical storage needs for more research. The present research made the initial attempt to examine the common but little-studied tonal bilingualism and the mental storage of tonal variants in bilingual lexicon experimentally. Our result is in-line with the integrated view of bilingual mental lexicon and the variant-frequency effects observed on segments [5, 6]. We have further clarified that tonal variants, even when they are not produced, show traces of their storage in the lexicon of bilingual speakers.

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5. References


