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## **A psycholinguistic investigation of speech production in Mandarin Chinese**

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## Summary

This dissertation investigates the speech production of Mandarin Chinese from a psycholinguistic approach. Why is it interesting to investigate Mandarin Chinese speech production? From a theoretical point of view, current psycholinguistic models of speech production have been mainly based on evidence from West Germanic languages, where orthographic and phonological forms follow a certain mapping captured in grapheme-to-phoneme conversion (GPC) rules. By contrast, in languages with a logographic script such as Mandarin Chinese, GPC is more opaque, which may result in a (different) role for orthography in speech production. Previous research on the speech production of languages with a logographic script also provided empirical evidence suggesting possible modifications to the current speech production models.

**Chapter 1** introduced the current psycholinguistic models of speech production. Most models agree that to overtly produce a word, speakers go through several stages: conceptual preparation, lemma retrieval, word-form encoding and articulation. At the word-form encoding stage, however, orthography and phonology are usually not dissociated. However, in languages with a logographic script like Mandarin Chinese, the orthographic representation of a lexical item - Chinese characters have a critical role in distinguishing homophones and may therefore be involved in speech production. In consequence, the speech production mechanisms of Mandarin Chinese may differ from what current models of speech production predict.

As the first experimental chapter, **Chapter 2** provided direct evidence for the involvement of orthography in speech production of Mandarin Chinese. Empirical evidence was reported to suggest the mandatory activation of orthography in speech production in English. More specifically, the spelling-sound inconsistency (e.g. joker, giant) will produce an inhibitory effect on

speech production, compared to consistency (e.g. joker, jewel). However, this finding was not replicated in Dutch, where presenting an orthographically-related but phonologically-unrelated word (e.g. cement) will not affect the naming latencies of the following target (e.g. congres).

There are at least two possible explanations for the discrepancy. One possibility is that the involvement of orthography may be task-dependent that only in tasks when the orthographic information is highly relevant, may there be the involvement of orthography in speech production. Another possibility is that the discrepancy may be attributed to the cross-linguistic differences. For instance, compared to that in English, the GPC is more transparent in Dutch, which may result in that orthography merely played any role in speech production in Dutch but some role in English.

In Chapter 2, we investigated the role of orthography in Mandarin Chinese using an adapted blocked cyclic naming paradigm. In this paradigm, participants were asked to overtly name pictures that were presented repeatedly in semantically homogeneous, phonologically homogeneous, or heterogeneous blocks. On each trial, a written Chinese character that was either orthographically related or unrelated to the target was briefly presented (for 75 ms) before the target picture. Consistent with previous research, an inhibitory semantic blocking effect and a facilitative phonological blocking effect in naming latencies were found. More importantly, we observed that the orthographically related characters facilitated picture naming in both the semantic and phonological blocks. In addition, the orthographic priming effect was independent of both the semantic and the phonological effects. These findings suggest orthography contributes to speaking in a picture naming task, lending further support to the presence of orthographic priming in spoken word production, at least in a language with a logographic script like Chinese.

The following chapter, i.e. **Chapter 3** investigated when and how orthography was involved during speech production. In previous research, the orthographic effect was observed at a similar stage to the semantic effect without the co-occurrence of any phonological effect. It was then suggested that orthography affected speech production via a lexico-semantic pathway. The critical evidence that supported this claim was that the orthographic effect was observed at negative SOAs (stimulus onset asynchrony) but this observation was not replicated in a later study. This chapter attempted to replicate it but did not observe any orthographic effect at negative SOAs in Experiments 1 or 2 and therefore suggested that it was unlikely that orthography affected speech production of Mandarin Chinese via a lexico-semantic pathway.

In Experiment 2 of Chapter 3, we used simplex characters to clearly dissociate orthography from the semantic representation and phonological representation. The orthographic effect was observed with the co-occurrence of the phonological effect, subsequent to the semantic effect. Since we made use of the simplex characters, i.e. characters without phonetic radical so that the GPC route was ruled out as a possible pathway. It is likely that orthographic relatedness affects speech production at another sub-lexical level, i.e. the character-to-syllable correspondence. More specifically, for a target (e.g. 兔, tu4, ‘rabbit’), the orthographically related distractor (e.g. 免, mian3, ‘exemption’) activated its orthographic neighbors (e.g. 兔, tu4, ‘rabbit’). Then, the activated character activated its syllable (tu4) and facilitated the speech production of the target.

Besides drawing evidence from behavioral data, in recent decades, researchers have increasingly used electrophysiological measurements to investigate the underlying mechanisms of speech production. With the high

temporal resolution of electrophysiological measurements, Chapters 4 and 5 tapped into the neural correlates of speech production of Mandarin Chinese.

**Chapter 4** investigated the neural correlates of semantic and phonological processing in speech production of Mandarin Chinese. Firstly, consistent with the findings in Chapter 2 and previous research, longer naming latencies were shown in semantically homogeneous blocks and shorter naming latencies in phonologically homogeneous blocks, relative to the heterogeneous blocks. Then, in the electrophysiological data, it was shown that the semantic factor significantly modulated electrophysiological waveforms from 200 ms and the phonological factor from 350 ms after picture presentation. The results are consistent with the estimation of meta-analyses on the neural correlates of speech production and studies using the go/no-go task and the picture-word interference task. In other words, the speech production of Mandarin Chinese also involves an earlier semantic processing and a later phonological processing and the temporal loci of these two stages are in line with those of the estimation of speech production in general.

**Chapter 5** tapped into a more specific detail in the process of speech production; that is, whether a word's syntactic features (e.g. number, grammatical gender, etc.) are automatically activated and selected in bare noun production. Previous research has shown that the lexico-syntactic features are activated and selected in noun phrase production when these features are necessary for production. For instance, producing a noun phrase (e.g. *de arm*, 'the arm', *common gender*) will be facilitated by a distractor that is gender-congruent rather than incongruent (e.g. *het been*, 'the leg', *neuter gender*). However, it is debated if the lexico-syntactic features are activated and selected in bare noun production when these features are irrelevant for production. In Mandarin Chinese, although gender or case is not overtly marked, it is

compulsory to use a classifier between a demonstrative and/or numeral and its associated noun.

Using the picture-word interference paradigm, we manipulated the congruency of Mandarin Chinese classifiers (i.e. a lexico-syntactic feature comparable to grammatical gender in psycholinguistic research) between the target picture (e.g. ‘coat’, *classifier-jian4*) and the superimposed distractor word (e.g. ‘luggage’, *classifier-jian4* or ‘rabbit’, *classifier-zhi1*). We measured the participants’ naming latencies and their electroencephalogram (EEG). As a result, classifier incongruency elicited a stronger N400 effect in the ERP analyses, suggesting the automatic activation of lexico-syntactic features in bare noun production. However, classifier congruency did not affect naming latencies, suggesting that the lexico-syntactic feature is not selected in bare noun naming when it is irrelevant for production. It is possible that speech production in languages with relatively simple morphological structures, the selection at the lexico-syntactic layer is not necessary. The study of classifier effects provided insights to the comparison with regard to lexico-syntactic feature encoding between spoken word production in West-Germanic languages (where gender is a prominent feature) and that in East Asian languages (where classification is a prominent feature).

In summary, this dissertation investigated the speech production in Mandarin Chinese from a psycholinguistic perspective. The characteristic of opaque GPC in Chinese provides an interesting test case for the speech production, especially with regard of the separate roles of orthography and phonology. In this dissertation, it was shown that orthography contributed to speech production, probably by activating its orthographic neighbor and then the corresponding target syllable. In addition, pure orthographic relatedness could affect speech production independently without interacting with semantic or phonological representations. Moreover, this dissertation used

electrophysiological measurement to investigate the fine-grained time course of speech production in Mandarin Chinese. It was shown that the semantic factor modulated the electrophysiological signals from 200 ms and the phonological factor from 350 ms after stimulus presentation. It was also shown that the lexico-syntactic feature (Chinese classifier) was automatically activated in speech production even when it was not necessary for production.

To conclude, this dissertation tapped into the details of speech production in Mandarin Chinese in the framework of current psycholinguistic models of speech production. The findings in this dissertation not only contribute to the understanding of the underlying neuropsychological mechanisms of speech production in Mandarin Chinese, but also provides insights into the understanding of the accountability of current models of speech production that are mostly based on evidence from West Germanic languages.