

Prediction or processing burden?

--The online comprehension of the classifier-noun pair in Mandarin Chinese

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Introduction. Information encoded in contexts, syntactic structures, lexicon, or even sounds in early linguistic regions has been shown to help readers anticipate the upcoming information [1, 2, 3]. Research on Mandarin also confirmed existing conclusions by showing that the classifier's meaning allows for prediction of the following noun (1) [4,5]. Different from using the preactivated ERP responses or eye gaze before the onset of the noun that were exploited in existing literature, our experiments manipulated and standardized the classifier-noun pair with a purpose to pinpoint the processing pattern of the entire NP. We found that apart from prediction, the bottom-up incremental incorporation is also a competing mechanism that might impose some burden through the entire classifier-noun comprehension process.

Experiment One. This preliminary experiment focused on classifiers and noun-noun compounds where both noun morphemes can stand alone as single-character nouns that match different classifiers (2). In a self-paced reading task, 20 native Chinese-speaking adults read sentences containing either grammatical or ungrammatical NPs followed by a grammaticality judgement task. The classifier in the grammatical NP matches the head noun on the right whereas the classifier in the ungrammatical NP matches the left noun (3). We analyzed the reading time of each Chinese character and found a spill-over effect of elongated reading time after the ungrammatical NP. This suggests that participants needed extra time to recognize and comprehend the semantic mismatch between the classifier and the head noun ($p = .012 < .05$, Fig. 1). The offline judgement task revealed that participants chose the correct judgement above pure chance ($p < .001$). Both the online and offline results confirmed that participants were very sensitive to the grammaticality of the classifier-noun pair.

Experiment Two. The second experiment studied single-character nouns and noun-noun compounds. The first session explored the predictability of single-character noun following its corresponding classifier, versus following a semantically neutral plural marker *xiē* (4) which reveals no semantic information about the following noun other than its plurality. Reading times generated by 40 adult participants showed that nouns following a classifier took unexpectedly longer time to comprehend than the plural control condition ($t(453) = 2.632$, $p = .009 < .01$, Fig. 2). We argue that the reason for this processing delay might result from the extra time participants took to examine the validity of the classifier-noun pair while the plural *one-xiē N* did not require any re-examination¹. The second session juxtaposed *one-Cl_i Noun_j-Noun_i* with the control NP *one-Cl_i Noun_i-Noun_i* (indices referring to semantic co-referentiality, see (5)). 432 sentence trials yielded a prolonged reaction time of reading the second character after the control NP ($t(432) = 2.980$, $p = .003 < .01$, Fig. 3). We interpret this elongated reading time as a spill-over effect which suggests that under the control condition, participants experienced more difficulty in incorporating the second noun morpheme with the temporarily grammatical *one-Cl_i N_i*. Incorporation requires reconstruction of the NP, echoing with the pattern we see in garden-path effects.

Conclusions. The two experiments generated findings that were not captured in previous processing studies [4,5]. We showed that double-checking the compatibility between new and old information as well as structural reconstruction during incremental processing are time-consuming. Therefore, from this study of classifier-noun pair in Mandarin we propose a generalization that even if earlier linguistic information boosts the reading efficiency by facilitating prediction, the information incorporation and reconstruction is definitely a competitive mechanism that enhances the tension between top-down prediction and bottom-up incrementality. However, more of the prediction effect should be further investigated due to the spill-over effects.

¹ Another possible explanation is that the average frequency of the CL is lower than that of *xiē* so that a longer comprehension time might occur for the CL and is reflected via a spill-over effect on the following noun.

Sample data.

(1) <i>yí -piàn miànbāo</i> one-CL bread 'a piece of bread'	(2) <i>yí -piàn shù -yè</i> one-CL tree -leaf 'a piece of leaf of a tree'
(<i>piàn</i> corresponds to objects with a thin, two-dimensional shape, e.g., bread)	(<i>piàn</i> corresponds to <i>yè</i> to denote thin-piece shape; <i>kē</i> corresponds to <i>shù</i> to denote plants)
(3) <i>yí -piàn/-*kē shù -yè</i> one -CL/CL tree -leaf 'a piece of leaf of a tree'	(5) <i>yì -běn shū / yì -xiē shū</i> one-CL book / one-pl book(s) 'one book/ some books'
Grammatical condition: CL = <i>piàn</i> Ungrammatical condition: CL = <i>kē</i>	(<i>běn</i> modifies book, or notebook; <i>xiē</i> is simply a plural marker that modifies plural nouns)
(6a) <i>yì -dī yǎn-lèi</i> (mismatch) one-CL eye-tear 'a drop of tear'	(6b) <i>yì -dī lèi-shuǐ</i> (match) one-CL tear-water 'a drop of tear'
(dī modifies nouns that denote drop-like liquid, such as tear, water, rain, etc. In the mismatch condition, dī only semantically matches N ₂ , but in the match condition, dī matches N ₁ and N ₂ .)	

Summary statistics.

Figure 1 Exp.1: An upsurge after the ungrammatical NP

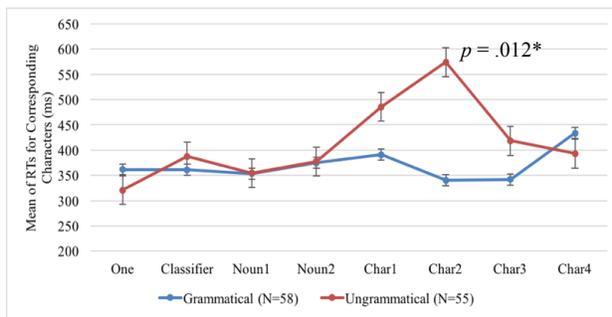


Figure 2 Exp.2 Session one: Longer RT under CL condition

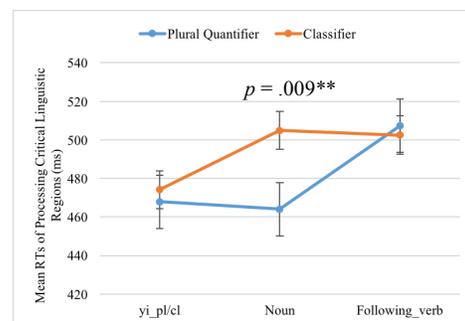
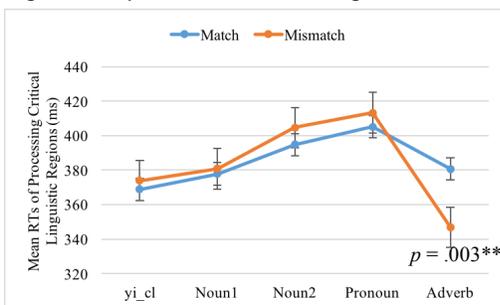


Figure 3 Exp.2 Session two: Longer RT after NP under match condition



Selected references.

- [1] DeLong, K. A., Kutas, M., & Urbach, T. P. (2005). Probabilistic word pre-activation during language comprehension inferred from electrical brain activity. *Nature neuroscience*. [2] Ehrlich, S. F., & Rayner, K. (1981). Contextual effects on word perception and eye movements during reading. *Journal of Verbal Learning and Verbal Behavior*. [3] Lau, E. et al. (2006). The role of structural prediction in rapid syntactic analysis. *Brain and Language*. [4] Kwon, N., Sturt, P., & Liu, P. (2017). Predicting semantic features in Chinese: Evidence from ERPs. *Cognition*. [5] Tsang, C., Chambers, C. G., & Mozuraitis, M. (2017). Compounds, competition, and incremental word identification in spoken Cantonese. *Language Cognition and Neuroscience*.