

Rapid prediction updating driven by Mandarin classifiers in Maze Reading

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While comprehenders continuously make predictions during sentence processing, these predictions may sometimes be incorrect. An open question is whether such prediction failures are ever costly. A previous EEG study found Italian speakers failed to use local adjectives to update their predictions after encountering prediction-inconsistent gender markers, suggesting that the costs generated by prediction failures limit the overall usefulness of prediction [1]. However, in a visual world eye-tracking study, Mandarin listeners were found to use the information conveyed by the specific classifier (CL) to revise predictions immediately [2]. Similarly, a recent EEG study found that Mandarin readers used informative adjectives to rapidly update their predictions after encountering a prediction-inconsistent CL, even without the aid of visual options [3]. Given the mixed evidence and the different designs across studies (Table 1), the current study aimed to obtain more comparable data by importing the design used in [1] into Mandarin and manipulating CL-context consistency and adjectives to investigate the local effects of prediction failures.

Method. 40 native Chinese speakers participated in a word-by-word Maze reading task involving 32 experimental items and 64 fillers, where distractors were automatically generated using [4]. Following the design of [1], we manipulated global Context {congruent, incongruent} to change whether the CL is consistent with the initial context-based prediction, and manipulated the local Adjective {predictive, neutral} by changing the informativeness of local semantic cues.

Prediction. If prediction failures do not block the use of local semantic cues [2-3], we expect predictive adjectives to speed the processing of target nouns in incongruent conditions. Otherwise [1], no effect of adjective is expected on the target noun in the incongruent condition. Given the results from [1-3], predictive adjectives in congruent conditions should facilitate target nouns.

Results. RT analyses using linear mixed effects models showed a main effect of Context ($p < .01$) on CLs. On target nouns, we found main effects of Context ($p < .001$), Adjective ($p < .05$), and their interaction ($p < .05$). Pairwise comparisons revealed that target nouns were facilitated by predictive adjectives only in incongruent conditions ($p < .01$), but not in congruent conditions ($p = .97$).

Discussion. Our results suggest that Mandarin readers can use subsequent semantic information to update predictions after prediction failures signaled by prediction-inconsistent CLs, supporting the conclusions in [2-3]. The difference between our results and [1] might indicate that comprehenders are better at dealing with semantically-based error signals (e.g., CLs) rather than morphosyntactically-based error signals (e.g., gender markers). Interestingly, predictive adjectives did not further facilitate target nouns in congruent conditions, suggesting that Maze reading may have a lower bound on RTs. Future studies will examine these possibilities.

	Update	Language	Task	Error signal	Local cues
Husband & Bovolenta (2020)	X	Italian	EEG while reading	Gender marker	ADJ
Chow & D. Chen (2020)	✓	Chinese	Visual world while listening	CL	CL
K. Chen et al. (2024)	✓	Chinese	EEG while reading	Specific CL or ADJ	ADJ
The current study	?	Chinese	Maze	Specific CL	ADJ

Table 1: A summary of three previous studies.

Context	Adjective	Sentences	Distractors
Congruent	Predictive	小明 走进 饮料店, 买 了 一 杯 鲜榨 的 果汁 来 解渴。	X-x-x 趋势 笑嘻嘻, 项 说 你 敢 语句 说 复辟 所 篇章。
Congruent	Neutral	小明 走进 饮料店, 买 了 一 杯 打折 的 果汁 来 解渴。	X-x-x 趋势 笑嘻嘻, 项 说 你 敢 语句 说 复辟 年 篇章。
Incongruent	Predictive	小明 走进 蛋糕店, 买 了 一 杯 鲜榨 的 果汁 来 解渴。	X-x-x 趋势 笑嘻嘻, 项 说 你 敢 语句 说 复辟 所 篇章。
Incongruent	Neutral	小明 走进 蛋糕店, 买 了 一 杯 打折 的 果汁 来 解渴。	X-x-x 趋势 笑嘻嘻, 项 说 你 敢 语句 说 复辟 年 篇章。

Table 2: Example sentences and distractors generated by A-maze, with vertical bars representing word cuttings. CLs and target nouns are bolded, as are their paired distractor words. See the next page for English translations and additional information about Mandarin classifiers.

CL				
	Est	SE	t	p
Adjective	0.98	23.4	0.04	.97
Context	-112.1	34.6	-3.24	.003**
Interaction	-25.5	46.9	-0.54	.59
Target noun				
	Est	SE	t	p
Adjective	-44.8	19.7	-2.28	.029*
Context	-100.3	22.5	-4.46	<.001***
Interaction	87.5	35.3	2.48	.016*
Contrast: Congruent - Incongruent				
	Est	SE	t	p
Congruent	1.02	23.1	0.04	.96
Incongruent	88.5	30.0	2.95	.007**

Table 3: Output of LMEM and post-hoc pairwise of RTs on CLs and target nouns.

Reference

[1] Husband, E. M., & Bovolenta, G. (2020). Prediction failure blocks the use of local semantic context. *Language, Cognition and Neuroscience*, 35(3), 273-291. [2] Chow, W. Y., & Chen, D. (2020). Predicting (in) correctly: listeners rapidly use unexpected information to revise their predictions. *Language, cognition and neuroscience*, 35(9), 1149-1161. [3] Chen, K., Xia, F., Wang, S., Chow, W. Y. (2024). Incremental prediction updating through consecutive cues: Evidence from ERPs *HSP 2024*. [4] Levinson, L., Tang, Y., Chiang, L. Y.-C., Zhou, W.-J., & Chung, S. (2023). Multilingual A-maze: Generating Maze Experiments in Mandarin and Beyond. *HSP 2023*.

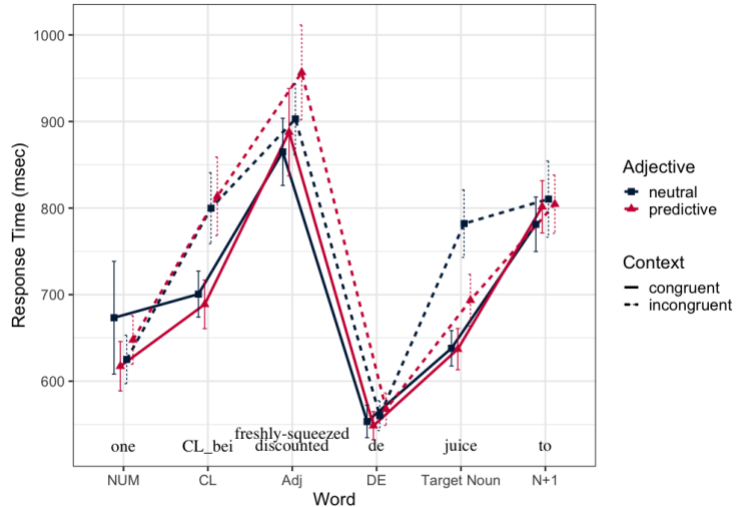


Figure 1: Estimated RTs in four conditions.

English translations for example sentences

Context	Adjective	Sentences
Congruent	Predictive	Xiaoming walked into a beverage shop and bought one CL_bei freshly-squeezed juice to quench his thirst.
Congruent	Neutral	Xiaoming walked into a beverage shop and bought one CL_bei discounted juice to quench his thirst.
Incongruent	Predictive	Xiaoming walked into a bakery shop and bought one CL_bei freshly-squeezed juice to quench his thirst.
Incongruent	Neutral	Xiaoming walked into a bakery shop and bought one CL_bei discounted juice to quench his thirst.

CLs and target nouns are bolded

Additional information about classifiers in Mandarin

Mandarin Chinese is a classifier language where a noun must be accompanied by a classifier when it is quantified or modified by a numeral. Classifiers typically indicate the category of the noun and are chosen based on characteristics such as shape, size, or type. For example, *bei* (杯) is the classifier used for liquids in a cup (e.g., *one CL_bei juice* in the above sentences), and *kuai* (块) is the classifier for cubic item (e.g., bread and cake). Thus, classifiers can serve as an error signal in predictive processing. For example, in incongruent conditions, the global context should raise an expectation for bread or cake, which should be modified by *kuai* rather than *bei*.