

Immediate revision of disconfirmed predictions: Evidence from Eye-tracking and ERPs

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Prediction has been argued to play a key role in successful language comprehension, but the creative nature of language means that our predictions often turn out to be wrong. Previous event-related potential (ERP) studies showed that comprehenders can reliably detect cues that conflict with comprehenders' predictions (e.g., an adjective that has a different grammatical gender than the most expected noun) [3-6], but to date little is known about what cognitive processes underlie the ERP effects elicited at the prediction-inconsistent cues. For example, do they simply reflect some sort of processing breakdown while comprehenders wait for the relevant bottom-up inputs to arise? Or do they reflect the processing costs incurred when comprehenders actively inhibit their original predictions and make new predictions? Here we took advantage of the rich classifier system in Mandarin Chinese to examine whether and how comprehenders update their noun prediction upon encountering an unexpected classifier. Since Mandarin has over 70 classifiers and different classifiers are associated with nouns with different semantic-conceptual properties like shapes and functions (e.g., 'zhi' for pens and tree branches) [7], a classifier that is inconsistent with listeners' existing noun predictions can not only serve as an error signal [6], but it can also be informative for making new noun predictions [8]. We found evidence from eye-tracking and ERPs which suggests that comprehenders can quickly use prediction-inconsistent classifiers to revise their predictions on the fly.

We created Mandarin Chinese sentences like (1) and (2), which end with a target noun that was either predictable or unpredictable given the initial context. Crucially, the target noun was preceded by a classifier and an adjective, and the classifier was either compatible with the predictable noun *flower* (e.g., 'duō'), or incompatible with *flower* but indicative of another contextually suitable noun like *leaf* (e.g., 'piàn'). A general classifier (e.g., 'ge', 'xie') that is compatible with both nouns (and therefore is uninformative) was used in the control conditions, resulting in the 2 (specific vs. general classifier) × 2 (predictable vs. unpredictable noun) design.

- (1) zài huāyuánlǐ wánshuǎ shí, xiǎonánhái sònggěi xiǎonǚhái yī {duō/xiē} hěnpiàoliàngde huā
"While playing in the garden, the little boy gave the little girl a {CL_{specific} / CL_{general}} beautiful flower."
- (2) zài huāyuánlǐ wánshuǎ shí, xiǎonánhái sònggěi xiǎonǚhái yī {piàn/xiē} hěnpiàoliàngde shùyè
"While playing in the garden, the little boy gave the little girl a {CL_{specific} / CL_{general}} beautiful leaf."

In **Experiment 1** (eye-tracking; n=23) spoken stimuli were presented together with a visual display with four objects. Listeners were more likely to look at the predictable object (*flower*) than the unpredictable object (*leaf*) prior to the classifier onset. Upon hearing a prediction-inconsistent classifier, listeners quickly directed their eye gaze away from the originally predictable object and immediately onto the (initially) unpredictable but contextually suitable object (Fig. 1). In **Experiment 2** (ERP; n=31) we removed the aid of a restricted visual context and measured participants' ERPs as they read the sentences for comprehension. In line with previous findings, we observed a clear predictability effect on the N400 at the noun in the general classifier conditions (Fig. 2), and prediction-consistent classifiers also elicited a smaller N400 than prediction-inconsistent classifiers (Fig. 3). Crucially, the unpredictable noun elicited a reduced N400 when it was preceded by an informative (specific) classifier relative to an uninformative (general) classifier (Fig. 4), and it elicited only a late frontal positivity (no N400 effect) relative to the predictable noun, suggesting that comprehenders were able to access the (initially) unpredictable noun as easily as the predictable noun. Taken together, these findings suggest that, even without the help of a restrictive visual context, comprehenders are able to use a prediction-inconsistent specific classifier to revise their disconfirmed predictions and pre-activate a contextually suitable (albeit originally unpredictable) noun very quickly.

References:

- [1] Kamide et al. (2003). JML, 49, 133-156. [2] Altmann & Kamide. (2007). JML, 57, 502-518. [3] Wicha et al. (2004). JoCN, 16, 1272-88. [4] Van Berkum et al. (2005). JEPLMC, 31, 443-467. [5] Szewczyk & Schriefers (2013). JML, 68, 297-314. [6] Kwon et al. (2017). Cognition, 166, 433-446. [7] Gao & Malt. (2009). LCP, 24, 1124-1179. [8] Klein et al. (2012). Oxford Studies in Theoretical Linguistics 42, 261-282.

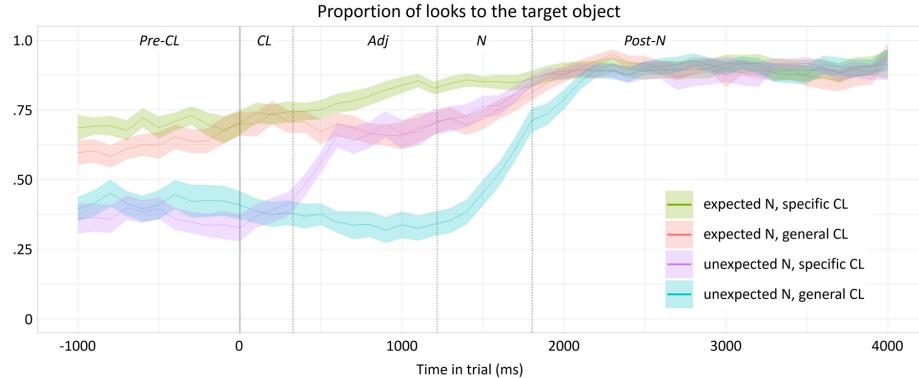


Figure 1. Average proportion of looks to the target object time-locked to classifier onset in Experiment 1.

General classifier (control) conditions

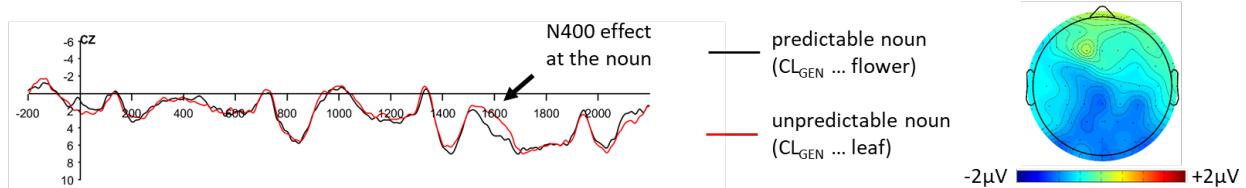


Figure 2. *Left*: Average ERPs in the general classifier conditions with a pre-classifier baseline in Experiment 2. Time zero marks the classifier onset; noun onset is at 1200ms. *Right*: Topographic distribution of the ERP effects (unpredictable minus predictable) 300-500ms after noun onset.

Specific classifier conditions

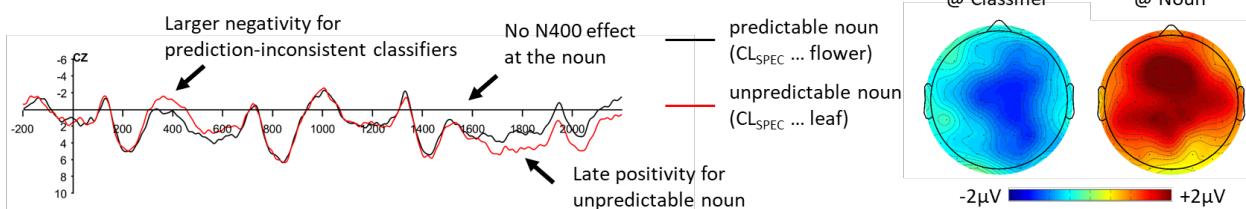


Figure 3. *Left*: Average ERPs in the specific classifier conditions with a pre-classifier baseline in Experiment 2. Time zero marks the classifier onset; noun onset is at 1200ms. *Right*: Topographic distribution of the ERP effects (unpredictable minus predictable) 300-500ms after classifier onset and 500-900ms after noun onset.

Unpredictable noun

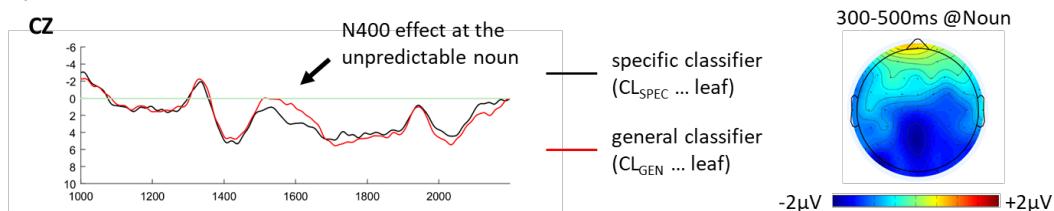


Figure 4. *Left*: Average ERPs at the unpredictable nouns with a pre-noun baseline in Experiment 2. Noun onset is at 1200ms. *Right*: Topographic distribution of the ERP effects (general minus specific) 300-500ms after noun onset.