

Rational comprehenders expect within-word exchange errors in Chinese sentence

Xuexian Lai & Fuyun Wu (Shanghai Jiao Tong University)

Comprehenders sometimes reach nonliteral interpretation for implausible sentences that contain edits of deletion, insertion or across-word exchange in English and Chinese [1-3]. For instance, when asked about the meaning of “*The package fell from the floor to the table*”, comprehenders would say it meant “*Something fell to the floor*” with a mean rate of 37% [2]. However, few studies examined whether implausible sentences induced by within-word transposition affect comprehenders’ interpretation, and if so, what the underlying mechanism is for such effects. Relevant work is especially lacking in Mandarin Chinese, a language in which words are commonly disyllabic, without space to mark word boundary.

Here we take advantage of the Chinese BA construction where the theme (of a canonical SVO sentence) occurs immediately after a causative light verb (or the preposition) BA. Relative to Control sentences (1a), we created **Transposition** sentences (1b) by transposing two adjacent characters of the post-BA NP and (semantic) **Violation** sentences (1c) by using a semantic anomalous noun. The Noisy-channel model [1] proposed that rational comprehenders can make inferences about the intended meaning by combining prior knowledge about plausible meanings with the possibility of noise corruption. Hence, sentences like (1b) would induce nonliteral interpretations that can be obtained by swapping two characters within the post-BA NP. Concerning the noise corruption within the noisy channel model, there are two competing hypotheses [4]. Speaker’s Channel hypothesis predicts that comprehenders are completely aware of the literal meaning of the input sentence. Thus, transposition errors can be noticed. By contrast, Comprehender’s Perceptual Channel hypothesis predicts that comprehenders often fail to notice transposition errors [5] due to misperception, resulting in meaning misinterpretation.

Using eye-tracking while reading (N=60), we created 30 sets of stimuli as in (1a-c). Participants answered comprehension questions that probed whether they interpreted sentences literally or non-literally. Off-line data showed that, as expected, participants had significantly more non-literal interpretations in the transposition condition (41%) compared to the Control (2.83%) or Violation (5.33%) conditions. Furthermore, they took significantly longer times to answer probe questions in the Transposition condition than in the other two conditions ($t < -10.95$). Focusing on the post-BA NP and the Verb regions, we ran linear mixed-effects models (LMM) on first-pass reading time (FPRT), regression path duration (RPD), and total reading time (TRT). Eye-movements data (Fig. 1) showed that the Transposition condition was (i) more difficult to process than the Control condition at the post-BA NP--suggesting participants detected transposition errors, and (ii) was easier to process than the Violation condition at the Verb, but as easy as the Control condition--suggesting transposition-induced disruptions were rather mild.

To further tease apart the two competing hypotheses of noise corruptions, eye movement measures and response times to answer probe questions were analyzed based on response type (Fig. 2). Following [5], we compared trials where participants (incorrectly) accepted transposed sentences (AT), trials where participants (correctly) accepted control sentences (AC), and trials where participants (correctly) dismissed transposed sentences (DT). At the post-BA NP region in RPD, DT was more difficult to process than in AT ($t = 3.06$), and AT was numerically more difficult to process than AC. Furthermore, participants took significantly longer to answer probe questions in AT than DT or AC ($t < -19.08$). These results imply that participants did notice transposition errors even when they (incorrectly) accepted a transposed sentence (i.e., when they interpreted transposed sentences nonliterally).

The overall data from eye movements and response times showed that participants were disrupted by within-word transpositions. This disruption suggests that, consistent with speaker’s channel hypothesis, Chinese comprehenders noticed transposition errors during sentence comprehension. Nonetheless, they tended to interpret implausible sentences non-literally, suggesting rational inference over the noisy channel. Additionally, our work extends the understanding of noisy channel models to include within-word exchange edits in the noise operations.

(1) Table 1 Sample set of stimuli

Context	Subject	BA	NP	Verb	Object
Etou zheshang hou, <i>‘After being stung on the forehead’</i>	nongfu <i>farmer</i>	ba <i>BA</i>	a. Control mifeng <i>bee</i>	ganchu le <i>drove out</i>	huacong <i>flowers</i>
			b. Transposition fengmi <i>honey</i>		
			c. Violation fengsheng <i>wind</i>		
<i>‘After being stung on the forehead, the farmer drove the bee/honey/wind out of flowers’</i> Comprehension question: Did the farmer drive away the bees?					

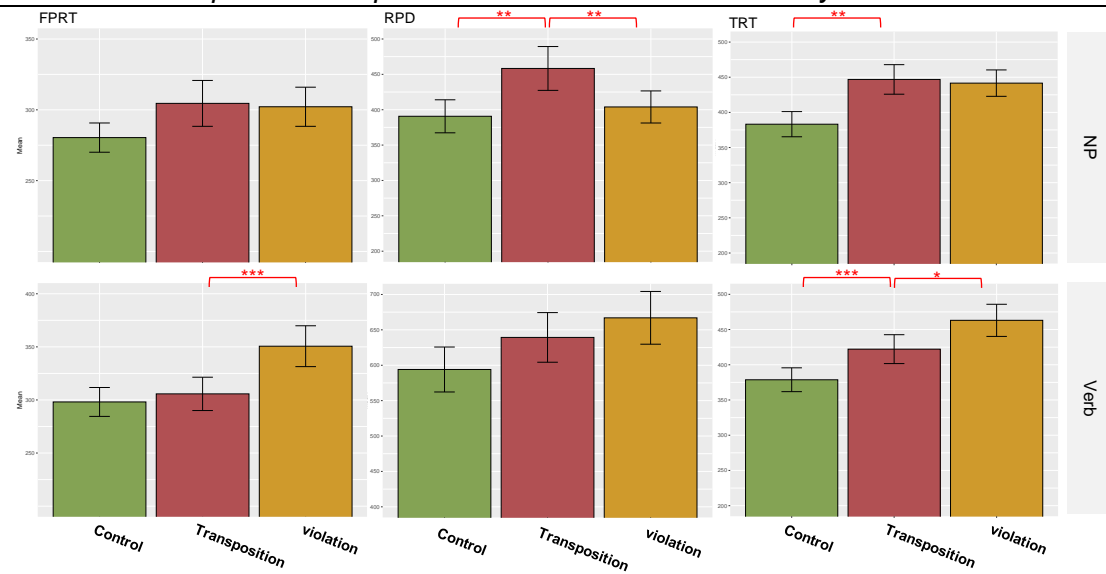


Fig. 1. Mean reading measures at the NP and the Verb regions

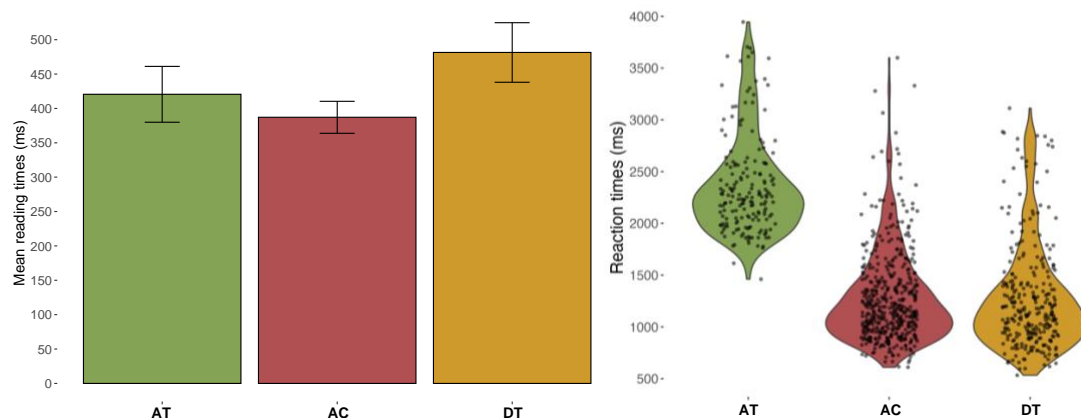


Fig.2. Mean reading measures (left) and Reaction times (right) by Response type. AT: accepting transposed sentences; AC: accepting control sentences; DT: Dismiss transposed sentences.

References:

- [1] Gibson, E., Bergen, L., & Piantadosi, S. T. (2013). *PNAS*, 110, 8051-6. [2] Poppels, T., & Levy, R. (2016). In *CogSci*. (pp. 378–383). [3] Zhan, M., Chen, S., Levy, R., Lu, J., & Gibson, E. (2023). *Cognitive Science*, 47(12), e13383. [4] Liu, Y. (2022). Doctoral dissertation, Harvard University. [5] Huang, K. J., & Staub, A. (2021). *Cognition*, 216, 104846.