

Mandarin argument structure processing: ERP reading data from reversible and irreversible NNV sentences with and without BA and BEI

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Introduction. Despite having no inflection for case or agreement, Mandarin Chinese has flexible word order. This presents a challenge for sentence processing models to explain how Mandarin speakers manage conflicting cues to assign agent and patient status. Behavioral data have shown word order plays a role in the absence of competing cues, but is overridden by animacy¹. Electrophysiological (EEG) experiments have reported both N400² and semantic P600³ effects for Mandarin semantic reversals. For noun-noun-verb (NNV) sentences specifically, experiments suggest that the preferred word order is object-subject-verb with an inanimate object and an animate subject and that animacy and word order interact in a complex way⁴; NNV sentences with no animacy contrast may be uninterpretable⁵. Questions still remain about 1) the relative strength of each cue and their interactions, especially in the case of conflicting cues, and 2) whether semantic reversals elicit N400 or P600 effects.

Methods. We recorded Mandarin monolinguals' (n = 30) EEG while they read transitive NNV sentences word-by-word (SOA 750 ms) and judged which noun was the agent. To create cue competition, we manipulated four cues: **1) Agent Animacy** and **2) Reversibility** (irreversible sentences had a single plausible agent with opposite animacy status of the patient; reversible sentences had two equally plausible agents with shared animacy status (see [Table 1](#) for examples)); **3) Word Order** (each noun could appear in 1st or 2nd position); and **4) Structure** (presence/absence of coverbs BA and BEI, which assign explicit agent status to the preceding (BA) or following (BEI) noun phrase, as shown in [Table 2](#)).

Results. For the behavioral data, logistic mixed effects models analyzing the proportion of first noun agent choice showed interactions for each cue manipulation (shown in [Tables 1 and 2](#)). Unlike in earlier Competition Model experiments¹, Word Order did not affect argument assignment for reversible sentences. When present, coverbs BA/BEI were the strongest cues, but slightly less so if resulting in implausible readings (*servant BEI mirror polished*). Word Order interacted with Reversibility, so plausible agents were more likely to be chosen in irreversible sentences. Inanimate agents were overall selected slightly less often than animate agents.

For the EEG data, we used linear mixed effects models to analyze ERP amplitudes in time windows at multiple sentence positions. Within the first noun time window, ERPs were not influenced by animacy. In the BA/BEI time window, the BA character elicited a smaller P200 than BEI or a noun, and the noun elicited a larger N400 than both BA and BEI ([Figure 1A](#)). On the verb, we found a significant, biphasic N400/P600 effect for BA semantic reversals ([Figure 1B](#)) and a significant frontal P600-like positivity for BEI semantic reversals ([Figure 1C](#)).

Conclusion. We adapted behavioral methods used in Competition Model studies to an ERP paradigm evaluating argument structure processing in Mandarin NNV sentences. Our behavioral results confirm a preference for animate over inanimate agents⁴ and that NNV sentences without contrasting animacy are ambiguous⁵. In line with predictions from the extended Argument Dependency Model², we found an N400 effect for BA semantic reversals, which could mean that the 750 ms SOA was sufficient for participants to predict the verb. In line with Chow & Phillips³, both BA and BEI reversals elicited a P600-like positivity. The difference between BA and BEI reversals indicates that each coverb impacts argument assignment differently; BA may confirm an agent-first default processing strategy⁶, while BEI requires reanalysis before processing the verb, which may contribute to the greater P200 amplitude. These results highlight the importance of crosslinguistic comparison of sentence processing.

Table 1. Effect of Reversibility, Agent Animacy, and Word Order collapsed across Structure. Dashed line shows chance level noun selection. Error bars show standard deviation.

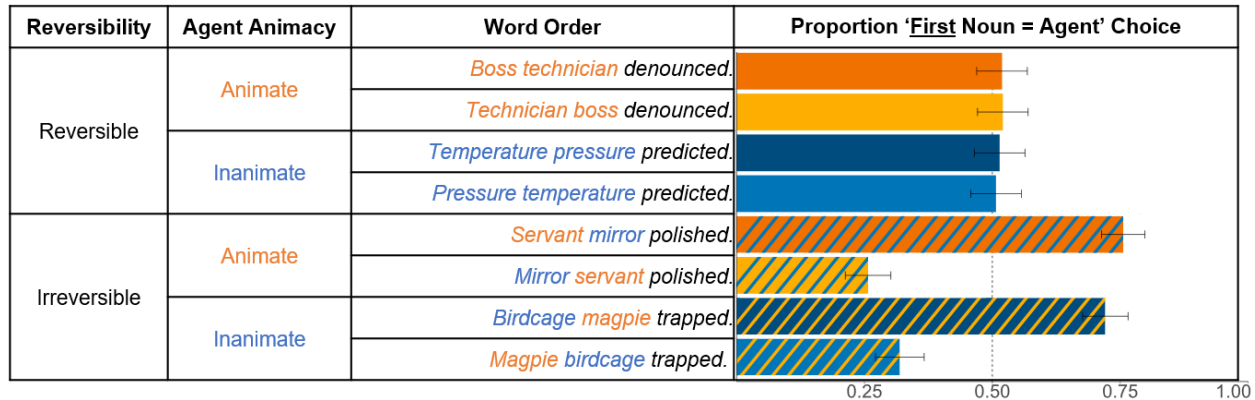


Table 2. Effect of Structure collapsed across other variables. Dashed line shows chance level noun selection. Error bars show standard deviation. LE is aspect marker in Mandarin.

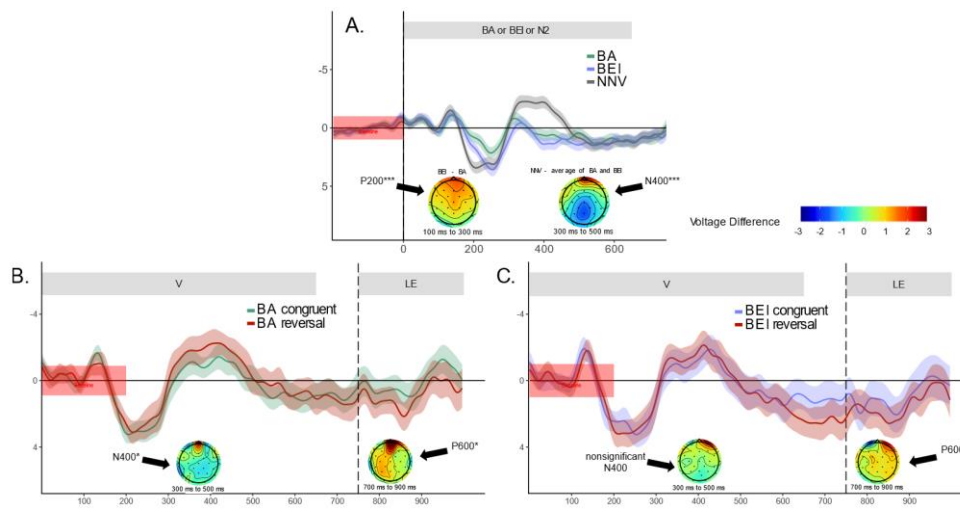
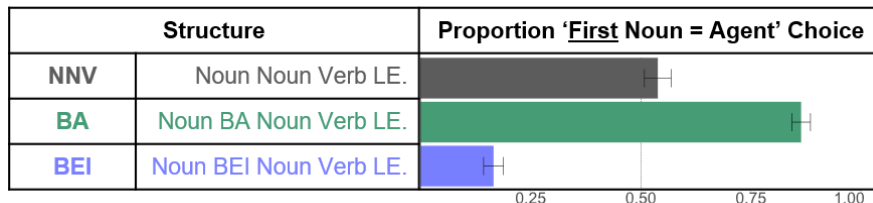


Figure 1. ERPs and voltage maps of select contrasts at Pz. Baseline interval at red square. Shading shows 95% confidence interval. **A.** Three Structure conditions at second word position (BA, BEI, or 2nd noun). **B.** Semantic reversal effect for BA irreversible sentences at verb onset, collapsed across animacy. **C.** Semantic reversal effect for BEI irreversible sentences at verb onset, collapsed across animacy. Verb-locked ERPs (B, C) were analyzed with pre- and post-onset baselines, and we determined that a post-onset baseline minimized spillover effects from preceding words. The post-onset baseline is shown here.

References: 1. Li, P et al. Cues as Functional Constraints on Sentence Processing in Chinese. in *Language Processing in Chinese* (eds Chen, HC & Tzeng, O) 207–234 (North-Holland, 1992). 2. Bornkessel-Schlesewsky, I et al. Think globally: Cross-linguistic variation in electrophysiological activity during sentence comprehension. *Br. Lang.* 117, 133–152 (2011). 3. Chow, WY & Phillips, C. No semantic illusions in the “Semantic P600” phenomenon: ERP evidence from Mandarin Chinese. *Br. Res.* 1506, 76–93 (2013). 4. Wang, L et al. The Role of Animacy in Online Argument Interpretation in Mandarin Chinese. in *Case, Word Order and Prominence* 40, 91–119 (2012). 5. Yu, S & Tamaoka, K. Age-related differences in the acceptability of non-canonical word orders in Mandarin Chinese. *Ling. Sin.* 4, (2018). 6. Wang, L et al. Exploring the nature of the ‘subject’-preference: Evidence from the online comprehension of simple sentences in Mandarin Chinese. *Lang. Cogn. Pr.* 24, 1180–1226 (2009).