

The timecourse of “under/connected” thematic relations in center-embedding illusions

Ungrammatical double center-embedding (DCE) sentences with a missing right-branching element exhibit illusions of grammaticality in languages like English (missing VP effect) and Mandarin Chinese (missing NP effect) [1-6]. A curious difference in these illusions is that in offline judgments, Mandarin missing NP sentences are “overconnected” in terms of thematic relations, compared with English missing VP sentences [6] (ex. 1-2; Fig. 1). Mandarin “overconnection” poses a problem for classic “structural forgetting” accounts of DCE illusions [1], which predict that the middle verb and its predictions are forgotten and left unconnected.

This study compares an “interference-and-repair” (henceforth “repair”) account of Mandarin missing NP illusions [6] with an alternative probabilistic non-repair account [7]. The accounts make divergent predictions about when semantically-anomalous thematic relations are detected in these sentences. Using a stops-making-sense (SMS) task that manipulated the plausibility of verb-NP pairings, we show that semantic anomalies are all detected early, suggesting that thematic relations can be built early (and not by repair), as predicted by [7].

a. Repair account [6]. In English missing VP sentences, when the parser encounters VP2, interference causes the parser to prematurely link NP1 with VP2, resulting in “underconnection” [3,6]. In Mandarin missing NP sentences, there is likewise premature linking of V1 and NP2. But this would leave V2 thematically “orphaned,” contrary to offline ratings showing that NP2 gets interpreted as V2’s theme argument (V2’s object). [6] proposes that the parser repairs the representation to link NP2 to V2, so that V2 would not be orphaned.

b. Non-repair account [7]. In this account, the parser links verbs and NPs, prioritising those that are still thematically “orphaned” (cf. [8]). In English missing VP sentences, when the parser encounters VP2, it would have already connected NP2, NP3, and V1, leaving only NP1 without a VP predicate. Consequently, the parser prioritizes linking NP1 to VP2. In contrast, in Mandarin missing NP sentences, when the parser encounters NP2 (analogous to English VP2), it would have connected only V3 and NP1, leaving both V1 and V2 without theme arguments (objects). The parser therefore tries to link V1 and V2 to NP2, perhaps probabilistically.

SMS task (48 Mandarin speakers on Prolific, 6 target sentences/condition). Like [7], we manipulated V1 and V2 in Mandarin missing NP sentences so that NP2 would be implausible arguments of these verbs (ex. 3). Sentences were presented phrase by phrase; participants gave “stop” responses as soon as they felt what they had read described an implausible action.

Predictions. Under the repair account, when NP2 is an implausible argument of V1 (“implausible V1 condition”), participants should give “stop” responses when NP2 appears, or shortly after. But when NP2 is an implausible argument of V2 (“implausible V2 condition”), “stop” responses should appear later, after repair. In contrast, the nonrepair account predicts no such delay for the implausible V2 condition.

Results. Participants gave “stop” responses early in both conditions, relative to the plausible baseline (Fig. 2). In fact, this early implausibility effect was larger for the implausible V2 condition: “stop” responses at NP2 occurred significantly more often than baseline for the implausible V2 condition ($b=0.02$, $p=.05$), but not for the implausible V1 condition ($b=0.01$, $p=.53$). (Significant effects were found for “stop” responses at the first spillover region for both conditions.) Similarly, log response times at NP2 were significantly longer for the implausible V2 condition ($b=0.04$, $p<.01$) and not for the implausible V1 condition ($b=0.02$, $p=.31$).

Discussion. Our results provide new support for the non-repair account, where the parser prioritizes connecting thematically “orphaned” elements in a sentence, even if there is no corresponding grammatical structure. To explain why this does not happen more frequently (why such illusions of grammaticality are not more common), we suggest that this is a strategy used only when the parser faces challenges in building and using a syntactic representation to track thematic relations (following [6]). These are exactly the challenges presented by DCE sentences, which are highly complex and demanding on memory resources [1-6].

(1) [_{NP1} The novel] [_{NP2} the author] [_{NP3} the company] [_{VP1} fired] [_{VP2} was banned]. (**Missing VP, English**)

(2) Subject V1 Dem V2 Dem V3
 Yuanzhang jiuqing peifu na-ge [_{RC} zhiqian kuajiangguo zhege [_{RC} cengjing duode
 director actually admire that-CL previously praised this-CL in.the.past win
 NP1 Adv de NP2
 yinyue-jiang xuduo-ci de jiaoxiangyuetuan ne, haishi peifu Fang zhihui ne?
 music-award many-times DE orchestra QPart or admire Fang conductor QPart

A possible reading: “Does the director actually **admire** that — who previously **praised** this **orchestra** that **won music awards** many times in the past, or [does s/he] admire Conductor Fang?” (**Missing NP, Mandarin**)

(3) “Stops-making-sense” experiment – Manipulating Mandarin NP2 as ...

- Plausible argument of V1, V2, V3: *admire ... praised... win award... orchestra*
- Implausible theme argument of V1: *in love with... praised... win award... orchestra*
- Implausible theme argument of V2: *admire ... in love with... win award... orchestra*

Fig. 1. Thematic relations in illusory DCE and grammatical DCE sentences. (adapted from [6,7])

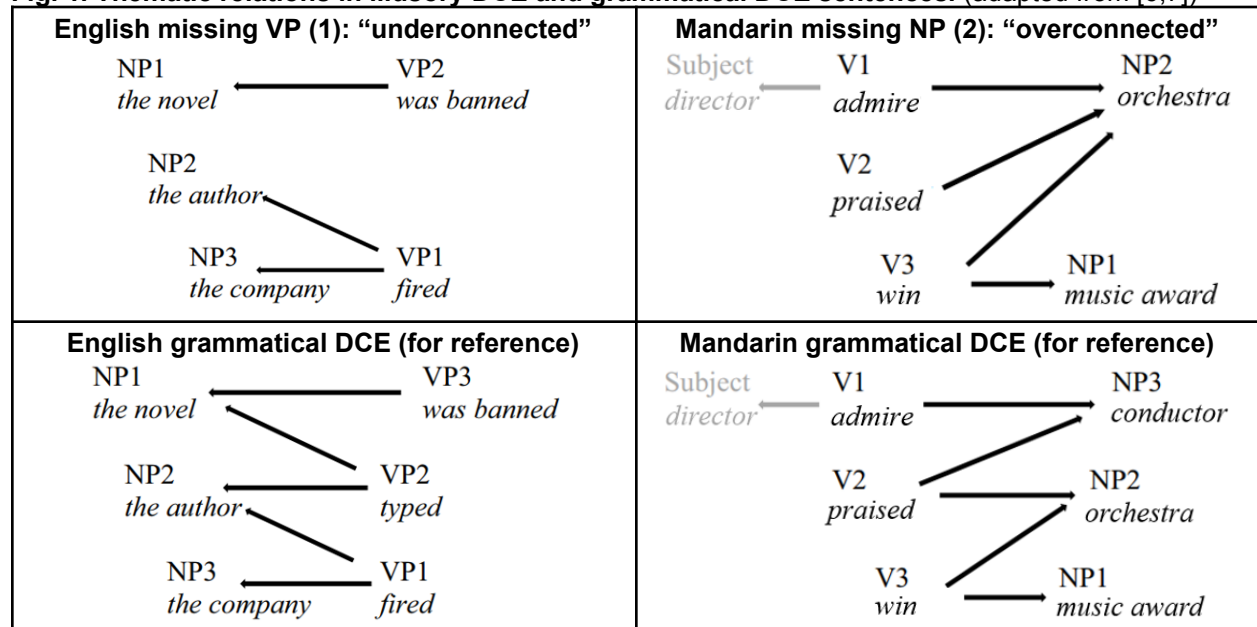
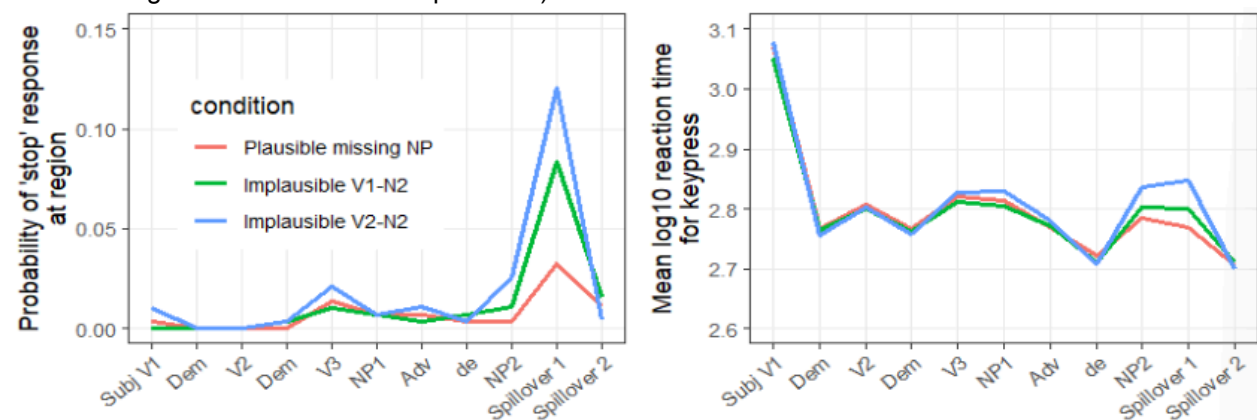


Fig. 2. Mandarin stops-making-sense results; critical region = NP2 (see main abstract for discussion of statistical significance at NP2 and Spillover 1)



Selected references: [1] Gibson & Thomas. (1999). *LCP*. [2] Vasishth et al. (2010). *LCP*. [3]. Häussler & Bader. (2015). *Frontiers*. [4] Frank & Ernst. (2019). *Psychological Research*. [5] Futrell et al. (2020). *Cog Sci*. [6] Huang & Phillips. (2021). *Glossa*. [7] Huang & Phillips. (2023). HSP poster. [8] Frazier. (1985). “Syntactic complexity.” In *Natural Language Processing*.