Missing-verb illusion in Turkish center-embeddings? An investigation of case interference and phrase lengths

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Background: Although grammatically permissible, doubly center-embeddings with relative clauses (2-CE-RCs), e.g., *The rat that the cat that the dog chased ate died* [1:286], are reported to be extremely difficult to process. The processing of 2-CE-RCs is so difficult that omitting a verb is argued to be unnoticed and to result in a grammaticality illusion [2]. This missing-verb illusion has been confirmed in some verb-initial languages (e.g., English [3]; French [4]). But findings on verb-final languages are inconclusive; they either support its presence (e.g. German [5]) or not (e.g., German [6]; Dutch [7]). [6] and [7] suggest that in verb-final languages the susceptibility to the illusion might be reduced due to more robust predictions for upcoming verbs. Turkish, also a head-final language, can provide further data on missing-verb illusion and head-finality. The present study tests this as well as the predictions of two recent accounts for processing 2-CE-RCs: (i) similarity-based interference [8] and (ii) prosodic phrase lengths [9]. (i) predicts that when similarity among subject NPs, e.g., in case marking, is decreased, processing 2-CE-RCs is easier and missing-verb illusion is weaker. (ii) predicts that the balanced prosodic phrasing of 2-CE-RCs eases their processing and leads to a weaker missing-verb illusion. **Design:** Two offline acceptability judgment experiments were conducted. Expt. 1 manipulated grammaticality (i.e., missing-verb) and morphological case interference. For grammaticality, VP2, *taşıdıkları (moved)* in (1,2)*,* was removed in the ungrammatical conditions (Ungra) but was present in the grammatical conditions (Gra). An additional adjective, *ahşap (wood)* was inserted in place of the omitted verb to control for the overall sentence length. For case interference, in high interference condition (HighInt; 1a), all three subject NPs were marked with the genitive case, -(*n*)*In*. In low interference condition (LowInt; 1b), NP1 had the (null) nominative case to decrease the morphological similarity among the subject NPs and the object NP4, *koltuğ-un (sofa-GEN),* was also marked with genitive case to keep phonological case repetition constant. Expt. 2 manipulated grammaticality (as in Expt. 1) and phrase lengths. In conditions that encouraged a relatively balanced phrasing of 2-CE-RCs (ENC; 2a), NP1 and VP1 were each lengthened [9] with two additional prosodic words (PWds), resulting in three PWds each [10]. In conditions that discouraged balanced phrasing (DISC; 2b), NP6 was lengthened with four additional PWds, and NP1 and VP1 were one PWd each. The overall sentence length was the same across ENC and DISC conditions. **Procedure:** 80 and 38 Turkish speakers took part in Expts. 1 and 2, respectively. The participants rated the sentences on a scale of 1 to 5 (5, acceptable), and answered comprehension questions on subject-verb relations. **Results:** Analyses were conducted with the R package *ordinal* [11]. Comprehension accuracy (including fillers) was >60% (see Table 1). For case interference, HighInt was judged to be more acceptable than LowInt (β = .40, *SE* = .13, *z* = 3.04); and for length, ENC was rated marginally more acceptable than DISC (β = .25, *SE* = .14, *z* = 1.76). For grammaticality, analyses showed that Gra overall was rated more acceptable than Ungra (Expt. 1: β = .36, *SE* = .17, *z* = 2.15; Expt. 2: β = .36, *SE* = .19, *z* = 1.88). While Gra received higher ratings than Ungra in HighInt in Expt. 1 (β = .54, *SE* = .22, *z* = 2.45) and in ENC in Expt. 2 (β = .48, *SE* = .25, *z* = 1.92); there was no reliable difference between Gra and Ungra in LowInt in Expt. 1 (β = .14, *SE* = .22, *z* = .67) and in DISC in Expt. 2 (β = .21, *SE* = .20, *z* = 1.03). **Discussion:** The results showed that overall there was no missing-verb illusion in Turkish, supporting the view that verb-final languages are less susceptible to missing-verb illusion [6,7]. But both case interference and phrase lengths modulated the illusion in Turkish, suggesting that the illusion may indeed be cross-linguistic [3] (see [12] for similar results). As predicted by [8], balanced phrase lengths eased the processing of 2-CE-RCs. Similarity-based interference had an effect on processing 2-CE-RCs but in the unpredicted direction, which can be because: (i) judgment (i.e., offline) data may reveal limited effects of case interference [13] and (ii) the non-factive reading of the subordinator *diye* may have caused an extra processing difficulty in the LowInt conditions ([14]). To test these possibilities, an eye-tracking experiment, with sentences excluding non-factive interpretation verbs, was conducted; its data analysis is under way.

References: [1] Chomsky & Miller (1963). In Luce et al. (Eds.). *Handbook of Math. Psy.* **[2]** Frazier (1985). In Dowty et al. (Eds), *Nat. lang. proc.: psy., comp. & theo. pers.* **[3]** Gibson & Thomas (1999). *Lang. & Cog. Pro., 14.* **[4]** Gimenes et al. (2009). *Lang. & Cog. Pro., 24*(3). **[5]** Häussler & Bader (2015). *Fron. In Psy, 6*(766). **[6]** Vasishth et al. (2010). *Lang. & Cog. Pro., 25*(4). **[7]** Frank et al. (2016). *Cog. Sci., 40*(3). **[8]** Lewis & Vasishth (2005). *Cog. Sci., 29*(3). **[9]** Fodor (2013). In Montserrat et al. (Eds.), *Lang. Down the Garden Path: The Cog. & Bio. Basis for Ling. Str.* **[10]** Deniz & Fodor (2017). *Lang. & Speech (60)*4. **[11]** Christensen (2018). **[12]** Dokudan et al. (2017). *Proceed. of AmLaP.* **[13]** Avetisyan et al. (2020). *J. of Mem. & Lang. 112*. **[14]** Özyıldız (2017). *Proceed. of SALT.*

(1) Materials in Expt. 1: Subjects and their verbs are in the same color; case is marked in bold. Here and in (2) brackets show clause boundaries; underlined VP2 is omitted in Ungra.

a. HighInt, Gra/Ungra: [Marangoz-lar-**ın** [nakliyeci-ler-**in** [kiracı-**nın** gri koltuğ-**u**
carpenter-PL-GEN mover-PL-GEN tenant-GEN gray sofa-ACC
NP1-GEN *NP2-GEN* *NP3-GEN* *NP4-NOM*

yerleştir-diğ-i] oda-ya taşı-dık-ları (ahşap) dolab-ı kur-duk-ları-nı]
place-FN-3SG room-DAT move-FN-3PL (wooden) cabinet-ACC set up-FN-3PL-ACC
VP3 *VP2* *VP1*

zaten bil-iyor-um.
already know-PROG-1SG

b. LowInt, Gra/Ungra: [Marangozlar-∅ [nakliyeci-ler-**in** [kiracı-**nın** koltuğ-**un**
carpenter-PL-NOM mover-PL-GEN tenant-GEN sofa-GEN
NP1-NOM *NP2-GEN* *NP3-GEN* *NP4-GEN*

minder-ler-i-ni yerleştir-diğ-i] oda-ya taşı-dık-ları (ahşap)
cushion-PL-POSS-ACC place-FN-3SG room-DAT move-FN-3PL (wooden)
VP3 *VP2*

dolab-ı kur-du-lar] diye bil-iyor-um.
cabinet-ACC build-PAST-3PL SUB know-PROG-1SG
VP1

(2) Materials in Expt. 2: Colored words manipulate phrase lengths: green for ENC, red for DISC. || marks implicit prosodic boundaries induced by phrase lengths.

a. ENC, Gra/Ungra: [İşinin ehli marangoz-lar-ın || [nakliyeci-ler-in [kiracı-nın gri
expert carpenter-PL-GEN mover-PL-GEN tenant-GEN gray
NP1 *NP6*

koltuğ-u yerleştir-diğ-i] odaya taşı-dık-ları (ahşap) dolabı ||
sofa-ACC place-FN-3SG room-DAT move-FN-3PL (wooden) cabinet-ACC

dikkatli şekilde kur-duk-ları-nı] bil-iyor-um.
careful manner set up-FN-3PL-ACC know-PROG-1SG
VP1

b. DISC, Gra/Ungra: [Marangoz-lar-ın || [nakliyeci-ler-in [kiracı-nın **oldukça**
carpenter-PL-GEN mover-PL-GEN tenant-GEN extremely
NP1 *NP6*

geniş gri koltuğ-u **büyük** **özen-le** yerleş-tir-diği] odaya
large gray sofa-ACC great care-with place-FN-3SG room-DAT

taşı-dık-ları (ahşap) dolab-ı || kur-duk-ları-nı] bil-iyor-um.
move-FN-3PL (wooden) cabinet-ACC set up-PAST-3PL-ACC know-PROG-1SG
VP1

'I know that the (expert) carpenters (carefully) set up the (wooden) cabinet that the movers moved to the room where the tenant placed the (extremely large) gray sofa/sofa's cushions (with great care).'

Table 1. Expts. 1 & 2 - Mean acceptability ratings, standard errors of ratings (in parentheses) and comprehension accuracies

	Experiment 1			Experiment 2		
	LowInt	HighInt	Accuracy	ENC	DISC	Accuracy
Gra	2.59 *(.05)*	2.86 *(.05)*	78%	2.87 *(.09)*	2.69 *(.09)*	81%
Ungra	2.40 *(.08)*	2.48 *(.08)*	65%	2.63 *(.08)*	2.54 *(.08)*	66%