German Relative Clauses: The missing-VP effect in double and triple embeddings

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Sentences with a double center embedding that are lacking the second VP such as 'The patient the nurse the clinic had hired ~~admitted~~ met Jack' have been argued to yield an illusion of grammaticality[1,2]. In SVO languages like English and French, these sentences are surprisingly often misjudged as grammatical[2,3,4] and even cause a facilitation of processing[5,6]. This grammaticality illusion has been attributed to working memory overload in doubly center-embedded relative clauses[2]. Research on German and Dutch, however, showed that in SOV languages, a missing VP does not lead to facilitation but to a slowdown in processing[5,6,cf.7]. The difference between SVO and SOV languages has been attributed to the higher exposure to structures imposing high memory demands in verb-final languages. Due to this higher exposure, the German parser may cope better with double embeddings. Under this interpretation, the data from SOV languages is compatible with a memory-based account of relative clause processing.

In two self-paced reading experiments, we investigated the hypothesis that the lack of a grammaticality illusion in German can be attributed to the German parser being more adapted to memory-straining structures. We hypothesized that if the cross-linguistic pattern of relative clause processing can be explained by memory limitations, it should be possible to increase memory demands up to a point where even in an SOV language a grammaticality illusion is caused. To this end, we created materials with triple center embeddings with or without the second VP missing and compared them with double center embedding conditions.

a) 3 emb., +VP2	Der Hase,	den der	Fuchs,	den der	Hund,	den der Jäger	sah,	jagte,	biss,	erreichte	**das**	**Versteck**	...
	The rabbit	that the	fox	that the	dog	that the hunter	saw	chased	bit	reached	the	den	...
b) 3 emb., - VP2	Der Hase,	den der	Fuchs,	den der	Hund,	den der Jäger	sah,	jagte,	~~biss~~,	erreichte	**das**	**Versteck**	...
	The rabbit	that the	fox	that the	dog	that the hunter	saw	chased	~~bit~~	reached	the	den	...
c) 2 emb., +VP2	Der Hase,	den der	Fuchs,	den der	Hund			jagte,	biss,	erreichte	**das**	**Versteck**	...
	The rabbit	that the	fox	that the	dog			chased	bit	reached	the	den	...
d) 2 emb., - VP2	Der Hase,	den der	Fuchs,	den der	Hund			jagte,	~~biss~~,	erreichte	**das**	**Versteck**	...
	The rabbit	that the	fox	that the	dog			chased	~~bit~~	reached	the	den	...

The same 48 items were presented in both experiments, but in Exp. 1 (N=40), each sentence was followed by a comprehension question whereas in Exp. 2 (N=40), a grammaticality judgment was required. Under a working memory account of relative clause processing, we expected *i)* to replicate the slowdown due to a missing VP in the double embeddings[5] and *ii)* an interaction between number of embeddings and grammaticality: in triple embeddings, the missing VP should lead to a reduced sensitivity to the ungrammaticality resulting in either a speed-up as in SVO languages or at least to a smaller slowdown than in the double embeddings.

Linear mixed models showed that, in both experiments, reading times at the region where it becomes clear that a VP is missing (the NP "das Versteck") were significantly longer in missing VP sentences (*Exp1*: *t=6.5; Exp2: t=11.5*). In contrast to the prediction of the working memory account, this effect was not modulated by an interaction with number of embeddings. Analysis of the grammaticality judgments showed that independently of the number of embeddings, the ungrammatical conditions were misjudged as grammatical in approx. 50% of the trials whereas approx. 90% of the grammatical sentences were judged correctly (*z=-17.7; p<0.0001*).

To summarize, we replicated the findings of an *increased* processing difficulty due to a missing VP in German[5,6] and showed that the grammaticality illusion examined here cannot be elicited by increasing memory demands. In line with results by [6], we conclude that the missing-VP effect is not likely to be caused by memory limitations, but may rather be a language-specific phenomenon subject to further investigation.

References **[1]** Frazier (1985). In Dowty et al. (Eds.). Nat Lang Parsing **[2]** Gibson & Thomas (1999). Lang Cogn Process. **[3]** Christiansen & MacDonald (2009). Lang Learn. **[4]** Gimenes et al. (2009). Lang and Cogn Process **[5]** Vasishth et al. (2010). Lang Cogn Process. **[6]** Frank et al. (2015). Cognitive Sci. **[7]** Bader et al. (2003), CUNY.