

Dynamic Prominence in the Processing of Complex Sentences: Evidence from EEG and Eye Movements

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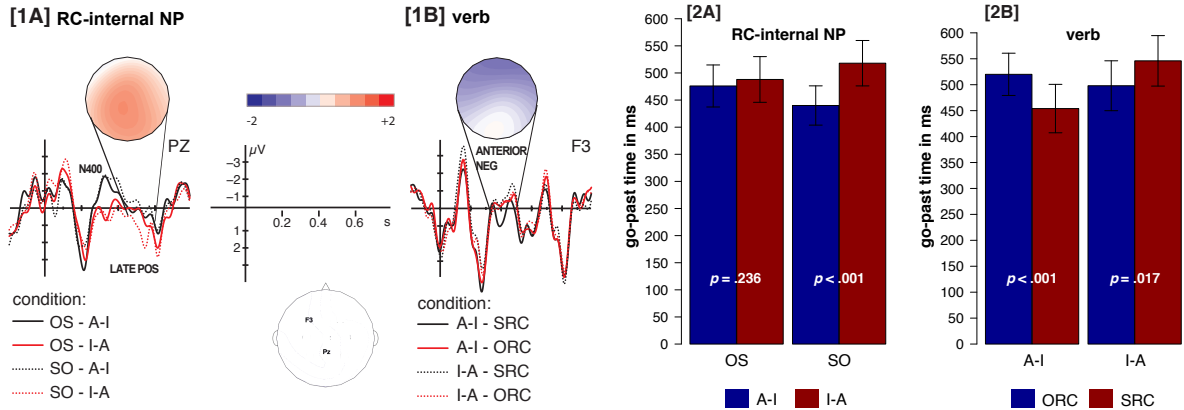
Introduction: Animacy is a semantic property that allows establishing a prominence relation between verbal arguments, with animates being more prominent than inanimates. In sentence comprehension studies, animacy-based prominence has been found to remedy processing penalties for dispreferred word order variations, notably object relative clauses (ORCs) vs. subject relative clauses (SRCs). This finding even holds for languages such as English, where animacy plays a minor role compared with the dominant word order cue (e.g. MacWhinney et al. 1984, Traxler et al. 2005). But while psycholinguistic studies confirm the significant impact of animacy on argument interpretation across languages, it remains unclear whether this influence is modulated dynamically within an unfolding complex sentence, as interactions between RC and matrix-clause information are understudied.

The present study: We conducted two experiments in German, where reliance on animacy as a probabilistic cue to argument interpretation is stronger than in English (MacWhinney et al. 1984), and where the ORC penalty is well established with animate referents and relativized nominative-marked RC heads. We investigated *whether and how the SRC/ORC asymmetry in German is affected by (1) animacy-based prominence within the RC and by (2) interactions between animacy and further prominence cues in the matrix clause.*

Our design fully crossed matrix-clause word order (SO_{HEAD} vs. OS_{HEAD}), animacy of the RC noun phrases ($A_{\text{HEAD}}-I$ vs. $I_{\text{HEAD}}-A$), and RC type (SRC vs. ORC). We recorded ERPs (Exp.1: $n=24$) and monitored eye movements (Exp.2: $n=48$) while participants read sentences with RCs that were locally ambiguous up to the RC-final verb (see Table 1 below).

Results: Both experiments revealed an interaction of RC type and animacy at the disambiguating verb: In Exp.1, ORCs and SRCs with inanimate heads showed a LAN-like negativity (but no late positivity) relative to SRCs with animate heads; see Fig. 1B. In Exp.2, we observed an SRC advantage for animate heads and an ORC advantage for inanimate heads; see Fig. 2B.

Additionally, both experiments revealed an interaction of matrix-clause word order and animacy at the RC-internal noun phrase. There was no effect of animacy when matrix-clause subjects were relativized ($OS_{\text{HEAD}}: I_{\text{HEAD}}-\underline{A} = A_{\text{HEAD}}-\underline{I}$), but we observed a late positivity (Exp.1) and longer reading times (Exp.2) for animate vs. inanimate noun phrases when matrix-clause objects were relativized ($SO_{\text{HEAD}}: I_{\text{HEAD}}-\underline{A} < A_{\text{HEAD}}-\underline{I}$); see Figs. 1A and 2A.



[1] **Exp. 1:** ERPs time-locked to the onset of the RC-internal NP [1A] and of the disambiguating verb [1B].

Topographic maps illustrate the scalp distribution of observed effects.

[2] **Exp. 2:** Go-past times for the RC-internal NP [2A] and for the disambiguating verb [2B]; error bars indicate 95% confidence intervals.

Discussion: Extending prior findings to German, our results confirm that animacy-based prominence may level the SRC/ORC asymmetry (Exp.1) or even invert it (Exp.2). Moreover, the experiments provided novel converging evidence for an interaction of matrix-clause information and RC-internal prominence relations. As sentence-initial noun phrases were animate in all conditions, the pattern of results suggests that the misalignment of prominence features (syntactic function, linear order, animacy) in the matrix clause affects the establishment of prominence relations in the embedded relative clause. This finding can be theoretically accounted for if we assume that the reliability of probabilistic cues to argument interpretation is updated dynamically in the processing of complex sentences.

References:

- MacWhinney, B., Bates, E., & Kliegl, R. (1984). Cue validity and sentence interpretation in English, German, and Italian. *J Verbal Learning Verbal Behav*, 23(2), 127-150.
- Traxler, M. J., Williams, R.S., Blozis, S.A., & Morris, R.K. (2005). Working memory, animacy, and verb class in the processing of relative clauses. *J Mem Lang*, 53(2), 204-224.

Table 1: Example sentences

SO _{HEAD}	A _{HEAD} -I	SRC	Der Politiker	bezahlte	die Terroristen,	die	die Nachricht	erhielten,	als der ...
			<i>the_{NOM} politician</i>	<i>paid</i>	<i>the_{ACC} terrorists_{pl}</i>	<i>that_{AMB}</i>	<i>the_{AMB} message_{sg}</i>	<i>received_{pl}</i>	<i>when the ...</i>
SO _{HEAD}	A _{HEAD} -I	ORC	Der Politiker	bezahlte	die Terroristen,	die	die Nachricht	verärgerte,	als der ...
			<i>the_{NOM} politician</i>	<i>paid</i>	<i>the_{ACC} terrorists_{pl}</i>	<i>that_{AMB}</i>	<i>the_{AMB} message_{sg}</i>	<i>upset_{sg}</i>	<i>when the ...</i>
SO _{HEAD}	I _{HEAD} -A	SRC	Der Politiker	verfasste	die Nachricht,	die	die Terroristen	verärgerte,	als der ...
			<i>the_{NOM} politician</i>	<i>wrote</i>	<i>the_{ACC} message_{sg}</i>	<i>that_{AMB}</i>	<i>the_{AMB} terrorists_{pl}</i>	<i>upset_{sg}</i>	<i>when the ...</i>
SO _{HEAD}	I _{HEAD} -A	ORC	Der Politiker	verfasste	die Nachricht,	die	die Terroristen	erhielten,	als der ...
			<i>the_{NOM} politician</i>	<i>wrote</i>	<i>the_{ACC} message_{sg}</i>	<i>that_{AMB}</i>	<i>the_{AMB} terrorists_{pl}</i>	<i>received_{pl}</i>	<i>when the ...</i>
OS _{HEAD}	A _{HEAD} -I	SRC	Den Politiker	bezahlten	die Terroristen,	die	die Nachricht	erhielten,	als der ...
			<i>the_{ACC} politician</i>	<i>paid</i>	<i>the_{NOM} terrorists_{pl}</i>	<i>that_{AMB}</i>	<i>the_{AMB} message_{sg}</i>	<i>received_{pl}</i>	<i>when the ...</i>
OS _{HEAD}	A _{HEAD} -I	ORC	Den Politiker	bezahlten	die Terroristen,	die	die Nachricht	verärgerte,	als der ...
			<i>the_{ACC} politician</i>	<i>paid</i>	<i>the_{NOM} terrorists_{pl}</i>	<i>that_{AMB}</i>	<i>the_{AMB} message_{sg}</i>	<i>upset_{sg}</i>	<i>when the ...</i>
OS _{HEAD}	I _{HEAD} -A	SRC	Den Politiker	frustrierte	die Nachricht,	die	die Terroristen	verärgerte,	als der ...
			<i>the_{ACC} politician</i>	<i>frustrated</i>	<i>the_{NOM} message_{sg}</i>	<i>that_{AMB}</i>	<i>the_{AMB} terrorists_{pl}</i>	<i>upset_{sg}</i>	<i>when the ...</i>
OS _{HEAD}	I _{HEAD} -A	ORC	Den Politiker	frustrierte	die Nachricht,	die	die Terroristen	erhielten,	als der ...
			<i>the_{ACC} politician</i>	<i>frustrated</i>	<i>the_{NOM} message_{sg}</i>	<i>that_{AMB}</i>	<i>the_{AMB} terrorists_{pl}</i>	<i>received_{pl}</i>	<i>when the ...</i>