Disentangling subjecthood, linear order, and information structure effects in pronoun resolution

Regina Hert (University of Alberta), Juhani Järvikivi (University of Alberta), Anja Arnhold (University of Alberta)

hert@ualberta.ca

While it is often assumed that referentially ambiguous subject pronouns typically choose the subject of the preceding sentence as their antecedent, it has long been debated whether this is best characterized as a subject preference (Frederiksen, 1981) or a first-mention effect (Gernsbacher et al., 1989). While both factors are typically conflated in English due to fixed word order, languages with flexible word order allow disentangling syntactic structure and linear order (e.g., Järvikivi et al., 2005). However, changes in word order often signal variation in information structure, which has also been shown to affect pronoun resolution (e.g., Colonna et al. 2012). In this study, we crossed manipulations of prosodically-marked information structure and word order in the flexible word order language German to tease apart the three factors.

60 university students from the University of Konstanz and the University of Oldenburg took part in this visual world eye-tracking experiment. Participants listened to dialogues where the target pronoun was preceded by a critical sentence in SVO (1a) or OVS (1b) order, with prosody marking the sentence-initial constituent as either a focus or a given topic (and, conversely, assigning the other role to the sentence-final constituent), resulting in four conditions, all well-formed in German. In addition to prosody, dialogue context enforced information structure (full example dialogue in Table 1).

1. (a) SVO: Der Schauspieler (Given Topic/Focus) hat den Koch angerufen
   'The actor (NOM) has called the cook (ACC)'

   (b) OVS: Den Koch (Given Topic/Focus) hat der Schauspieler angerufen
   'The cook (ACC) has called the actor (NOM)'

After each dialogue, participants answered a question regarding to whom they thought the subject pronoun was referring. We analyzed these offline responses with generalized linear mixed-effects models. The best model showed that both word order and prosody, as well as the interaction between them, were significant. Overall there was a subject preference in all four conditions, which however decreased when the object was focused (Given Topic + SVO and Focus + OVS; Fig. 1).

The eye gaze data for the segment with the critical manipulation (Fig. 2a) showed an increase in looks towards the focused referent for both subject and object referents. For the segment with the pronoun (Fig. 2b), there was an increase in looks towards the subject if the subject referent was focused in the preceding sentence (Given Topic + OVS and Focus + SVO). When the object referent was focused in the preceding segment, there were more looks towards the object during the initial part of the pronoun segment, but more looks towards the subject later. Statistical analyses using Generalized Additive Mixed Models confirmed that the differences in looks described here are significant.

These results show that prosody guides visual attention to the focused referent and that prosody and information structure can partially override the subject preference in the interpretation of pronouns when the referent in focus is the object. Nonetheless, the subject preference is stable across conditions. Since in this experiment we did not disentangle syntactic from semantic structure, we cannot exclude any semantic effects. Thus, the subject preference was simultaneously always a preference for the agent. By contrast, by clearly separating subject- and first-mention effects while controlling for information structure, the present study provides evidence that subjecthood / agentivity outweighs order of mention in German pronoun resolution.
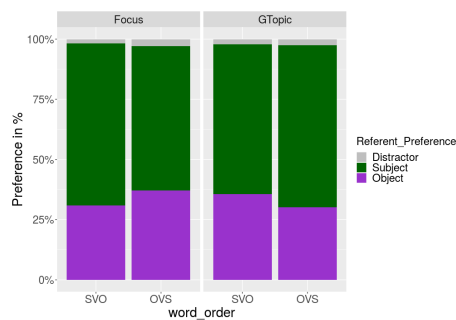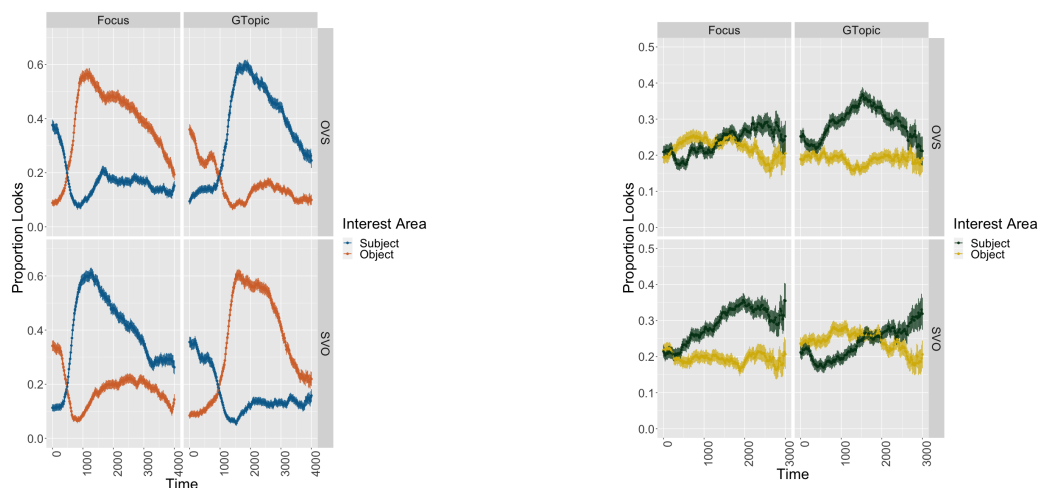
Fig. 1. Referent preference in percentage by condition.

(a) Segment 1 (Critical manipulation)

(b) Segment 2 (Pronoun)

Fig. 2. Proportion of looks by condition for two time segments

Table 1. Example dialogue in Focus + SVO word order condition. Critical sentence with manipulation of word order and information structure in italics, pronoun bold.

German	English translation
A: Ich habe gerade Ärger in meiner Strick-gruppe, in der auch der Koch, der Schau-spieler, der Maurer und der Detektiv sind. Wir haben einen Termin verschoben und ziemlich viel rumtelefoniert. Als letztes hat jemand den Koch angerufen.	A: I have some problems in my knitting group which also includes the cook, the actor, the bricklayer, and detective. We postponed an appointment and called back and forth. Lastly, someone called the cook.
B: Und wer hat den Koch angerufen?	B: And who called the cook?
A: *Der Schaupieler hat den Koch angerufen*, und zwar mit einem Handy. **Er** war zu diesem Zeitpunkt schon ziemlich müde.	A: *The actor called the cook*, namely with a mobile phone. **He** was already pretty tired at this point.
B: Das ist aber schade.	B: That is too bad.

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