Effects of syntactic structure and information structure on reference resolution

Reduced anaphoric forms are assumed to refer to entities that are prominent / salient in interlocutors’ minds ([1],[11]). It is commonly assumed that entities in a discourse model differ in how salient they are, and various factors—including information-structural notions like topic and focus—have been argued to contribute to salience and to the likelihood of subsequent pronominal reference. Some researchers claim that topical entities are most salient (e.g. [10]), whereas others regard focused entities as more salient (e.g. [12],[5],[9], cf.[13]). Taking steps to reconcile these views, [2] and [8] agree that topicality and focusing increase salience, but disagree regarding the relative salience of topics vs. foci. In light of existing work showing that grammatical role influences salience ([10] and many others), the divergence in these results may be due to differences in topic/foci grammatical roles: [2] tested subject topics and object foci, whereas [8] looked at subject topics and subject foci.

We aim (i) to better understand contributions of grammatical role, topicality and focusing, and (ii) to investigate the relative contributions of different kinds of information for reference resolution more generally. It has been suggested that multiple weighted constraints guide reference resolution (e.g.[1],[2],[4]). We test the hypothesis that, for the default pronominal form in a language, structural constraints (e.g. subjection) are weighted equal to (or more heavily than) informational-structural constraints (e.g. topicality, focusing). We claim that although grammatical properties such as subjection are connected to a referent’s information-structural properties (e.g. topic status), they do not coincide fully and can have different effects during processing. More speculatively, we suggest that the hypothesized greater influence of structural constraints may stem from the cognitive consequences of the central role that factors like subjection play in successful comprehension. To test the idea that structural constraints outrank information-structural constraints, and to investigate more generally how topicality, focusing and grammatical role influence reference resolution, we report the results of an earlier sentence-completion study (Exp.1), and two new visual-world eye-tracking experiments (Exp.2-3). Exps. 1 and 2 investigate corrective focus, and Exp. 3 looks at presentational focus.

**Exp.1—Sentence completion.** In this earlier study we manipulated grammatical role (subject / object), topicality/focus and syntactic form (SVO/cleft). We embedded the SVO/cleft critical sentence in a corrective context (ex.1). By comparing clefts vs. SVO we can investigate clefted and unclefted foci (1a/1c,1b/1d). We follow [6] and many others in assuming that pronominalization correlates with topicality. Participants read mini-dialogs (ex.1) and provided spoken continuations, which were transcribed and coded for which referent in the preceding critical sentence (cleft/SVO) the subsequent prompt pronoun is used to refer to. Continuations revealed a significant preference to interpret prompt-pronouns as referring to the subject of the preceding sentence (p<0.05). There were no main effects of topicality/focusing.

These results suggest that the subject constraint guides reference resolution more than the information-structural constraints investigated here. However, sentence completion methodology does not allow us to draw conclusions about the time-course of processing. We cannot tell whether grammatical role guides reference resolution from the initial moments onwards, or whether its effects only emerge later in the course of processing, perhaps following an earlier processing phase during which other factors (topicality/focusing) also influenced processing.

**Exp.2—Eye-tracking.** To investigate effects of grammatical role, topicality and (corrective) focus using a more sensitive measure, and to explore how their effects unfold over time, we used eye-tracking. Participants wore a lightweight head-mounted eye-tracker while listening to mini-dialogues (same basic conditions as Exp.1, see ex.1) and looking at scenes
depicting the relevant characters. We analyzed which characters participants looked at as soon as they heard the subject pronoun following the critical SVO/eleft sentence. Existing research shows that eye-movements to entities in a display are closely time-locked to potential referents that a listener is considering as language unfolds over time (e.g. [7],[14]). We can thus use eye-tracking as a tool to shed light on what participants consider as potential referents for pronouns as the sentence unfolds in real time. Participants’ eye-movements reveal an overarching subject preference (p<0.05), emerging soon after pronoun onset. This shows that grammatical role guides reference resolution early on, and is not a late strategy that only appears in off-line tasks.

Exp.3—Eye-tracking. Exp.3 uses eye-tracking to investigate topicality and subjecthood without the presence of corrective focus (stimuli modified from Exp.2). Now the main emphasis is on SVO sentences with a pronominalized subject/object and a discourse-new referent as the other argument (i.e., new-information/presentational focus, not corrective focus). Eye-movements reveal effects of subjecthood and topicality. When subjecthood and topicality coincide (pronominalized subject, full-NP object), we see an early, persistent subject preference (p<0.05). When subjecthood and topicality conflict (full-NP subject, pronominalized object), eye-movements show that subject and object compete equally. This shows that, upon encountering a subject pronoun, the human language processing system considers both the pronominalized, discourse-old object and the new-information subject as possible antecedents for the pronoun. Crucially, in Exp.2, these same sentences (the only difference is that the subject is in corrective focus in Exp.2 and new information in Exp.3) showed a clear subject preference—i.e., the subject in corrective focus ‘wins’ over the pronominalized, discourse-old object. This difference reveals that corrective focus does indeed influence reference resolution: A subject that is in corrective focus has a greater salience advantage over a pronominalized (topical) object (Exp.2) than does a subject that is merely new information (Exp.3).

Conclusions. Our findings show the subjecthood constraint can be modulated but not overridden by the information-structural constraints tested here. This (i) supports the claim that multiple constraints guide reference resolution, (ii) shows that corrective focus and new-information/presentational focus have different effects on reference resolution, and (iii) supports our hypothesis concerning the relative contributions of grammatical role and information-structural factors. The experiments also suggest that eye-tracking is a useful tool for investigating effects of information structure and syntactic structure on real-time reference resolution.

(1) A: The cowboy kicked the mechanic.  
(a) B: No, that’s wrong! He^{topic} kicked the fisherman^{focus}. He….
(b) B: No, that’s wrong! The fisherman^{focus} kicked him^{topic}. He….
(c) B: No, that’s wrong! It was the fisherman^{focus} that he^{topic} kicked. He…
(d) B: No, that’s wrong! It was the fisherman^{focus} who kicked him^{topic}. He…