Pronouns are a shortcut way to refer to entities that are highly active in interlocutors' shared discourse models. Psycholinguistic processing studies have shown that, in many languages, adults' attention to potential pronoun antecedents is facilitated by linguistic properties such as subject/agenthood, the first-mentioned status of the potential antecedent in discourse, the verb causality bias, and information structure.

Apart from these linguistic factors, recent studies show that adult language comprehension is immediately affected by the hearer’s extra-linguistic environment, namely the visual context and other cues to shared attention. Recently, Nappa and Arnold (2014) showed participants videos in which a narrator told a short story like *Puppy is having some pizza with Panda Bear. He wants the pepperoni slice.* The narrator turned her head and looked at one of the two possible referents (e.g., *puppy* or *panda bear*) while the participants heard the pronoun (*he*). They found that if the narrator gazed at the second-mentioned antecedent, it increased the selection of this antecedent significantly compared to neutral gaze or gaze at the first-mentioned antecedent. In contrast, Pykkönen-Klauck & Järvikivi (submitted) found that the mere co-presence or absence of either the grammatical subject or the object character during the antecedent sentence did not modulate pronoun resolution in adults: if one of the potential antecedents left the visual scene before the ambiguous pronoun was heard, it did not affect interpretation of that pronoun. This suggests that visual cues of social nature, but not others, affect language comprehension. Moreover, the gaze cue in Nappa and Arnold, accompanied by a head turn and coinciding with the pronoun, was salient enough to be taken as pointing.

To investigate the role of non-linguistic factors on processing of ambiguous pronouns, we used the visual world eye-tracking paradigm. We asked whether narrator eye-gaze to one of two possible referents before the onset of the pronoun – a more subtle cue than has been tested in previous studies – affects 1) the time course of processing and 2) referent selection preferences in adults. Participants listened to stories like *There are the tiger and the monkey. The tiger kisses the monkey near the bridge. He wants to stay home from school today* while their eye movements to visually presented animal characters were tracked. Crucially, during the action (e.g., *The tiger kisses the monkey*), but not during the pronoun, an on-screen narrator (a hedgehog) looked at either the subject or the object character. After each story, the participant was then asked to answer a prompt question requiring pronoun resolution, e.g., *Who wants to stay home from school today?*

Seventy-one native English-speaking adults were tested, and results were analyzed using mixed effects modelling. For trials in which the participant looked at the narrator during the critical portion of the story (i.e., when the narrator's gaze was on one of the animal characters), there was a significant main effect of the narrator's gaze ($\chi^2(1) = 11.92, p < .001$), such that the proportion of looks to the subject was lower when the narrator had gazed at the object during the action portion of the story. The effect of the narrator's eye gaze impacts offline referent selection as well, with more people choosing the object in response to the prompt question (e.g., *Who wants to stay home from school today?*) when they had looked at the narrator while the narrator was gazing at the object ($\chi^2(1) = 9.44, p = .002$). This suggests that non-linguistic visual/social cues do affect pronoun resolution and language processing online, and that such cues can even help overcome strong linguistic biases like the subject/agenthood and first-mentioned bias – even when these cues are subtle and occur before the ambiguous pronoun is heard.
References

Nappa, R. & Arnold, J. E. (2014). The road to understanding is paved with the speaker’s intentions: Cues to the speaker’s attention and intentions affect pronoun comprehension. *Cognitive psychology*, 70, 58-81.