The immediate effect of the crossover constraint on pronoun resolution in English

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Introduction Previous studies on antecedent retrieval show that semantic cues of the pronoun are only accessible when the antecedent is in a structurally accessible/licit position (e.g., Sturt'03; Dillon et al.'13) during early-stage processing, contrasting with other studies finding that structural constraints are not prioritized over semantic cues (e.g., Badecker & Straub'02; Patil et al.'16). To examine these two views, this study probes the relative accessibility of structural and semantic cues in the processing of strong and weak crossover constructions in English.

In a crossover construction, a *wh*-phrase (*which man*) moves across a co-indexed pronoun, like *he*/*his* in (1a,2a), which violates a slew of structural constraints (e.g., Reinhart'83; Lasnik & Stowell'91). We refer to these constraints collectively as the *crossover constraint*. It is generally accepted that strong crossover (SCO) is worse than weak crossover (WCO) as SCO additionally violates the Binding Principle C (Chomsky'81). This study thus not only examines whether the crossover constraint is prioritized relative to the semantic cue of gender in WCO, but also probes how the increased weighting of structural cues in SCO (crossover + Principle C) relative to WCO (crossover) impacts pronoun resolution at different processing stages.

To preview our **self-paced reading** results (Exp.1: SCO; Exp.2: WCO), we find that regardless of the weighting of the structural cues, semantic cues are only utilized when the antecedent (*wh*-phrase) is in a structurally accessible position. This contrasts with prior findings by Kush et al.'17, which could be ascribed to differences in experimental designs and sentence complexity.

Methods Native English speakers (N = 85 in Exp.1; N = 89 in Exp.2) read sentences (24 targets, 48 fillers) region by region and made acceptability judgment after each trial. The gender congruency of the TARGET (match/mismatch) and the DISTRACTOR (match/mismatch) were crossed in a 2x2 factorial design. See ex.(1-2). The *target* refers to the structurally licit co-referent (e.g., *Peter*), while the *distractor* refers to the structurally illicit co-referent (e.g., *which man*). Following prior work (e.g., Sturt'03; Kush et al.'17), we take the *gender mismatch effect*, characterized by *reading slowdowns when a pronoun and its antecedent have different genders*, as a diagnostic of whether readers attempt to establish coreferences.

Results RTs were analyzed using mixed-effect linear models (*lme4* in R). In **Exp.1** on SCO (**Fig.1**), at the critical **pronoun** (*he/she*) and the two spillover regions, there was only a main effect of TARGET (ps < 0.05): RTs were longer when the *target* antecedent and the pronoun mismatch in gender (gender mismatch effect). The gender of the *distractor* did not impact processing at any region. Similarly in acceptability judgment (**Fig.2**), participants were only affected by the gender of the *target* (p < 0.05) but not by the gender of the distractor.

In **Exp.2** on WCO (**Fig.3**), the crossover constraint similarly has an immediate effect as there are main effects of TARGET (ps < 0.05) only at the **pronoun** (*his/her*) and the spillover NP region. The absence of any distractor effect suggests that the gender of the structurally inaccessible distractor was not used by the participants at an early stage. Significant distractor gender effects only appeared for the final two regions (ps < 0.05, details not discussed due to space), which contrasts with the absence of any distractor effects in Exp.1 on SCO. This difference in late-stage processing patterns between Exp.1 and 2 suggests that online pronoun resolution is sensitive to the weighting of structural constraints (Principle C + crossover constraint vs. crossover constraint). The post-reading judgment results in Exp.2 (**Fig.4**) also show distractor gender effects (but only significant within the *target match* conditions).

Conclusion The study yields evidence suggesting that the semantic gender of the *distractor* has a limited impact on pronoun resolution in the crossover constructions in English, as shown by our finding that (i) the gender of the distractor was not considered by participants in the SCO construction (Exp.1) and (ii) the gender of the distractor only impacts late-stage processing in the WCO construction (Exp.2). Together, these results are more compatible with a syntax-driven account of pronoun resolution (e.g., Sturt'03; Chow et al.'14), at least in English.

Example target stimuli in Exp.1 – SCO (slashes mark different regions in self-paced reading):

(1a) TARGET MATCH/DISTRACTOR MATCH
Peter/ told/ us/ which man/ in/ the office/ he/ had/ promoted__/ recently.

(1b) TARGET MATCH/DISTRACTOR MISMATCH
Sarah/ told/ us/ which man/ in/ the office/ she/ had/ promoted__/ recently.

(1c) TARGET MISMATCH/DISTRACTOR MATCH
Sarah/ told/ us/ which man/ in/ the office/ he/ had/ promoted__/ recently.

(1d) TARGET MISMATCH/DISTRACTOR MISMATCH
Peter/ told/ us/ which man/ in/ the office/ she/ had/ promoted__/ recently.

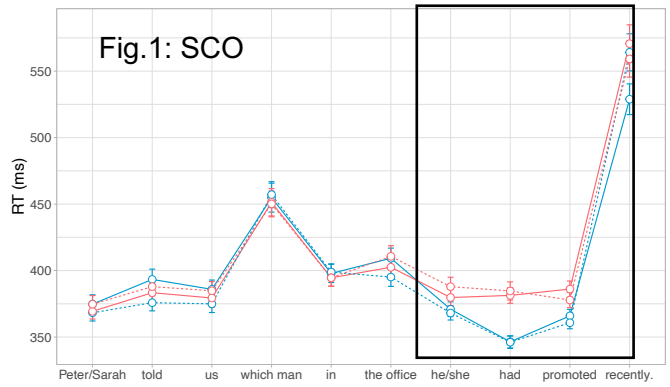
Example target stimuli in Exp.2 – WCO

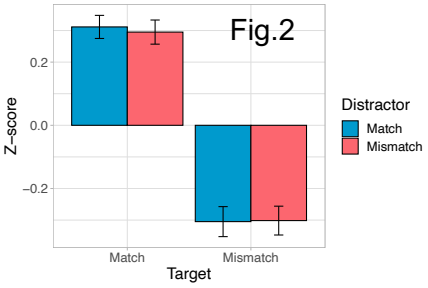
(2a) TARGET MATCH/DISTRACTOR MATCH
Peter/ wondered/ which man/ in/ the office/ his/ supervisor/ had/ promoted__/ recently.

(2b) TARGET MATCH/DISTRACTOR MISMATCH
Sarah/ wondered/ which man/ in/ the office/ her/ supervisor/ had/ promoted__/ recently.

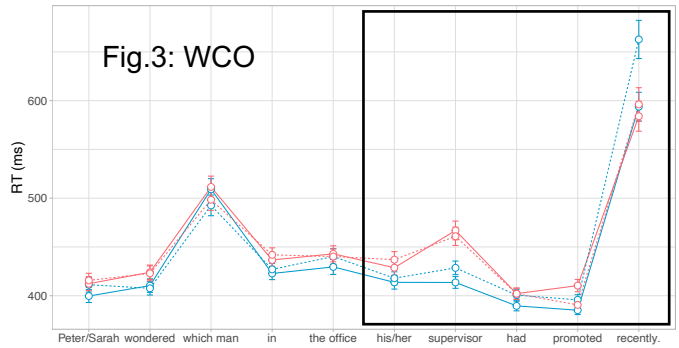
(2c) TARGET MISMATCH/DISTRACTOR MATCH
Sarah/ wondered/ which man/ in/ the office/ his/ supervisor/ had/ promoted__/ recently.

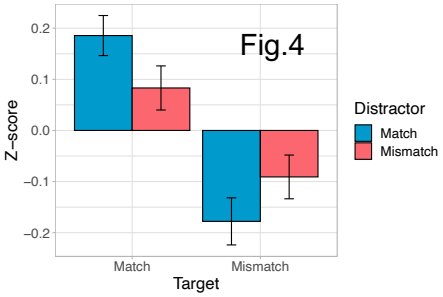
(2d) TARGET MISMATCH/DISTRACTOR MISMATCH
Peter/ wondered/ which man/ in/ the office/ her/ supervisor/ had/ promoted__/ recently.





Acceptability





Acceptability

Selected references Badecker & Straub'02. The processing role of structural constraints on the interpretation of pronouns and anaphors. Chow et al.'14. Immediate sensitivity to structural constraints in pronoun resolution. Kush et al.'17. Looking forwards and backwards: The real-time processing of strong and weak crossover. Sturt'03. The time-course of the application of binding constraints in reference resolution.