

Sensitivity to gender cues during anaphor resolution: evidence from visual world eye-tracking

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Background. Anaphor resolution is constrained by both structural (e.g., binding principles/BT) and non-structural factors (agreement features like gender). However, models differ on the views of how people apply these constraints to guide their anaphor resolution. **The structural dominant approach** emphasizes the importance of structural constraints such that people apply BT as an initial filter or use it to narrow down the referential domain first (1, 2) relying less on agreement features. On the other hand, **the multiple constraints approach** claims that people use both syntactic and non-syntactic features to guide resolution initially (3, 4). The role of *gender cues on English anaphor resolution* is one of the best-studied cases. Some studies (1, 2, 5) found that, especially for reflexives, resolution is not susceptible to interference effects from items that are in a BT incompatible position (i.e., non-local c-commanding) but match the gender of the anaphors. However, many other studies (3, 4, 6, 7) do find that people use non-structural cues in parallel with syntactic constraints. The current study aims to contribute to the debate of whether or not people use both structural and non-structural constraints initially during anaphor resolution using English pronouns and reflexives as test bed. (They are in argument positions which should uncontroversially obey binding principles). Following the multiple constraints approach, we predict that people are sensitive to both syntactic cues (e.g., binding principles) and non-syntactic cues (e.g., gender) and use them to guide their search of the antecedents initially.

Method. See Table 1. Using the visual word paradigm, 36 English native speakers were asked to click on the image that represents the last word in the sentence they heard (critical items: *Occupation1-Verb-Occupation2-PP-Pronoun/Reflexive*). The display contained three pre-normed images that represent two occupations and a PP/location. We manipulated two factors: the *anaphoric form* presented in the spoken stimuli: reflexive or pronoun, and the gender pair of occupation images: both match the gender of the anaphor or only the BT-compatible one matched the gender.

Results. People's final interpretations of both pronouns and reflexives strictly followed the binding principles (Table 2 ~97% of the BT-compatible choices). Time-course data are presented in Figure.1. Using logistic mixed effects models with gender pair (both vs. single match) and anaphor type (pronoun vs. reflexive) as fixed effects and maximum random effects for both items and subjects, we predicted the fixation to the (BT-compatible) *Target* (0/1: fixated or not) during an 800ms time-window starting from 200ms after the onset of the anaphor because it takes ~200ms to perform a saccade in the visual world paradigm (8). Results showed a main effect of the gender pair such that people had fewer target fixations when both antecedents matched the gender of the pronoun/reflexive ($\hat{\beta}=.59$, $z= 4.86$), the effect is larger for pronouns than reflexives (interaction effect: $\hat{\beta}=.37$, $z= 2.93$). A further analysis on the initial time-window (200~500ms) also showed a similar significant effect of the gender pair ($\hat{\beta}=.66$, $z= 3.01$) indicating that people did use gender cues to guide resolution initially.

Conclusions. Results are consistent with the multiple constraints approach where both structural and non-structural constraints influence anaphor resolution from the beginning of the antecedent search in a form-specific sensitivity way: pronoun resolution is more sensitive to non-structural constraints (e.g., gender) than reflexives (3). What's more, the use of both linguistic and non-linguistic information (e.g., the gender information was encoded on visual stimuli only) during anaphor resolution supports a highly interactive and contextually sensitive model of human language processing.

Design and materials:

Table.1 Visual-world eye-tacking:

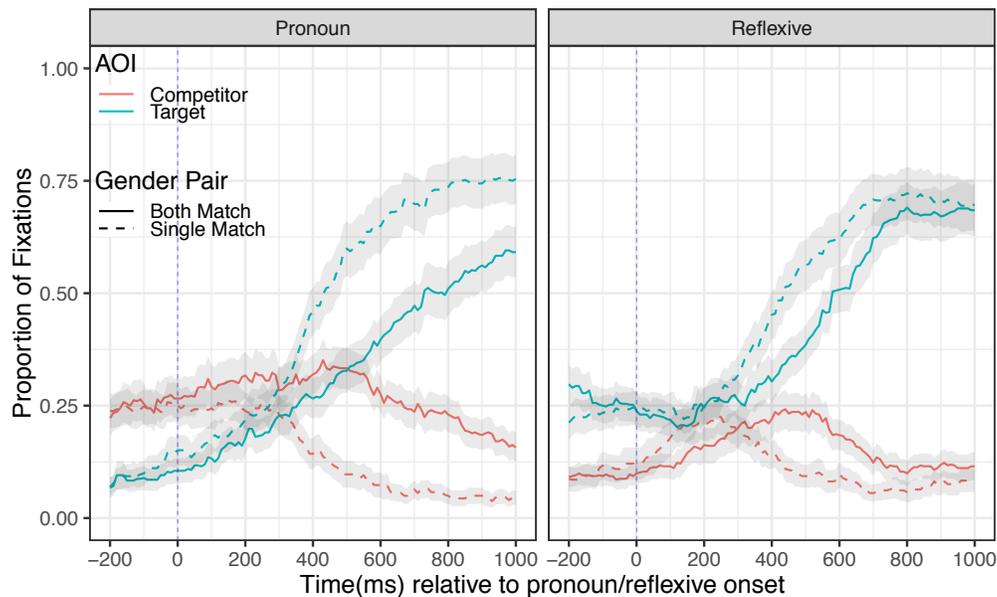
Task: “Click on the image that represents the last word you have just heard.”	
Stimuli: 16 items + 16 fillers (spoken materials). Occupation 1-Verb-Occupation 2-PP-Pronoun/Reflexive <i>e.g., The pharmacist believed that the pianist at the store embarrassed her/herself.</i>	
Display:	Manipulations:
	<p>A. Gender Pair: Both match vs. single match</p> <p>B. Anaphor Type: Pronoun vs. Reflexive</p> 

Results:

Table.2 Click data: Choices of the Target/BT-compatible antecedent

	Both Match	Single Match
Pronoun	95.83%	97.22%
Reflexive	98.61%	98.61%

Figure.1 Time-course data



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