Language affects pragmatic reasoning: The case of adjective interpretation

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Most eye-tracking studies on adjective interpretation have been conducted in English (e.g., Sedivy, 2003, 2005; Aparicio et al., 2017), yet most world languages have postnominal modification, unlike English (Dyer, 2013). We used the Visual World paradigm to investigate how adjective position affects (i) the visual search for a referent and (ii) the pragmatic processes underlying reference resolution. We compared the processing of modified definite descriptions using color, material and scalar adjectives (e.g., 'The black lamp') across two languages with prenominal modification (PreN: Hindi and Hungarian) and two with postnominal modification (PostN: Catalan and Wolof). Samples were collected in the original countries (India, Hungary, The Balearic Islands and The Gambia, respectively), spanning four language families (Indo-Aryan, Finno-Ugric, Romance and Niger-Congo) and including languages with and without a written tradition (Hindi, Hungarian and Catalan vs. Wolof).

We tested two hypotheses (N=28 per language): first, since language is processed incrementally and efficiently (Eberhard et al., 1995; Spivey et al., 2001), we predicted that speakers of PreN languages would establish referential contrast *across categories* (e.g., black objects > black lamp), whereas speakers of PostN languages would establish referential contrast *within a category* (lamps > black one; see Fig.1). This means that, in the 0-Competitor condition (0C), the visual search for the referent would be guided by the adjective in PreN languages, but by the noun in PostN languages; and therefore, in 1C, only PreN speakers would suffer interference from the property competitor (see Fig.1). As predicted, PreN speakers revealed a difference between 0C and 1C (Hindi: 7.2% increase in Target fixations in 0C vs 1C during the NP window; 95% CI: 3.9%-10.4%; Hungarian: 8.4% increase; 95% CI: 6%-10.6%), unlike PostN speakers (Catalan: .08% increase; 95% CI: -1.9%-1.9%; Wolof: 0.6% increase; 95% CI: -1.4%-2.6%). Further analyses confirmed that the property competitor caused the interference in 1C (see Fig.2).

Second, we used the 'Sedivy paradigm' to investigate how the two language groups interpret adjectives contrastively: in 2C, PreN speakers could derive a contrastive inference when processing the adjective and anticipate the noun, whereas in 1C, they would need to wait for the noun to resolve the temporary ambiguity created by the adjective. Conversely, PostN speakers should be faster to identify the target in 1C than in 2C, where they would first consider the two competitors and then use color to choose between them, hence deriving a contrastive interpretation but without a pragmatic inference. As predicted (see Fig.3), the average difference in Target fixations in 2C vs 1C was significantly different in Hindi vs Catalan (8.5% difference; 95% CI: 6.2%-10.5%); Hindi vs Wolof (9.9% difference; 95% CI: 7.7%-11.9%); Hungarian vs Catalan (8.4% difference; 95% CI: 6.2%-10.6%) and Hungarian vs Wolof (9.9% difference; 95% CI: 7.7%-11.9%) but comparable in languages with the same adjective position.

Our eye-tracking results confirm that, because language is processed incrementally, speakers of PreN languages establish referential contrast across categories, whereas speakers of PostN languages establish it within a category. More importantly, adjective position also determines whether the contrastive interpretation of an adjective is the result of a pragmatic inference (PreN languages) or incremental language processing (PostN languages). Just as it has been argued that one of the effects of language on thought can be observed in *thinking for speaking* (Slobin, 1996; Wolff & Holmes, 2011), our results show that language structure affects *thinking for interpreting*. Thus, at the computational level – the highest level of abstraction (Marr, 1982), reference could be characterized as a universal pragmatic function. However, the computational problems posed by this universal function must be solved in a language-specific manner, even when interpreting equivalent referential expressions in the same visual context. We therefore conclude that language affects pragmatic reasoning at the algorithmic level.

Fig.1: Sample displays from the three visual conditions in the Color Adjective condition. The targets were, from left to right, 'the black feather', 'the black drum' and 'the black lamp'. Similar displays were constructed for Material and Scalar adjectives.

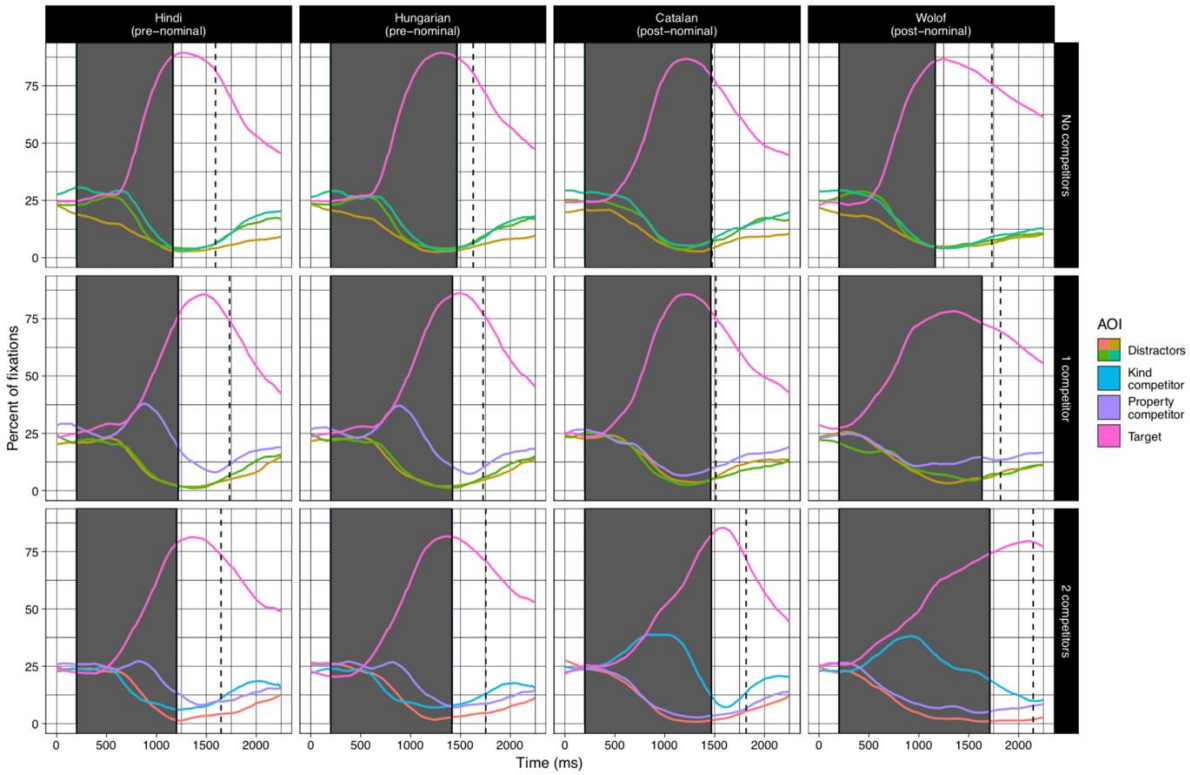

Fig.2: Percentage of fixations on the four objects in a display over time. The grey area represents the average duration of the NP and the dashed line the average RT (click on target).

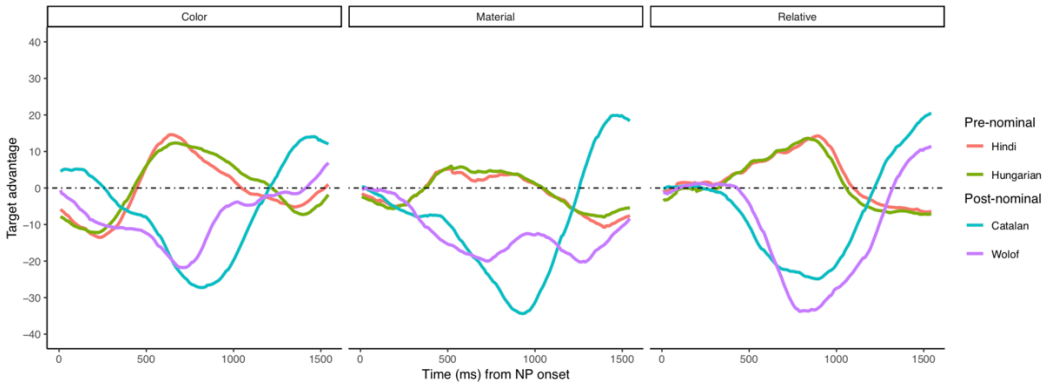

Fig.3: Target advantage/disadvantage in 2C vs. 1C for each language and adjective type.