# Referential Chains: Predictive Processes and Form-to-Function Mapping as Revealed by Naturalistic Story Stimuli using EEG

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In the present research, we explore the relationship of the form of a referential expression and the form of its antecedent and the continuity predictions derived from it during online language comprehension using regression-based event-related potentials (rERP). We analyzed electroencephalographic (EEG) data recorded while participants (N=35, mean age 25, range 20-34yrs) listened to a German audio book recording of *The Little Prince* by Antoine de Saint-Exupéry to investigate referential processing. We were particularly interested in predictive processes related to matched predictions (P300 time window, 200-300ms) and prediction errors (N400 window, 300-500ms) (e.g., Roehm et al., 2007). We contrasted referential chains with different referential forms. Based on their particularly strong prominence contrast, we chose to contrast anaphoric nouns and pronouns (in bold) with noun or pronoun antecedents (underlined), resulting in four conditions: pronouns with pronoun antecedent (P-P chain, (1), N=152), pronouns with noun antecedent (N-P chain, (2), N=63), nouns with noun antecedent (N-N chain, (3), N=40) and nouns with pronoun antecedent (P-N chain, (4), N=51).

1. <u>She</u> [the flower] adjusted her petals one by one. **She** did not wish to go out into the world all rumpled, like the field poppies. (The Little Prince, chapter 8)
2. And <u>the little prince</u> broke into a lovely peal of laughter, [...] Then **he** added […] (chp. 2)
3. I have serious reason to believe that the planet from which the little prince came is <u>the asteroid known as B−612</u>. **This asteroid** has only once been seen ... (chp. 4)
4. But he was in Turkish costume, and so nobody would believe what <u>he</u> said […] So in 1920 **the astronomer** gave his demonstration all over again, dressed with impressive style and elegance. (chp. 4)

Based on the literature on referential form and prominence (e.g., Gundel et al., 1993), we assume that referents of pronouns with pronoun antecedent are the most prominent referents in our comparison, because both antecedent and anaphor mark their referent as prominent. They are followed by pronoun anaphors with noun antecedent, since nouns mark a referent as less prominent than pronouns but a pronoun anaphor enhances the prominence status of the referent. Pronoun-noun chains are the least predicted type of the investigated referential chains: a referent established as prominent (reference via pronoun) is continued with an expression marking it less prominent, constituting a discourse structural mismatch. Noun anaphors with noun antecedent, by contrast, are very common, e.g., in a chain with indefinite antecedent and definite anaphor or for reasons of disambiguation. In summary, we propose the following prominence ranking, which we assume to be reflected in P300 and N400 amplitude: P-P > N-P > N-N > P-N.

We calculated linear mixed effect models with mean P300 and N400 amplitude as dependent variable using the formula *µV~laterality\*saggitality\*anaphor type\*antecedent type+covariates (*e.g., referential distance). The results support our predictions by revealing a significant influence of the form of an antecedent on the P300 (reduced P300 for unpredicted continuations) and N400 amplitude (increased N400 for non-prominent continuations) time-locked to an anaphor. Note, that the main effect of anaphor type is difficult to interpret, since nouns and pronouns differ on so many levels of (non-)linguistic representation. We thus focus on the effect of antecedent type within anaphor types. There, the effects depend on the referential form of the anaphoric expression, pointing to an interaction of prediction (forward-looking function of the antecedent) and form-to-function mapping (backward-looking function) of referential expressions in the establishment of referential relations. We argue that this interaction can be explained from a predictive coding (Friston, 2005) perspective on language comprehension and event-related potentials (Bornkessel-Schlesewsky and Schlesewsky, 2019).
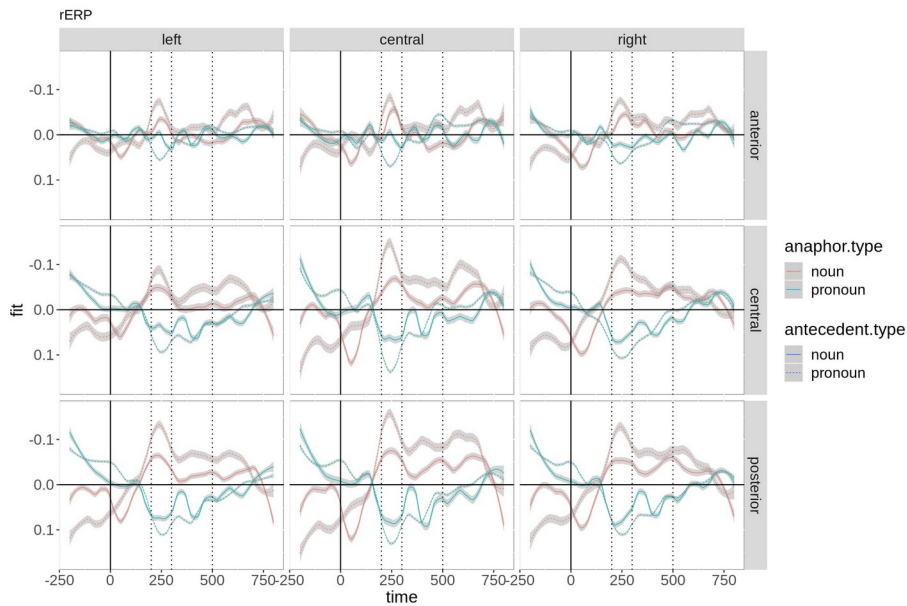
*Figure 1: Fitted microvolt values for the experimental conditions. Red: noun anaphors; blue: pronoun anaphors; solid: noun antecedent; dashed: pronoun antecedent. Shaded areas represent 83 % confidence intervals (an approximation to the traditional 0.05 level of significance for visualization purposes).*
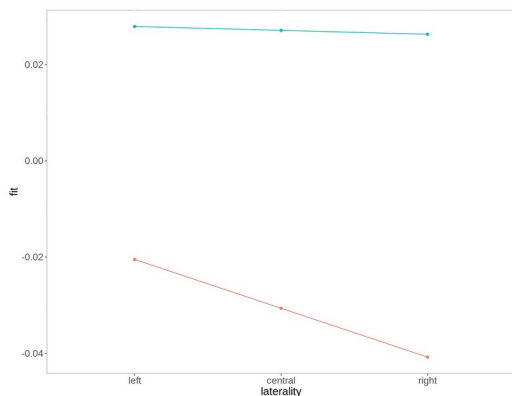


*Figure 2: Fitted values for the interaction saggitality\*antecedent type\*anaphor type in the P300 time window.*
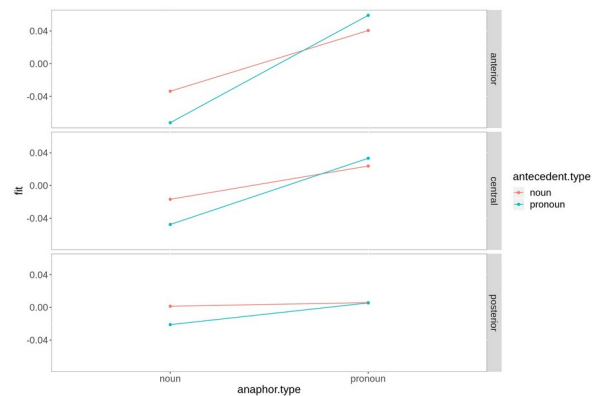


*Figure 3: Fitted values for the interaction saggitality\*antecedent type\*anaphor type in the N400 time window.*

**References**

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