ERP evidence of object agreement attraction in comprehension

Robin Schäfer, Sol Lago & Titus von der Malsburg (University of Potsdam)
rschaefer@uni-potsdam.de

The efficient processing of subject-verb agreement is key for language comprehension. But comprehenders can make errors: for example, in sentences like *The chemist* _with the test tubes_ *ARE conducting an experiment*, the ungrammatical verb elicits reduced processing difficulty when there is an intervening plural prepositional phrase (PP), consistent with a partial failure to detect the agreement violation [1,2]. This processing facilitation, compared to a sentence with a singular PP, is called *agreement attraction*. However, most comprehension work to date has focused on attraction from PP constructions, which are non-obligatory sentence constituents. By contrast, it is unclear whether attraction is also elicited by obligatory sentence constituents, such as argument direct objects (DO) in simple transitive sentences [3]. Since verbs have a close syntactic relationship with object arguments, their processing may be particularly robust and thus immune to attraction errors. Attraction from DO arguments is therefore an important test case for the generality of attraction effects in comprehension. This study used event-related potentials (ERP) to examine whether object arguments elicit attraction. If so, we predicted that attraction should modulate the P600 amplitude to ungrammatical verbs, with sentences with plural DOs eliciting reduced P600 amplitudes compared to sentences with singular DOs [2,3].

Methods and results: Materials consisted of 120 German embedded clauses with a subject-object-verb order. We manipulated the number of the DO and of the verb (singular/plural) in a 2 × 2 factorial design (**Table 1**). 33 participants read the sentences in RSVP (SOA = 450ms) and provided sentence-final acceptability judgments. Bayesian linear mixed models with the predictors *DO number, grammaticality* and their interaction were used to analyze acceptability judgments and P600 amplitudes 600–1000ms post-verb onset. ERP results: Ungrammatical sentences elicited an increased P600 compared to grammatical sentences (est. = 3.03 µV, 95% CrI = [1.64, 4.43] µV; **Figures 1–2**). Critically, an effect of attractor number in ungrammatical sentences indicated that the P600 component was reduced in the presence of a plural DO (est. g= -2.07 µV, 95% CrI = [-3.59, -0.55] µV). Acceptability results: The presence of a plural DO decreased accuracy in both grammatical and ungrammatical sentences (est. = -0.75 log odds, 95% CrI = [-1.03,-0.46] log odds).

Discussion: Our results show that intervening DOs elicit agreement attraction immediately at the verb: Attraction decreased the amplitude of the P600 component in ungrammatical sentences with plural DOs. These attraction effects persisted after participants had finished reading the sentences, such that these were misjudged more often when containing plural DOs. Taken together, these results provide evidence that DO constructions, despite their argument status, can elicit patterns of attraction similar to those of PP constructions, resembling previous findings in production [4,5]. Importantly, our results further add to the idea that attraction errors are pervasive and widespread in language comprehension by showing ERP effects of agreement attraction in another language and in a different syntactic configuration.

References. [1] Wagers, Lau & Phillips (2009). *J Mem Lang*. [2] Tanner, Nicol & Brehm (2014). *J Mem Lang.* [3] Shen, Staub & Sanders (2013). *Lang Cogn Process.* [4] Hartsuiker, Antón-Méndez & Van Zee (2001) *J Mem Lang.* [5] Franck, Soare, Frauenfelder & Rizzi (2010). *J Mem Lang*.

Table 1. Sample item set, illustrating the 2 × 2 factorial design manipulating the number of the DO and of the verb (singular/plural). Event-related potentials were recorded at the embedded verb (underlined).

Grammatical sentences (singular / plural DO)

Pia erzählt, [dass der Mann **die Frau$_{ACC.SG}$** / **die Frauen$_{ACC.PL}$** gestern heimlich <u>beobachtete$_{SG}$</u>],...
Pia says, that the man$_{SUBJECT}$ the woman$_{DO}$ / women$_{DO}$ yesterday secretly <u>watches</u> ...

Ungrammatical sentences (singular / plural DO)

Pia erzählt, [dass der Mann **die Frau$_{ACC.SG}$** / **die Frauen$_{ACC.PL}$** gestern heimlich *<u>beobachteten$_{PL}$</u>],...
*Pia says, that the man$_{SUBJECT}$ the woman$_{DO}$ / women$_{DO}$ yesterday secretly *<u>watch</u>...*

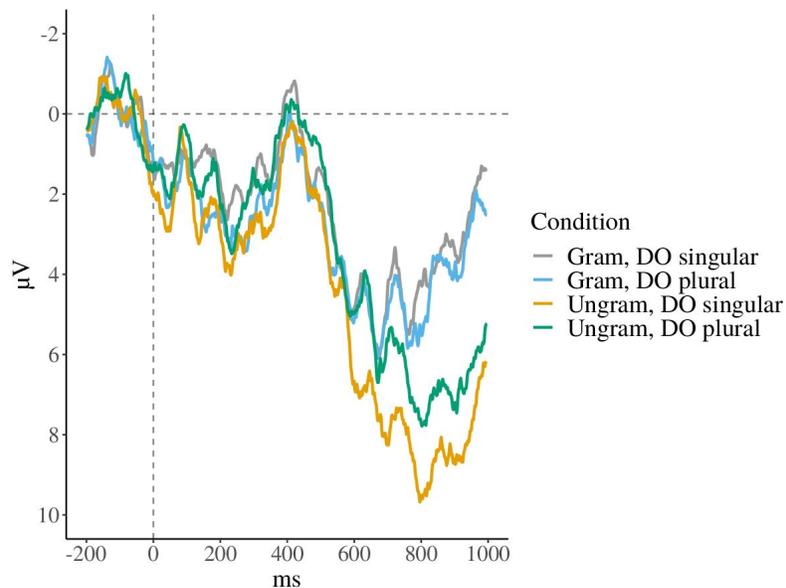**Figure 1**. By-condition averages at electrode Pz at the embedded verb, 600–1000ms post-verb onset.

Figure 2. Topographic distribution of P600 effect. *Grammaticality effect (left)*: grammatical - ungrammatical conditions. *Attraction effect (right)*: Ungram, DO singular - Ungram, DO plural.

600 ms - 1000 ms

-2.86 µV   0 µV   2.86 µV