

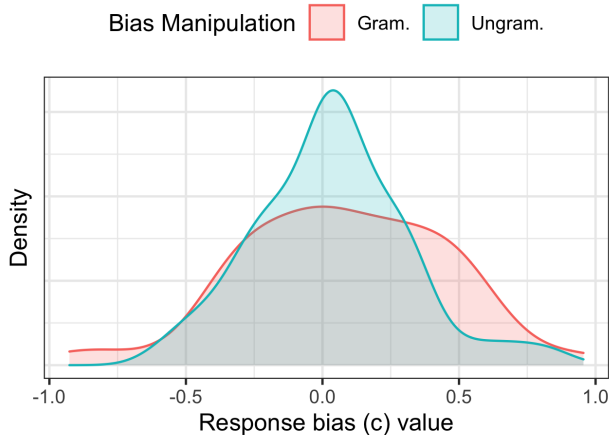
## Response Bias Manipulation in Turkish Agreement Attraction

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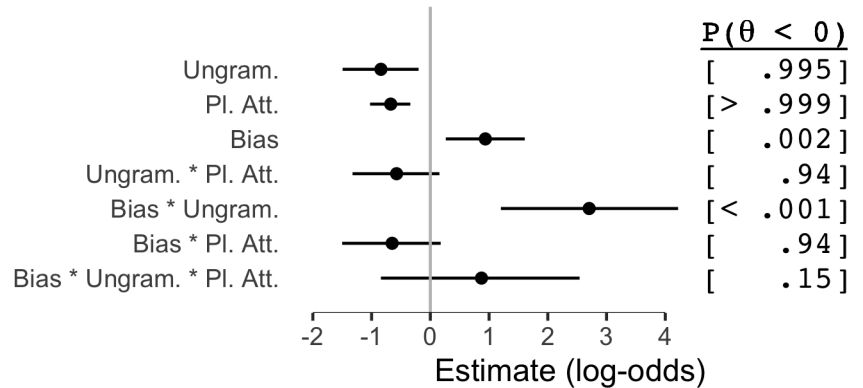
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Recent research showed that people sometimes make systematic errors in establishing a number agreement relation between a verb and its agreement controller, when a syntactically unrelated NP (the attractor) interferes. As a result, speakers may produce sentences like \**The key to the cabinets are rusty*, or misclassify them as acceptable [1,10,13]. According to *representational accounts* of this so-called *agreement attraction*, the presence of an attractor affects the number encoding of the agreement controller [4], while *retrieval accounts* assume that the attractor may be erroneously retrieved instead of the agreement controller [5,13]. As a result, agreement attraction in comprehension appears to occur only in ungrammatical sentences, where there is an already-existing subject-verb agreement error. This finding is then interpreted as evidence for an underlying process where readers retrieve a number-matching attractor using the cues given by the verb if they cannot retrieve the subject. Recent work [7] argues that this so-called grammaticality asymmetry is due to participants' bias towards grammatical responses, and follows from Ratcliff's drift-diffusion model (DDM) [11]. Hammerly, Staub, and Dillon [7] (HSD) manipulated participants' response bias by means of instructions and the ratio of grammatical to ungrammatical fillers. They found that when the bias is reduced, the effect of a plural attractor was comparable in both grammatical and ungrammatical conditions. Their findings align with theories that attribute agreement attraction to the representational errors rather than retrieval errors. Because this result is of major theoretical significance and has so far been attested in only one experiment, we attempted to replicate it in another language (Turkish) and in a different syntactic construction (a complex NP with a genitive modifier), as shown in (2). Since the DDM account of the grammaticality asymmetry is not limited to a particular language or a particular structure, we expected to replicate HSD's results. **METHODS:** The experiment ( $N=114$ ) was conducted online using IbexFarm [3]. Our design included 2 within-subject factors (*Attractor x Verb number*:  $2 \times 2$ ) as in (2) and the between-subject factor *Bias*, biasing participants towards grammatical or ungrammatical responses by means of (i) instructions and (ii) ratio of ungrammatical to grammatical fillers. We used 40 experimental items and 40 filler items. **BIAS:** Unlike HSD, we assessed bias based on responses to filler items. Fig. 1 shows that our participants did not respond to our bias manipulation. In order to nevertheless test the predictions of the DDM model, we grouped participants according to their bias estimate  $c$  [9]. **RESULTS:** Among participants biased towards grammatical responses ( $c < 0$ ), we observed a significant grammaticality asymmetry (Fig. 3). In a Bayesian GLM (Fig. 4), this observation is surfaced as an interaction between attractor and verb number. Among part. with an ungrammaticality bias ( $c > 0$ ), the effect of a plural attractor in ungrammatical conditions is comparable to the one in grammatical conditions (Fig. 5), with no evidence for such an interaction (Fig. 6). When pooled data from both groups was analyzed with response bias as a continuous predictor, we observed weak evidence for a three-way interaction pointing towards a positive effect of ungrammaticality bias on the agreement attraction effect (Fig. 2). **CONCLUSION:** Evidence for the effect of *Bias* on agreement attraction were suggestive but not exactly definitive according to our Bayesian models. We were able to replicate theoretically significant findings of HSD: When *Bias* is reduced, the agreement attraction effects were also observable in grammatical conditions. However, we were not able to replicate HSD's experimental manipulation: manipulating *Bias* through the ratio of ungrammatical to grammatical sentences and instructions was not successful.

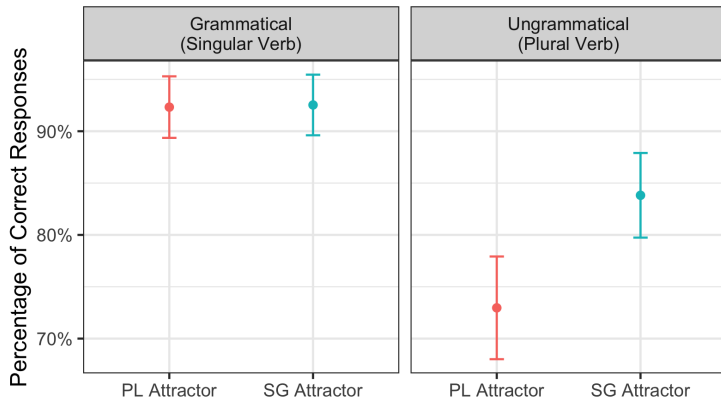
**A. Figures:** The data was preprocessed and visualized using R and the *tidyverse* packages, and was analyzed with the packages *brms* and *rstan* to fit maximal Bayesian hierarchical models [6]. Error bars in Fig. 3 and Fig. 5 show adjusted 95% CrIs [2].



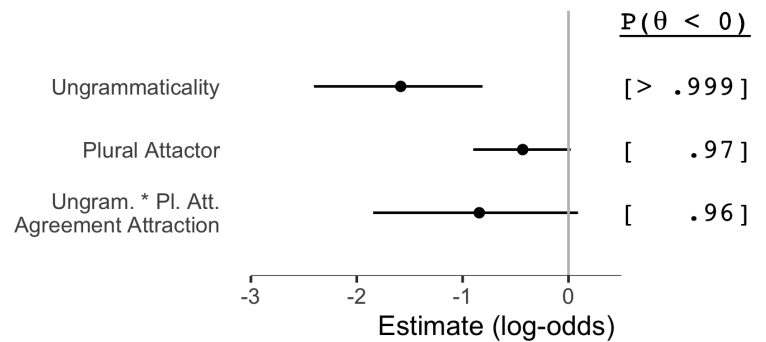
**Fig. 1.** Density of c-values grouped according to our bias manipulation.



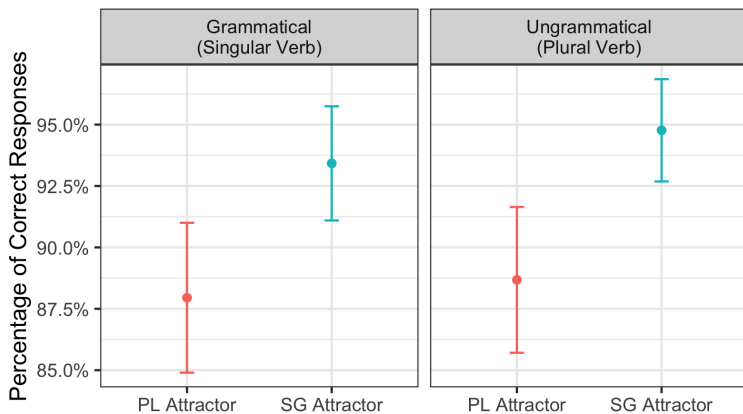
**Fig. 2.** Estimates and 95% CrIs for the regression coefs with calculated bias as a continuous predictor.



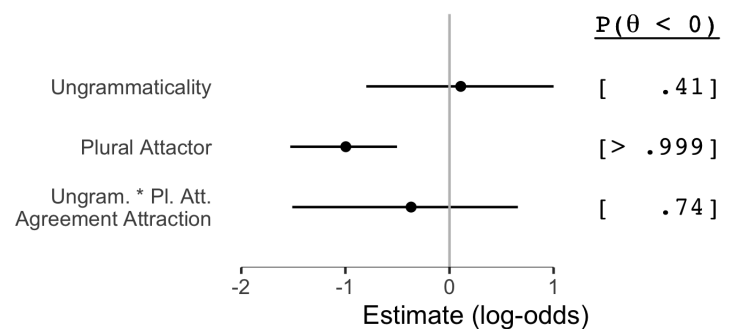
**Fig. 3.** Percentage of correct responses of participants with a bias towards gram. responses.



**Fig. 4.** Estimates and 95% CrIs for the regression coefs for participants with gram. response bias.



**Fig. 5.** Percentage of correct responses of participants biased towards ungram. response.



**Fig. 6.** Estimates and 95% CrIs for the regression coefs for participants with ungram. response bias.

## B. More on Agreement Attraction and Turkish

The agreement controller and the verb are marked **purple**; the attractor is marked **brown**. Slashes show the conditions (2x2: plurality of attractor vs. grammaticality).

(1) The **friend** of the **nurse/nurses** frequently **visit/visits** ...

Following Lago et al. [8], we used genitive-possessive constructions such as ‘[[the doctor’s] car]’ ([[doktor-un<sub>GEN</sub>] araba-sı<sub>POSS</sub>]). Unlike in English, Turkish attractors precede the agreement controller. Previous studies showed that non-intervening attractors also facilitate agreement attraction [13], and agreement attraction effects are observed in Turkish [8,12].

(2) a. Singular Attractor, Grammatical (Singular Verb)

**Yönetici-nin**      **aşçı-sı**      mutfak-ta      sürekli      **zıpl[a]-ıyor.**  
manager.SG-GEN    cook-POSS    kitchen-LOC    non-stop    jump-IMPF.SG  
‘The cook of the manager is jumping in the kitchen non-stop.’

b. Singular Attractor, Ungrammatical (Plural Verb)

\* **Yönetici-nin**      **aşçı-sı**      mutfak-ta      sürekli      **zıpl[a]-ıyor-lar.**  
manager.SG-GEN    cook-POSS    kitchen-LOC    non-stop    jump-IMPF-PL  
‘\*The cook of the manager are jumping in the kitchen non-stop.’

c. Plural Attractor, Grammatical (Singular Verb)

**Yönetici-ler-in**      **aşçı-sı**      mutfak-ta      sürekli      **zıpl[a]-ıyor.**  
manager-PL-GEN    cook-POSS    kitchen-LOC    non-stop    jump-IMPF.SG  
‘The cook of the managers is jumping in the kitchen non-stop.’

d. Plural Attractor, Ungrammatical (Plural Verb)

\* **Yönetici-ler-in**      **aşçı-sı**      mutfak-ta      sürekli      **zıpl[a]-ıyor-lar.**  
manager-PL-GEN    cook-POSS    kitchen-LOC    non-stop    jump-IMPF-PL  
‘\*The cook of the managers are jumping in the kitchen non-stop.’

## References:

[1] Bock & Miller, 1991. *Cognitive Psychology*. [2] Cousineau, 2005. *Tutorials in quantitative methods for psychology*. [3] Drummond <https://spellout.net/ibexfarm/> [4] Eberhard, Cutting, and Bock, 2005. *Psychological review*. [5] Engelmann, Jäger, & Vasishth, 2019. *Trends in cognitive sciences*. [6] Gelman & Hill, 2007. [7] Hammerly, Staub, & Dillon, 2019. *Cognitive Psychology*. [8] Lago, Gračanin-Yukse, Şafak, Demir, Kırkıcı, & Felser, 2019. <https://osf.io/qn5g4/> [9] Macmillan & Creelman, 2005. [10] Pearlmutter, Gamsey, & Bock, 1999. *JML*. [11] Ratcliff (1978). [12] Türk & Logačev, 2020. <https://osf.io/x9pv7/> [13] Wagers, Lau, & Philips, 2009. *JML*.