Novel analysis of response bias challenges representational accounts in attraction

Utku Turk[1] & Pavel Logacev[2]
[1]University of Maryland at College Park, [2]Boğaziçi University

People 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 [1,10,12]. According to *representational accounts*, the presence of an attractor affects the number encoding of the agreement controller [4]. *Retrieval accounts* assume the attractor may be erroneously retrieved instead of the agreement controller [5,12]. One piece of evidence taken to support retrieval accounts is an observed grammaticality asymmetry, such that agreement attraction in comprehension occurs in ungrammatical sentences only. Recently, Hammerly et al. [7] (HSD) manipulated participants' response bias by instructions and the ratio of grammatical to ungrammatical fillers. They found that with reduced bias, the effect of a plural attractor was comparable in both grammatical and ungrammatical conditions. Their findings align with theories that attribute agreement attraction to representational errors rather than retrieval errors. However, HSD calculated participant biases' using all items ($bias_{all}$). The inclusion of experimental items that are prone to attraction may inflate the estimates. **CURRENT WORK** proposes a different way to integrate response bias using only filler items in calculation ($bias_{filler}$). Upon **RE-ANALYSIS OF HSD** (Fig2), we find symmetrical attraction effects in experimental sentences, independent of the $bias_{filler}$. The fact that the grammaticality asymmetry surfaced independent of a priori response bias tells us that either there are multiple sources of response bias reflected in fillers and experimental items to different degrees, or HSD's results were due to overconfidence in their bias calculation. As a follow up, we conducted a **CONCEPTUAL REPLICATION** (*N=114*) of HSD in Turkish following the same manipulations: 2 within-subject factors with 40 experimental and 40 filler items (1). We introduced a between-subject *Bias* manipulation in the same way as HSD. Since their account of the grammaticality asymmetry is not limited to a language or a structure, and response bias should apply similarly to both fillers and experimental items, we expected to replicate their results using $bias_{filler}$. In order to test their predictions, we grouped participants according to their bias estimate *c*, which we calculated using filler items [9]. Our **RESULTS** (Fig1) showed that only participants with an ungrammaticality bias (*c>0*) showed attraction effects in grammatical sentences. Our Bayesian GLM fitted to grammatical sentences verified this observation with a negative interaction ($\hat{\beta}$*=-0.55; CI=[-1.12; 0.03]; P(β<0)=0.97*) between attractor number and bias (Fig3), which clearly entails fewer "yes" responses in grammatical sentences with a plural attractor as the bias towards "yes" responses decreased. We found no evidence for an interaction in ungrammatical sentences ($\hat{\beta}$*=0.34; CI=[-0.23; 0.94]; P(β<0)=0.13*), meaning that bias did not affect the presence of the attraction effect (Fig4). Even though we were able to replicate the theoretically significant findings of HSD, i.e. the role of bias in the grammaticality asymmetry, our preliminary multilevel meta-analysis of previous attraction data [8,12] show no evidence for a negative interaction in grammatical sentences (Fig5) ($\hat{\beta}$*=0.4; CI=[-0.41; 1.16]; P(β<0)=0.14*). On the contrary, certain studies showed a reversed sign for the interaction. Taken together, our experiment, re-analysis of HSD, and preliminary meta-analysis cast doubt on this influential argument for representational accounts and do not yet indicate whether the grammaticality asymmetry mainly reflects response bias.

Figures: Data preprocessed and visualized using R and the *tidyverse* packages, and analyzed with the packages *brms* and *cmdstan* to fit maximal Bayesian GLMs [6]. Error bars in Fig1 and 2 show adjusted 95% CrIs [2]. Bias calculated using only filler items.

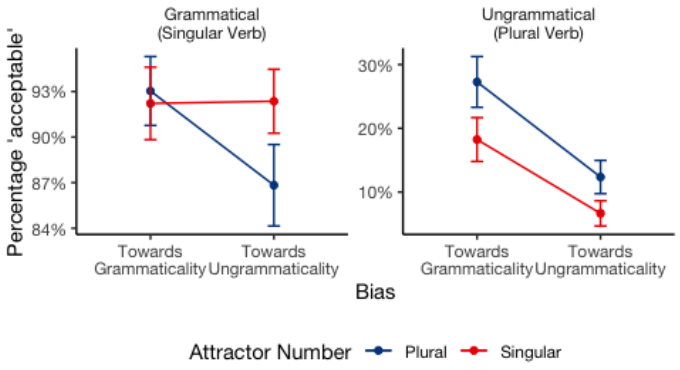

Fig1. Percentage of acceptable responses in our exp.

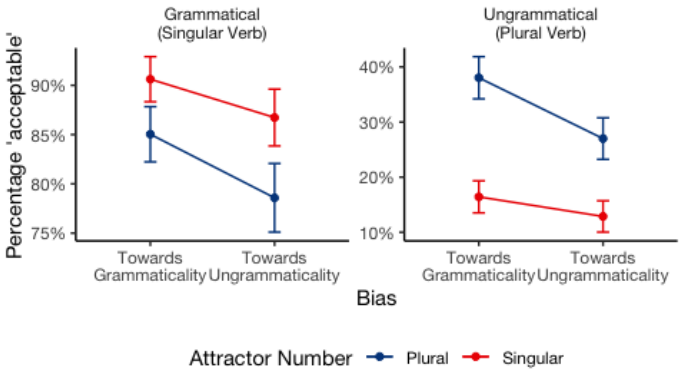

Fig2. Percentage of acceptable responses in re-analyzed HSD

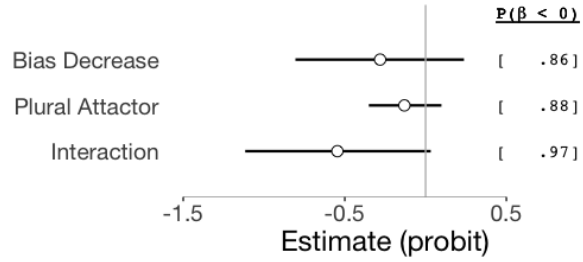

Fig3. Estimates and 95% CrIs for the regression coefs for the model of responses to grammatical sentences

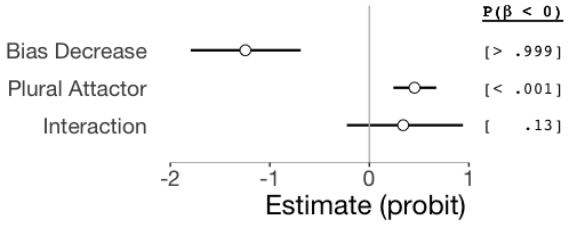

Fig4. Estimates and 95% CrIs for the regression coefs for the model of responses to ungrammatical sentences

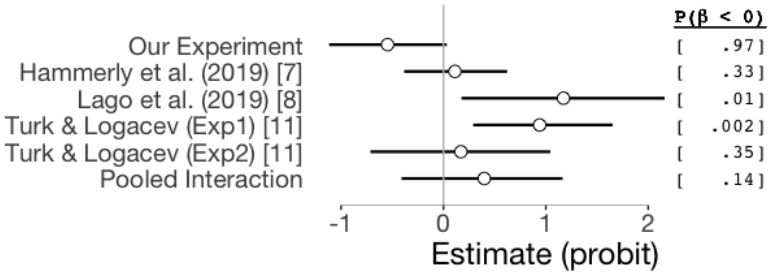

Fig5. Interaction Estimates and 95% CrIs for a Bayesian Multilevel Meta-Analysis using grammatical sentences.

(1) 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

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

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

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 manager(s) (is/are) jumping in the kitchen non-stop.

Experimental sentences used in our experiment. Attractors are underlined and immediately precede the head.The experiment was conducted in IbexFarm [3].

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-Yuksek, Şafak, Demir, Kırkıcı, & Felser, 2019. https://osf.io/qn5g4/ **[9]** Macmillan & Creelman, 2005. **[10]** Pearlmutter, Gamsey, & Bock, 1999. *JML*. **[11]** Türk & Logačev, 2020. https://osf.io/x9pv7/ **[12]** Wagers, Lau, & Philips, 2009. *JML*.