The Role of Shallow Processing in Agreement Attraction

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Systematic errors in the processing of syntactic dependencies have been a key element in understanding natural language processing [3, 7]. For example, research has shown that readers exhibit number agreement attraction effects in sentences like (1) [5, 6, 9]. These effects were found to be robust in a variety of constructions in different languages. Lago et al. [4] recently demonstrated such effects in Turkish: they found number attraction effects in genitive-possessive constructions such as *'[[the child's] toy]'* ([[çocuğ-un$_{Gen}$] oyuncağ-ı$_{Poss}$]). Using sentences like (2), they manipulated the number of the genitive attractor (*singer*) and the number agreement on the main verb with the singular head noun of the complex NP. They hypothesized that genitive NPs can trigger agreement attraction in Turkish, unlike in English, due to their frequent use as subjects of embedded clauses. Thus, genitive NPs were hypothesized to be *a priori* be likely agreement controllers. However, the head nouns in Lago et al.'s experimental items such as (2) was systematically ambiguous between accusative and the possessive case. This ambiguity may have enhanced agreement attraction effects, since accusatives are *a priori* unlikely agreement controllers. We addressed this issue in experiment 1. **Exp1 (N = 118):** We hypothesized that if the morpho-phonological ambiguity was a key factor in agreement attraction in Turkish, resolving it should inhibit attraction affects. To test this hypothesis, we conducted a replication of Lago et al. [4]'s speeded acceptability judgment experiment using unambiguous head nouns. The original items contain only consonant-ending head subjects, for which the genitive ending is *-I*, which is ambiguous between the possessive and the accusative case in Turkish. In our replication, we used 40 sets of experimental items with vowel-ending head subjects, such as (3), in order to avoid this local ambiguity. For vowel-ending head subjects the accusative surfaces as *-yI*, and the possessive as *-sI*. **Results:** The ungrammatical sentences with plural attractors were rated as acceptable more often than their counterparts with singular attractors (Fig. 1). The estimates and 95% credible intervals (CIs) of a Bayesian GLM in Fig. 2 confirm this observation: the positive interaction between sentence grammaticality and attractor number points to a larger effect of attractor number in ungrammatical sentences. Thus, we replicated an agreement attraction effect of comparable magnitude (10%, compared to 11% in [4]), and conclude that the possessive-accusative ambiguity plays no appreciable role in number attraction in Turkish. **Exp2 (N = 79):** The second question we raise is whether agreement attraction in Turkish is the result of a task-specific strategy. It is possible that the number agreement effects observed in Turkish may be the result of a *form-driven processing strategy*, by which participants with insufficient information in a particular trial due to an attentional lapse attempt to judge a sentence with a plural matrix verb as acceptable if they recall a plural morpheme in the sentence. To test this hypothesis, we exploited the morpho-phonological syncretism between nominal plural and verbal plural *agreement* morphemes in Turkish: both surface as *-lAr*. We hypothesized that under form-driven processing, we should observe an effect similar to agreement attraction, even if the *'attractor'* was a verb bearing a plural-agreement suffix. We conducted a speeded acceptability judgment experiment with 40 sets of experimental items such as (4). In all sentences, the head noun was modified by a one-word pre-nominal relative clause. **Results:** We found no effect resembling agreement attraction in the ungrammatical conditions (Fig. 3). A Bayesian GLM comparing experiments 1 and 2. Fig. 4 shows a negative three-way interaction between experiment (type of attractor), attractor number, and grammaticality, which entails a clearly reduced effect of agreement attraction in experiment 2 compared to experiment 1. **Conclusion:** Taken together, our findings demonstrate a number agreement attraction effect in Turkish, and excludes an form-driven processing account as an alternative explanation. Thus, the results of experiment 2 supports an account of agreement attraction based on the use of abstract linguistic features, rather than mere form.

A. Examples: The agreement target and the probe is marked with blue whereas the attractor is marked with red. Backslashes show the conditions (2x2: *plurality of attractor x grammaticality*). Abbreviations used in this paper are as follows: GEN = genitive, LOC = locative, NMLZ = nominalizer, PL = plural, POSS = possessive, PROG = progressive, PST = past, SG = singular.

(1) *The key to the cell/cells are/is rusty from many years of disuse.* [9]

(2) *Şarkıcı-lar/∅-(n)ın vokalist-i   sahne-de sürekli   zıpla-dı-lar/∅.*
     singer-PL/.SG-GEN back.up.singer.SG-POSS stage-LOC constantly jump-PST-PL/.SG.

     'The singers' backup vocalist jumped on the stage non-stop.' [4]

(3) *Yönetici-ler/∅-(n)in aşcı-sı   mutfak-ta   sürekli   zıpl-ıyor-lar/∅.*
     manager-PL/.SG-GEN cook-POSS kitchen-LOC non-stop jump-PROG-PL/.SG.

     'The cooks of the manager were jumping in the kitchen non-stop.'

     a. SGSG: Yönetici-∅-nin aşcı-sı mutfak-ta sürekli zıpl-ıyor.
     b. *SGPL: Yönetici-∅-nin aşcı-sı mutfak-ta sürekli zıpl-ıyor-lar.
     c. PLSG: Yönetici-ler-in aşcı-sı mutfak-ta sürekli zıpl-ıyor-∅.
     d. *PLPL: Yönetici-ler-in aşcı-sı mutfak-ta sürekli zıpl-ıyor-lar.

(4) *Tut-tuk-lar/∅-ı   aşcı mutfak-ta   sürekli   zıpl-ıyor-lar/∅.*
     hire-NMLZ-PL/.SG-POSS cook kitchen-LOC non-stop jump-PROG-PL/.SG.

     'The cook that they hired were jumping in the kitchen non-stop.'

     a. SGSG: Tut-tuğ-∅-u aşcı mutfak-ta sürekli zıpl-ıyor-∅.
     b. *SGPL: Tut-tuğ-∅-u aşcı mutfak-ta sürekli zıpl-ıyor-lar.
     c. PLSG: Tut-tuk-lar-ı aşcı mutfak-ta sürekli zıpl-ıyor-∅.
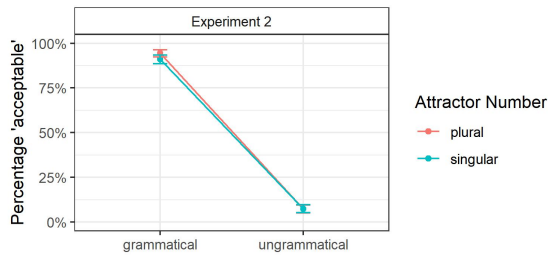   d. *PLPL: Tut-tuk-lar-ı aşcı mutfak-ta sürekli zıpl-ıyor-lar.

B. Figures: Experiment results were gathered from *Ibexfarm* with speeded acceptability judgment tests. The data is analyzed using R packages brms [1] and rstan [8] to fit Bayesian hierarchical models [2].
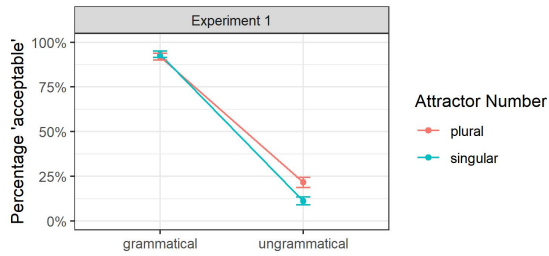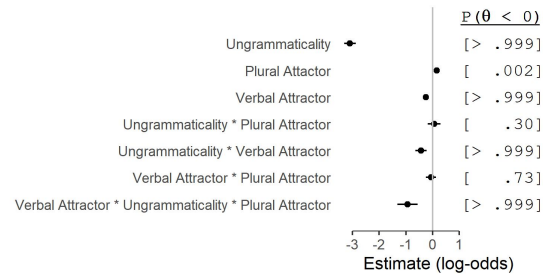

(1) Exp1: Percentage of 'yes' (acceptable) responses.
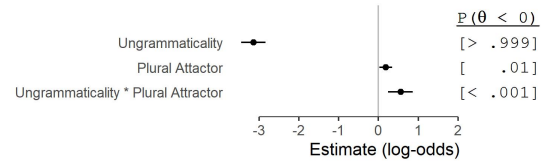
(2) Exp1: Estimates and 95% CIs for the regression coefs.

(3) Exp2: Percentage of 'yes' (acceptable) responses.

(4) Exp2: Estimates and 95% CIs for the regression coefs.

Selected References

 [1] P.-C. Bürkner. *J. Statistical Softw.* 2017. **[2]** A. Gelman and J. Hill. 2007. **[3]** E. Gibson and J. Thomas. *Lang. Cognitive Process.* 1999. **[4]** S. Lago et al. *Linguistic Approaches to Biling.* 2018. **[5]** J. L. Nicol, K. I. Forster, and C. Veres. *J. Mem. Lang.* 1997. **[6]** N. J. Pearlmutter, S. M. Garnsey, and K. Bock. *J. Mem. Lang.* 1999. **[7]** C. Phillips, M. Wagers, and E. F. Lau. *Syntax Semant. 37: Exp. at Interfaces*. 2011. **[8]** Stan Development Team. 2019. **[9]** M. W. Wagers, E. F. Lau, and C. Phillips. *J. Mem. Lang.* 2009.