The Role of Shallow Processing in Agreement Attraction

A number of studies have demonstrated that comprehenders do not always accurately process dependencies within a sentence. For instance, they are susceptible to 'illusions of grammaticality', such as the *missing-VP effect* (Gibson & Thomas, 1999), or *illusory NPI licensing* (Drenhaus et al., 2005). Another instance of grammaticality illusions that has drawn great interest in the literature is *agreement attraction* in comprehension (Pearlmutter et al., 1999; *inter alia*). The most commonly attested instance of such agreement attraction surfaces as reduced processing difficulty in sentences that are ungrammatical due to a mismatch in number agreement between the verb of a sentence and its subject if the verb instead agrees with another, grammatically unrelated, noun phrase (NP) in the sentence.

In a speeded acceptability judgment task, Wagers et al. (2009) demonstrated agreement attraction effects in the processing of sentences like (1). They showed that in ungrammatical conditions (**The key to the cell(s) are …)*, sentences with plural attractors were found more acceptable than their counterparts with singular attractors. No such effect was observed in grammatical conditions (*The key to the cell(s) is …*). Most accounts of this phenomenon assume that the presence of a plural attractor creates a grammaticality illusion. These accounts assume either (i) that the presence of a plural attractor makes readers misperceive the singular head noun as a plural, or (ii) that the parser may sometimes misidentify the attractor NP as the agreement controller.

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

Agreement attraction effects of grammatical number and other features have been demonstrated in a range of languages. For example, Lago et al. (2018) found a number attraction effect in Turkish. In a speeded-acceptability task, they presented sentences like (2), in which the singular head noun of the subject NP (*'vokalisti'*) always required singular agreement on the verb (*'zıpladılar/zıpladı'*). In addition to verb agreement, they manipulated the grammatical number of the genitive-bearing possessor NP serving as an attractor. In the ungrammatical versions of (2), when the verb exhibited plural agreement, they observed an increase in acceptability when the attractor was plural (*'singers'*) compared to when it was singular (*'singer'*).

(2) [[Şarkıcı-lar/ø-(n)ın] vokalist-i] sahne-de sürekli zıpla-dı-lar/ø.
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.'

Lago et al. hypothesize that genitive NPs can trigger agreement attraction in Turkish, because Turkish makes heavy use of genitive subjects, which means genitives are *a priori* likely to function as agreement controllers. The underlying assumption is that agreement processes rely on the case of an NP to determine its fit for the role of an agreement controller. If that is so, the structure in (2) is problematic in that the marking on the head noun is ambiguous between possessive and accusative case, while only possessive-marked NPs qualify as agreement controllers. Therefore, if engaged in shallow processing, readers may be more likely to misidentify the genitive NP as the agreement controller when the head noun, which is the only other alternative, is ambiguous, compared to when it is not.

Experiment 1. We decided to test this hypothesis by attempting to replicate Lago et al.'s findings with unambiguous head nouns. The original items contained a local ambiguity because all head nouns ended in a consonant, and thus required the possessive suffix *-I*, which coincides with the accusative suffix for this class of nouns. For nouns ending in vowels, however, these suffixes have distinct forms: *-sI* and *-yI*. In order to avoid local ambiguity, we modified Lago et al.'s experimental items, and produced 40 sets of experimental items like (3) with head nouns ending with a vowel.

(3) [[Yönetici-ler/ø-(n)in] aşçı-sı] mutfak-ta sürekli zıpla-dı-lar/∅ .
manager-Pl/Sg-Gen *cook-Poss* *kitchen-Loc* *constantly* *jump-Pst-Pl/Sg.*
'The managers' cook jumped in the kitchen non-stop.'

We conducted a speeded acceptability judgment experiment (*N=107*) with native Turkish speakers on the *Ibexfarm* online platform. Participants saw 40 experimental sentences and 40 fillers. We used the R packages brms (Bürkner, 2018) and rstan (Stan Development Team, 2019) to fit Bayesian hierarchical models (Gelman & Hill, 2007).

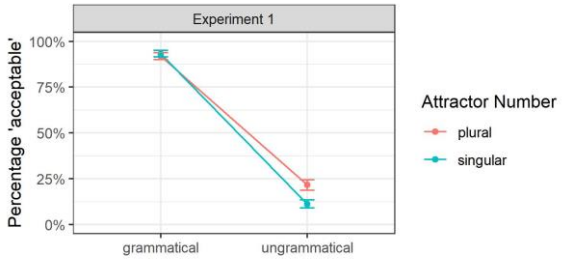

Figure 1. Percentage of 'yes' (acceptable) responses of Experiment 1.

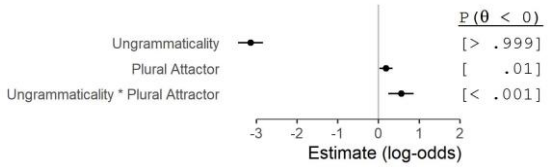

Figure 2. Estimates and 95% credible intervals for the regression coefficients for Experiment 1.

Figure 1 shows the average proportions of *'acceptable'* responses by experimental condition. It shows that ungrammatical sentences with plural attractors are rated as acceptable more often than their counterparts with singular attractors. The estimates and 95% CIs of a Bayesian GLM in Figure 2 confirm this observation: the positive interaction between sentence grammaticality and attractor number is in line with a larger effect of attractor number in ungrammatical sentences. Thus, our results constitute a successful replication of Lago et al.'s findings: We replicated an agreement attraction effect of comparable magnitude (10%, compared to 11% in the original study). We conclude that the possessive-accusative ambiguity plays no role in number attraction in Turkish.

To account for their findings, Lago et al. (2018) assume a cue-based memory retrieval mechanism. That is, they assume that upon reaching the verb, the parser attempts to retrieve its agreement controller (the subject) using a cue-based retrieval mechanism (Lewis & Vasishth, 2005; Jäger et al., 2017). The assumption is that in sentences such as (2) and (3), features such as case and number information are used to identify the agreement controller in memory. In ungrammatical sentences, when the verb bears plural agreement, no NP in memory will match both retrieval cues. However, in ungrammatical plural attractor conditions, the attractor matches one of the cues, which can lead to its erroneous retrieval on some occasions. This cannot happen in ungrammatical singular attractor conditions. This difference in the probability of erroneous retrievals is presumably what surfaced as a number agreement attraction effect, as observed in Lago et al., and our Experiment 1.

However, there is an alternative explanation that has yet to be ruled out: task-specific strategies. The aim of our second experiment was to test whether agreement attraction in Turkish may be an instance of a '*form-driven processing strategy*'. Assuming that readers sometimes engage in shallow processing, they may sometimes end up with insufficient information to reliably classify a sentence as (un)acceptable. In such cases, participants may choose to classify sentences with plural-agreement-bearing verbs as acceptable if they have a memory of a nominal plural morpheme in the sentence. Such a response strategy would lead to a larger number of *'acceptable'* responses in ungrammatical plural attractor conditions than in ungrammatical singular attractor conditions.

Experiment 2. In order to rule out such a response strategy as a possible explanation of the agreement attraction effect in Turkish, we conducted a second speeded acceptability judgment experiment. In it, we made use of the morpho-orthographic ambiguity between the nominal plural and the verbal plural marker, both of which have the same form in Turkish, namely *-lar* or *-ler*. In our experimental sentences, which followed the structure in (4), we used object relative clauses with dropped subjects. Like in Experiment 1, the agreement target is the matrix verb (‘*sıkıldılar’)*, while the *‘attractor’* is the relative clause verb (‘*beklettikleri’*). We manipulated the presence of plural agreement on the ‘attractor’, and on the matrix verb. We hypothesized that participants employing the response strategy outlined above would be more likely to classify a sentence with a plural-agreement-bearing verb as acceptable when the relative clause verb also bears a plural marker. Thus, the use of such a response strategy should mimic an agreement attraction effect, in spite of the attractor being a verb.

(4) [[Bekle-t-tik-ler/Ø -i] araştırmacı] gün boyunca sıkıl-dı-lar/Ø .
wait-Caus-Nmlz-Pl/Sg-Poss researcher.Sg day long bore-Pst-Pl/Sg.
‘The researcher that they kept waiting felt bored all day long.’

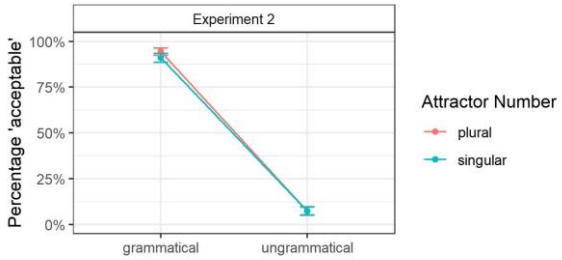

Figure 3. Experiment 2: Percentage of ‘yes’ responses in experimental conditions.

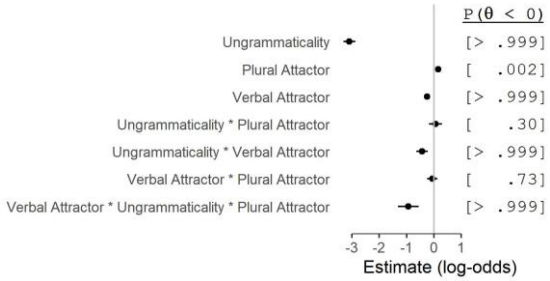

Figure 4. Estimates and 95% CIs for the regression coefficients for Experiment 2.

Figure 3 shows the average percentage of *‘acceptable’* responses by experimental condition. It shows no effect resembling agreement attraction in the ungrammatical conditions. Figure 4 shows the coefficient estimates and 95% CIs of a Bayesian GLM comparing the results of Experiments 1 and 2. As is visible from the figure, the model shows a negative three-way interaction between grammaticality, type of attractor (nominal vs. verbal), and attractor number, which entails a clearly reduced effect of agreement attraction in Experiment 2 compared to Experiment 1. This finding contradicts our hypothesized form-driven processing strategy and supports an account of agreement attraction based on the use of abstract linguistic features, rather than mere form.

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