

Accounting for Uninformed Responses in Preference Studies: An MPT Model

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INTRODUCTION. Relative clause attachment has been a key phenomenon in the field of sentence processing [1,7]. In this literature, languages with postnominal RCs have received the most attention. However, RC attachment preferences in languages with prenominal RCs, such as Turkish, may be of particular importance: While in ambiguous English sentences like (1), the potential attachment sites precede the RC, analogous Turkish sentences follow the inverse pattern. Therefore, the potential attachment sites are encountered *in sequence, after the RC*, like in sentence (2). Given ample evidence for incremental sentence comprehension [4,8], RCs in sentences like (2) should exhibit a strong tendency to attach to the first available attachment site (NP1). However, prior studies of RC attachment in Turkish have yielded estimates close to those in languages with postnominal RCs: The magnitude of the NP1 preference was in the range of 55-70% [2,3,6]. Surprisingly, the magnitude of the attachment preference is similar to results from Spanish and English: 71% and 67%, respectively [1].

We speculated that the preference estimates for Turkish [2,3,6] may underestimate the true preference strength due to some participants' (i) occasional lack of engagement in the task followed by haphazard responses [5], or (ii) their inability to correctly encode and retrieve the adopted interpretation at the level of attentional resources allocated to the task. Assuming that participants' responses on such trials are *uninformed*, and amount to equi-biased guesses, their presence would bias the estimated attachment preference towards 50% to a degree determined by the percentage of such trials.

EXPERIMENT. In order to *obtain better estimates of RC attachment preferences in Turkish*, we conducted a 2AFC experiment (N=75), in which participants read sentences like (3), in which the RC attachment was either ambiguous, or where it was unambiguously attached to NP1 or NP2. After reading the sentence in a self-paced manner, they were asked about RC attachment in that sentence (*'Who RC-ed?': NP1/NP2*) and selected either the NP1 or the NP2 head noun. A second aim was *testing whether participants strategically delay RC attachment until NP2 has been fully processed*. To that end, we manipulated the distance between the head nouns of NP1 and NP2 by interposing an adjective modifying NP2 (in green in the examples in (3)). If the magnitude of the NP1 attachment preference in previous studies is low because participants delay RC attachment, it should remain unaffected by an additional word between the head nouns. Otherwise, we expected the increased distance between the attachment sites to increase the magnitude of the NP1 attachment preference in line with the incrementality hypothesis.

ANALYSIS. We analyzed the question responses using a Multinomial Processing Tree (MPT) model [9] in Fig. 1, which encoded our assumption that participants sometimes correctly encoded and retrieved NP1 and NP2 structures, and in those instances always responded in accordance with that retrieved structure, but that this process is fallible and that NP1 and NP2 attachment interpretations may be associated with different failure rates [9]. When one of those processes fails due to insufficient attentional resources or lack of engagement, participants are assumed to produce an *uninformed response*, choosing NP1 or NP2 with equal probability. Importantly, in ambiguous conditions, participants are assumed to sometimes adopt NP1 attachment interpretations (with probability h), and sometimes NP2 attachment interpretations (with probability $1-h$). We fitted a Bayesian MPT model, with full random effect structure for participants and items for each parameter using *brms* and *rstan*.

RESULTS. The average percentages of NP1 responses results in Fig. 2 (left) indicate that the magnitude of the NP1 attachment preference is affected by additional distance between the two head nouns (adjacent: 67%, non-adjacent: 75%), suggesting that participants do not postpone RC attachment. Our estimates of the NP1 attachment probability h in Fig. 2 (right) indicate that the presence of uninformed responses leads to an underestimation of the effect of distance (adjacent: 68%, CI=[59; 76], non-adjacent: 80%, CI=[73; 86]).

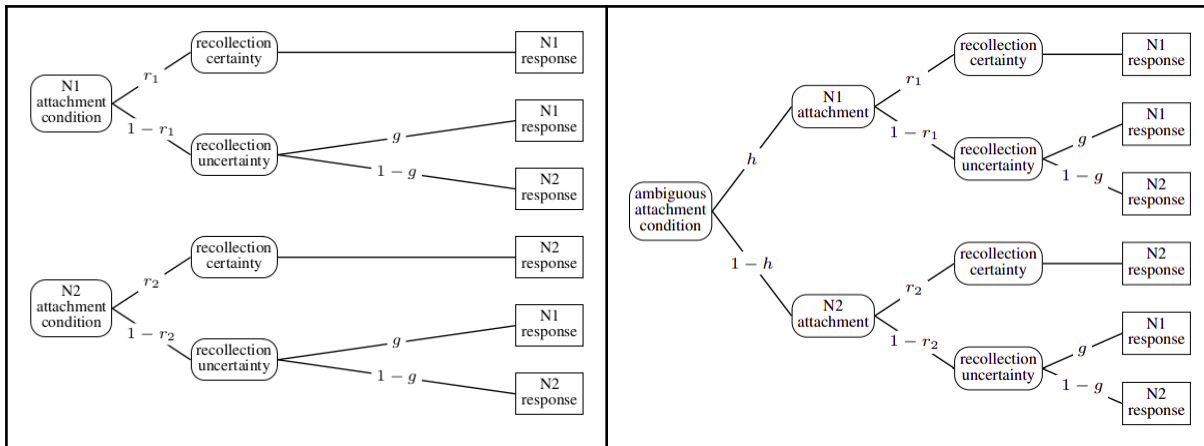


Figure 1. MPT model of the RC attachment 2AFC task. The three processing trees represent the structure and probabilities of the events in each of the three attachment conditions (*NP1 attachment, NP2 attachment, and ambiguous*). Parameters r_1 and r_2 represent probabilities of successfully encoding and recalling NP1 or NP2 interpretations, respectively. Parameter h represents the probability of adopting an NP1 interpretation in ambiguous sentences. Parameter g represents the guessing bias towards NP1 responses. (For present purposes, we assumed that $g=0.5$).

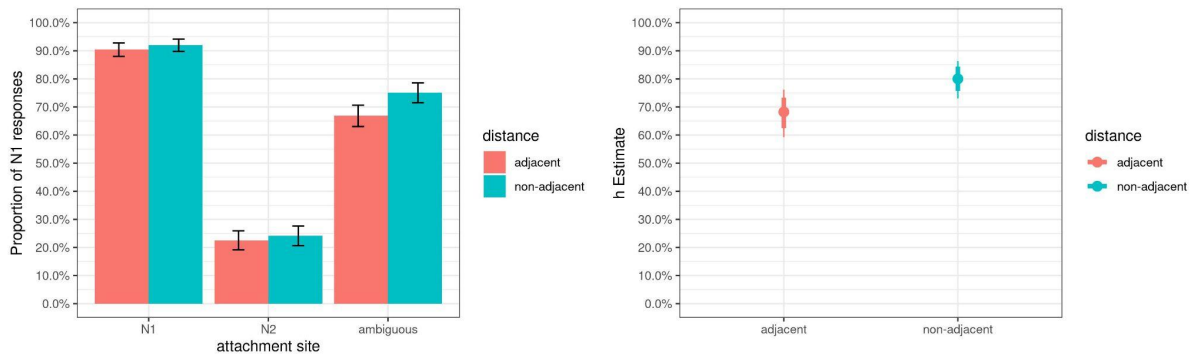


Figure 2. Percentages of NP1 responses obtained in the experiment (left panel) and estimates of the probability of disambiguation towards NP1 (h) according to the model in Fig. 1 (right panel).

References:

[1] Hemforth et al. (2015). *Lingua*. [2] Başer & Hohenberger (2020). *JPR*. [3] Kırkıcı (2004). *Turkic Languages*. [4] Tannenhaus, Carlson & Trueswell. (1989). *LCP*. [5] Oppenheimer, Meyvis & Davidenko (2009). *J of Exp. Social Psychology*. [6] Dinçtopal-Deniz (2010). [7] Grillo & Costa (2014). *Cognition*. [8] Pickering & van Gompel (2006). [9] Batchelder & Riefer. (1999). *PBR*. [10] Logacev & Dokudan (2021).

Examples and Stimuli:

- (1) The **daughter** of the **woman** [who is on the balcony]_{RC} was frightened.
- (2) [Oğlanı gören]_{RC} [[**kadının**]_{NP1} **kızı**]_{NP2} korkmuş.
boy saw-SPart woman-GEN daughter-POSS scare-PAST
'The daughter of the woman who saw the boy was frightened.'
- (3) Tarih dersinde, [Fransa'da doğduğu tahmin edilen]_{RC} ...
history class-LOC France-LOC born presumed-PART

a./a' NP1 ATTACHMENT

... [[**şövalye-nin**]_{NP1} (**parlak**)_{ADJ} [**kılıcı-i**]]_{NP2} anlatıldı.
knight-GEN shiny sword-POSS told
'In history class, the shiny sword of the knight who was presumed to have been born in France was discussed.'

b./b' NP2 ATTACHMENT

... [[**saray-ın**]_{NP1} (**güzel**)_{ADJ} [**prens-es-i**]]_{NP2} anlatıldı.
palace-GEN beautiful princess-POSS told
'In history class, the beautiful princess from the palace who was presumed to have been born in France was discussed.'

c./c' AMBIGUOUS ATTACHMENT

... [[**şövalye-nin**]_{NP1} (**güzel**)_{ADJ} [**prens-es-i**]]_{NP2} anlatıldı.
knight-GEN beautiful princess-POSS told
'In history class, the beautiful princess of the knight who was presumed to have been born in France was discussed.'