

# Processing temporary syntactic ambiguities in Greek while reading.

Nerantzini, M., Drakoulaki, K., Katsimpokis, D., Mpozou, A., Andrikopoulou, A., Peristeri, E., & Varlokosta, S.

## Introduction

- Syntactic ambiguity resolution is typically associated with increased reading times, especially in sentence-regions requiring re-analysis.
- English-speaking children exhibit strong reliance on syntactically-based heuristics, like Late Closure whereby the Determiner Phrase (DP) is attached to the critical verb (Engelhardt, 2014; Traxler, 2002) ≠ Greek-speaking children tend to rely on morphological cues (case & agreement) carried by critical DPs and verbs to override Late Closure and par consequence garden path effects (Papadopoulou & Tsimpli, 2005).

Whereas previous studies give clues as to which aspects of language are critical to resolve garden path effects in locally ambiguous subject/object sentences, the mechanisms underlying their processing in adulthood remain unknown.

In the current study, we used an eye-tracking-while-reading approach to probe the mechanisms of local structural ambiguity in Greek-speaking adults and investigate the role of morphology in guiding garden-path resolution processes.

## Research Questions

- (a) How are morphological cues, like agreement and case, integrated in the online processing of locally ambiguous sentences?
- (b) How does morphological cue integration manifest in the eye-movements of adults involved in an eye-tracking while-reading paradigm?

## Results

### First fixation Duration:

No main effects or interactions of object/subject readings on first fixation durations across IAs and agreement/case conditions ( $p > 0.05$ ).

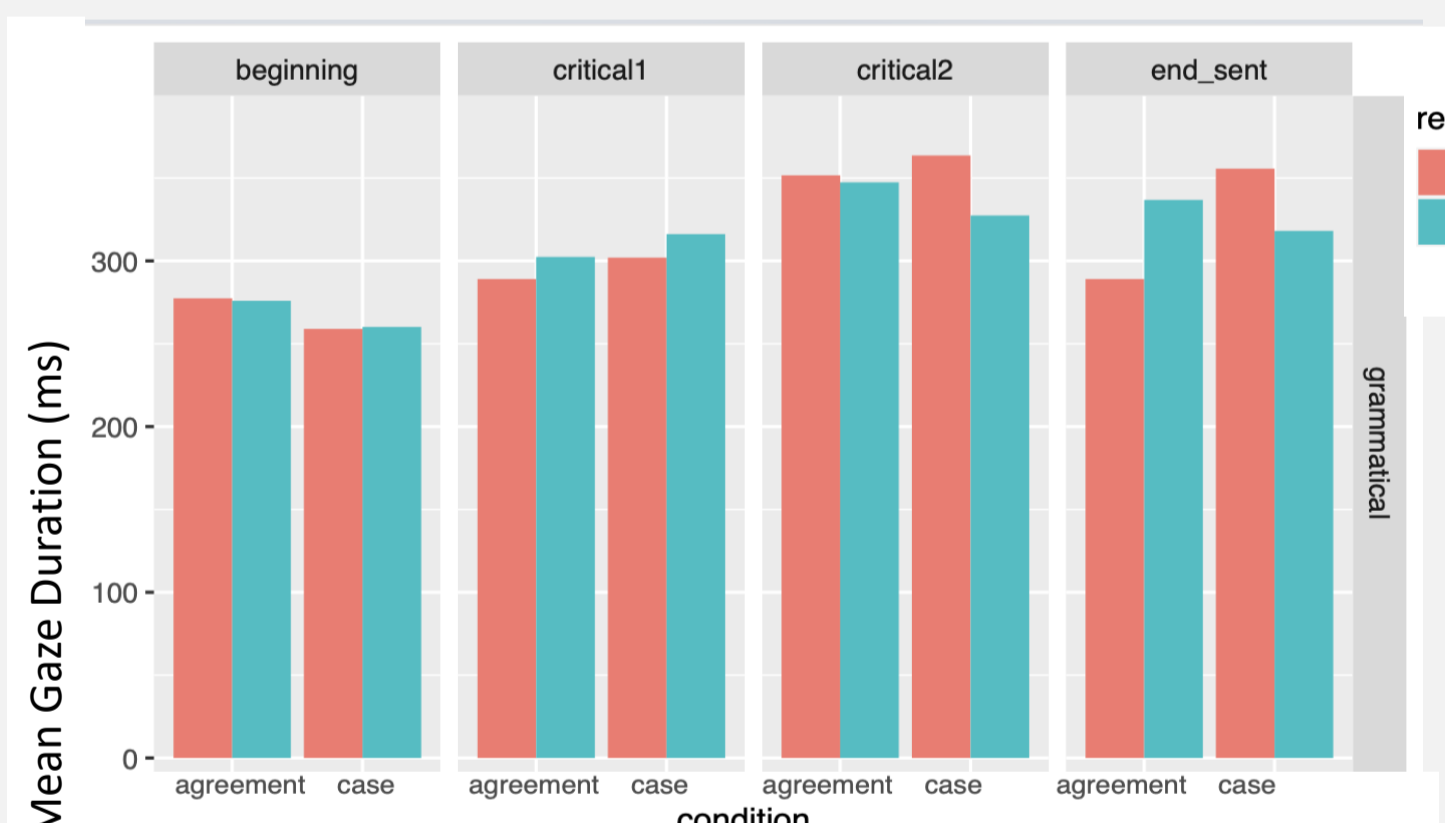
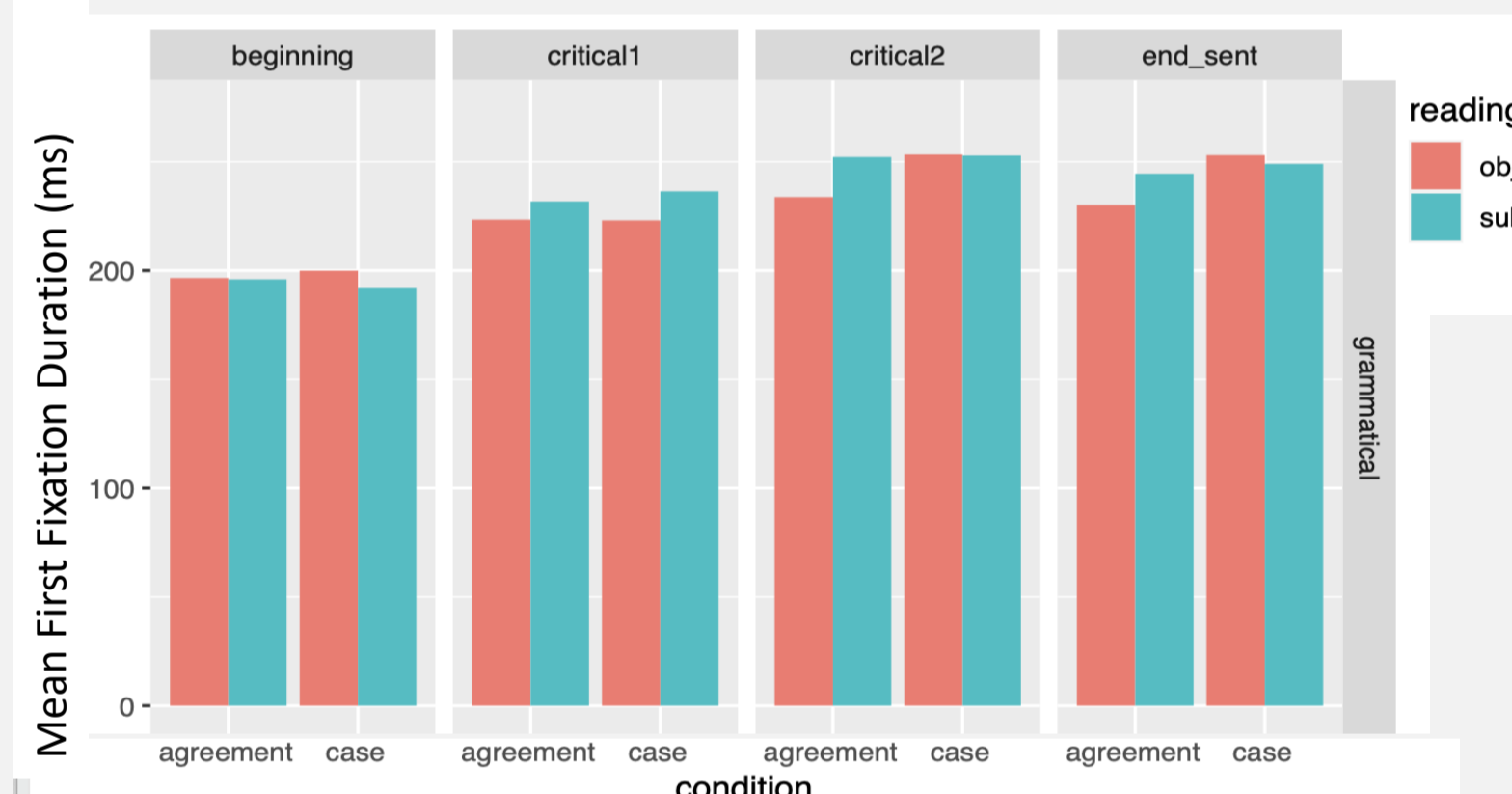
### Agreement condition:

No effects on object/subject readings of the first critical region

### Case condition:

IAs: Object and subject readings of the first critical region had higher first fixation durations than the beginning of the sentence, but lower than the second critical region and also lower than the end of the sentence.

→ the first and the second critical regions showed increasingly higher first fixation durations as compared to the beginning of the sentence irrespectively of the reading or the condition.



### Gaze Duration:

Object/subject readings had no main effect across IAs and agreement/case conditions ( $p > 0.05$ ).

### Agreement condition:

Gaze durations of object readings were faster than subject readings in the end of the sentence. (as predicted)

IAs: Gaze durations of object and subject readings were slower in the second critical region as compared to the first critical region, the beginning of the sentence and the end of the sentence.

### Case condition:

Gaze durations of object readings were slower than those of subject readings in the end of the sentence. (contra predictions?)

IAs: Gaze durations of object readings were slower in the second critical region as compared to the first critical region, and also the beginning of the sentence.

### Mean Second-pass Duration:

#### Agreement condition:

Main effect of subject/object reading in the beginning of the sentence and the first critical region, with subject readings having much larger re-reading durations than objects (above 100ms on average in both cases). (as predicted).

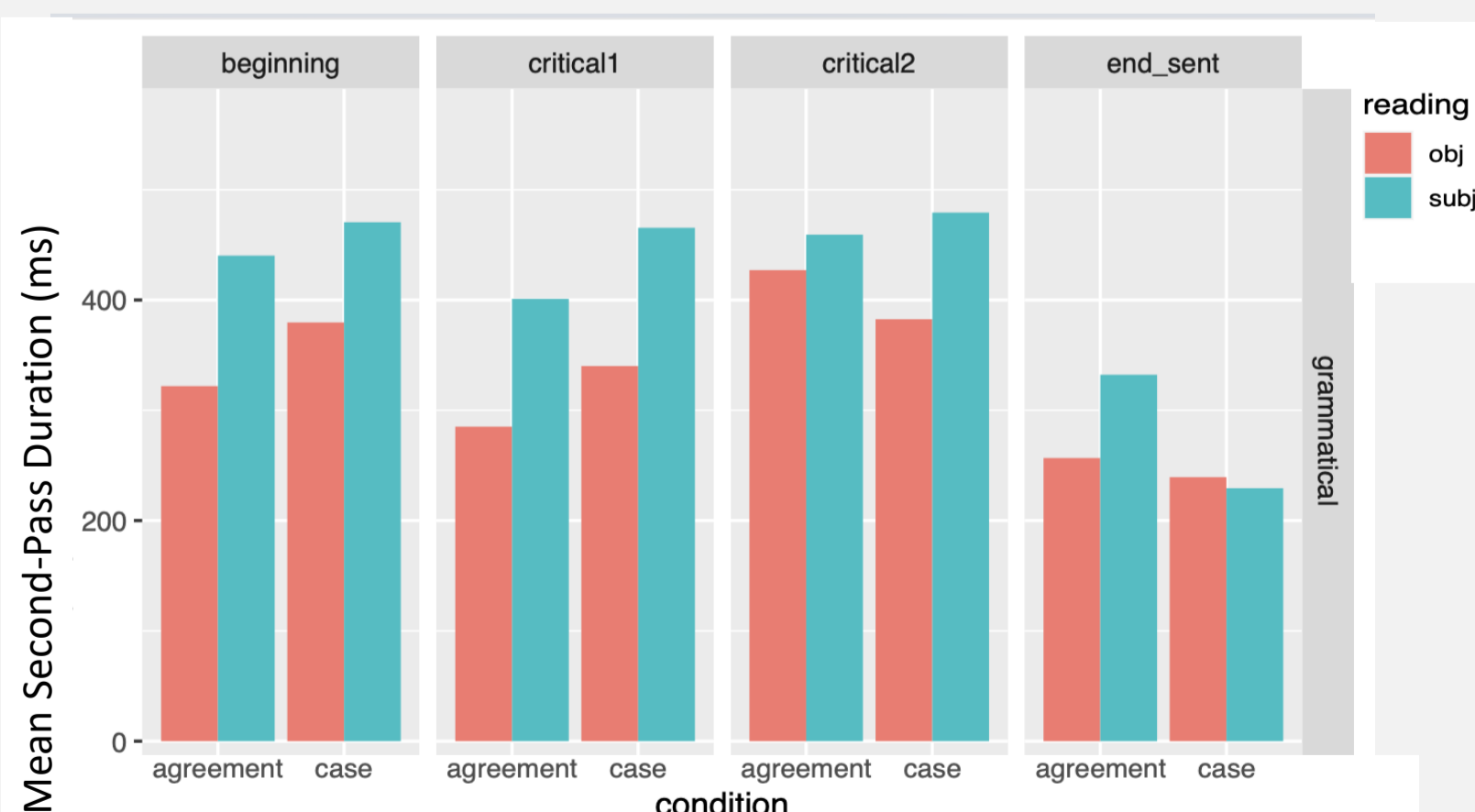
Interaction between subject/object rereading times within the first and the second critical regions: the difference found in the first critical region was substantially reduced in the second critical region.

IAs: Rereading times of the second critical region in object and subject reading sentences were higher than the first critical region as well as the beginning of sentence. (as predicted)

#### Case condition:

Main effect of subject/object reading in the beginning of the sentence, in the first critical region and the second critical region, with subject readings having substantially higher rereading durations (about 130ms average difference in the first critical region). (as predicted)

IAs: In subject reading sentences, both first critical region and the second critical region showed higher rereading times as compared to end of the sentence or beginning of sentence.



## Methods

### Participants

- 60 Greek monolingual adult speakers participated in the study (mean age = 27;4).

### Materials

- Sentences involving subject/object ambiguities. We manipulated
  - the **argument structure of the embedded verb** (optionally transitive vs. intransitive verbs) and
  - the **syntactic function** of the DP following the embedded verb (object vs. subject).
- Local syntactic ambiguity was resolved either by the verbal inflection of the main verb (**Agreement condition 1 & 3**) or the morphological case carried by the DP following the subordinate verb (**Case condition 2 & 4**).
- Six lists of 34 sentences (half grammatical, half ungrammatical)
- After the participants finished reading the sentence, they answered to a recall question to establish attention maintenance throughout the experiment.

### Conditions

(1) Optionally transitive verb; object-subject reading; (grammatical) reading in agreement condition

- a. "Kathos etroge/ ta revithia/ **gemise**/ me fuskales", While (s)he was eating/ the chickpeas/ (s)he blistered herself/ with cysts.
- b. "Kathos etroge/ ta revithia/ **gemisan**/ me fuskales", While (s)he was eating/ the chickpeas/ blistered/ with cysts.

(2) Optionally transitive verb; object-subject reading; (grammatical) reading in case condition

- a. "Kathos etroge/ **tus lukumades**/ gemise/ me fuskales", While (s)he was eating/ the donuts/ (s)he blistered herself/ with cysts.
- b. "Kathos etroge/ **o lukumas**/ gemise/ me fuskales", While (s)he was eating/ the donut/ blistered/ with cysts.

(3) Intransitive verb; object ungrammatical – subject grammatical reading in agreement condition

- a. "Kathos etrehe/ ta revithia/ **gemise**/ me fuskales", While (s)he was running/ the chickpeas/ (s)he blistered herself/ with cysts.
- b. "Kathos etrehe/ ta revithia/ **gemisan**/ me fuskales", While (s)he was running/ the chickpeas/ blistered/ with cysts.

(4) Intransitive verb; object ungrammatical – subject grammatical reading in case condition

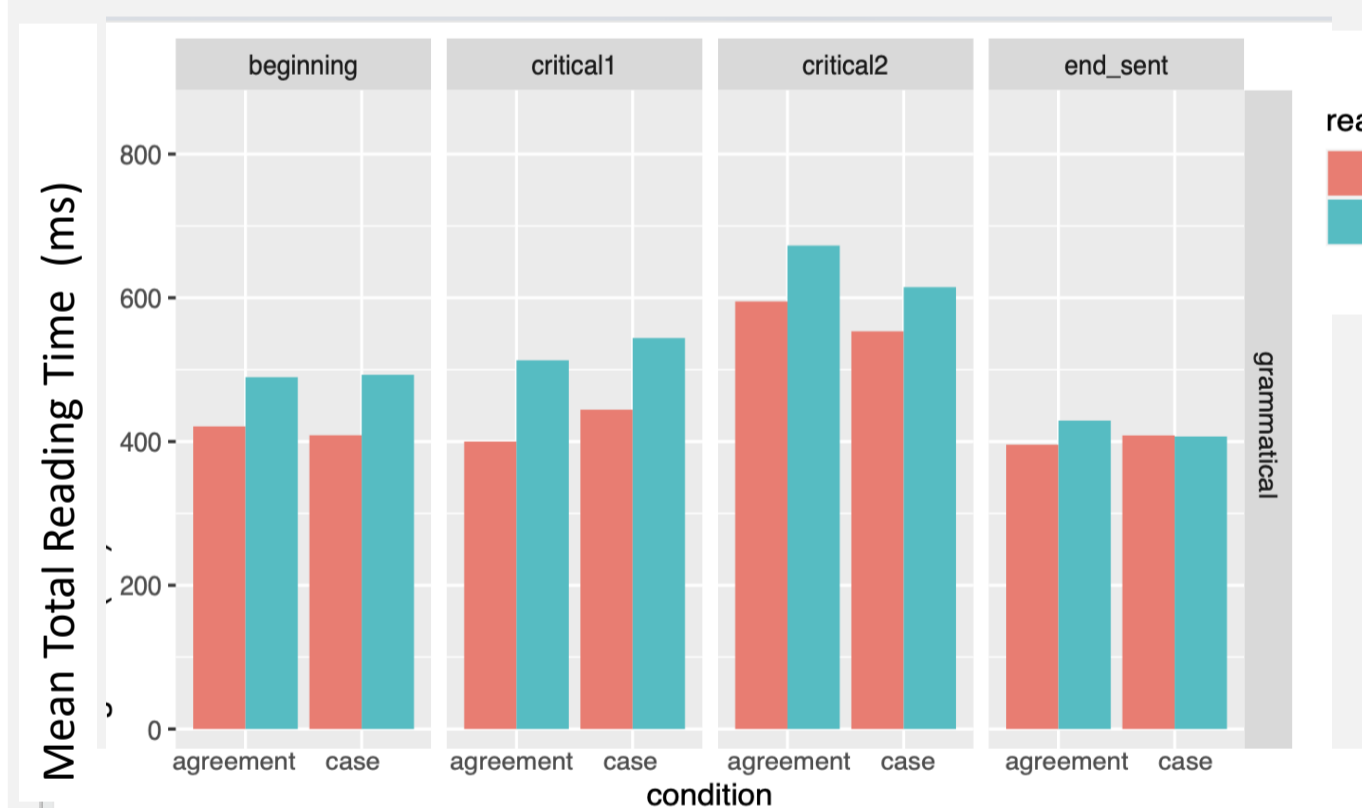
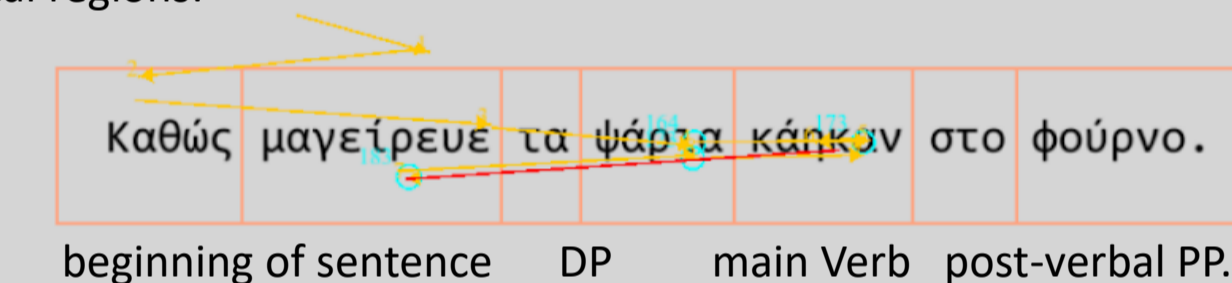
- a. "Kathos etrehe/ **tus lukumades**/ gemise/ me fuskales", While (s)he was running/ the donuts/ blistered/ with cysts.
- b. "Kathos etrehe/ **o lukumas**/ gemise/ me fuskales", While (s)he was running/ the donut/ (s)he blistered herself/ with cysts.

- **Analysis:** Linear mixed-effects models (analyses were conducted only on the accurately interpreted trials)

- **Dependent variable:** eye-tracking measures

- **Independent variables:** object/subject, case/agreement, IA.

### Critical regions:



### Total Reading Time:

Subject reading sentences had higher durations than object reading ones in the first critical region of the agreement and case conditions. (as predicted). However, this effect was not replicated in the second critical region of either the agreement or the case condition.

Subject reading sentences exhibited higher total reading time already from IAs corresponding to the beginning of sentence in the case condition; this was not found in the agreement condition.

Interaction between IAs from the beginning of sentence and IAs in the end of sentence for subject/object readings in the case condition.

## Discussion

✓ Participants successfully integrated morpho-syntactic information (e.g., S-V agreement and case marking) to revise initial (mis)parses of garden path sentences: when encountering the main verb, participants accessed the verb's argument structure assigning the theme role to the post-verbal DP, making predictions about the upcoming sentence constituents (contra Late Closure).

✓ Parsing preferences: strong preference for object reading (for similar findings see Kjelgaard & Speer 1999; Traxler 2002, for English; Papangeli & Marinis 2009; Peristeri et al., 2020 for Greek; but see Papadopoulou & Tsimpli 2005), although verbs' optional transitivity triggers the activation of two parallel structures and can make sentences more vulnerable to misinterpretation.

✓ In sentences with subject reading, verb agreement markers and case in the DP considerably slowed down participants' reading times relative to sentences with object reading → Morphological cues seemed to be overridden by participants' strong thematic role assignment preferences but were re-integrated later in time (see second pass and total reading times), revising their initial parsing strategies.

## References

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