Ambiguity Advantage Effect in Wh-Questions

Joshua Lieberstein and Matt Wagers • Department of Linguistics, University of California, Santa Cruz

UNIVERSITY OF CALIFORNIA SANTA CRUZ

1. Background: Ambiguity Advantage

- **Ambiguity Advantage Effect**: Comprehenders are better & faster at processing a sentence when it is **globally ambiguous**. Previously, observed for PP attachment site [1-2] and pronominal reference [3].

  (1) The son of the driver with the mustache was pretty cool. [1]

- **Filler-Gap Dependency**: In a wh-question, a **dependency** must be formed between the wh-element and the gap it leaves [4].
- Ambiguity in (2) arises from **two possible gaps**, embedded subject or object, modulated by the optional transitivity of embedded verb.

(2) Who did the teacher want ___ to draw ___?

Research Question:

Is there an ambiguity advantage for filler-gap dependencies?

- Possible Models:
  - **Unrestricted Race Model:** A serial-stochastic parsing model. Competing parses 'race' to be processed. Ambiguous sentences do not need to be re-analyzed leading to faster processing times. [5]
  - **Good-Enough Parsing:** Sentences are underspecified. Globally ambiguous sentences are processed faster; both parses are available.[6]

Hypothesis:

If ambiguity advantage extends to filler-gap dependencies; sentences with multiple gaps will be processed faster than sentences with one gap.

2. Methods/Design

- **Speeded Acceptability Judgment Task**
  - 43 English speaking students from UCSC
  - RSVP (Rapid Serial Visual Presentation) [7] 250ms/word; 100ms pause.
  - Speeded Judgments, 2000ms response window
- Administered remotely and in-person using PCIbex [8]
- 3x2 Dependency Type x Grammaticality
  - 6 conditions: {Ambiguous, Long, Short} x {Grammatical, Ungrammatical}
    - Unambiguous verbs are subject control (Long) or object control (Short)
    - Ambiguity arises from verbs that are subject control or exceptional case marking in tandem with an optionally transitive verb

(3a) Who did the mother need <who> to drive <∅>?

(3b) Who did the mother need <∅> to drive <who>?

  - Ungrammatical sentences were created by filling all possible gaps
  - Items distributed via Latin square (36 items)
  - 108 fillers - equal parts grammatical and ungrammatical

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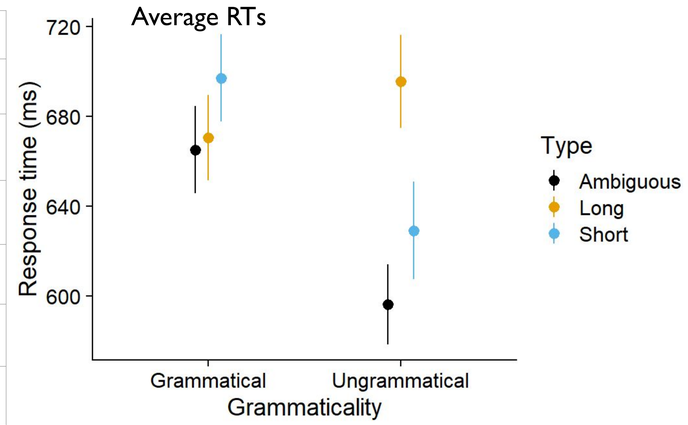
3. Results: Ambiguity advantage in ungrammatical sentences. Trend overall.

Condition	Sentence
Grammatical, Ambiguous	Who did the teacher **want** ___ to draw ___?
Ungrammatical foil to Ambig	Who did the teacher **want** the student to draw the model?
Grammatical, Long	Who did the teacher **agree** to draw ___?
Ungrammatical foil to Long	Who did the teacher **agree** to draw the model?
Grammatical, Short	Who did the teacher **tell** ___ to draw?
Ungrammatical foil to Short	Who did the teacher **tell** the student to draw the model?



- **Accuracy.** On average, participants were 80% accurate but accuracy did not vary with condition. A X^2 test yielded no significant differences (p = 0.13)

We fit a Linear Mixed Effects Model with Log-transformed RTs as the dependent variable with Helmert coding to represent the distinction between Ambiguous and Unambiguous conditions (Long + Short); and the Long v. Short contrast between Unambiguous conditions.

- **Factors**: Ambiguity, Length, Grammaticality, and their interactions
  Significant effects:
  - Ambiguity: (β = 0.062, (0.012,0.11); p = .012)
  - Grammaticality: (β = -0.063, (-0.11,-0.017); p = .0073)
  - Length x Grammaticality: (β = 0.15, (0.037, 0.26); p = .0088)

  No significant effect for Ambig x Gram (β = 0.645; (-0.034, 0.163))
- **Pairwise Comparisons**. Ambiguous v. Short, Ambiguous v. Long
  - Long: (β =.0804, (0.026, 0.13); p = .0033)
  - No significance for Short: (β = 0.043; (-0.015, 0.101))
  - Ambiguous sentences are responded to significantly faster than Long *viz a viz* Short. Especially in Ungrammatical conditions.

  Short v. Long yields no significance β =-0.045, (-0.1, 0.12); p = .13)

4. Discussion

General Effect of Ambiguity

- Ambiguous sentences are responded to faster
  - More pronounced for ungrammatical sentences
  - Supports global ambiguity aiding the comprehender
  - Patterns similarly to previously observed ambiguity advantage
- No significant interaction for Ambiguity x Grammaticality
  - Unexpected that ungrammatical ambiguous sentences are responded to fastest.

General Effect of Grammaticality

- Ungrammatical sentences are responded to faster
- A possible reason for this is implicit prosody associated with questions
  - Task effects require processors to form their own prosody
  - Ungrammatical sentences have multiple prosodic parses
- Ambiguous sentences pattern with the optimal parse
  - Speed up for ungrammatical explained by Unrestricted Race Model[4]
  - Globally ambiguous sentences do not require re-analysis.

Main Findings:

- **Ambiguity Advantage Effect present in wh-questions**
- Ungrammatical Ambiguous sentences see a large speed-up in response times
- Trend towards ambiguity advantage effect in grammatical sentences

Crossover effect for Length replicates Frazier, Clifton and Randall[3]

- Short grammatical sentences more local competition for the gap site
- Long ungrammatical sentences re-analyze embedded verb as transitive.

Future Directions

(1) How does the argument structure frequency for the critical verbs and embedded verbs interact with the observed effect?

(2) What effect does implicit prosody have for the ungrammatical sentences?

(3) How does the Maze task impact the effect found? Does incremental parsing increase or decrease the effect size?

[1]Traxler et al. (1998). *JML*, 39(4), 558-592. [2]Dillons et al. (2019). LM&C, 45(7). [3]Grant et al. (2020). Glossa 5(1). [4]Frazier et al. (1983). Cognition, 13(2), [5] van Gompel et al. (2000). Reading [6] Swets et al. Memory & Cognition 36, (2008) [7] Potter (2018). Routledge. [8] Zehr & Schwarz (2018). PennController (IBEX).