

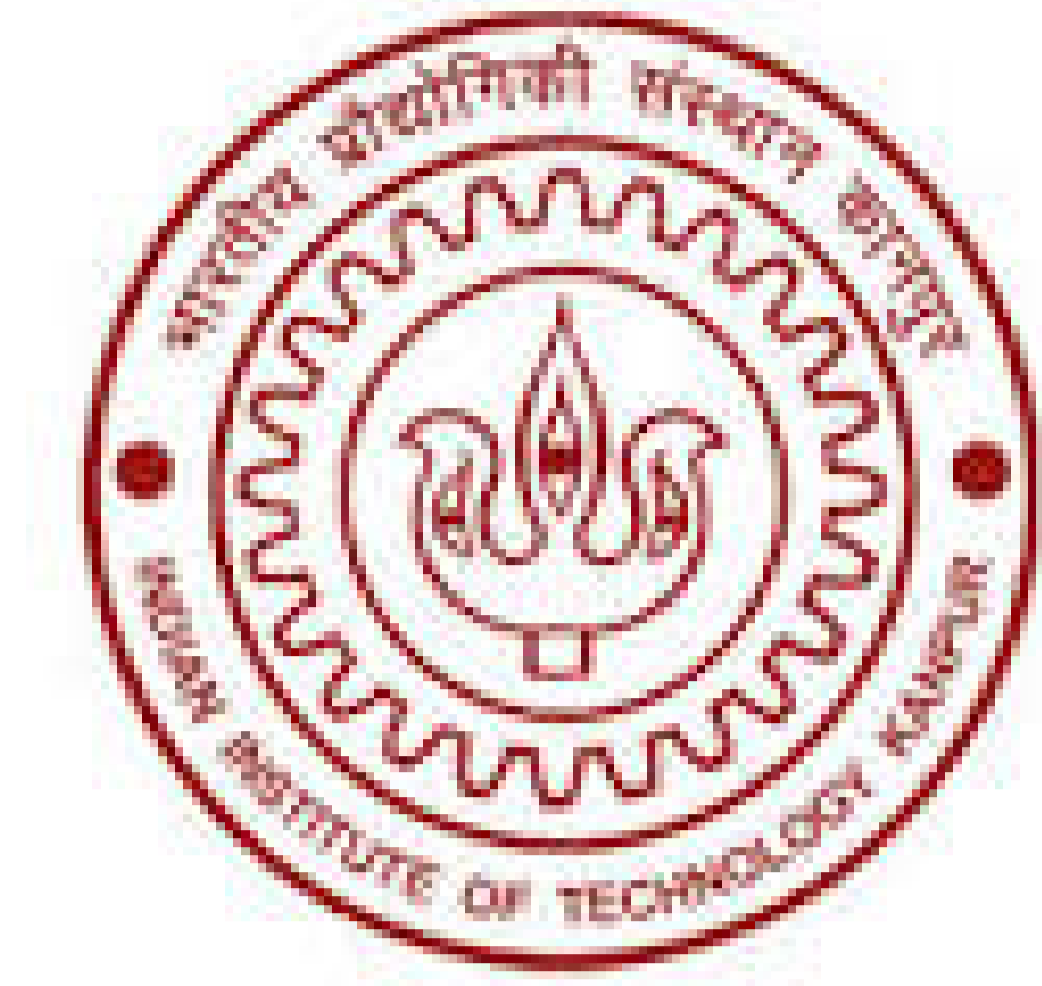
Effect of Plausibility on Analysis of Garden Paths

A Gaze-Tracking Study

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[with assistance from Dr. Amitabha Mukerjee, for course SE367 : Cognitive Science]



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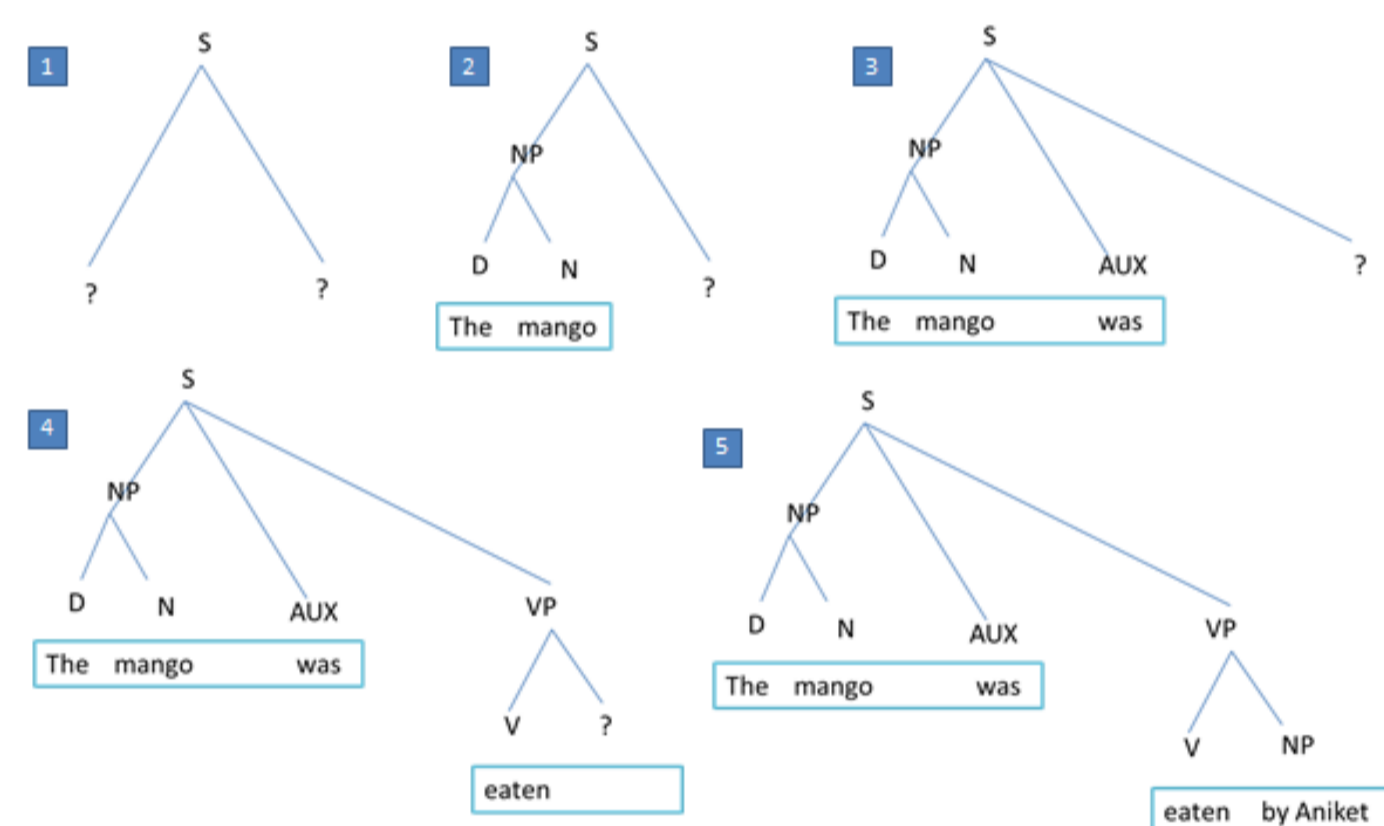
Abstract

Research on the cognitive science of sentence processing has been driven heavily by the study of resolution of syntactic ambiguity in Garden Path sentences. Recent work has shown that apart from syntax, semantics is another essential component that affects the analysis of sentences. In this study, we analyze the role of semantic plausibility in resolution of syntactically ambiguous Garden Path Sentences.

Theory of Incremental Evaluation

- Sentences processed sequentially, most 'probable' parse tree selected at every word.
- Probability predominantly defined by the *syntactical role* of words, rather than semantic meaning.

Construction of the sentence – 'The mango was eaten by Aniket.'

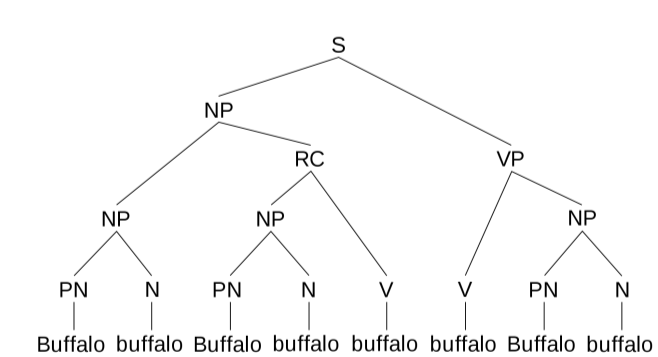


Garden Path sentences: The most likely parse in incremental evaluation will be incorrect.

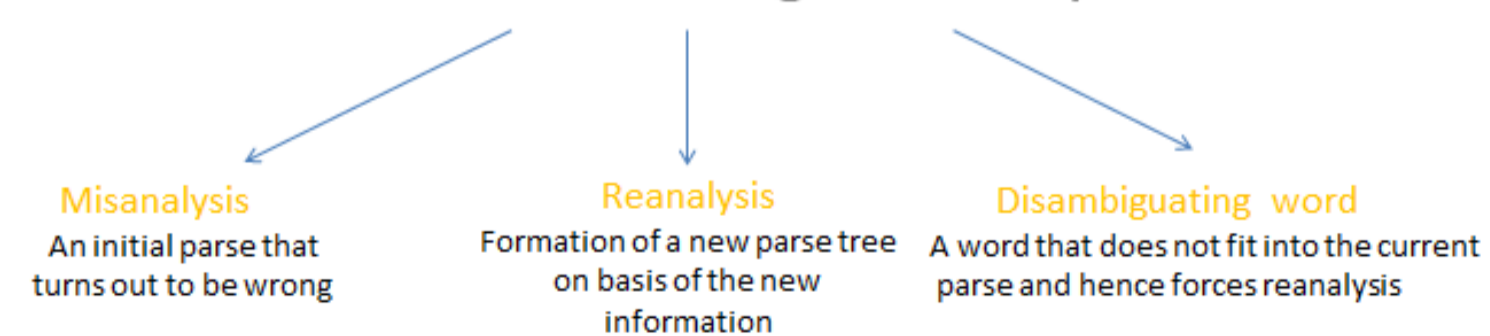
→ **The criminal confessed his sins** which upset kids harmed too many people.

→ **As the woman edited the magazine about fishing** amused all the reporters.

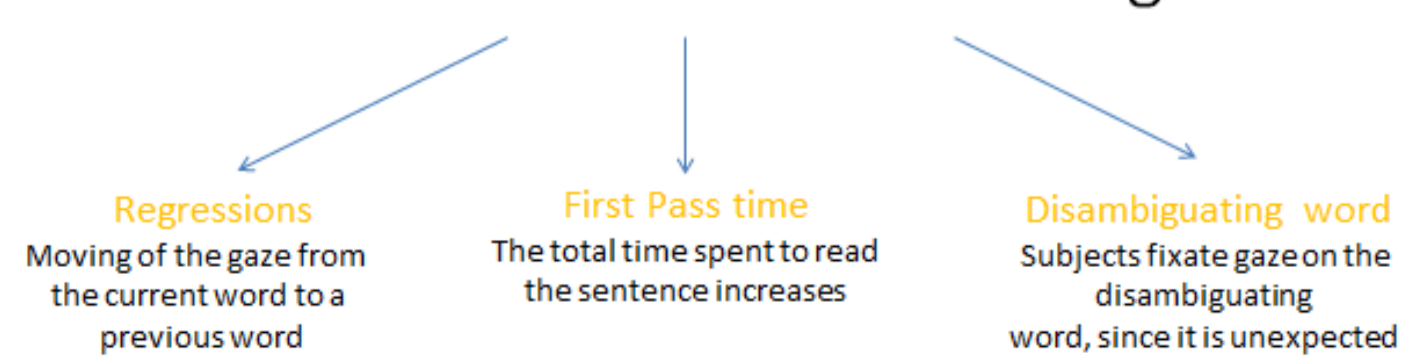
Impossible to parse sentences!



Resolution through reanalysis



Observation in Gaze Tracking



Proposed Theory

[Pickering and Traxler, 1998]

◇ **Syntactic role of elements in a sentence predominantly controls its parsing, BUT semantic plausibility of the parse defines the extent of attachment towards the sentence.**

◇ **Greater semantic plausibility of initial parse → Greater attachment → Larger time in reanalysis → ↑ Regressions, ↑ First pass time**

Experimental setup

Two related experiments conducted simultaneously.

• **Experiment 1 : Subordinate Class Ambiguities**

A clause dependent on a main clause.
→ **When the ambassador negotiated the treaty** about arms upset many of the civilians.

• **Experiment 2 : Complement Clause Ambiguities**

A clause introduced by a complementizer such as that or whether.
→ **The sailor reads the chart from London** described new routes around the world.

4 types of sentences can be formed.

- **Type I.** Initial parse plausible, syntactic disambiguation absent.
As the artist paints the picture of the roses pleases the critics greatly.
- **Type II.** Initial parse plausible, syntactic disambiguation present.
As the artist paints, the picture of the roses pleases the critics greatly.
- **Type III.** Initial parse implausible, syntactic disambiguation absent.
As the artist sings the picture of the roses pleases the critics greatly.
- **Type IV.** Initial parse implausible, syntactic disambiguation present.
As the artist sings, the picture of the roses pleases the critics greatly.

Methodology

1. Gaze Tracking apparatus and software designed by **SensoMotoric Instruments (SMI)** used.
2. 8 test sentences + 18 fillers. No two test sentences consecutive.
3. 4 sentences for each of the two experiments → types I, II, III, or IV.
4. All sentences written over two lines, sufficient distance (1") between the two lines.

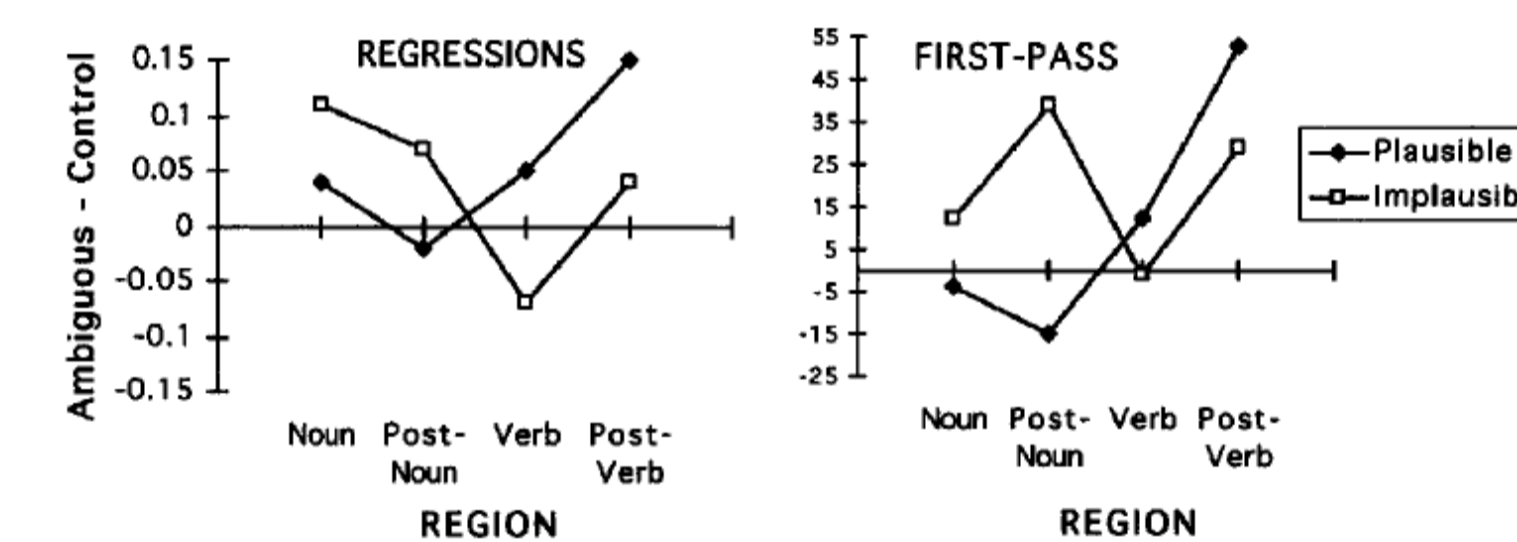
Instructions

- Do not waiver focus from the sentence. Read sentence sequentially, word by word.
- You can go to a previous word to understand the meaning, but always focus on the current word you are reading.
- Close your eyes once you are done reading the sentence. (This is an indicator for the experimenter to move to the next sentence)
- Understanding the meaning of the sentence is essential to the experiment. Close your eyes only after understanding the meaning.

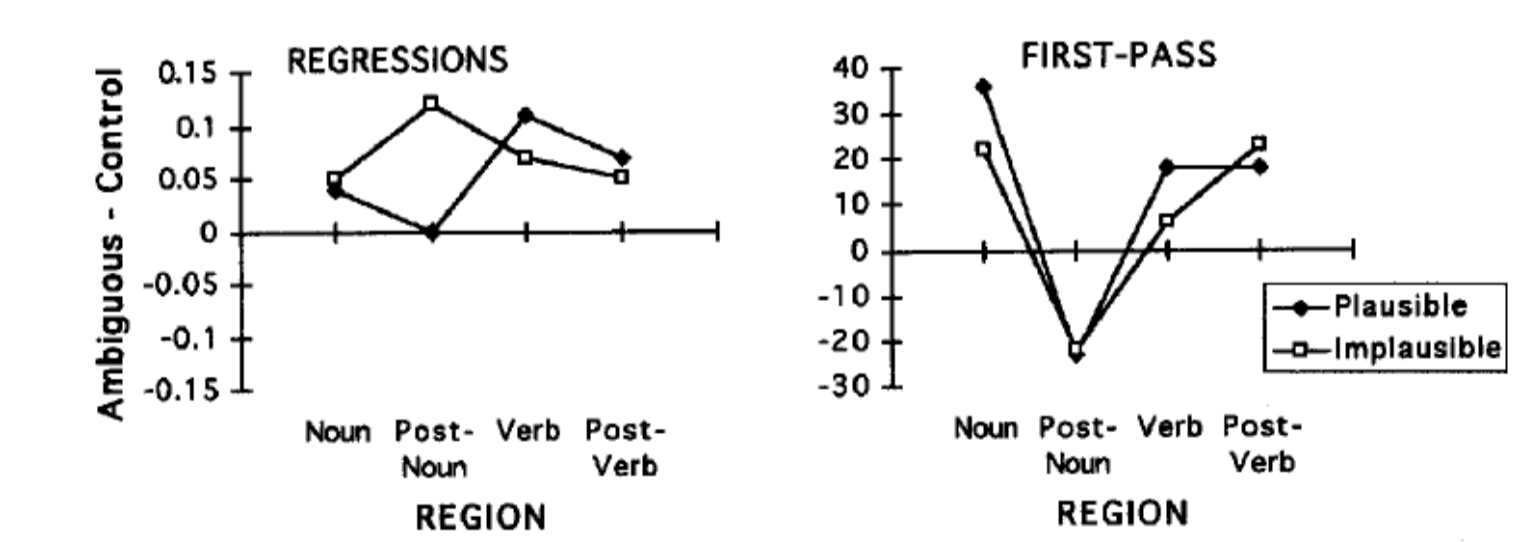
Results



Plots : Experiment 1 (Data from authors [2])



Plots : Experiment 2 (Data from authors [2])



Discussion and Conclusion

[Pending data analysis, based on videographic observation]

1. It was clear that readers commit to a more plausible initial analysis. Often, the implausible sentences did not even show regressions. This validates our primary hypothesis, indicating an **essential role of semantics in parsing**.
2. Effects of disambiguation were delayed, appearing as regressions from postverb regions. Often no local effects were present, only overall increase in total pass time.

3. **Possible Explanation :** On encountering an unexpected structure, subjects *delay* analysis, and await more information from following words, before making a decision. This is an expected cognitive reply to an unexpected situation.

Possible improvements in setup

→ **Issue :** The apparatus required the head to be kept stationary. Violation drastically affected calibration.

Solution : An adjustable chin-rest could be provided.

→ **Issue :** The gaze of subjects often diverted from the sentence despite clear instructions.

Solution : A dark background around the sentence, with the sentence embedded over a white background could be used to make sure that subjects focus on the sentence.

Impending research

- Analyzing the data which is in csv (comma separated values) format, and contains x-y coordinates of the subject's gaze.
- Plotting of first pass and regression data against sentence probabilities obtained by using the statistical Stanford parser.

References

- [1] Julie E Boland, Michael K Tanenhaus, Greg Carlson, and Susan M Garnsey. Lexical projection and the interaction of syntax and semantics in parsing. *Journal of Psycholinguistic Research*, 18(6):563–576, 1989.
- [2] Martin J Pickering and Matthew J Traxler. Plausibility and recovery from garden paths: An eye-tracking study. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24(4):940, 1998.
- [3] Patrick Sturt. The time-course of the application of binding constraints in reference resolution. *Journal of Memory and Language*, 48(3):542–562, 2003.
- [4] Matthew J Traxler and Martin J Pickering. Plausibility and the processing of unbounded dependencies: An eye-tracking study. *Journal of Memory and Language*, 35(3):454–475, 1996.