Structural analysis of expected and unexpected clauses in sentences

using *gaze-tracking* studies

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Introduction

• Consider the following sentences
  ➢ The ball was kicked by Bhutia into the goal.
  ➢ The ball was kicked into the goal by Bhutia.
  ➢ Bhutia kicked the ball into the goal.

• Above sentences are all grammatically correct.

• Only the third one seems natural.

• First two sentences have an added adverbial clause, that could be avoided.
Incremental evaluation

• The brain constructs parse trees incrementally, or by looking at the local context of the phrase.

• How would the brain parse the following two sentences?

• “The mango was eaten by Aniket”
The mango was eaten by Aniket.
The mango was eaten by Aniket.
The mango was eaten by Aniket.
The mango was eaten by Aniket.
The mango was eaten by Aniket.
Ambiguities in incremental evaluation

• What happens with such sentences?

• “Buffalo buffalo Buffalo buffalo buffalo buffalo Buffalo buffalo”
Garden path sentences

- **Definition**: A grammatically correct sentence that starts off in such a way that a reader's interpretation using the most likely parse in incremental evaluation will be incorrect. The reader is lured into a parse that turns out to be a dead end.


- “As the police stopped the driver became very frightened”

  Source: Pickering and Traxler, ‘98
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• In speech, ambiguities are much easier to resolve due to punctuation related inflections.
Disambiguation and reanalysis

• On hitting a clause that is unexpected with respect to the current analysis, a disambiguation occurs through reanalysis.

• These effects can be observed, in gaze-tracking studies, by statistical analysis of
  1. Regressions: moving from the current spot to a spot on the left.
  2. First pass time
  3. Overall fixation time.

• Note that parts 1 and 2 focus on a local clause, and are concerned with its plausibility, whereas part 3 deals with the sentence as a whole.
Study 1 (replication)

- Traxler and Pickering (‘98) study the effect of garden path sentences have, using gaze tracking studies.

- Unnatural / unexpected parts of sentences will have larger `first pass time` and `regressions` as compared to naturally expected parts.

- Sentences that contain unexpected clauses will have a larger `total pass time`.
Subordinate-clause ambiguities

• “As the woman edited the magazine amused all the reporters”
Subordinate-clause ambiguities

• “As the woman edited the magazine amused all the reporters”

• Object analysis (‘magazine’) turns out to be wrong. ‘Amused’ indicates that it must be the subject of the verb phrase, and not the object of the noun phrase.
Attachment to a more plausible clause

• Pickering and Traxler (‘98) noted that first pass time was longer if the first part of the clause was more plausible.

• Readers ‘attached themselves more strongly’ to that clause.
  – As the woman edited the magazine amused all the reporters. (difficulty in reanalysis)
  – As the woman sailed the magazine amused all the reporters. (more easily reanalyzed)
Complement-clause ambiguities

• “The criminal confessed his sins harmed too many people.”
Complement-clause ambiguities

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• Again, we can have a plausible object phrase, and an implausible one. Consider,
Complement-clause ambiguities

• “The criminal confessed his sins harmed too many people.”

• Again, we can have a plausible object phrase, and an implausible one. Consider,

• “The criminal confessed his gang harmed too many people.”
‘Control’ sentences

• As the woman edited the magazine amused all the reporters → As the woman edited, the magazine amused all the reporters

• The criminal confessed his sins harmed too many people → The criminal confessed that his sins harmed too many people
Proposition

• The above work also ‘induces’ the following two classes of sentences.

• Those that are plausible, and also have an expected structure VS those that are plausible, but have an unexpected structure.
  – The magician touched the boy with a wand.
  – The magician touched the boy with a ball.

• Both sentences completely natural, punctuated, and in their most canonical forms. Yet, the first one is more easily parsed.
Study 2 (proposed)

• What sentential structures are more natural?

• A paragraph containing around 15 sentences of *various syntactic forms*.

• All sentences grossly *plausible*.

• Pass time, and number of regressions measured for each sentence.

• Followed by an ANOVA on average reading time and variance across subjects, for various sentences.
References:


- “The time-course of the application of binding constraints in reference resolution”, Sturt ‘03


- “Eye movements in reading and information processing: 20 years of research”, Rayner and Keith ’98

- “The On-line Study of Sentence Comprehension: Eyetracking, ERPs and Beyond”, book by Manuel Carreiras ‘04