An MPT model of garden-pathing and reanalysis with dissociable process costs

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What is the cost of garden-pathing and syntactic reanalysis?

Typical experiment:

a. While the team trained the striker wondered ...  
b. While the team trained, the striker wondered ...

→ Compare mean reading times at *wondered* in a. vs b.
Introduction

Some problems with this approach:

- In some trials, reading may be “shallow”, “good enough”, or “mindless” (e.g., Ferreira & Patson, 2007; Reichle et al., 2010)
- Garden-pathing may not occur in all trials (non-deterministic parsing) (e.g., van Gompel et al., 2000, 2005)
- Syntactic reanalysis can be overt or covert: it can involve or not involve rereading (e.g., Frazier & Rayner, 1982; Lewis, 1998)
- Readers may reject garden-path sentences as ungrammatical instead of performing reanalysis (“triage”) (Meng & Bader, 2000; Fodor & Inoue, 2000)
- Processing cost due to unexpectedness of the disambiguating word (“surprisal”) (e.g., van Schijndel & Linzen, 2018, 2021)
Inattention
Surprisal + Triage
Reanalysis
A novel computational model

Idea: Implement aforementioned proposals as latent processes in a multinominal processing tree (e.g., Erdfelder, 2009)

- Processing of garden-path sentences modeled as sequential occurrence or non-occurrence of cognitive processes
- MPT model estimates probabilities of occurrence and costs for each process
- The model is fitted to experimental data (reading measures plus acceptability judgments)

**Assumptions:** Regression/rereading indicates overt reanalysis; negative acceptability judgments indicate failure to compute correct structure
Attentive?
Probability: $p_{attentive}$

- no
- yes (pay attention cost)

Biased guess
Probability: $p_{bias}$

- ACCEPT
- REJECT
- ACCEPT

Garden-pathed?
Probability: $p_{gp}$

- no
- yes (pay GP cost)

Triage?
Probability: $p_{triage}$

- no
- yes

Covert reanalysis?
Probability: $p_{covert}$

- no (pay regression cost)
- yes (pay reanalysis cost)

- REGRESS

Success?
Probability: $p_{covert\_success}$

- no
- yes

- REJECT
- ACCEPT

Success?
Probability: $p_{overt\_success}$

- no
- yes

- REJECT
- ACCEPT

no (pay regression cost)

yes (pay reanalysis cost)
Sentence types (Paape & Vasishth, 2021)

NP/Z ambiguity

a. While the team trained the striker \(\text{wondered}\) ...

b. While the team trained, the striker \(\text{wondered}\) ...

RRC ambiguity

a. The lawyer sent \(\text{by the governor}\) was neglected ...

b. The package sent \(\text{by the governor}\) was neglected ...
Results

- “Pure” garden-pathing costs 34–88 ms, covert reanalysis costs 572–688 ms.
- More garden-pathing in NP/Z sentences (99%) than in RRC sentences (75–93%).
- Orthographic disambiguation in NP/Z sentences more effective (5–16%) than semantic disambiguation in RRC sentences (46–76%).
- Triage more likely in NP/Z sentences (34–59%) than in RRC sentences (2–7%).
- Covert reanalysis more likely in RRC sentences (78–89%) than in NP/Z sentences (35–56%).
- Covert reanalysis often fails in NP/Z sentences (45–64%) but not in RRC sentences (11–22%).
- Overt reanalysis also often fails in NP/Z sentences (52–78%).
Conclusions

- With the right model and data, costs of garden-pathing and reanalysis can be dissociated
- Reanalysis is quite expensive by psycholinguistic standards
- Garden-pathing in NP/Z sentences is close to deterministic, garden-pathing in RRC sentences much less so
- Semantic “disambiguation” is less effective than orthographic disambiguation
- NP/Z sentences show high triage probability, along with high probability of reanalysis failure
References


