Introduction

- The distinction between active subject-extracted and object-extracted relative clauses (RCs) has been studied extensively, but little attention has been paid to passive RCs, which are much more frequent than object-relatives and somewhat more frequent than transitive subject-relatives.

- A number of studies have found that passive sentences are more difficult than active structures in offline measures. (Fodor, Bever, & Garrett, 1974; Caramazza & Zurif, 1976)

- However, Carrithers (1989) found that passive sentences can actually be faster than actives in self-paced reading, suggesting that online and offline measures of sentence complexity may not agree in the case of passives.

- But these results do not bear directly on the processing of relative clauses and are questionable because the semantic plausibility was not carefully balanced across conditions and the results of the offline measure (T/F probe sentences which were all true) were not reported.
In general, offline comprehension measures have not been taken seriously enough in experiments involving online tasks.

Probe sentences are usually phrased actively, biasing the results towards active or subject-extracted RC conditions.

True/false probe items are not particularly sensitive.

False probe sentences are often created by repeating part of the sentence with a noun or verb changed. These could be answered with a surface-form comparison and may not reflect deeper thematic processing.

- The violinist that flattered the sponsor insulted the conductor.
- T/F: The violinist flattered the cellist.

Can offline comprehension scores be dissociated from online reading time and, if so, what implications does this hold for processing theories?
Experimental Design

- The goal of this experiment was to accurately assess both the online and offline comprehensibility of sentences in which the matrix subject is modified by various types of relative clause.
- The relative clauses were either active or passive and either subject-extracted or object-extracted.
- The first two noun phrases were fairly neutral with respect to subject- or object-hood of the RC verb, and were swapped to counterbalance the semantic relationships across conditions.
- The online measure was reading time in a self-paced, moving window paradigm.
- The offline measure involved multiple choice (four options), fill-in-the-blank statements.
- The query statements asked about either the main or relative clause and were phrased either actively or passively, and were therefore not always answerable by trivial surface-form comparisons.
Example Sentences

- **AS: Active, Subject-extracted (subject relatives)**
  - The reporter that attacked the senator ignored the president.
  - The senator that attacked the reporter ignored the president.

- **AO: Active, Object-extracted (object relatives)**
  - The reporter that the senator attacked ignored the president.
  - The senator that the reporter attacked ignored the president.

- **PS: Passive, Subject-extracted (passives)**
  - The reporter that was attacked by the senator ignored the president.
  - The senator that was attacked by the reporter ignored the president.

- **PO: Passive, Object-extracted**
  - The reporter that the senator was attacked by ignored the president.
  - The senator that the reporter was attacked by ignored the president.
Example Questions

- The reporter that attacked the senator ignored the president.
  - The reporter attacked the _______.
    A: reporter   B: senator   C: president   D: plumber
  - The _______ attacked the senator.
    A: president   B: plumber   C: senator   D: reporter
  - The reporter _______ the senator.
    A: was attacked by   B: ignored   C: was ignored by   D: attacked
  - The senator was attacked by the _______.
    A: reporter   B: senator   C: president   D: plumber
  - The _______ was attacked by the reporter.
    A: president   B: plumber   C: senator   D: reporter
  - The senator _______ the reporter.
    A: was attacked by   B: ignored   C: was ignored by   D: attacked

  - The reporter ignored the _______.

- One question about the relative clause, one about the main clause.
Processing Theories

- Presumably the sentence-initial noun phrase is first taken to be an agent (given the animate NPs used in this experiment).
- Subject-extracted passives (PS) and active object relatives (AO) will therefore require a change of thematic role for this NP.
- If a parse-tree is being constructed, a change at the structural level may be required as well.
- Will these changes impair comprehension ability and will they be reflected in online reading times?
Processing Theories

- Structure-first theories suggest that the syntax module makes an initial commitment (to the active reading).
  - If the syntax module then detects the passive, it presumably must slow down to rearrange the structure.
  - The thematic module must also change its commitment.
  - Must the syntactic processor wait for the thematic to be ready before continuing?
  - Or does it just plow ahead independently?

- Interactionist theories suggest more communication between the thematic processor and lower levels, possibly to the point that there is no clear distinction.
  - In this case, wouldn’t the lower levels find out if the thematic processor is having trouble and slow down?
  - Alternatively, interactionist theories might hold that the thematic processor does not necessarily commit to a single reading. In this case, the thematic roles could be confused but will not signal this confusion and the rest of the system will happily soldier on.

- Specific versions of either type of theory may or may not predict the possibility of a dissociation between reading rate and thematic clarity.
Corpus Frequency

- Frequency counts in the Penn Treebank (Brown and WSJ):

<table>
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<tr>
<th>RC Type</th>
<th>All RCs</th>
<th>Modifying the Matrix Subject</th>
<th>Modifying the Matrix Object</th>
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Methods

- 24 experimental items. 36 fillers. 48 participants.
- Five additional participants were replaced because of excessively bad comprehension (4) or slow reading (1) on the filler items.
- Sentences were presented with masked, moving-window, self-paced reading.
- Two questions followed each experimental item; one or two followed each filler.
- For each participant, a linear regression equation was computed to predict the reading time as a function of word length. This prediction was subtracted from the raw times to obtain residual reading times.
The N1 that V1 the N2 was V1 by the N2.

Region

0 100 200 300 400 500 600 700 800 900 1000

Average Raw Reading Time Per Word (ms)

Active Subject
Active Object
Passive Subject
Passive Object

Region

The N1 that V1 the N2 was V1 by the N2.

V2 the N3.
Raw Reading Times

- Active Subject
- Active Object
- Passive Subject
- Passive Object

Average Raw Reading Time Per Word (ms)
The N1 the N2 was V1 the N2 by was V1 V2 the N3.

Region

Average Residual Reading Time Per Word (ms)

Active Subject
Active Object
Passive Subject
Passive Object
Conclusions

- Passive sentences and object relatives are not comprehended as well as active subject relative RCs.
- Passives are read more quickly than object relatives.
- Raw reading times for passives are as fast or faster than those for active subject relatives.
- Residual reading times for passives are somewhat slower than those for subject relatives on the relative clause and main verb, but not overall.
- Reading rates are in line with frequency data, comprehension scores are not.
- These results suggest that the online sentence reading control mechanism is not necessarily sensitive to processing difficulty at the thematic level.
- In general, what types of thematic errors or difficulties cause us to slow down when reading and which are ignored indefinitely?