A cross-linguistic investigation of similarity-based interference

Daniela Mertzen, Anna Laurinavichyute, Brian Dillon & Shravan Vasishth

March 21, 2020
33rd Annual CUNY Human Sentence Processing Conference
Cue-based retrieval theories (McElree, 2000; Van Dyke & Lewis, 2003; Lewis & Vasishth, 2005)

• Language comprehension requires rapid formation of dependencies

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• Successful long-distance dependency resolution requires use of working memory system to temporarily store previously encoded items in memory

• Cue-based retrieval theories model sentence comprehension drawing on general principles of human memory system
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• dependency formation relies on **cue-based retrieval** of syntactic encodings in memory

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</tr>
<tr>
<td>+ subject</td>
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<td>{+subject,</td>
</tr>
<tr>
<td>+ animate</td>
<td>+ animate</td>
<td>+ animate,</td>
</tr>
<tr>
<td>+ “can lie”</td>
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• retrieval mechanism is prone to **similarity-based interference**
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![Diagram showing retrieval cues](image-url)
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The journalist who saw the thief yesterday lied

{+subject, +animate, +“can lie”}
Research questions

• What are the memory mechanisms that subserve sentence comprehension?

• Can semantic similarity-based interference effects during real-time sentence comprehension be observed cross-linguistically?
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Van Dyke & McElree (2006) Self-paced reading + recall task

Memory load conditions
table  sink  truck

No interference
It was **the boat** that the guy who lived by the sea **sailed** in two sunny days.

Interference
It was **the boat** that the guy who lived by the sea **fixed** in two sunny days.
Van Dyke & McElree (2006)

**Memory load conditions**

| table | sink | truck |

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- SAILABLE

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**Comprehension question:** Did the guy live by the sea?

Recall: __________  __________  __________
Van Dyke & McElree (2006) results

Memory load x Interference interaction (critical verb)

Load conditions: fixed > sailed

No load conditions: fixed ≈ sailed

→ Pattern consistent with cue-dependent retrieval interference
Van Dyke & McElree (2006) results

Memory load x Interference interaction (critical verb)

Load conditions:  
- fixed > sailed

No load conditions:  
- fixed ≈ sailed

Pattern consistent with cue-dependent retrieval interference

Van Dyke, Johns & Kukona (2014)

No evidence of Memory load x Interference interaction
Our study  Eye-tracking + recall task

- re-examined similarity-based interference

**English**
Our study  Eye-tracking + recall task

- re-examined similarity-based interference
- Investigated similarity-based interference cross-linguistically
Design

For each

2 x 2 fully-crossed factorial design

Factor 1: Memory load (load vs. no load)
Factor 2: Interference (no interference vs. interference)
Memory load conditions

No interference
The boat that the guy who lived by the sea sailed in the morning seemed to be very old.

Interference
The boat that the guy who lived by the sea fixed in the morning seemed to be very old.

No memory load conditions

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The boat that the guy who lived by the sea sailed in the morning seemed to be very old.

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- SAILABLE  + FIXABLE

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No memory load conditions
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Comprehension question: Did the guy live by the sea?
Recall: ________  ________  ________
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<td>The boat</td>
<td>that</td>
<td>the guy fixed</td>
</tr>
<tr>
<td>Parfum</td>
<td>Rauch</td>
<td>Leder</td>
</tr>
<tr>
<td>perfume</td>
<td>smoke</td>
<td>leather</td>
</tr>
<tr>
<td>Der Kaffee</td>
<td>den</td>
<td>der Mann</td>
</tr>
<tr>
<td>The NOM coffee</td>
<td>that.ACC</td>
<td>roch smelled</td>
</tr>
<tr>
<td>ТаХ болезнь</td>
<td>которую</td>
<td>врач</td>
</tr>
<tr>
<td>That.NOM illness</td>
<td>that.ACC</td>
<td>discovered</td>
</tr>
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<td>пропажа</td>
<td>ампула</td>
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- **CASE**: Case marking
- **FIXABLE**: Fixable elements
- **ACC**: Accusative case
- **SMELLABLE**: Smellable
- **DISCOVERABLE**: Discoverable
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<td>French</td>
<td>Parfum Rauch Leder</td>
<td>Der Kaffee den der Mann roch smelled</td>
</tr>
<tr>
<td>Russian</td>
<td>бардак пропажа ампула</td>
<td>Та болезнь которую врач обнаружил discovered</td>
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* CASE:
+ FIXABLE
- ACC
+ SMELLABLE
+ DISCOVERABLE
Depth of processing manipulation
(within-subjects)

Version 1: 40 items
• difficult questions
inducing deep processing

Did the guy live by the sea?
Depth of processing manipulation (within-subjects)

Version 1: 40 items
• difficult questions
  inducing deep processing

Version 2: 40 new items
• simple questions
  inducing shallow processing

Did the guy live by the sea?

Did the word sea appear in this sentence?
### Our study

**Eye-tracking + recall task**

<table>
<thead>
<tr>
<th>Language</th>
<th>Version</th>
<th>Subjects</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td>66</td>
<td>40</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td>122</td>
<td>40</td>
</tr>
<tr>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td>109</td>
<td>40</td>
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Pre-registered predictions

For each

**Memory load x Interference** interaction at the critical verb (fixed/sailed) in total reading time
Predictions: Language

Memory load x interference interaction

\[ \approx \]
Raw data (Total fixation times)

English: raw TFT condition means and 95% CIs (critical verb)
Raw data (Total fixation times)

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Russian: raw TFT condition means and 95% CIs (critical verb)
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English: raw TFT condition means and 95% CIs (critical verb)

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</tr>
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<tbody>
<tr>
<td>load</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>no load</td>
<td>▲</td>
<td>▲</td>
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German: raw TFT condition means and 95% CIs (critical verb)

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- no interference
- interference
Region of practical equivalence (ROPE)

Region of practical equivalence (ROPE)

Null region with possible outcomes

- Estimate in ms

Null region with possible outcomes: A, B, C, D, E, F.
Region of practical equivalence (ROPE)

Null region with possible outcomes
Region of practical equivalence (ROPE)

Null region with possible outcomes

No evidence of effect
Region of practical equivalence (ROPE)

Null region with possible outcomes

- Evidence of predicted effect
- No evidence of effect
Total fixation time results (preregistered analysis)

Load x Interference interaction, critical verb (posterior means and 95% credible intervals)

- complex
- simple
Total fixation time results (preregistered analysis)

Load x Interference interaction, critical verb (posterior means and 95% credible intervals)

- **German**

  Effect (TFT in ms)

  - Complex
    - Lower bound: -20
    - Upper bound: 20

  - Simple
    - Lower bound: 0
    - Upper bound: 20

- **complex**
- **simple**
Total fixation time results (preregistered analysis)
Total fixation time results (preregistered analysis)

Load x Interference interaction (critical verb)

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<th>Russian</th>
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<td>effect (TFT in ms)</td>
<td>!50!</td>
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- complex
- simple
First pass reading time results

Load x Interference interaction (critical verb)

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<tbody>
<tr>
<td>English</td>
<td><img src="image" alt="Graph for English complex" /></td>
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- complex
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Main finding

- No evidence of the predicted Memory load x Interference interaction in any tested language
Implications

- No support for hypothesis that sentence-external items in working memory interfere with retrieval during sentence processing

- Interference effects caused by sentence-external distractors may be very small and difficult to detect

or

- Interfering distractors play a role only when they appear within a sentence: currently being tested cross-linguistically
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Implications

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or

- Interfering distractors play a role only when they appear within a sentence, particularly when distractor intervenes between target dependency (Van Dyke & McElree, 2011)

  ➡️ currently being tested cross-linguistically
Thank you
Questions: mertzen@uni-potsdam.de

Stay safe!