Coreference Processing and Levels of Analysis in Object-Relative Constructions; Demonstration of Antecedent Reactivation with the Cross-Modal Priming Paradigm

Tracy Love & David Swinney, 1996
Quick Reminder
Coreference

- Phenomenon in sentence processing
- Subject **links** between two elements in the sentence:
  1. Antecedent
  2. Coreference element

Bart doesn’t like the girl, but the girl likes **him**

Antecedent

Coreference Element
Coreference (cont’d)

Also occurs in **fillers and gaps**, in which:

filler = antecedent

gap/trace = coreference element

This is **the girl** that I wanted to talk with \( t_i \) yesterday at the park
Cross-Modal Lexical Priming Naming Task

• Online measure used in research of lexical access

• **Purpose**: check if related primes facilitate activation of target
Introduction
According to formal linguistics approaches, the object-relative constructions are perceived as involving “movement” of the object from a point following the verb to a point prior to it.

There is the bank that the boy saw

filler

gap
Object-Relative Constructions (cont’d)

Formal linguistics approaches claim that upon encountering such constructions, we recover an underlying memorial representation of the canonical word-order of the sentence they were derived from.

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the boy saw ____  →  the boy saw the bank
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subject  verb  object
How can we examine whether such underlying representation exists?

Ambiguous words were used as antecedents.

It was hypothesized that:

- If our representation is deep (semantic) $\rightarrow$ only a single, context relevant meaning of the ambiguity will be reactivated at the gap.
- But, if representation is superficial (phonological) $\rightarrow$ all meanings of the ambiguity will be reactivated.
For Example

*It is the bank that the boy took the money from* 

Superficial Representation

Deep Representation
Time-course of Antecedent Reactivation

There was a debate in the literature concerning the time in which an antecedent is linked to its coreference element.

Either:
- immediately upon encountering it (e.g. the active filler hypothesis; Frazier, 1987)
- at the end of the sentence

Both end-of-sentence probe verification task and CMLP have been employed in order to address this question
CMLP’s Ability to Demonstrate Antecedent Reactivation

- CMLP is sensitive to the time course of online processing
- Studies using CMLP had been used to reveal antecedent reactivation (e.g. Hickok 1993)
- However, it has later been argued that the CMLP filler-gap study contains a confound (McKoon & Ratcliff, 1994). According to this confound, some related probes are facilitated since they are better continuation of the sentence than the control probes
For Example

There is the bank that the boy saw * yesterday night

The related probe money would be a better continuation than the unrelated probe chair.

Facilitation of probe didn’t occur due to antecedent reactivation.
CMLP’s Ability to Demonstrate Antecedent Reactivation (cont’d)

- This study argues that CMLP is **immune** to such confound, since the auditory sentence *continues uninterruptedly*; thus, subjects do not integrate the visual probe into it.

- In order to test facilitation, one needs to show that priming occurred:
  1. Only at the gap position
  2. Not prior to that point
Research Objectives

1. **Theoretical** - study the nature of the process in which antecedent fillers are linked to their structural gaps, while processing object-relative structures
   - When exactly does the linkage occur?
   - Does an underlying representation of the sentence exist?

2. **Methodological** - examine the ability of CMLP to demonstrate antecedent reactivation, when potential plausible-continuation confound is controlled.
Method
Participants

- Pretests: 70 participants
- Experiments: 139 participants
- Undergraduates from Univ. of California
- Native English speakers
- No evidence of brain injuries, learning disabilities or abnormal mental behavior
Pretests

Ambiguity Bias

• **Purpose**: determine primary & secondary meaning of each ambiguity
• 30 participants were shown ambiguous words. For each word, they provided their first associate. Then, provided an associate to another meaning of the word
• Tallies of 1\textsuperscript{st} and 2\textsuperscript{nd} choices for each meaning were made
• 40 ambiguous words that had clear preference for primary meaning were chosen
A-Priori Equated RT for Related & Control Probes

- **Purpose**: check whether there is a difference in RT to related vs. control words
- 30 participants were shown the related and control words and had to name them aloud
- Differences in mean RTs were not significant (related- 483 msec, unrelated- 484 msec)
Pretest (cont’d)

Plausible Continuation of Probes with the Sentence

- **Purpose**: control the possible plausible-continuation confound in CMLP.

- 10 Subjects saw a sentence up to the last word before the probe point. They had to rate on 1-5 scale the degree to which each probe word was a good continuation of the sentence.

- No significant difference between related vs. control probes was found.
Brief Demonstration
Instructions

You have 2 tasks:

1. Listen and understand the sentence that I am about to speak to you now. At certain times of the experiment, I will test you on its content.

2. Watch the screen, and when you see a word appear, name it out loud as rapidly as you can.
Who purchased Jimmy’s pen?

1. His father
2. His aunt
3. His mother-in-law
4. His friend
What did the professor insist?

1. That the exam will be written with a pencil
2. That the exam will be completed in ink
3. That students will use multiple colors
4. That students will buy a pen
Design and Procedure for Studies 1 & 2

- There were 90 filler and experimental sentences, each contained probes of four types:

  **Filler example: Pen**

1. Related probe to primary meaning (RP) - PENCIL
2. Unrelated probe to primary meaning (PC) - JACKET
3. Related probe to secondary meaning (SR) - JAIL
4. Unrelated probe to secondary meaning (SC) – TALE
Design and Procedure for Studies 1 & 2 (cont’d)

- Subjects were told they have **2** tasks:
  - Sentence comprehension
  - Naming of the visual word.

- Subjects set in front of a computer
- A recorded sentence started playing
- A visual word appeared on screen at **one of 3 probe points**
Design and Procedure for Studies 1 & 2 (cont’d)

Three Probe Points

- **Probe 1**: Immediately after the ambiguity
- **Probe 2**: 700 msec prior to the verb
- **Probe 3**: At the gap position
Design and Procedure for Studies 1 & 2 (cont’d)

- RT was measured for each probe type (RP, PC, SR, SC) in each of the probe positions (1+2+3)
- Voiced responses were recorded via microphone
Study 1

- 51 subjects
- Repeat the finding of multiple-meaning activation upon encountering a lexical ambiguity.
- Experimental and control probes for primary and secondary meaning were presented at probe point 1 (immediately following ambiguity)
Study 2

- 88 subjects
- Examine if the antecedent is reactivated at the gap position
- Experimental and control probes for primary and secondary meaning were presented at probe points 2 & 3 (700 msec after the verb & at the gap position)
Results
Study 1

*Filler Example: Pen*

<table>
<thead>
<tr>
<th>Response Time</th>
<th>Primary Meaning</th>
<th>Secondary meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Related probe</td>
<td>521 s</td>
<td>529 s</td>
</tr>
<tr>
<td>Control Probe</td>
<td>533</td>
<td>537</td>
</tr>
</tbody>
</table>
Study 1 (cont’d)

The professor insisted that the exam be completed in ink, so Jimmy used the new pen that his mother-in-law recently purchased because the multiple colors allowed for more creativity.

Results replicate prior studies, by revealing that at probe point 1, both primary and secondary meanings of the ambiguous word are activated immediately following their occurrence, even at a strong biasing context.
Study 2

**Filler Example: Pen**

<table>
<thead>
<tr>
<th>Probe Position</th>
<th>Primary Meaning</th>
<th>510</th>
<th>Secondary meaning</th>
<th>510</th>
</tr>
</thead>
<tbody>
<tr>
<td>Related probe</td>
<td></td>
<td>n.s.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Probe</td>
<td>513</td>
<td></td>
<td></td>
<td>515</td>
</tr>
</tbody>
</table>
Study 2 (cont’d)

The professor insisted that the exam be completed in ink, so Jimmy used the new pen that his mother-in-law recently purchased because the multiple colors allowed for more creativity.

At probe point 2, neither primary nor secondary meaning were (still) activated.

*
Study 2 (cont’d)

Filler Example: Pen

<table>
<thead>
<tr>
<th></th>
<th>Primary Meaning</th>
<th>Secondary meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Related probe</td>
<td>496</td>
<td>507</td>
</tr>
<tr>
<td>Control Probe</td>
<td>514</td>
<td>509</td>
</tr>
</tbody>
</table>

Probes Position 3
The professor insisted that the exam be completed in ink, so Jimmy used the new pen that his mother-in-law recently purchased because the multiple colors allowed for more creativity.

At probe point 3, primary meaning was activated, while secondary meaning was not. This represents a significant reactivation of the primary meaning.
Discussion
Filler-gap Linkage in Object-Relative Constructions

• Results of study 2 demonstrate that a gap causes an **immediate** reactivation of its antecedent filler
• This emphasizes the immediate and online use of structural knowledge in coreference processing of object-relative constructions.
CMLP’s Ability to Demonstrate Antecedent Reactivation

- Results show that when plausible-continuation confound is controlled for, evidence for antecedent reactivation is still obtained.
- Thus, CMLP provides a reliable and unbiased measure of the time-course of antecedent reactivation.
Underlying Representation of the Sentence

- While attempting to determine the antecedent for a gap, a deep representation of the sentence is recovered.
- Evidence derives from the activation of only the context relevant meaning of the ambiguous word.
- These data support a view that coreference is carried out across a deep memory representation of the sentence.
Thanks