Does the parser exclusively use structure-sensitive search in reflexives? Evidence from Mandarin Chinese

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Outline

1 Introduction

2 Experiment

3 Modeling

4 Conclusions
Outline

1. Introduction
2. Experiment
3. Modeling
4. Conclusions
Parse a sentence . . .

The human parser is sensitive to **structural constraints** in real time.
Parse a sentence . . .

**Structural-sensitive search**

In anaphoric dependencies, the antecedent *c-commands* the reflexive. (Chomsky, 1981; Reinhart, 1981)
Structure-sensitive search: recent evidence

Xiang, Dillon, and Phillips (2009)

1. The tough soldier [ that Katie treated in the military hospital ] introduced herself to all the nurses.

Gender: Katie = herself

2. The tough soldier [ that Fred treated in the military hospital ] introduced herself to all the nurses.

Gender: Fred ≠ herself

see also Sturt (2003)
Phillips, Wagers, and Lau (to appear)

“we tentatively suggest that argument reflexives are immune to interference from structurally inaccessible antecedents because antecedents are retrieved using only structural cues.”

“we are suggesting that the person, gender, and number features of reflexives like himself, herself, and themselves play no role in the search for antecedents.”
Cue-based retrieval

Lewis and Vasishth (2005); Lewis, Vasishth, and Van Dyke (2006)

S → NP VP
  → N V NP
  → John protected PN
  → himself
Cue-based retrieval

Lewis and Vasishth (2005); Lewis et al. (2006)
Cue-based retrieval

Lewis and Vasishth (2005); Lewis et al. (2006)

\[
S \\
\begin{array}{c}
NP \\
N \quad V \quad NP \\
John \quad \text{protected} \quad \text{PN} \\
\end{array}
\begin{array}{c}
\text{cat: } S \\
\text{num: } sing \\
\text{spec: } NP \\
\text{comp: } VP \\
\text{tense: } past \\
\end{array}
\begin{array}{c}
\text{cat: } VP \\
\text{num: } sing/pl \\
\text{tense: } past \\
\text{comp: } NP \\
\text{head: } protected \\
\end{array}
\begin{array}{c}
\text{cat: } NP \\
\text{num: } sing \\
\text{case: } nom \\
\text{gender: } M \\
\text{head: } John \\
\end{array}
\begin{array}{c}
\text{cat: } NP \\
\text{num: } sing \\
\text{case: } acc \\
\text{gender: } M \\
\text{head: } himself \\
\end{array}
\]
Similarity-based interference (SBI)

**high SBI**
1. The tough **soldier** that **Katie** treated in the military hospital introduced **herself** to all the nurses.

**low SBI**
2. The tough **soldier** that **Fred** treated in the military hospital introduced **herself** to all the nurses.

Xiang et al. (2009)
Research questions
Research questions

What searching strategy does the parser employ in building anaphoric dependencies?

Is the structure-sensitive search exclusive?

Can interference effect surface under a stronger statistical power?
Outline

1. Introduction
2. Experiment
3. Modeling
4. Conclusions
Test memory access using *ziji*

Our work was motivated by Dillon et al. (submitted).

Mandarin reflexive *ziji*:

local / long-distance binding.
completely retrospective.
Test memory access using *ziji*

**Our work was motivated by Dillon et al. (submitted).**

Mandarin reflexive *ziji*:

- local / long-distance binding.
- completely retrospective.

**Structural constraints**
- The antecedent c-commands *ziji*
- The antecedent locates in the subject position.

**Non-structural constraints**
- The antecedent is animate and sentient.

cf. Huang and Liu (2001); Huang, Cole, and Hermon (2006)
Test memory access using *ziji*: locality

(1) Local

(2) Non-local

c.f. Liu (2009); Li and Zhou (2010); Dillon et al. (submitted)
Test memory access using *ziji*: interference effect

(1) Local
   (a) Non-Interfering (b) Interfering

(2) Non-local
   (c) Non-Interfering (d) Interfering
A self-paced reading experiment:

- $2 \times 2$ factorial design: Locality $\times$ Interference
- 24 sets of conditions; 70 fillers
- 120 Mandarin-speaking undergraduate subjects in China.
- A yes-no comprehension question after the stimulus sentence.
a: *Non-local; Non-interfering*

反對派领袖 表示 [这个声明 [在 抗议 失控 的时候]]_{AdvP} opposition-leader say the-statement at protest lose-control time
告诫了 自己 的 党员]_{S}
warned ziji ’s party member

‘The opposition leader said that this statement warned his party members when the protest got out of control.’

b: *Non-local; Interfering*

反對派领袖 表示 [这个声明 [在 抗议者 失控 的时候]]_{AdvP} opposition-leader say the-statement at protest lose-control time
告诫了 自己 的 党员]_{S}
warned ziji ’s party member

‘The opposition leader said that this statement warned his party members when protesters got out of control.’
Experiment conditions

c: Local; Non-interfering

This statement said that the opposition leader warned his party members when the protest got out of control.

d: Local; Interfering

This statement said that the opposition leader warned his party members when protesters got out of control.
Mean reading times for each condition

6.08% data (RT > 2000 ms) were removed.

- LD-no-interfering
- LD-interfering
- Local-no-interfering
- Local-interfering

Reading times (ms): 350, 400, 450, 500, 550, 600, 650, 700

NP1 V1 NP2 at NP3 V2 time V3 ziji de NP4
Mean RTs at critical and spillover regions

Reading Time (ms) at 'ziji', 95% CI

Reading Time (ms) at 'ziji+1', 95% CI
### Statistical analyses

#### Results from the linear mixed model

<table>
<thead>
<tr>
<th>Region</th>
<th>Contrast</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ziji$</td>
<td>Locality</td>
<td>$-0.026$</td>
<td>$0.013$</td>
<td>$-1.92$</td>
</tr>
<tr>
<td></td>
<td>Interference</td>
<td>$0.027$</td>
<td>$0.013$</td>
<td>$2.03$</td>
</tr>
<tr>
<td></td>
<td>Loc.$\times$Interf.</td>
<td>$-0.026$</td>
<td>$0.013$</td>
<td>$-1.97$</td>
</tr>
<tr>
<td>$ziji + 1$</td>
<td>Locality</td>
<td>$-0.024$</td>
<td>$0.010$</td>
<td>$-2.26$</td>
</tr>
<tr>
<td></td>
<td>Interference</td>
<td>$0.023$</td>
<td>$0.010$</td>
<td>$2.25$</td>
</tr>
<tr>
<td></td>
<td>Loc.$\times$Interf.</td>
<td>$-0.001$</td>
<td>$0.010$</td>
<td>$-0.94$</td>
</tr>
</tbody>
</table>

**Note:** We used orthogonal contrast coding ($\pm \frac{1}{2}$ for each factor). RTs were log-transformed.
Sentence processing as memory retrieval

Sentence processing as memory retrieval


\[ A_i = B_i + \sum_j W_j S_{ji} \]

Activation value

\[ A_i = B_i + \sum_j W_j S_{ji} \]

- Activation value
- Similarity-based interference
- Baseline activation
Sentence processing as memory retrieval


\[ A_i = B_i + \sum_j W_j S_{ji} \]

Retrieval time: \[ T_i = Fe^{-A_i} \]
Dependencies

Long-distance Retrieval

这个声明
this announcement
NN_IN

表示
say
VV

反对派领袖
opposition leader
NN_AN

抗议(者)
protest(er)
NN_IN(AN)

在
at
PP

失控
lost control
VV

的时候
time
NN

告诫了
warned
VV

自己
ziji
PN

Local Retrieval

这个声明
this announcement
NN_IN

表示
say
VV

反对派领袖
opposition leader
NN_AN

抗议(者)
protest(er)
NN_IN(AN)

在
at
PP

失控
lost control
VV

的时候
time
NN

告诫了
warned
VV

自己
ziji
PN
Caculating the retrieval latencies... 

a: Non-local; Non-interfering

\[ A = -3.17 \]
\[ T = 334 \text{ ms} \]
Calculating the retrieval latencies...

b: *Non-local; Interfering*

\[
A = -3.58 \\
T = 502 \text{ ms}
\]
Modeling results

Reading Time (ms) at 'ziji', 95% CI

Predicted Reading Time (ms) at 'ziji'
Using Mandarin *ziji*, we showed that:

- Building the anaphoric dependency is subject to **locality**. (confirms the results of Dillon et al. (submitted)).

- The retrieval of antecedent can suffer **interference** from elements that share non-structural cues, such as *animacy* (cf. Phillips et al. (to appear)).

- The parser does not seem to **exclusively** use structural cues for antecedent resolution of reflexives.
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