Beyond embedding: The effects of priming from complex sentences

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Variability affects production

People are sensitive to the linguistic variation they encounter in their environment and are likely to reuse recently encountered forms.

Customer: “At what time does your store close?”
Clerk: “Nine o-clock.” OR “At nine o-clock.”

Levelt & Kelter (1982)
Variability affects production

People even replicate the frequency at which they encounter a linguistic variant:

- Goldrick & Larson (2008) probabilistic distributions of phonotactic constraints
- Kaschak et al. (2006) probabilistic distributions of the Dative Alternation
Variability affects production

Speakers use variants they have recently encountered.
But sometimes...

However, encountering a variant doesn’t always lead to use of the same or similar form.
Variability isn’t always replicated

Hudson & Newport (2005) – Adults and children were trained on a novel language that had probabilistic distributions of features (e.g., a determiner occurred 60% of the time).

- Children usually chose one form from the input and used it all the time.
- Adults did the same when tested with new words.
Variability isn’t always replicated

Speakers sometimes use variants they have recently encountered.
Potential reasons

- Cognitive features of the individual independent of the linguistic input
  - working memory or age
- Ways in which the individual interacts with the linguistic input
  - frequency of the variants
  - linguistic context in which the variant occurs
    - e.g. structural position

This research focuses on this last possibility, namely how syntactic context (i.e. embedding) affects speakers’ ability to replicate variation.
Research questions

How does the input’s linguistic context affect the likelihood of a form’s reuse?

How does the complexity of the syntactic context affect speakers’ ability to reproduce variation?

Hypothesis: The more complex the syntactic context in which a variant occurs, the harder it is to access the variant and to replicate its use.
Why syntactic context might matter

We know that syntactic context matters for binding and extraction.

**Binding of anaphors:**

* David$_1$ recognized the man$_2$ that hit himself$_1$.

**Island violations:**

Marta knows the man who Diane saw on Wednesday.

* When does Marta know the man who Diane saw ____ ?

Intended answer: “On Wednesday”
Why syntactic context might matter

- Typological:
  Languages may have rules that apply only to matrix or embedded positions (e.g. verb-second).

- Historical:
  Matrix and embedded positions show different patterns of innovation (Pintzuk 1999).
Why syntactic context might matter

Acquisition:
Some (e.g. Lightfoot 1991, Pearl & Weinberg 2007) argue that forms in embedded positions are not informative to young learners.

“Pat believes that Celina eats beans.”
If syntactic context matters . . .

Speakers’ should show different patterns of repetition depending on where a variant occurred within the syntactic structure.

- They may be more or less likely to reproduce a variant if it originally occurred in a matrix or embedded position.
Testing sensitivity to variation

Structural priming research has found that speakers tend to reuse linguistic forms they have recently encountered (e.g. Bock 1986; Branigan, Pickering & Cleland 2000; Corley & Scheepers 2002; Pickering & Branigan 1998).
Structural priming and embedding

Scheepers (2003) –

- Exposed speakers to primes with high-attaching or low-attaching relative clauses

  High-Attaching: The assistant announced the score [mas,sing] of the candidate [fem,sing] that [mas,sing]

  Low-Attaching: The assistant announced the score [mas,sing] of the candidate [fem,sing] that [fem,sing]
Structural priming and embedding

Scheepers (2003) –

- Found that speakers’ productions had the same pattern of embedding as the primes
- Concluded that speakers must be attending to embedding and how clauses are combined
Structural priming and embedding

Branigan et al. (2006) –

• Tested whether changes to the “global syntax” affected the priming behavior of forms of the Dative Alternation

  • Matrix: The racing car driver showed the torn overalls…
  • Adverbial clause: As the Anne claimed, the racing car driver showed the torn overalls…
  • Complement clause: The report claimed that the racing car driver showed the torn overalls…
Structural priming and embedding

Branigan et al. (2006) –

- Priming was as likely regardless of the position of the prime
- Concluded that speakers do not (need to) attend to embedding and argue that the priming Scheepers found was due to semantic overlap
Primining in the current experiment

The DATIVE ALTERNATION refers to the ordering of objects after dative verbs such as give, hand, and show.

Dative Object (DO)
- Seth gave Allison the cookies.

Prepositional Dative (PD)
- Seth gave the cookies to Allison.
Using the Dative Alternation

I place forms of this alternation in matrix and embedded positions and see whether this affects priming behavior.
Using the Dative Alternation

First, replicating with complement clauses:

**Matrix**: As the report stated, Seth gave **Allison the cookies**.

**Embedded**: The report stated **that Seth gave Allison the cookies**.
Using the Dative Alternation

Then, extending with relative clauses

**Matrix:** The man **who** knows Leslie gave **Allison** the cookies.

**Embedded:** Leslie knows the man **who** gave **Allison** the cookies.
### Hypotheses

<table>
<thead>
<tr>
<th>Syntactic Context’s contribution</th>
<th>Will both positions prime?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Context Doesn’t Matter:</strong></td>
<td>Yes – and equally as well</td>
</tr>
<tr>
<td>language users cannot make</td>
<td></td>
</tr>
<tr>
<td>reference to the context, just</td>
<td></td>
</tr>
<tr>
<td>the alternation.</td>
<td></td>
</tr>
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</table>

This theory would be in keeping with Branigan et al. (2006)
### Hypotheses

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<tr>
<th>Syntactic Context’s contribution</th>
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<tr>
<td><strong>Context Matters I:</strong> variation that occurs in some contexts cannot affect priming.</td>
<td><strong>No</strong> – only one, matrix</td>
</tr>
</tbody>
</table>

This theory would be in keeping with a strong version of Lightfoot (1991)/Pearl & Weinberg (2007).
### Hypotheses

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<tr>
<td><strong>Context Matters II:</strong> language users are sensitive to context and can use information that occurs in some contexts better.</td>
<td><strong>Yes</strong> – but one position may be stronger</td>
</tr>
</tbody>
</table>

This theory would be in keeping with a weakened version of Lightfoot (1991)/Pearl & Weinberg (2007).
<table>
<thead>
<tr>
<th>Tested theory</th>
<th>Predictions</th>
</tr>
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<tbody>
<tr>
<td>Context Doesn’t Matter</td>
<td>Main effect of prime</td>
</tr>
<tr>
<td></td>
<td>No effect of position</td>
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<tr>
<td></td>
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<td></td>
<td>Significant interactions</td>
</tr>
<tr>
<td>Context Matters II</td>
<td>Main effect of prime (Possible)</td>
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<td></td>
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Design of Experiment 1: Priming from complex sentences

- Extending Branigan et al.’s results, which found priming from complement clauses, using new methodology and a lag of one filler between prime and target.
- Repeating same design as above using relative clauses.
Design of Experiment 1

- 18 dative verbs, 9 in matrix, 9 in embedded
- Each block has 4 filler tasks with 1 between prime and target.
- Alternations (DO or PD) are restricted to either matrix or embedded position leading to four conditions:

<table>
<thead>
<tr>
<th>Complement Clause</th>
<th>Relative Clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO-matrix/PD-embedded</td>
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</tr>
<tr>
<td>PD-matrix/DO-embedded</td>
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</tr>
</tbody>
</table>
Design of Experiment 1

- Two slide types: READ and COMPLETE.
- READ slides contained a full sentence (filler or prime).
- COMPLETE slides contained a sentence fragment followed by 3 words, one verb in all caps and two nouns or a noun-adjective pair.

Example:

rubies                                      cautious
duchess                                      skier
PROMISE                                      BE

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Primes and targets

- The chosen dative verbs were not overly biased toward either construction (Gries 2005):
  - Matrix – buy, feed, issue, lend, make, pass, take, teach, throw
  - Embedded – award, bake, hand, offer, owe, promise, sell, serve, show

- Both the verbs and the contexts of the primes were repeated in the targets.
**Instructions**

- For the READ slides, participants were told to read carefully but at a natural pace.
- For the COMPLETE slides, they were told that they had to use all three words but could change the tense of the verb and add words (e.g., articles and prepositions) as necessary, but they shouldn’t do more than was necessary.
Participants completed either the Complement or Relative clause condition.

A total of 123 native speakers of American English from Northwestern University participated for partial course credit or pay (30 participants per condition).

Three were excluded due to a high number of OTHER responses, indicating difficulty with the task.
Analysis

Responses were scored as either DO, PD, or OTHER.

OTHER:
The pitcher who loved the fans threw the ball at the coach.

PD:
The pitcher who loved the fans threw the ball to the coach.

DO:
The pitcher who loved the fans threw the coach the ball.
Analysis (continued)

For analysis, the rau scores (Studebaker 1985) for the number of PD completions were calculated by taking the number of PD divided by the sum of PD and DO completions.

$$\frac{PD}{(PD+DO)}$$
“Other” responses occurred at a normal rate (12%, stdev = 0.15), given results from previous experiments (e.g., Bock & Griffin, 2000).

Participants who were over 2 stdevs from the mean were removed leading to the exclusion of the aforementioned 3 participants.
Results: Complement clauses

- Main effect of prime for participants
  \[ F(1, 57) = 22.20, p < .00 \]
- Main effect of prime for items
  \[ F(1, 16) = 25.84, p < .00 \]

Participants were more likely to produce a PD following a PD prime (52%) than following a DO prime (38%).
**Results: Complement clauses**

- No effect of position
  \[ F(1, 58) = 2.87, p > .05 \]
- No interaction prime *
  position
  \[ F(1, 58) = 0.32, p > .05 \]

Priming from a PD prime or DO prime was independent of where the prime occurred (matrix or embedded).
Results: Relative clauses

- Main effect of prime for participants
  F(1, 58) = 5.88, p < .05
- But not for items
  F(1, 16) = 3.07, p > .05

Participants were more likely to produce a PD following a PD prime (57%) than following a DO prime (50%).
Results: Relative clauses

- No effect of position
  \[ F(1, 58) = 0.53, p > .05 \]
- No interaction prime *
  position
  \[ F(1, 58) = 0.006, p > .05 \]

Priming from a PD prime or DO prime was independent of where the prime occurred (matrix or embedded).
Discussion

- These data replicate the findings of Branigan et al. (2006)
  - Extends their findings with complement clauses to lag of one intervening item
  - Extends their findings to relative clauses
- There is no support for “Context Matters I”.
- Because there was only a main effect of prime, there may be support for the “Context Doesn’t Matter”.
These data suggest that priming is equally as strong under certain conditions (e.g., when there is a only one filler between prime and target and when the verb is repeated).

But what if we change these conditions?
Experiment 2: Priming from complex sentences over time

Manipulating the lag – Priming occurs from both positions, but is the priming as strong over time from each?

Change: Lengthen the number of filler tasks between prime and target (Bock & Griffin, 2000).
Experiment 2:

If the prime is strong, then we should see continued priming over longer lags, i.e., when more filler items separate the prime and target.

If we see different patterns of priming from the two positions at longer intervals, then context may be exerting an influence on accessibility to the prime.
Experiment 2: Design

- Used the DO-matrix/PD-embedded version of the relative clause version of Experiment 1.

- Placed 3 fillers between prime and target.

- Participants: 30 speakers of North American English from the Northwestern University community.
## Experiment 2: Design

<table>
<thead>
<tr>
<th>Example block 1-lag</th>
<th>Example block 3-lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>FILLER</td>
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</tr>
<tr>
<td>PRIME</td>
<td>PRIME</td>
</tr>
<tr>
<td>FILLER</td>
<td>FILLER</td>
</tr>
<tr>
<td>TARGET</td>
<td>FILLER</td>
</tr>
<tr>
<td>FILLER</td>
<td>FILLER</td>
</tr>
<tr>
<td>FILLER</td>
<td>TARGET</td>
</tr>
</tbody>
</table>
Results: Priming over time

- Main effect of prime for participants
  $F(1, 58) = 29.04, p < .00$

- And for items
  $F(1, 32) = 5.48, p < .05$

Participants were more likely to produce a PD following a PD prime (55%) than following a DO prime (41%).
Results: Priming over time

- Marginal effect of lag
  \[ F(1, 58) = 3.66, p = .07 \]

- Marginal interaction prime * lag
  \[ F(1, 58) = 3.47, p = .08 \]

There was a tendency for more DO completions in the longer lag, primarily due to responses in matrix position (i.e. those with DO primes).
The data suggest that speakers are more likely to produce a DO completion following a DO-Matrix prime at longer lags (3 items) than shorter ones (1 item).

- Could be something about DO primes at longer lags.
- Could be something about matrix primes at longer lags.
Previous research has found that priming tends to decline immediately (i.e. if there is even one intervening item) and then to plateau or dip then rise slightly (Bock & Griffin 2003, Hartsuiker et al. 2008).

• These trends hold for both DO and PD primes in simple sentence.
• The “something about DO primes” account is unlikely but possible.
The “something about matrix” account could be possible, but more research is necessary to determine

- whether these trends hold for PD primes
- whether these trends hold for other forms of embedding (i.e. complement clauses)

If these trends do hold, then we may have support for “Context Matters II”.

Summary

- Priming from various positions and various clause types is possible, suggesting priming is pervasive.

- It is still unclear whether context matters as the complexity of the task increases (e.g. the number of tasks between the prime and target increases).
  - Either the Context Doesn’t Matter or the Context Matters II accounts could be correct.
Future Studies

Experiment 3: Extending to other contexts

- Is priming as strong when the prime’s and the target’s contexts don’t match?
- **Change:** The prime will occur in one position and the target will be in the other.

Experiment 4: Extending to novel verbs

- Is priming as strong from each position when the prime’s and target’s verbs differ?
- **Change:** The target and prime will have different dative verbs.