Meaning, Argument Structure, and Parsing: Evidence from Syntactic Priming

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Studying Parsing

- How do people construct meaning from sentences?
- How does parsing work?
- How is syntactic knowledge represented and accessed during sentence interpretation?
Parsing supports semantic interpretation.

“...a sentence is more than a collection of words: the word meanings are structured into the meaning of the sentence by means of semantic relations among them. These semantic relations are to some degree signaled by the syntactic structure of the sentence...”

--Jackendoff, 2002, p. 58
“Words and Rules”:
- Look up individual words.
- Determine their syntactic category (noun, verb, preposition, etc.)
- Apply generic processing heuristics to build structure.

(e.g., Frazier, 1979).
Lexicalist Syntax: Syntactic structures are tied to individual words (MacDonald et al., 1994; Vosse & Kempen, 2000).

“...verbs do at least sometimes specify some of the syntax...of their syntactic arguments.”
Jackendoff, 2002, p. 141
For example:

(3) The defendant examined...

Can continue:

- (4) The defendant examined the weapon...
  - or

- (5) The defendant examined by the lawyer...
Argument Structure

“examined” requires 2 semantic arguments: agent & theme

“bet” requires 4

“rained” requires 0

(Jackendoff, 2002; Levin, 1993)
(4) “The defendant examined the weapon...”

“defendant” is agent of examined

(5) “The defendant examined by the lawyer...”

“defendant” is patient/theme of examined
1. The defendant examined the weapon

2. The defendant examined by the lawyer was lying.
The defendant examined

The defendant examined
#2 violates the Linking Hierarchy for NP arguments --

Agent > Theme

#2 is syntactically complex

So comprehenders prefer option #1.
Can we prime the more complex structure?

The defendant examined
If so, when?

- **Words and Rules**: Anytime the prime and target share structure.

- **Lexicalist syntax**: Overlapping lexical items should increase priming. Overlapping lexical items may be necessary.
Comprehension Data:

- Repetition facilitates processing, **IF** structures are repeated many times.
- Repetition speeds processing of conjuncts.
- Subliminal verbs affect ambiguity resolution.
- Off-line interpretation preference is biased by primes.

(Carey, Mehler, & Bever, 1970; cf. Dooling, 1974; Cuetos et al., 1996; Frazier et al., 2000, 1984; Mehler & Carey, 1967; Trueswell & Kim, 1998;
Production Data:

- Passives prime passives.
- Double-objects/ datives prime.
  (e.g., Bock, 1986; Branigan et al., 2000; Bock & Loebell, 1990; Savage et al., 2003)

  e.g., “give”
GIVE WAR A CHANCE
dog

bone

give
GIVE A CHANCE TO WAR.
Nicole Kidman

give

ciess

give

kiss
Lexical repetition increases priming in production.

- Verb repetition.
  (in fragment completion; Pickering & Branigan, 1998)

- Nouns and maybe adjectives.
Experiments 1 and 2

– Does repeated structure facilitate processing (priming)?

– Does lexical repetition matter?
Experiment 1

- Reduced relatives:

The defendant examined by the lawyer was unreliable.

(Frazier & Rayner, 1982; Rayner, Carlson & Frazier, 1983; Trueswell et al., 1993; Clifton et al., 2003)
Prime and Target Types:
- Reduced Relative (RR)
- Main Clause (MC)

Design: 2 (prime) x 2 (target)
- RR then RR
- MC then RR
- RR then MC
- MC then MC
Fancy counterbalancing across lists so:

- Every target sentence serves as a prime.
- Every prime sentence serves as a target.

“Baseline” = time to process region when sentence appears as prime.
Verbs repeated across prime and target.

The defendant examined by the lawyer...

The engineer examined by the board...
Scoring region:

PP/NP

The engineer examined by the board… (PP)

The engineer examined the license… (MC)*
Total Time: PP/NP Region

Experiment 1
Results:

Repeated structure speeds RR target processing.

Little or no effect of prime on MC targets.
Experiment 2

Is repeating the verb necessary?

- **Stimuli:** MC and RR sentences from E1.
- **Design:** Same. 2 (prime) x 2 (target).
BUT! Prime and target verbs are always different.

The defendant examined by the lawyer…

The accountant paid by the company…

Procedure: otherwise identical to E1.
Total Time: PP/NP Region

Experiment 2
Experiment 1 vs. Experiment 2
Results Summary:

- There is no priming in Experiment 2.
- Across experiments: Repetition x Prime x Target Interaction
- Lexical repetition matters.
Other experiments show priming for
- Full relative primes
- Short relative primes
- Passive primes
- Also in visual world paradigm (Arai et al., 2007, *Cognitive Psychology*)

ONLY if verb is repeated.
Could the priming effects be semantic?

Experiment 3: ERP Experiment
(Ledoux et al., 2007)

- Targets: Reduced relatives
- Primes: Main clause, Reduced Relatives
- Overlap? Verb overlap.
- N400 usually indexes semantic processing load
- P600 usually indexes syntactic processing load.

(Kutas et al., 2006; but cf. Kuperberg; Osterhout & Kim)
Results: @ Noun within the PP

Ledoux et al., 2007, *Psych. Science*
Summary:

- Smaller P600 when reduced relative target follows reduced relative prime.
- Suggests syntactic source.
Experiment 4: A stronger test of the syntactic & semantic hypotheses.

Prime and target verbs are either:
- identical
- synonyms
Primes:

- “The actor watched by the director...” (repeated)
- “The actor observed by the director...” (synonym)

Targets:

- “The children watched by the sitter...”
a. Priming effects: Repeated condition

b. Priming effects: Synonym Condition

c. Priming effects: Repeated and Synonym targets

*Topo maps represent subtractions of the ERP waves shown.*
Summary:

- Repeated verbs reduced the P600.
- Synonymous verbs did not reduce the P600.
- Effect is syntactic rather than semantic.
Are the effects strategic?

Repeated verb allows readers to predict upcoming structure.

Accurate prediction ➔ faster processing.
Experiment 5: Noun Overlap
(Traxler & Tooley, accepted pending revisions, *LCP*)

- The lawyer sent by the governor arrived late. (RR Prime)
- The lawyer sent the files to the governor but they arrived late. (MC Prime)
- The lawyer examined by the board passed easily. (RR Target)
Overlap only in prime-target pairs.

Overlapping nouns were 100% valid cue.
Noun Overlap Experiment, First Pass

<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>Noun</th>
<th>Verb</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
</tbody>
</table>

First Pass Time (ms)

Legend:
- Blue: Prime
- Red: RR Target
- Yellow: MC Target
Noun Overlap Experiment, Total Time

<table>
<thead>
<tr>
<th></th>
<th>Prime</th>
<th>RR Target</th>
<th>MC Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noun</td>
<td></td>
<td></td>
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</table>

Total Time (ms)
Summary:

- Priming at repeated noun with spillover at non-repeated verb.
- No effect on PP region.
- So: Strategic cue did not prime syntax.
Meta-analysis

12 eye-tracking experiments with “repeated verb” condition

- The defendant examined by the lawyer... (prime)
- The engineer examined by the board... (target)

- 523 participants
- The first 2 items from 12 experiments
Items 1 and 2: Total Time PP Region

Total Time (ms)

Prime: 800 ± 100
Target: 700 ± 50
The first item from 12 experiments.

N = 512
Experiments with No Strategic Cues

![Bar chart showing total time, PP Region (ms) with error bars for different conditions.](chart.png)

- **Experiments:**
  - **No Verb Repeated (Experiment 2):**
    - Prime: 720 ms
    - Target: 740 ms
  - **No Verb Repeated (Experiment 3):**
    - Prime: 780 ms
    - Target: 820 ms
  - **Yes Verb Repeated (Experiment 1):**
    - Prime: 700 ms
    - Target: 740 ms
  - **Yes Verb Repeated (Experiment 7):**
    - Prime: 780 ms
    - Target: 820 ms
  - **Yes Verb Repeated (Experiment 10):**
    - Prime: 800 ms
    - Target: 840 ms
Experiments With Strategic Cues

Prime vs. Target

Verb Repeated?

Yes No

3 4 5 6 8 9 11

Experiment

Total Time, PP Region (ms)
Experiments with Repeated Verbs

![Graph showing the impact of strategic cue on total time spent in PP region (ms) for prime and target conditions. The x-axis represents the strategic cue conditions (No, Yes), and the y-axis represents the total time (ms). The graph includes error bars for each condition.](image-url)
Experiments Without Repeated Verbs

![Bar chart showing total time in milliseconds for different conditions and experiments.](chart.png)

- **Strategic Cue?**
  - Yes: 800
  - Synonyms: 700
  - No: 800
  - No: 800
  - No: 800

- **Experiments**
  - 11: Yes
  - 6a: Synonyms
  - 6b: No
  - 2: No
  - 3: No
Results Summary:

1. Priming occurs without strategic cues.
2. Priming fails to occur with strategic cues.
3. Verb overlap appears to be critical for the reduced relative.

Why?
Representations?

Bock & Levelt’s Production Model

- Message
- Functional Processing
  - Lemma
  - Selection
  - Function
  - Assignment
- Positional Processing
  - Constituent Assembly
  - Inflection
- Phonological Encoding
  - Sound errors
  - Stranding errors
  - Word exchanges
- To output systems
Functional Pr
Lemma
Selection

"examine"

examine(1)  
\[v[\text{agent, patient}] \Rightarrow \text{N-V-N}\]

examine(2)  
\[v[\text{patient, agent}] \Rightarrow \text{N-RC [v [PP [Prep. N]]]}\]
Vosse & Kempen (2000, *Cognition*):

Fig. 1. Lexical frames associated with the words of sentence (1).
See also Jackendoff (2002, 2007 *Brain Research*)
Processing?

- Fully lexicalized syntax (MacDonald et al., 1994).


*Argument Structure Hypothesis (ASH)*
Conclusions

1. Priming is not semantic.

2. Priming is not strategic.

3. Priming reflects the use of lexically projected syntactic structures in comprehension.
Acknowledgements

- Kristen Tooley
- Tamara Swaab
- Kerry Ledoux
- Martin Pickering

- NIH (#1R01HD048914-01A2)
- NSF (#0446618)