Processing Consequences of Coercion: The Influence of World Knowledge and Linguistic Context

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SFB 441 - Linguistic Data Structures
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Outline

1. Introduction
2. The Influence of Linguistic Context: Experiment 1
3. The Influence of World Knowledge: Experiment 2
4. Summary and Conclusions
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1. Introduction
   - Aktionsart and Aspectual Coercion
   - Hypotheses

2. The Influence of Linguistic Context: Experiment 1

3. The influence of world knowledge: Experiment 2

4. Summary and Conclusions
An Example of Aspectual Coercion (Moens & Steedman, 1988)

1) It took John more than three days to play the Minute Waltz in less than sixty seconds for more than an hour.

- John play- the MW in less than 60s (→ telic situation)
- John play- the MW in 60s for more than 1h (→ atelic sit.)
- It took John more than three days to ... (→ telic sit.)

We feel intuitive difficulty in processing the sentence.
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Classification of Different Situation Types

The four classical Aktionsarten (Vendler, 1967):

- States (to be sad, to resemble one’s mother)
- Activities (to run, to push a cart)
- Achievements (to reach the top, to win the race)
- Accomplishments (to build a house, to play the MW)
Linguistic Evidence for the Classification

Classical test: co-occurrence with *in-* and *for-*adverbials

2a) John ran *for* two hours.
2b) *John ran *in* two hours.

3a) *John reached the top *for* two hours.
3b) John reached the top *in* two hours.
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2a) John ran *for* two hours.
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3a) *John reached the top *for* two hours.
3b) John reached the top *in* two hours.
For-Adverbials (Hamm & van Lambalgen, 2005)

Temporal semantic framework formulated in constrained logic programming:

- Make the query $\exists ?For(process, x)$ true
- Program clause representing a *for*-adverbial:
  \[
  \text{Happens}(stop_p, t) \land \text{HoldsAt}(time_p(x), t) \rightarrow \text{For}(p, x)
  \]

- Update the model with a contextually given stop event
- Time elapsed between $start_p$ and $stop_p = x$
4) John was running for two hours.

- Make $\text{HoldsAt}(p_{\text{run}}, t), t < \text{now}, \text{For}(p, 2h)$ succeed
- Unification of process variable with run yields a model
For-Adverbials with Accomplishments

5) John built a house...

- Make $\textit{Happens}(e_{\textit{build}}, t), t < \textit{now}$ succeed
For-Adverbials with Accomplishments: Coercion

5) John built a house for two years.

- $\ ?\ Happens(e_{build}, t), t < now, For(p, 2\ years)$
- Stop event happens before finish
- Inference of the completed house is no longer valid
Two Types of Coercion

Subtractive Coercion:

- Parts of the eventuality get stripped off

Additive Coercion:

6) The mountaineer reached the top in three hours.

- The achievement denotes a punctual change of state
- *In three hours* requires a durative preparatory process
- Missing aspectual information has to be added
In-Adverbials (Hamm & van Lambalgen, 2005)

Representation of an *in*-adverbial:

- \( \text{Happens}(\text{finish}_p, t) \land \text{HoldsAt}(\text{time}_p(x), t) \rightarrow \ln(e, x) \)

- The query \( \ln(e, x) \) succeeds if
  - There is a culminating event that finishes the preparation
  - The preparatory process lasted for \( x \) time
6) The mountaineer reached the top \textit{in} three hours.

\textit{The right kind of preparatory process has to be inferred}
6a) After the helicopter had finally started, the mountaineer reached the top in three hours.

6b) After he was able to start climbing, the mountaineer reached the top in three hours.

▶ Linguistic (and extralinguistic) context is required to determine the right kind of process.
Two possible ways the processor may resolve coercion:

Encapsulated Aspectual Processing
Initially, aspectual processing is restricted to sentential information. World knowledge and discourse context are only considered after a type-mismatch has been encountered.

Open-Minded Aspectual Processing
World knowledge and discourse context are considered simultaneously with sentential information.
Processing of Context Information

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**Open-Minded Aspectual Processing**
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Is Information from Preceding Discourse directly integrated?

No: Local Aspectual Accessibility Hypothesis

Aspectual processing is (at least initially) limited to the sentential domain. Discourse information comes in later.

Yes: Global Aspectual Accessibility Hypothesis:

In aspectual processing, missing eventualities are immediately incorporated from preceding discourse.

▷ Reading time study (Experiment 1)
Is World-Knowledge Integrated Right Away?

**No: Reject-And-Recompute Hypothesis**

Trying to compose a coercing stimulus with the existing representation leads to the rejection of the initial semantic analysis and causes a recomputation of the situation model.

**Yes: Smooth-Update Hypothesis**

The already computed representation is modified without rejecting it first.

▶ ERP study (Experiment 2)
Introduction

Aktionsart and Aspectual Coercion

Hypotheses

The Influence of Linguistic Context: Experiment 1

The influence of world knowledge: Experiment 2

Summary and Conclusions
Experiment 1 - Design

**atelic context:**
For half a year now, John has been *swimming* every morning. When he started, he was almost drowning but he’s becoming better by the day.

**telic context:**
For half a year now, John has been *swimming two kilometers* every morning. When he started, it took him almost one hour but he is becoming faster by the day.

**target with *in*-adverbial:**
Heute schwamm er *in nur dreißig Minuten.*
(Today he swam in only thirty minutes).

**target with *for*-adverbial:**
Heute schwamm er *ganze dreißig Minuten.*
(Today he swam for thirty minutes).
Experiment 1 - Method

- Self-paced reading, moving window presentation
- Three-sentence discourses were read phrase by phrase
- Target sentences used unambiguous activity verbs
- Without supporting context, target sentences with *in*-adverbials are ungrammatical
- *Makes sense?* judgment after each trial
- 24 experimental items in four conditions + 48 distractors
- Latin square design
- 32 participants
An Illustration of the Method
An Illustration of the Method

John — — — ———. — — — — — — — ———.
An Illustration of the Method

—- swims ——-. —— – —- — —— ——-. 
An Illustration of the Method

--- every morning. --- --- --- --- --- --- ---.
An Illustration of the Method

—- —- ——-. Today – —- — —— ——-. 
An Illustration of the Method

--- --- --- ---. --- he swam --- --- ---.
An Illustration of the Method

— — — — ——-. —— — — for thirty minutes.
An Illustration of the Method

Makes sense?
Experiment 1 - Judgments

- *In*-adverbials need a telic context
- *For*-adverbials were accepted with atelic and telic contexts
- But: *For*-adverbials following a telic context involve subtractive coercion.

![Graph showing the percentage of "yes" responses for different conditions.](image)
Introduction

Linguistic Context: Exp. 1
World Knowledge: Exp. 2
Conclusion

Experiment 1 - Reading Times

- *In*-adverbials in a telic context = atelic *for*-adverbials
- Culmination is immediately available from discourse
- Telic *for*-adverbials more difficult than atelic *for*-adverbials
- Difficulty due to subtractive coercion
Experiment 1 - Reading Times

![Graph showing reading times for different contexts: telic / in, telic / for, atelic / in, atelic / for. The x-axis represents three conditions: Heute morgen (today morning), joggte er (ran him), and adverbial. The y-axis represents reading times per character in milliseconds (ms). The graph illustrates the processing consequences of coercion in understanding different linguistic contexts.]

Oliver Bott, Processing Consequences of Coercion
Experiment 1 - Discussion

- Following a telic context an activity verb is interpreted as accomplishment
- Discourse information can override lexical aspectual preferences
  - This does not lead to processing difficulty
  - Discourse information is used right away
  - The study provides evidence for global aspectual accessibility:

Global Accessibility Hypothesis:
In aspectual processing, missing eventualities are immediately incorporated from preceding discourse.
Following a telic context an activity verb is interpreted as accomplishment

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Reject-and-Recompute vs. Smooth-Update

**mism.** The mountaineer reached the top for three hours ...

**coerc.** The mountaineer reached the top in three hours ...

<table>
<thead>
<tr>
<th>Reject-and-Recompute</th>
<th>Smooth-Update</th>
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<tbody>
<tr>
<td>ERPs indicate two processes</td>
<td>ERPs indicate only one process</td>
</tr>
<tr>
<td>- reject initial interpr.</td>
<td>- update the model with a preparatory process</td>
</tr>
<tr>
<td>- recompute the situation model</td>
<td></td>
</tr>
<tr>
<td>Early on, aspectual mismatch and coercion elicit the same effects</td>
<td>Mismatch and coercion elicit qualitatively different ERP effects</td>
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<td>Adverbial: mismatch vs. coercion vs. control</td>
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### Experiment 2 - Design

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- **Mismatch**: Ganze 5 Min. hatte der Förster die Falle entdeckt, obwohl ...
  - For 5 min. had the ranger the trap discovered although ...

- **Coercion**: In 5 Min. hatte der Förster die Falle entdeckt, obwohl ...
  - In 5 min. had the ranger the trap discovered although ...

- **Control**: Vor 5 Min. hatte der Förster die Falle entdeckt, obwohl ...
  - 5 min. ago had the ranger the trap discovered although ...

- **Adverbial**: mismatch vs. coercion vs. control

- **Critical segment**: participle (*entdeckt*)

- Apart from the first word physically identical stimuli

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- **Adverbial**: mismatch vs. coercion vs. control
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**Adverbial:** mismatch vs. coercion vs. control

- Critical segment: participle (*entdeckt*)
- Apart from the first word physically identical stimuli
- Processing differences must be due to semantic context
Experiment 2 - Method

- Sentences presented word by word (800 ms per word)
- *Did the sentence make sense?* judgment after each trial (time limit 4s)
- 120 experimental items in three conditions + 180 distractor sentences
- Latin square design
- 24 participants

- EEG continuously recorded using a standard montage with 29 scalp electrodes
- Referenced to linked mastoids
- Only artefact free trials
Experiment 2: EEG recordings
Experiment 2 - Judgments

- Mism. < coerc. < contr.
- Coercion accepted in more than 75%.
- No differences in answer time.
- Subjects computed coerced meanings during reading.

![Bar chart showing percent "yes, makes sense" judgments for mismatch, coercion, and control conditions.]

percent "yes, makes sense" judgements

- mismatch
- coercion
- control
Experiment 2 - ERPs 500-900ms Post Stimulus

- Mismatch elicits a P600
- Coercion leads to a sustained anterior negativity
- But no P600
- Increased working memory demands in coercion
- But no rejection
Experiment 2 - mismatch effect

Mismatch elicits a P600
Experiment 2: Coercion Effect

Coercion leads to a working memory LAN
Semantics interpretation breakdown in aspectual mismatch indexed by P600

- Coercion elicits only a working memory LAN
- Update of the situation model with an inferred preparatory process via abductive reasoning
- The study provides evidence for a smooth update:

Smooth-Update Hypothesis

The already computed representation is modified without rejecting it first.
Experiment 2 - Discussion

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We Found ...

- Smooth integration of world knowledge
- Context influences are overriding lexical preferences

The results provide evidence for open-minded processing

Open-Minded Processing

World knowledge and discourse context are considered simultaneously with sentential information.
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Open-Minded Processing

World knowledge and discourse context are considered simultaneously with sentential information.
What Does This Have to Do with this Workshop?

- Language often expresses only parts of the meaning
- But we understand more than what is said
- Linguistic representation is enriched with extralinguistic information which is automatically brought in
- This is done via abductive reasoning:
  7) If a mountaineer reaches the top of K2, how did he get there?
Language often expresses only parts of the meaning

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This has consequences for reasoning tasks involving linguistic instructions:

**Faithful Interpretation**

In every-day reasoning, a perceiver will try to make a given sentence true rather than falsifying it.