Event knowledge and models of logical metonymy interpretation

Alessandra Zarcone

May 9, 2014

Logical metonymy and covert events

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around 1949 in New York
→ writing

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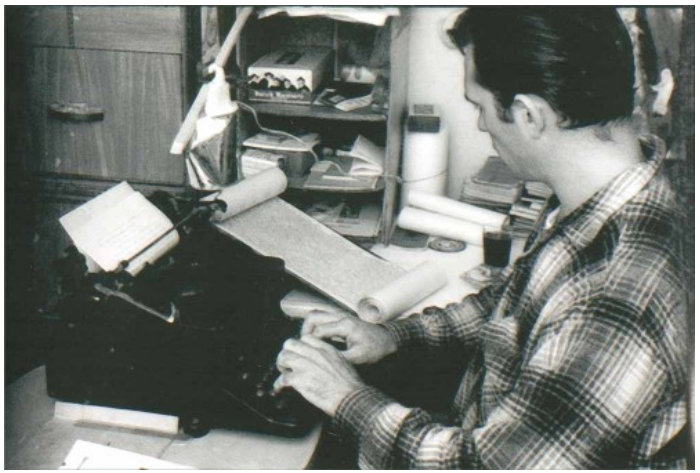

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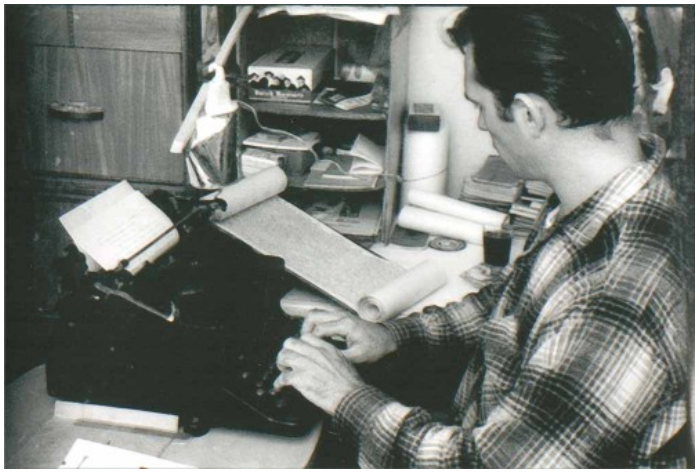

Logical Metonymies [Pustejovsky, 1995]

- involve *covert events* (*metonymy*: book $\rightarrow$ writing the book)
  - not realized on the surface, but understood
  - influence reading times
  - a challenge to compositionality
- **The Source Question**:
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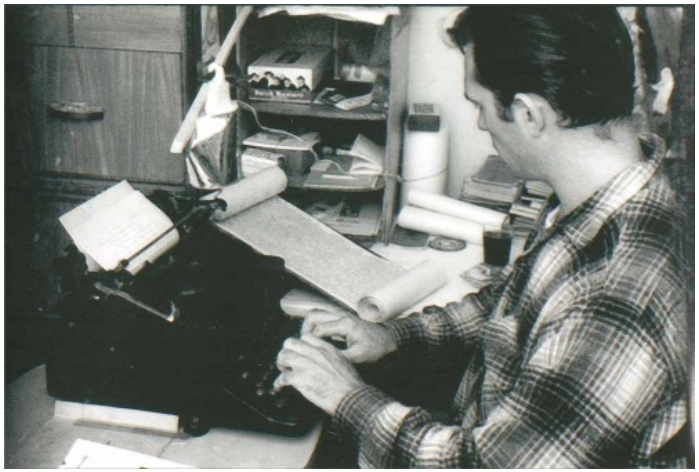

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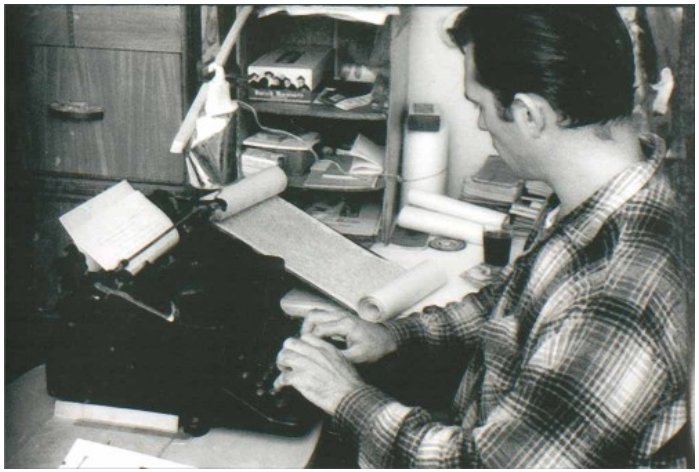

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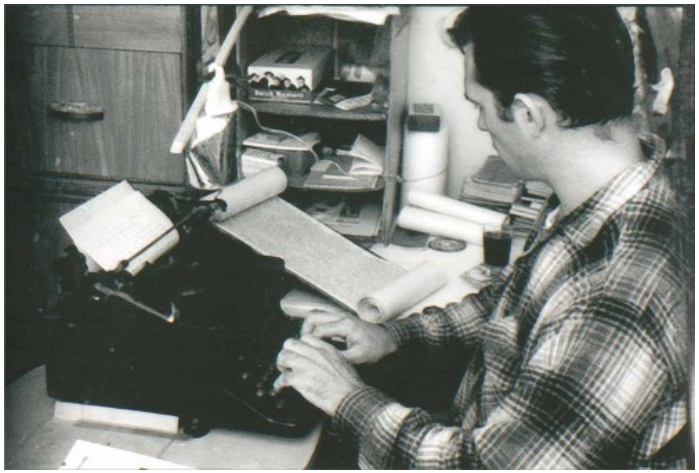

Logical Metonymies [Pustejovsky, 1995]

- EVent-selecting verb + ENtity-denoting object
  $\Leftrightarrow$ Jack Kerouac began **his journey**$_{EV}$ across America.
- **The Trigger Question**:
  What *triggers* the metonymy (and the covert event)?

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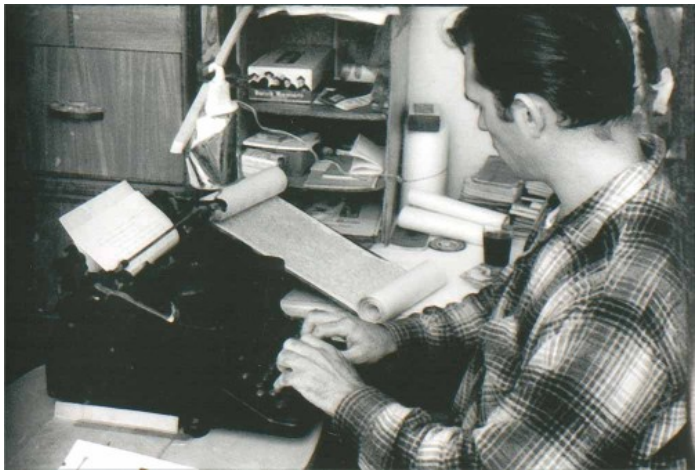

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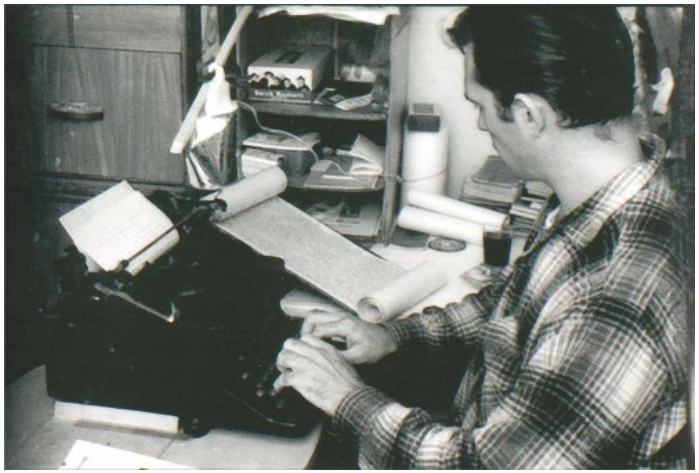

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Outline

The Lexical Hypothesis

The Lexical Hypothesis [Pustejovsky, 1995]:

- **The Source Question**: What is the *source* of the covert event?
  - ⇒ artifacts associated with events in the lexicon (qualia)
    - book $\xrightarrow{production}$ **writing**
    - book $\xrightarrow{purpose}$ **reading**
- **The Trigger Question**: What *triggers* the metonymy?
  - ⇒ type-clash: event-selecting verb + entity-denoting obj.
    - began **his journey**$_{EV}$ vs. began **his book**$_{EN}$

✓ preserves compositionality and the generative power of the lexicon

× underestimates the range of covert events and their context-sensitivity [Zarcone and Padó, 2010, Zarcone and Rüd, 2012]

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- **The Source Question**: What is the *source* of the covert event?
  - ⇒ post-lexical inferences tapping into world knowledge
  - *regret* → an event has previously been performed
  - *begin* → the subject begins an event with the object
- **The Trigger Question**: What *triggers* the metonymy?
  - ⇒ underspecification of logical metonymies
  - begin the book → **reading**, **writing**, **translating**, ...

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An alternative hypothesis:

- more context sensitive ($\Leftrightarrow$ Lexical Hypothesis)
- testable set of interpretations ($\Leftrightarrow$ Pragmatic Hypothesis)

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Psycholinguistic motivation

wash car

wash hair

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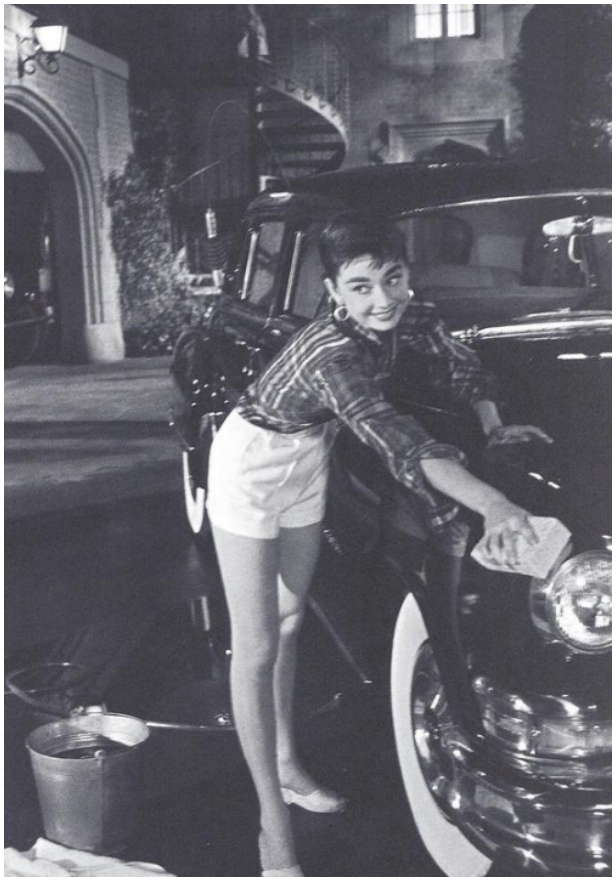
→ *hose, sponge, outdoor*



wash hair

→ *shampoo, sink, bathroom*

Psycholinguistic motivation

Generalized event knowledge [McRae and Matsuki, 2009]:

Prototypical knowledge about events and their participants
(first and second-hand experience, available in our memory)

- activated by words in isolation ⇒ cue concepts from typical scenarios

  $\langle arrest \rangle \xrightarrow{agent} cop$

  $\langle arrest \rangle \xrightarrow{patient} crook$

- words rapidly combine ⇒ **expectations** about upcoming input
  [Bicknell et al., 2010, Matsuki et al., 2011]

  Donna used the hose to wash her filthy...

- Operationalize thematic role-based expectations
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My proposal: the Words-as-Cues Hypothesis

The **baker** finished the icing

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The **baker** finished the icing → **spreading**

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The **child** finished the icing → **eating**

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The Words-as-Cues Hypothesis [Zarcone et al., 2014]:

- **The Source Question**: What is the *source* of the covert event?
  ⇒ generalized knowledge of events and their participants:
  covert events relevant to typical event scenarios are retrieved
  The baker finished the icing
- **The Trigger Question**: What *triggers* the metonymy?
  ⇒ low thematic fit between the verb and the object
  event-denoting nouns are better fillers for metonymic verbs
  ✓ begin **the journey** ⇔ × begin **the book**

✓ ranked (testable) set of interpretations, determined by context

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generalized event knowledge: high thematic fit covert events, relevant to typical scenarios

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The Source Question: Psycholinguistic evidence

Der Konditor	/	**das Kind**	hörte auf,	die Glasur	aufzutragen	und fing mit..
The baker	/	**the child**	finished	the icing	to spread	and started with...

$\mathbf{RT}_{high} < \mathbf{RT}_{low}$

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facilitation effect for the **high typicality** condition

[Zarcone et al., 2014]

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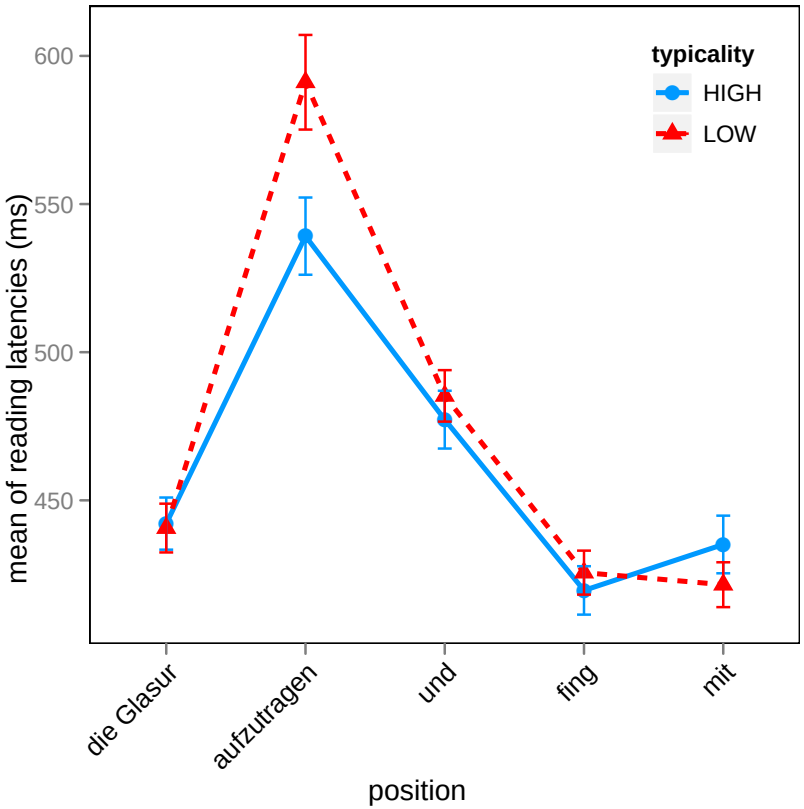

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The Source Question: Computational modeling

A computational model of covert event interpretation for the Words-as-Cues Hypothesis:

- **similarity-based**: ranked set of interpretations
  $\Rightarrow$ similar verbs, similar expectations
- **compositional**: typical arguments $\rightarrow$ expectations for covert events
  $\Rightarrow$ integration of contextual cues
- **thematic-fit based** model
  $\Rightarrow$ the event with the best thematic fit is chosen

Konditor	aufhören	Glasur	auftragen	essen
Kind	aufhören	Glasur	essen	auftragen

Task: choose the high-typicality event over the low-typicality event (dataset from the psycholinguistic experiments)

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  $\Rightarrow$ the event with the best thematic fit is chosen

Konditor	aufhören	Glasur	auftragen	essen
Kind	aufhören	Glasur	essen	auftragen

Task: choose the high-typicality event over the low-typicality event (dataset from the psycholinguistic experiments)

The Source Question: a similarity-based model

Distributional Memory (DM) [Baroni and Lenci, 2010]

- corpus-extracted weighted *word-link-word* tuples

	⟨*verb,bomb*⟩	⟨*subj,kill*⟩	⟨*verb,gun*⟩	⟨*subj,shoot*⟩	⟨*verb,book*⟩	⟨*subj,read*⟩
marine	40.0	82.1	85.3	44.8	3.2	3.3
teacher	5.2	7.0	9.3	4.7	48.4	53.6

- Weighted expectations (**thematic fit**):
  marine $\xrightarrow{object}$ *gun*, *bomb*, ...
- English DM [Baroni and Lenci, 2010] and German DM [Padó and Utt, 2012]

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The Source Question: a similarity-based model

A **compositional** model inspired by the ECU model, [Lenci, 2011]:

- subject's expectations: *brewer* $\xrightarrow{subj}$ *event*
- object's expectations: *beer* $\xrightarrow{obj}$ *event*
- metonymic verb's expectations: *finish* $\xrightarrow{comp^{-1}}$ *event*

$\Rightarrow$ composed expectations: $\langle brewer, finish, beer \rangle \xrightarrow{covert\ event}$ *prototype*

Thematic fit of an event:
similarity to the prototype

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Sim(pr,brew) $>$ **Sim(pr,drink)**

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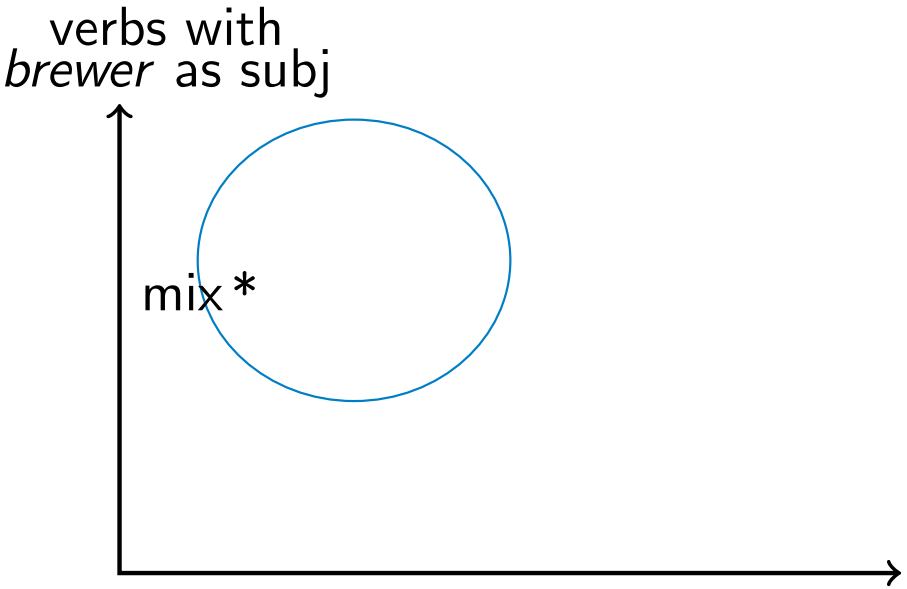

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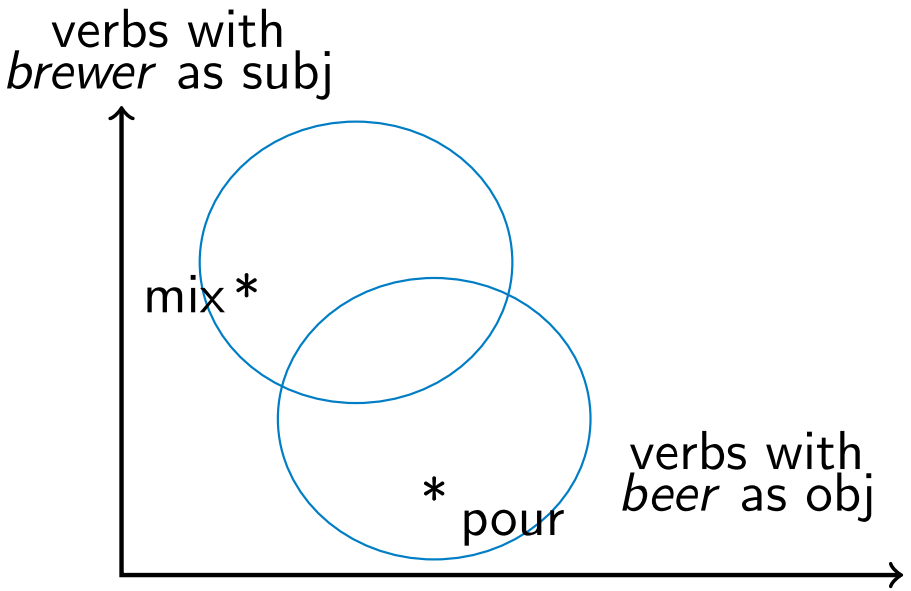

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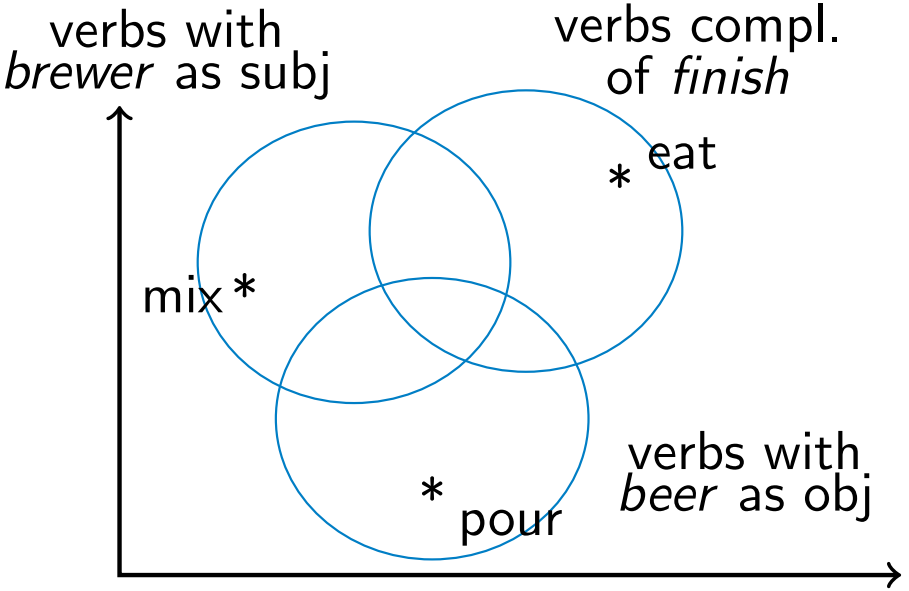

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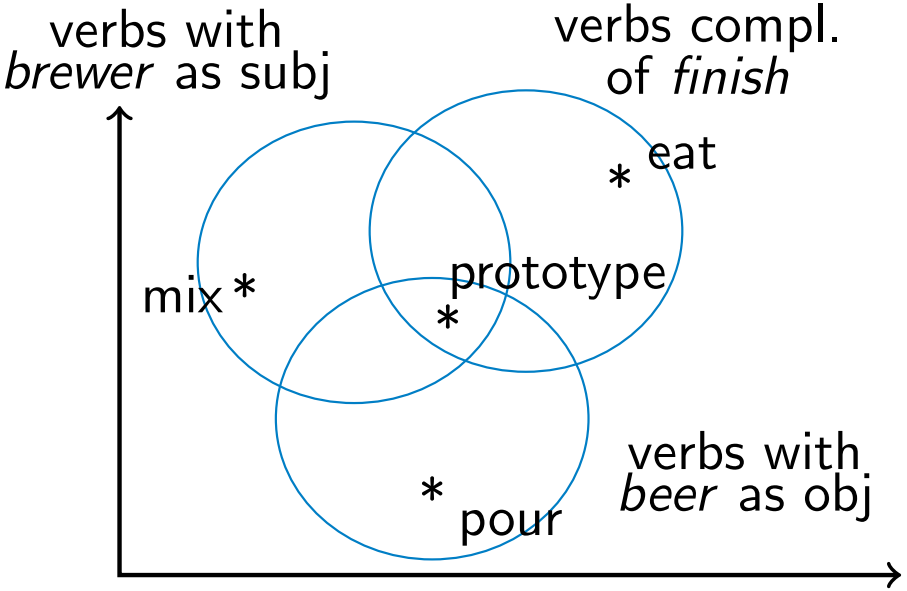

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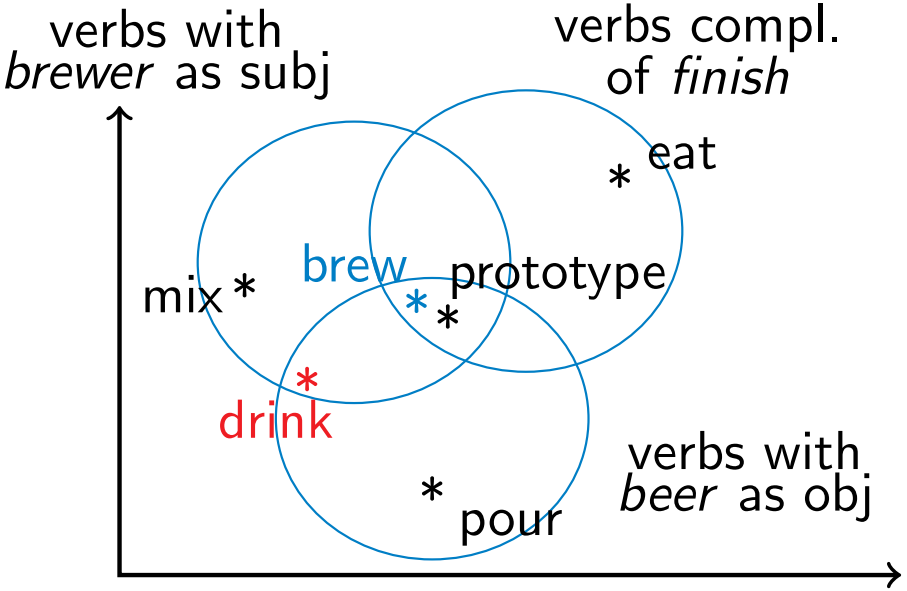

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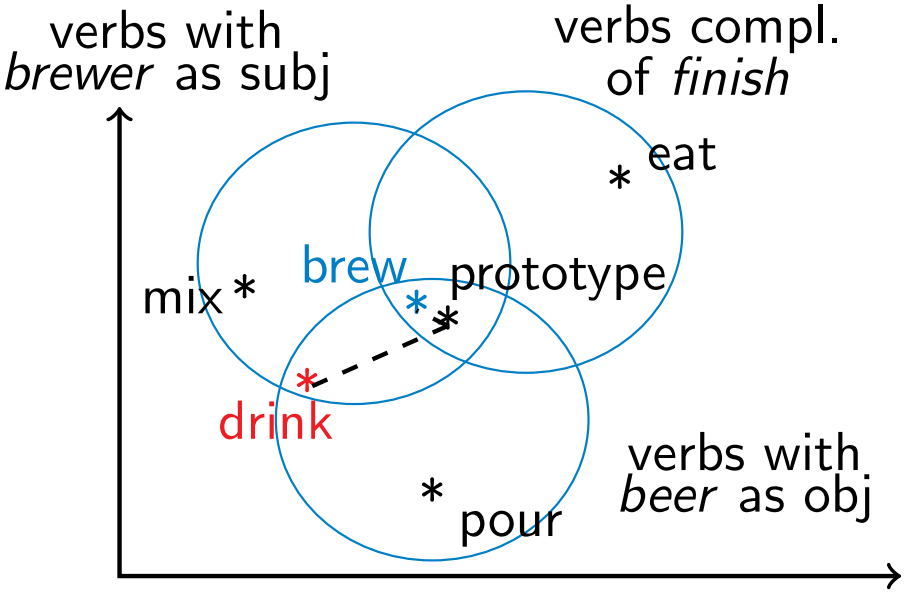

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The Source Question: Computational modeling

- Comparison with **Probabilistic Models** [Lapata et al., 2003]: covert event in a given context maximizes $P(s, v, o, e)$

		Probabilistic Models		Similarity-based Models	
	BL	SOV	SO	SOV	SO
Accuracy	50%	62%	75%	53%	68%
Coverage	100%	44%	75%	94%	98%
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What is the source of the covert event?

⇓

✓ generalized event knowledge: high thematic fit covert events, relevant to typical scenarios

What triggers the metonymy?

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low thematic fit between the verb and the object: event-denoting nouns are better fillers for metonymic verbs

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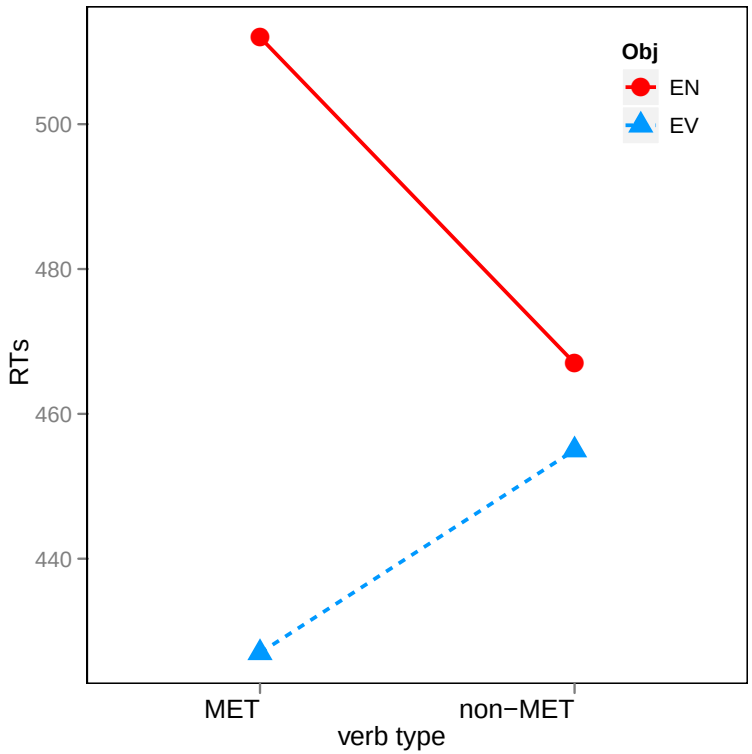
The Trigger Question: Computational Modeling

	EV	EN
meton. v.	✓ The boy **started** the **fight**	× The boy **started** the **puzzle**
non-meton. v.	✓ The boy **saw** the **fight**	✓ The boy **saw** the **puzzle**



- longest reading times for metonymic verb + entity-denoting object
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[Traxler et al., 2002]

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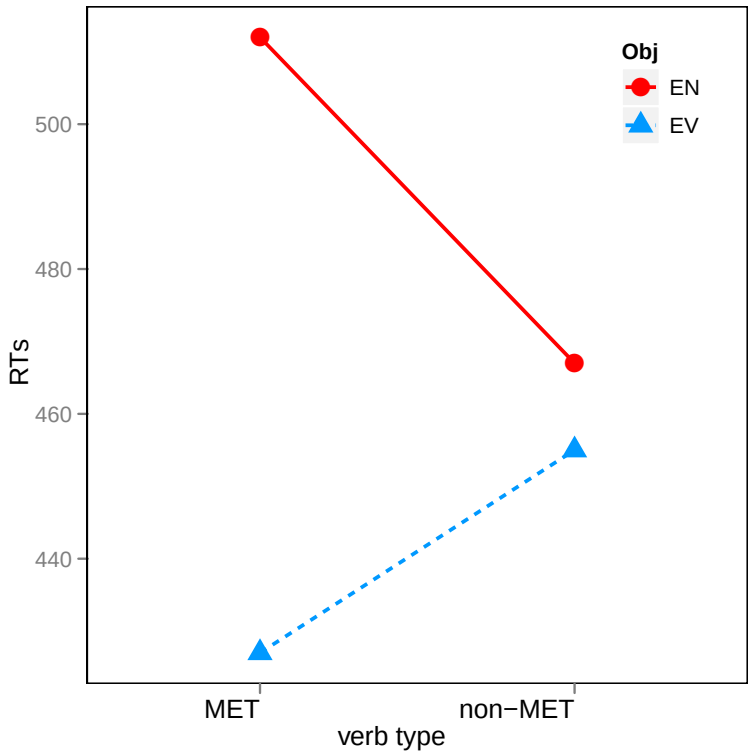

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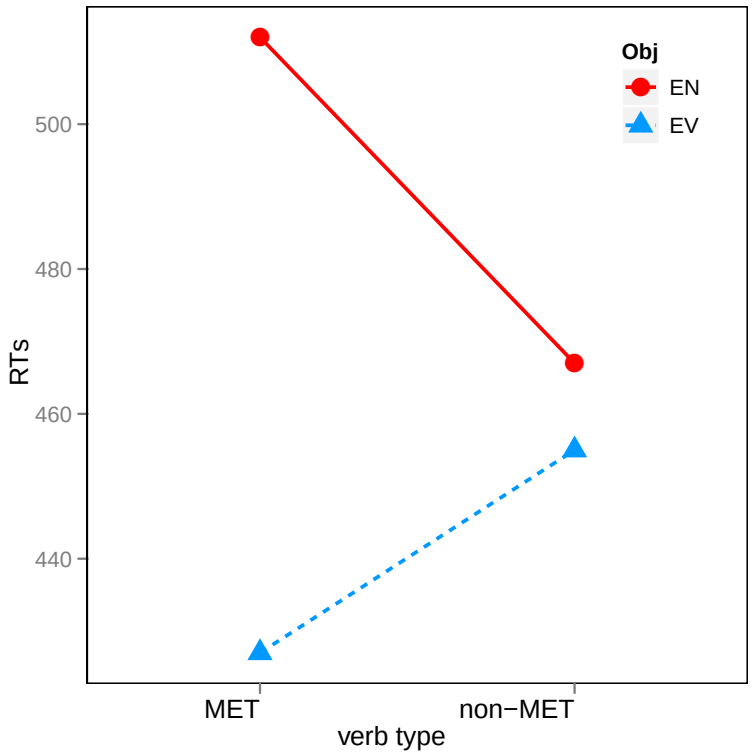

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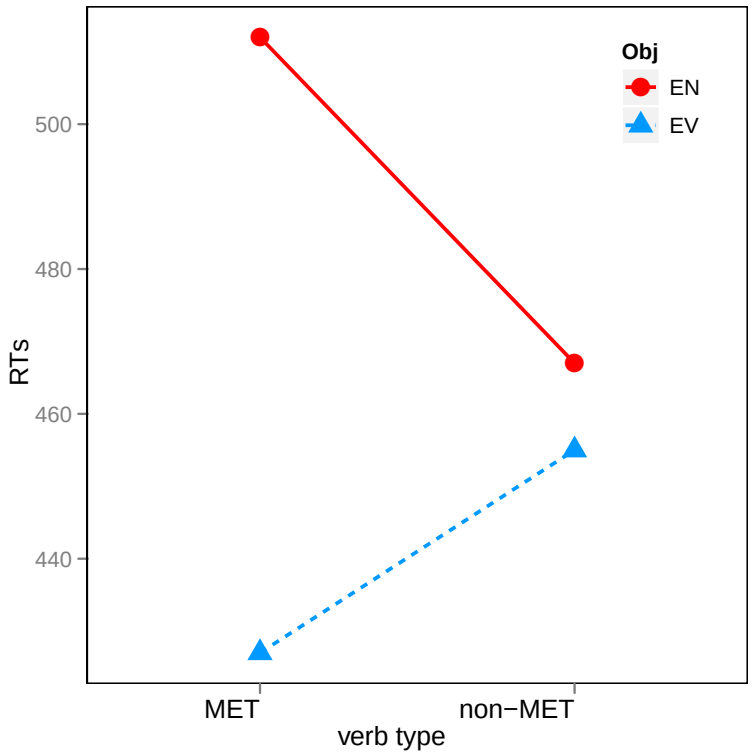

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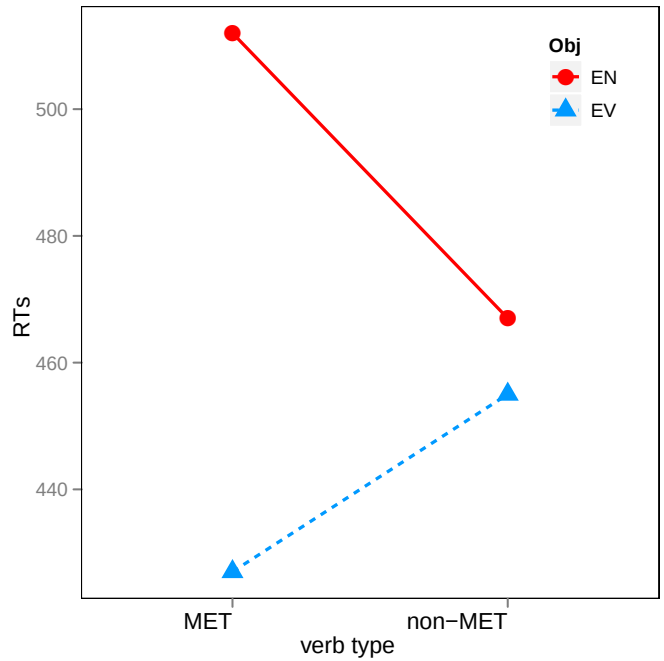
The Trigger Question: Computational Modeling

The boy [started / saw] **the fight$_{EV}$** / **the puzzle$_{EN}$**

RT Study



highest processing costs

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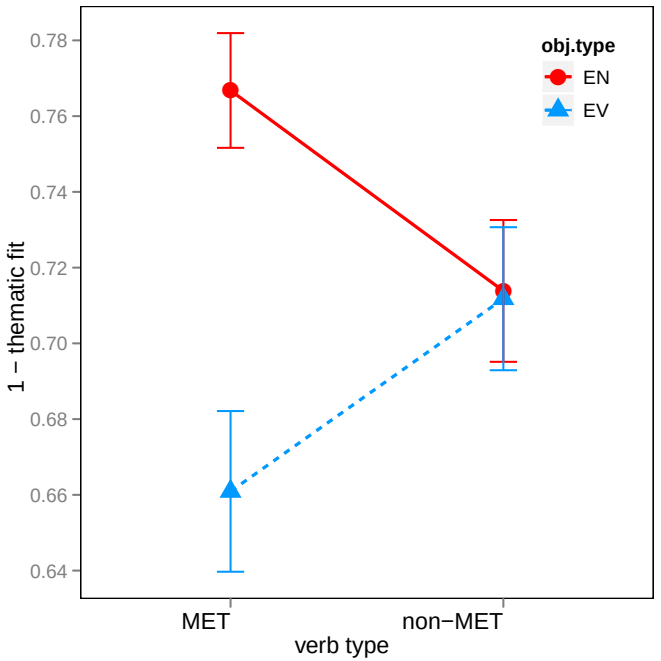
Thematic-fit Model



highest $(1 - th.fit)$ scores

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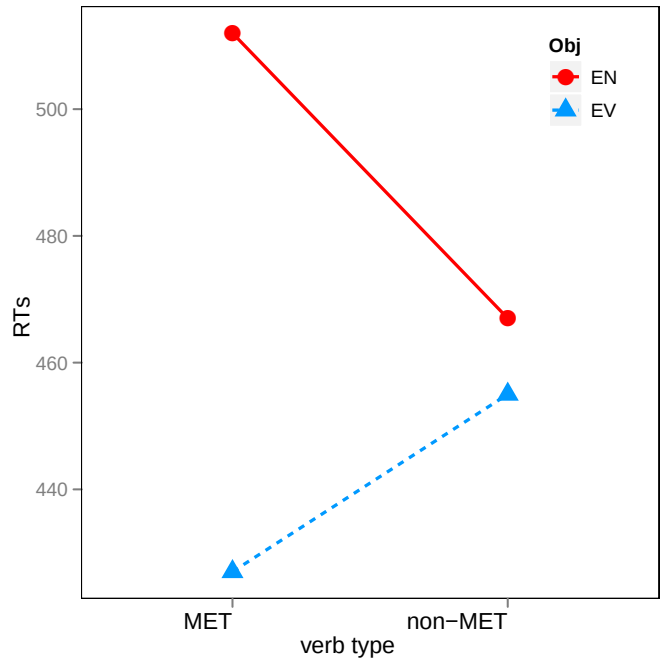

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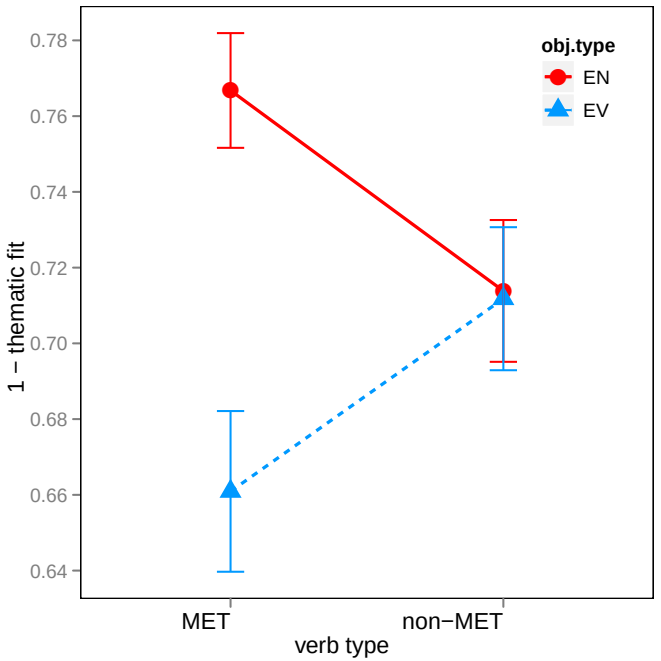

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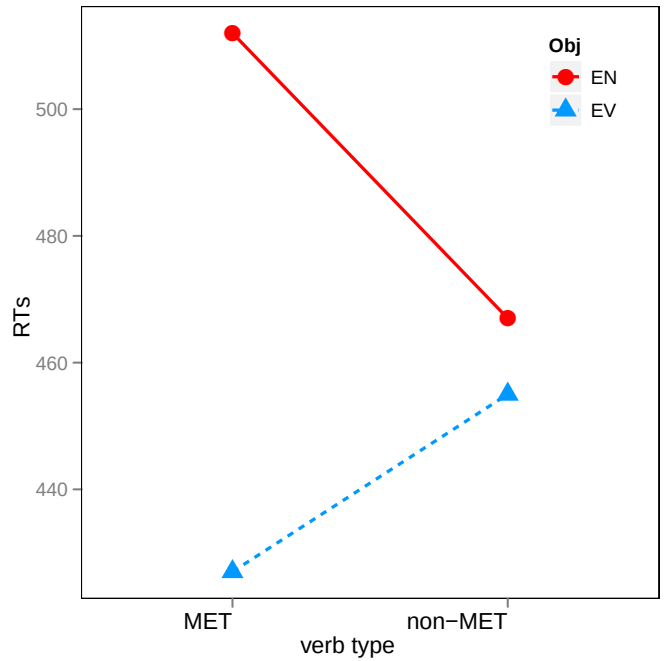

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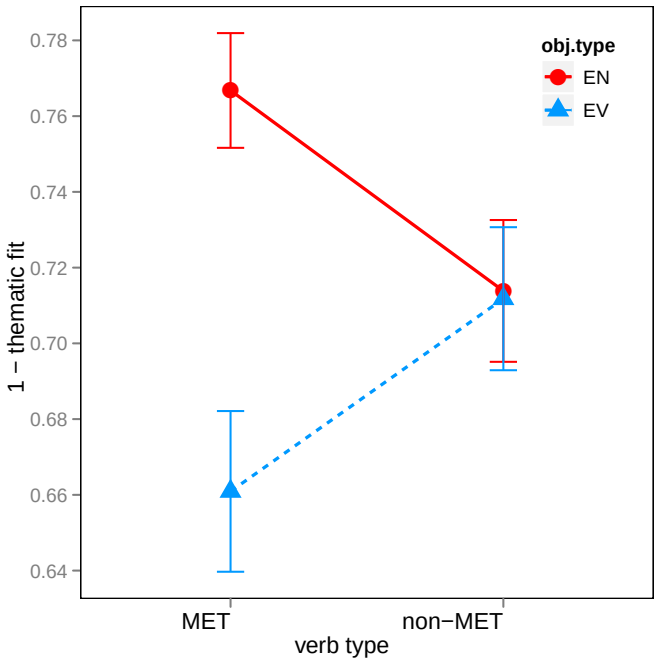

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The Trigger Question: Computational Modeling

What triggers the metonymy?

$\Downarrow$

low thematic fit between the verb and the object:
event-denoting nouns are
better fillers for metonymic verbs

- metonymic combinations distinguished in terms of **thematic fit**
- distributional characterization of metonymic verbs in terms of their **selectional behavior**

[Zarcone et al., 2013, Utt et al., 2013]

Is thematic fit or type responsible for triggering the logical metonymy?

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The Trigger Question: Psycholinguistic Evidence

Das Geburtstagskind hat mit den Geschenken / der Suppe / der Feier / der Schicht **angefangen**.

The birthday boy has with the presents / the soup / the party / the shift **begun**.

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2 EN-denoting objects,
2 EV-denoting objects

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Prediction from a type account:

$$\mathbf{RT}_{EV,HIGH} < \mathbf{RT}_{EN,HIGH}$$
$$\mathbf{RT}_{EV,LOW} < \mathbf{RT}_{EN,LOW}$$

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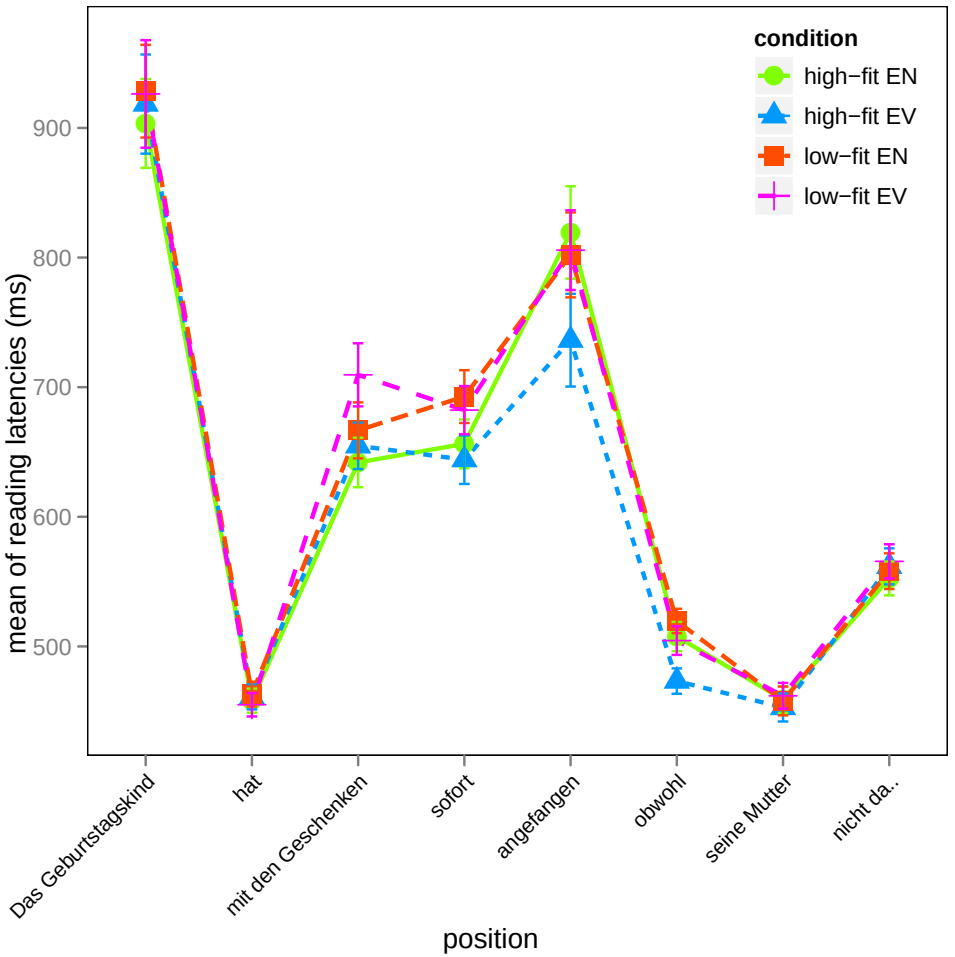


Results:

$RT_{EV,HIGH} < RT_{EV,LOW}$,
$RT_{EN,HIGH}$, $RT_{EN,LOW}$

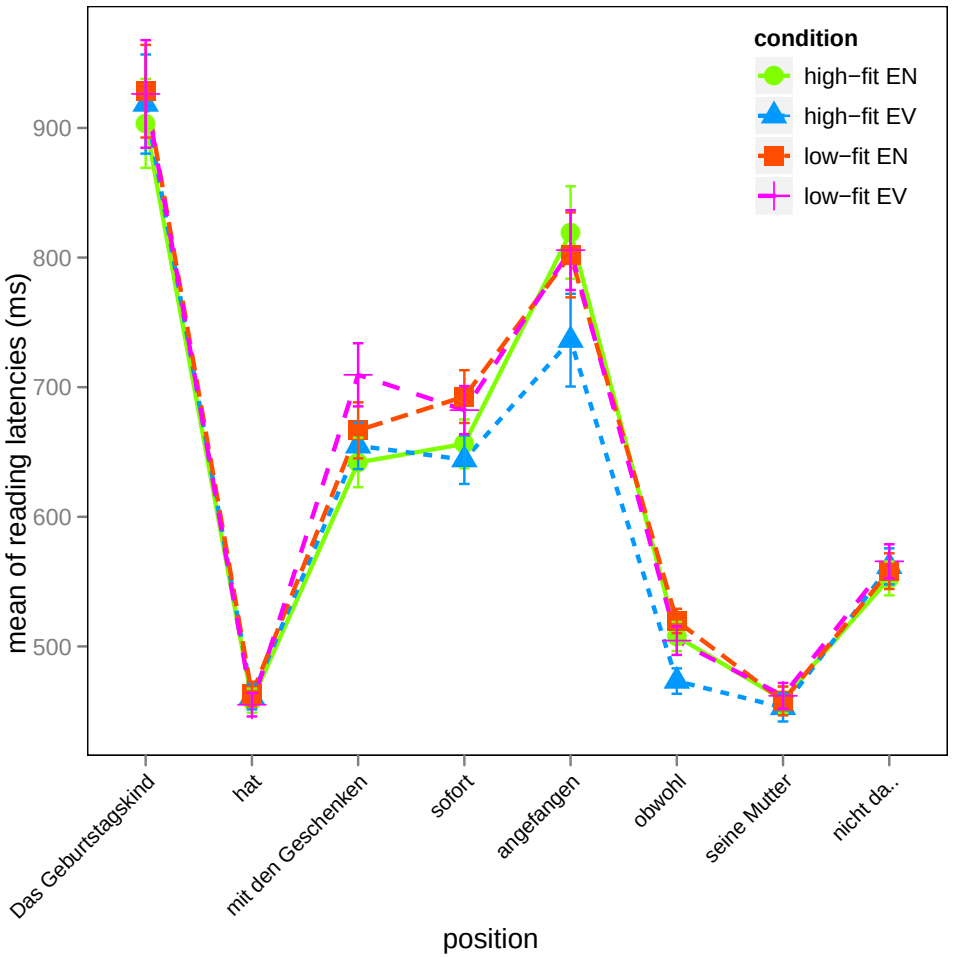
⇓

Both **type** and **thematic fit** are necessary

[Zarcone and Padó, 2013]

The Trigger Question: Psycholinguistic Evidence

Das Geburtstagskind hat mit **den Geschenken** / **der Suppe** / **der Feier** / **der Schicht** **angefangen**.
The birthday boy has with **the presents** / **the soup** / **the party** / **the shift** **begun**.



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The Words-as-Cues Hypothesis revisited

What is the source of the covert event?

⇓

✓ generalized event knowledge: high thematic fit covert events, relevant to typical scenarios

What triggers the metonymy?

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× low thematic fit between the verb and the object:

✓ type + thematic fit: expectations for high-typicality event-denoting objects

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Incremental, context-driven and expectation-driven specification process:

- metonymic verbs' selectional properties
  $\rightarrow$ expectations for high-typicality event-denoting objects
- contextual cues
  $\rightarrow$ update expectations for high-typicality covert events
- semantic type as yet another constraint contributing to the expectation building process

A hybrid model [Resnik, 1996, Schulte im Walde, 2006]:

- semantic type emerging from observed distributional behavior
- selectional preferences as distributions over classes of fillers
- encoding both thematic fit and type

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Lexicon and world knowledge

Different theories of logical metonymy,
different position of **event knowledge** in the cognitive architecture
(lexicon vs. world knowledge)

⇒ linguistic (lexical) knowledge:
systematic, amenable to generalization, a more feasible object of analysis

⇒ world knowledge:
situated, culture-dependent, no systematic characterization and analysis

"The most common argument [...] for drawing a strict boundary
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Work on generalized event knowledge:

- it is possible to make predictions and verify hypotheses regarding the role of world knowledge in linguistic processing
- evidence for early use of rich knowledge about typical events and their participants

  $\Rightarrow$ during processing of explicit input

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Thank you!

The research presented was funded
by the German Research Foundation (DFG)
as part of the SFB 732 - project D6

Cooperation with Alessandro Lenci and Jason Utt