Comprehenders infer causal interaction between meaning intent & grammatical probability

Mark Myslín & Roger Levy
University of California, San Diego
What determines what people say?

Fidelity of form to intended message

Processing efficiency
Zach brought bagels to the office. ~ Zach brought the office bagels.
Syntactic alternations

Zach brought bagels to the office. ~ Zach brought the office bagels.

Forms differ in meaning.

- Principle of No Synonymy
- Construction Grammar

Bollinger, 1968; Goldberg, 1992, 1995; Krifka, 2004; Pinker, 1989
Syntactic alternations

Zach brought bagels to the office. ~ Zach brought the office bagels.

Forms differ in meaning.
- Principle of No Synonymy
- Construction Grammar

Forms are synonymous.
- Psycholinguistics of sentence production
- Modern probabilistic syntax
- Variationist sociolinguistics

Bollinger, 1968; Goldberg, 1992, 1995; Krifka, 2004; Pinker, 1989

Ferreira, 1996; Bresnan et al, 2007; Rappaport Hovav & Levin, 2008; Weiner & Labov, 1983
Form-meaning fidelity and processing efficiency jointly influence syntactic preference.
Probabilistic causal inference

- **Causal models** (aka Bayes nets)
- Formally represent causal relations
- Constrain probability distributions over sets of variables
A causal model

Season

Rain

Street wet

Sprinkler
A causal model

Common-effect scenario (‘explaining away’)

season

rain

sprinkler

street wet
A causal model

Common-effect scenario (‘explaining away’)

- rain
- season
- street wet
- sprinkler
Causal inference in syntactic alternation

meaning
intent

form

production
circumstances
Causal inference in syntactic alternation

meaning intent

production circumstances

form

Zach brought bagels to the office.

The dative alternation
Causal inference in syntactic alternation

meaning intent

form

production circumstances
Causal inference in syntactic alternation

Zach brought bagels to the office.

The dative alternation
Causal inference in syntactic alternation

Zach brought bagels to the office.

PO PREPOSITIONAL OBJECT

The dative alternation

Zach brought the office bagels.

DO DOUBLE OBJECT
Meaning intent → Form

Grammatical restrictions

- *I sent my skis to Colorado.*
- *I sent Colorado my skis.*

Causal inference in syntactic alternation

meaning intent

production circumstances

form
Causal inference in syntactic alternation
Production circumstances → Form

- DO and PO structures are (partially/wholly) synonymous
- Choice optimizes production ease, information structure...
  - Short ≺ long
  - Definite ≺ indefinite
  - ...

Bresnan et al., 2007; Larson, 1988; Rappaport Hovav & Levin, 2008
Causal inference in syntactic alternation

**DO:** Possession (VERB the X the Y)

**PO:** Location (VERB the Y to the X)
Causal inference in syntactic alternation

**DO**: Possession (VERB the X the Y)

**PO**: Location (VERB the Y to the X)
Experiment 1: Alien language game

You hear:

The zarg prolted the cherid to a really gromious flig.

What is more likely to be true?

The cherid is in a new place.  
The cherid has a new owner.

ITEM 10 of 35
### Experiment 1: Alien language game

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DO: Possession  (VERB the X the Y)  PO: Location  (VERB the Y to the X)
Comprehenders infer a trade-off between form-meaning fidelity and processing efficiency.
Verbs in syntactic alternation

Syntax-meaning associations may be mediated through syntax-verb associations. 58% of DO constructions occur with give.

P (give | DO) → prolt ≈ give → P (POSSESSIVE | give) → HIGH

English verbs would eliminate this possibility. Bresnan & Nikitina, 2009
Verbs in syntactic alternation

- Syntax-meaning associations may be mediated through syntax-verb associations.

Bresnan & Nikitina, 2009
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58% of DO constructions occur with *give*. 

*English verbs would eliminate this possibility* 

Bresnan & Nikitina, 2009
Verbs in syntactic alternation

- Syntax-meaning associations may be mediated through syntax-verb associations.

58% of DO constructions occur with *give*.

*The zarg prolted the cherid a really gromious flig.*
Verbs in syntactic alternation

- Syntax-meaning associations may be mediated through syntax-verb associations.

58% of DO constructions occur with *give*.

*The zarg prolTED the cherid a really gromious flig.*

\[
P(\text{give}|\text{DO}) \rightarrow \text{prolt} \approx \text{give} \rightarrow \mathbb{P}(\text{POSSESSIVE}|\text{give})
\]

(The original text appears to contain a typographical error, specifically replacing 'Tam' with 'prolt' in the sentence.)
Verbs in syntactic alternation

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58% of DO constructions occur with *give*.

\[
P(\text{give}|\text{DO}) \rightarrow \text{prolt} \approx \text{give} \rightarrow P(\text{POSSESSIVE}|\text{give})
\]

- English verbs would eliminate this possibility

*The zarg prolted the cherid a really gromious flig.*

Bresnan & Nikitina, 2009
Verbs in syntactic alternation

What are the respective contributions of verb and syntactic alternant to sentence meaning?

Hypothesis A: Meaning resides in verbs, not syntactic alternants

Hypothesis B: Meaning resides in both

Goldberg, 2002; Rappaport Hovav & Levin, 2008
Verbs in syntactic alternation

- What are the respective contributions of verb and syntactic alternant to sentence meaning?

Hypothesis A: Meaning resides in verbs, not syntactic alternants

Hypothesis B: Meaning resides in both Goldberg, 2002; Rappaport Hovav & Levin, 2008
Verbs in syntactic alternation

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What are the respective contributions of verb and syntactic alternant to sentence meaning?

She kicked X to Y. ~ She kicked Y X.

Goldberg, 2002
What are the respective contributions of verb and syntactic alternant to sentence meaning?

*She prolted X to Y. ~ She prolted Y X.*

Goldberg, 2002
Verbs in syntactic alternation

What are the respective contributions of verb and syntactic alternant to sentence meaning?

She kicked X to Y. ~ She kicked Y X.

Goldberg, 2002
Verbs in syntactic alternation

- What are the respective contributions of verb and syntactic alternant to sentence meaning?

PO  VERB  DO

Location change

use of foot

Possession change

She kicked X to Y. ∼ She kicked Y X.

Goldberg, 2002
Experiment 2: English verbs

The zarg prolted the cherid to a really grimious flig.
Experiment 2: English verbs

The zarg the cherid to a really grimious flig.
The zarg kicked the cherid to a really grimious flig.
Experiment 2: English verbs

The zarg kicked the cherid to a really grimious flig that was all charpy.
Experiment 2: English verbs

The zarg kicked the cherid to a really grimious flig that was all charpy.

- 76 attested alternating English verbs

brought carried delivered funneled
prepaid allocated allowed assigned assured
bet brought ceded charged cost dealt denied
extended swapped fed flipped floated gave
granted guaranteed allotted handed issued leased
left sent lent mailed made offered fined owed
assessed paid permitted accorded afforded
presented loaned promised quoted read awarded
refused reimbursed repaid resold ran sold served
showed slipped submitted bequeathed supplied
took taught told tendered traded voted willed
wished wrote asked dropped lost played
passed kept set cut

Bresnan et al, 2007; Gries & Stefanowitsch, 2004
Verbs and syntactic alternants both contribute to sentence meaning.

**Exp 1: Alien verbs**

**Exp 2: English verbs**

**DO**: Possession (VERB the X the Y)

**PO**: Location (VERB the Y to the X)
Exp 1: Alien verbs

Verbs and syntactic alternants both contribute to sentence meaning.

DO: Possession (VERB the X the Y)  
PO: Location (VERB the Y to the X)
Beyond the dative alternation

- Do comprehenders make these causal inferences in other alternations?
Beyond the dative alternation

- Do comprehenders make these causal inferences in other alternations?
- The *spray-load* alternation
Beyond the dative alternation

▶ Do comprehenders make these causal inferences in other alternations?
▶ The *spray-load* alternation

| She sprayed | the wall | with paint. |
| NP | NP |
| WITH | WITH-VARIANT |

~

| She sprayed | paint | onto the wall. |
| NP | PP |
| INTO | INTO-VARIANT |
Beyond the dative alternation

- Do comprehenders make these causal inferences in other alternations?
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Beyond the dative alternation

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- Far fewer claims of synonymy

Anderson, 1971; Goldberg, 2002; Gropen, 1991; Pinker, 1989
Experiment 3: *Spray-load* alien language game

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<td>INTO</td>
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*Which is more likely?*

- The cherid got completely covered in flig.  
  **COMPLETIVE** inference
- Part of the cherid is still blank.  
  **PARTITIVE** inference

**WITH**: Completive (VERB the X with Y)  
**INTO**: Partitive (VERB Y into the X)
**Experiment 3: *Spray-load* alien language game**

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**WITH**: Completive (VERB the X with Y)  
**INTO**: Partitive (VERB Y into the X)
Experiment 4: English *spray-load* verbs

- brushed
- crammed
- crowded
- cultivated
- dabbed
- daubed
- draped
- drizzled
- dusted
- hung
- heaped
- injected
- jammed
- loaded
- mounded
- packed
- piled
- planted
- plastered
- pumped
- rubbed
- scattered
- seeded
- settled
- sewed
- showered
- slathered
- smeared
- smudged
- sowed
- spattered
- splashed
- splattered
- sprayed
- spread
- sprinkled
- spritzed
- squirted
- stacked
- stuck
- stocked
- strung
- stuffed
- swabbed
- wrapped

Levin, 1993
Exp 3: Alien verbs

Exp 4: English verbs

**WITH:** Completive (VERB the X with Y)

**INTO:** Partitive (VERB Y into the X)
Conclusions

Meaning-form fidelity and processing efficiency jointly influence syntactic preference. Comprehenders infer trade-off between these two variables. Arguably synonymous alternations (dative) and less-arguably synonymous alternations (spray-load) contribute to sentence meaning. Ongoing work on adaptability and speaker-specificity of causal models.
Conclusions

- Meaning-form fidelity and processing efficiency jointly influence syntactic preference
Meaning-form fidelity and processing efficiency jointly influence syntactic preference

- Comprehenders infer trade-off between these two variables
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Conclusions

► Meaning-form fidelity and processing efficiency jointly influence syntactic preference
  ▶ Comprehenders infer trade-off between these two variables
  ▶ Arguably synonymous alternations (dative) and less-arguably synonymous alternations (spray-load)
► Verbs and syntactic alternants both contribute to sentence meaning
Conclusions

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  - Comprehenders infer trade-off between these two variables
  - Arguably synonymous alternations (dative) and less-arguably synonymous alternations (*spray-load*)

- Verbs and syntactic alternants both contribute to sentence meaning

- Ongoing work on adaptability and speaker-specificity of causal models
Thank you!

Agatha Ventura   Jake Prasad
Exp 1(b). Grammatical manipulation: **length only**

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**DO**: Possession (VERB the X the Y)  
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Exp 1(c). Grammatical manipulation: *definiteness only*

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**DO**: Possession (VERB the X the Y)  
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Exp 1(c). Grammatical manipulation: definiteness only

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**PO**: Location (VERB the Y to the X)
Exp 1(c). Grammatical manipulation: definiteness only

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Experiment 1: Alien language game

Comprehenders build fine-grained causal models of their interlocutors’ productions

(a) Length & definiteness
(b) Length only
(c) Definiteness only

DO: Possession (VERB the X the Y)
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