Distribution, Inference, and Event Structure

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Slides available at aaronstevenwhite.io

Data available at $\begin{cases} \text{megaattitude.io} \\ \text{decomp.io} \end{cases}$

Collaborators

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Department of Computer Science

Introduction

Overarching question

How are a verb's **semantic properties** related to its **syntactic distribution**? Gruber 1965; Fillmore 1970; Zwicky 1971; Jackendoff 1972; Grimshaw 1979, 1990; Pesetsky 1982, 1991; Pinker 1989; Levin 1993

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Semantic Properties

$$\begin{bmatrix} + & \text{TELIC} \\ - & \text{DURATIVE} \\ - & \text{STATIVE} \\ & \ldots \end{bmatrix}$$

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Semantic Properties ⟷ Syntactic Distribution

$$\begin{bmatrix} + & \text{TELIC} \\ - & \text{DURATIVE} \\ - & \text{STATIVE} \\ & \ldots \end{bmatrix} \qquad \begin{Bmatrix} [\_\_\_\text{NP}] \\ [\_\_\_\text{S}] \\ [\_\_\_\text{VP}] \\ \ldots \end{Bmatrix}$$

What could matter?

Factors claimed to affect the distribution of nominals

Sensitive to event structural properties like stativity, telicity, durativity, causativity, transfer, etc. (see Levin and Rappaport Hovav 2005)

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Sensitive to event structural properties like stativity, telicity, durativity, causativity, transfer, etc. (see Levin and Rappaport Hovav 2005)

Factors claimed to affect the distribution of clauses

Sensitive to 'content-dependent' properties like representationality, preferentiality, factivity/veridicality, communicativity, etc. Bolinger 1968; Hintikka 1975; Hooper 1975; Stalnaker 1984; Farkas 1985; Villalta 2000, 2008; Kratzer 2006; Egré 2008; Scheffler 2009; Moulton 2009; Anand and Hacquard 2013; Rawlins 2013; Portner and Rubinstein 2013; Anand and Hacquard 2014; Spector and Egré 2015; Bogal-Allbritten 2016; Theiler et al. 2017

Overarching Hypothesis

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The distribution of clauses is determined by the **same** semantic properties as the distribution of nouns (cf. Koenig and Davis 2001)

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Not properties dependent on having propositional content

(White and Rawlins, 2017, 2018)

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Not properties dependent on having propositional content

(White and Rawlins, 2017, 2018)

Intuition

Predicates that take clauses characterize neo-Davidsonian eventualities, like any other verb. (Kratzer 2006; Hacquard 2006; Moulton 2009; Anand and Hacquard 2013, 2014; Rawlins 2013; Bogal-Allbritten 2016; White and Rawlins 2016b a.o.)

Case study

Question

How direct is the relationship between content-dependent properties and syntactic distribution?

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Focus

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Claim

There is no direct relationship between factivity and veridicality (*qua* semantic properties) and syntactic distribution

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Two content-dependent properties – factivity and veridicality – that are argued to determine selection of interrogatives & declaratives

Claim

There is no direct relationship between factivity and veridicality (*qua* semantic properties) and syntactic distribution

The relationship is mediated by event structural properties.

Outline

Introduction

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Veridicality and distribution

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Veridicality and distribution

Veridicality

A verb V is **veridical** iff NP V S *entails* S Karttunen 1971a; Egré 2008; Karttunen 2012; Spector and Egré 2015 a.o.

Veridicality and factivity

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b. Jo **proved** that Bo was alive $\rightarrow$ Bo was alive

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A verb V is **factive** iff NP V S *presupposes* S Kiparsky and Kiparsky 1970; Karttunen 1971b *et seq*

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A verb V is **factive** iff NP V S *presupposes* S Kiparsky and Kiparsky 1970; Karttunen 1971b *et seq*

(2) a. Jo didn't **know** that Bo was alive $\rightarrow$ Bo was alive
b. Jo didn't **prove** that Bo was alive $\not\rightarrow$ Bo was alive

Veridicality/factivity and responsivity

Responsivity (Lahiri, 2002)

A verb is **responsive** iff it takes interrogatives and declaratives see also Karttunen 1977b,a; Groenendijk and Stokhof 1984 *et seq*

(3) a. Jo **knew** that Bo was alive.
    b. Jo **knew** whether Bo was alive.

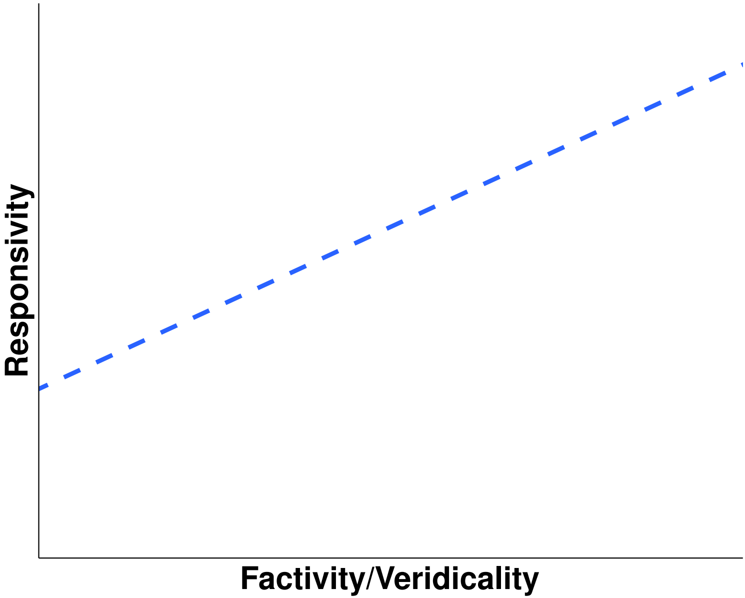
Generalization

A verb is **responsive** iff {**factive** (Hintikka, 1975) / **veridical** (Egré, 2008)}

see also George 2011; Uegaki 2012, 2015; cf. Beck and Rullmann 1999; Spector and Egré 2015

(4) a. Jo **knew** {that, whether} Bo was alive.
    b. Jo **thought** {that, *whether} Bo was alive.

Predicted correlation



Testing correlation

Measurement of syntactic distribution

MegaAcceptability dataset (White and Rawlins, 2016a)

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Measurement of veridicality

MegaVeridicality dataset (White and Rawlins, 2018)

Predicting responsivity from veridicality

MegaAttitude materials

Ordinal (1-7 scale) acceptability ratings

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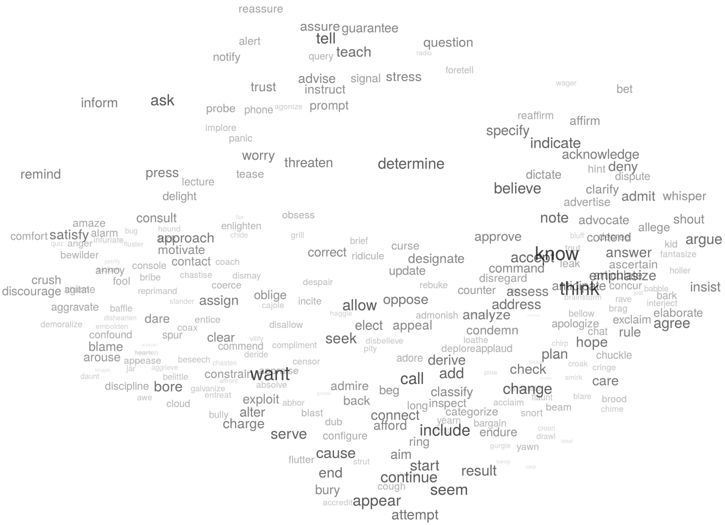
for

1000 clause-embedding verbs

Verb selection



MegaAttitude materials

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1000 clause-embedding verbs

$\times$

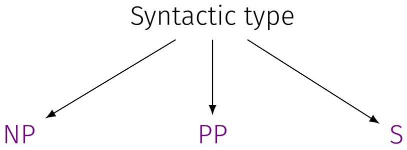
50 syntactic frames

Sentence construction

Challenge

Automate construction of a very large set of frames in a way that is sufficiently general to many verbs

Frame construction



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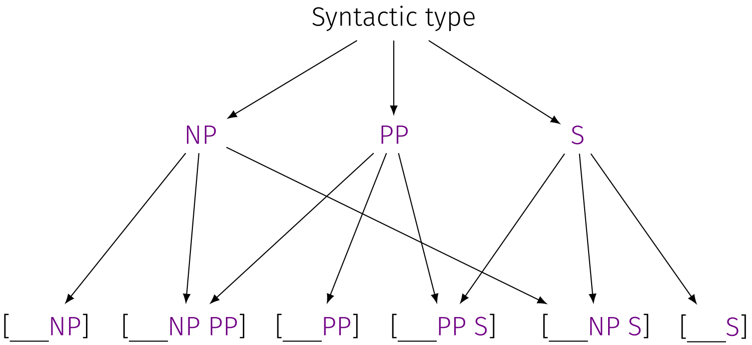

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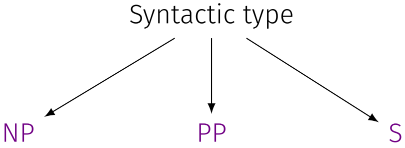

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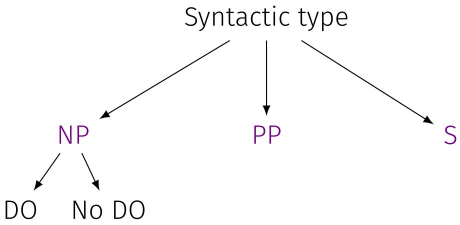

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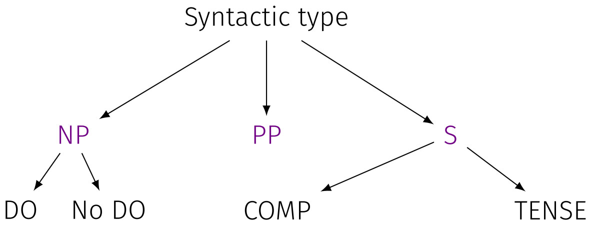

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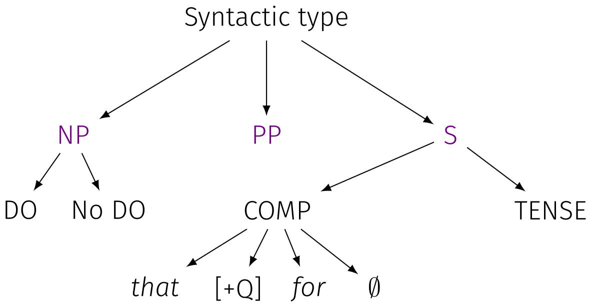

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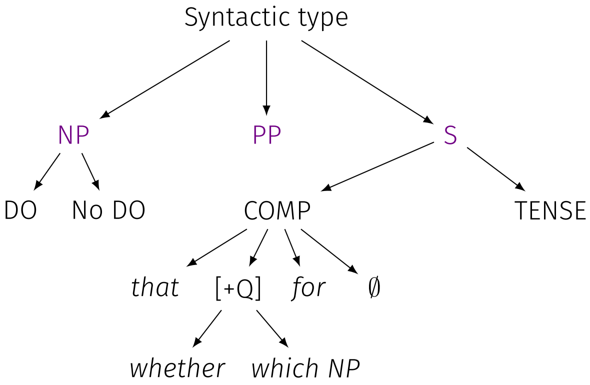

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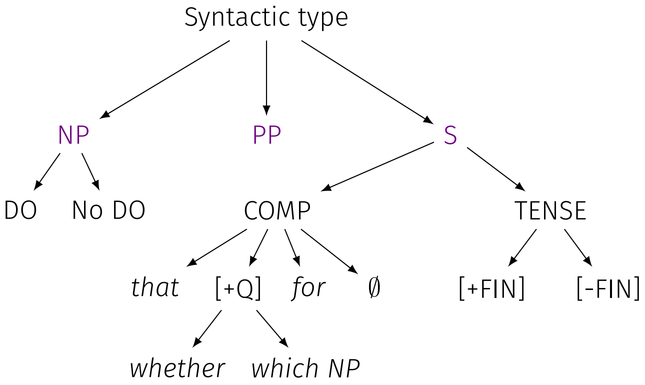

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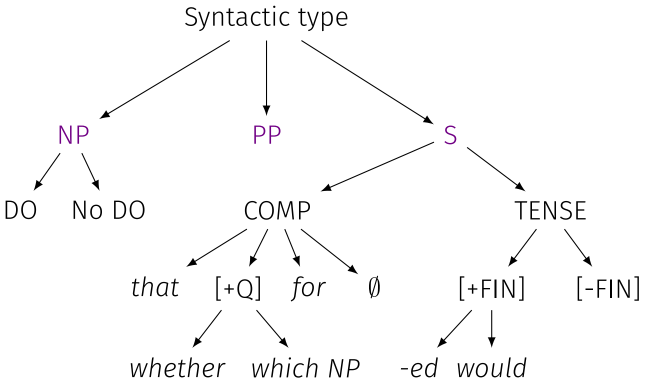

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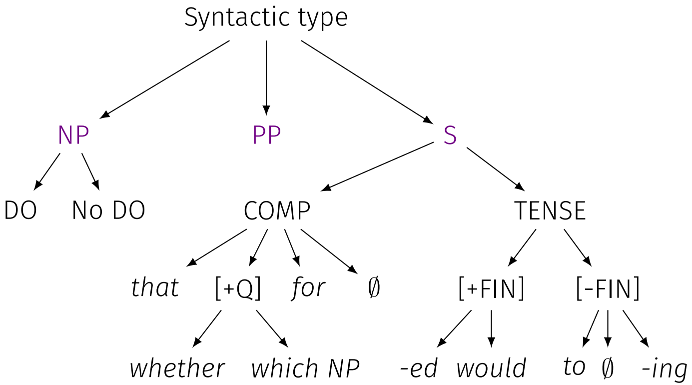

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Automate construction of a very large set of frames in a way that is sufficiently general to many verbs

Solution

Construct semantically bleached frames using indefinites

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(5) Examples of responsives

a. *know* + NP V {that, whether} S
Someone knew {that, whether} something happened.

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   Someone told someone {that, whether} something happened.

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- 727 unique Mechanical Turk participants
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- 5 judgments per item
    - No annotator sees the same sentence more than once

Task

Sentence Acceptability Task (expert annotation)

Requester: JHU Semantics Lab | **Reward:** $0.00 per HIT | **HITs Available:** 20 | **Duration:** 14 weeks 2 days

Qualifications Required: None

1. Someone needed whether something happened.

1 2 3 4 5 6 7

2. Someone hated which thing to do.

1 2 3 4 5 6 7

3. Someone was worried about something.

1 2 3 4 5 6 7

4. Someone allowed someone do something.

1 2 3 4 5 6 7

Turktools (Erlewine and Kotek, 2015)

Validating the data

Interannotator agreement

Spearman rank correlation calculated by list on a pilot 30 verbs

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Same verbs used by White (2015); White et al. (2015), selected based on Hacquard and Wellwood's (2012) attitude verb classification

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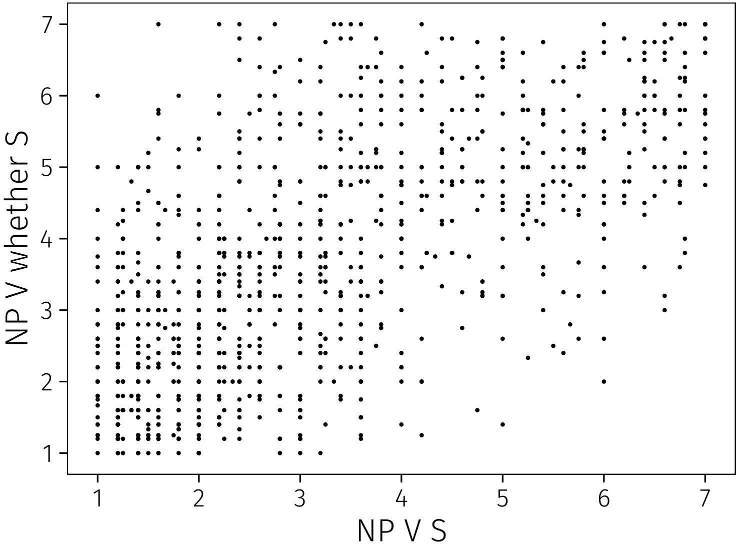
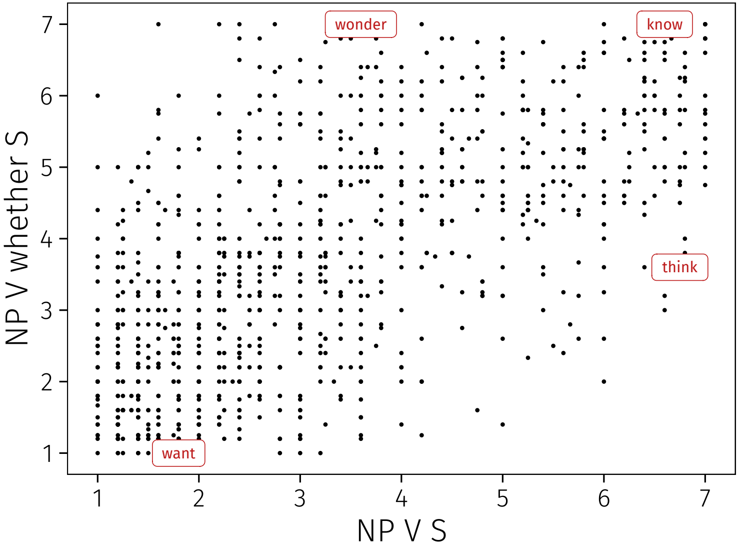
1. **Linguist-to-linguist**
   median: 0.70, *95% CI:* [0.62, 0.78]
2. **Linguist-to-annotator**
   median: 0.55, *95% CI:* [0.52, 0.58]
3. **Annotator-to-annotator**
   median: 0.56, *95% CI:* [0.53, 0.59]


NP V whether S
NP V S
1
2
3
4
5
6
7
1
2
3
4
5
6
7

Results



What about frequency?

Question

Did you really need to go to all this trouble to collect acceptability judgments? Couldn't you just get it from frequency distributions?

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Answer 1

Necessarily yes. Because learners do it.

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Answer 1

Necessarily yes. Because learners do it.

Answer 2

Practically no. At least not without a model that's effectively equivalent to whatever the learner uses.

Corpus data

42.8 million verb-subcategorization frame pairs extracted from Parsed ukWaC (PukWaC) (Baroni et al., 2009)

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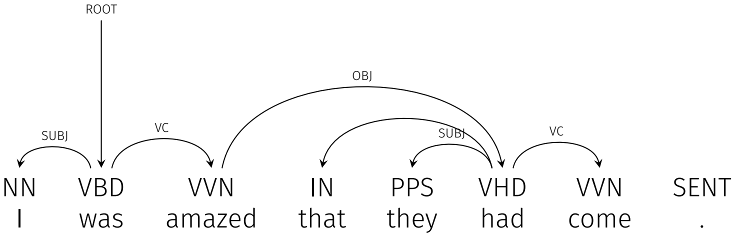

Subcategorization frame extraction

Features extracted see White 2015 for details

1. Form of the matrix subject (i.e. potentially expletive?)

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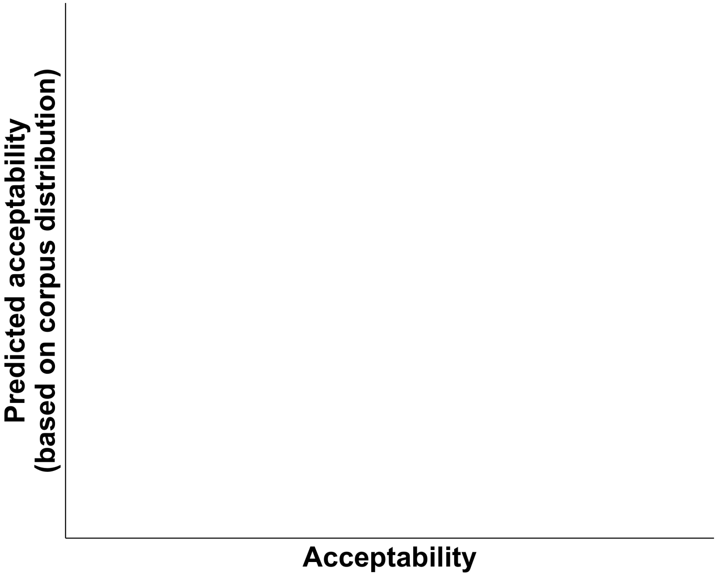
   5.1 ...what the complementizer is (if any)
   5.2 ...what the WH word is (if any)
   5.3 ...what the subject is (if any)
   5.4 ...tense/aspect for the embedded verb (and all auxiliaries)

Acceptability v. PukWaC corpus counts



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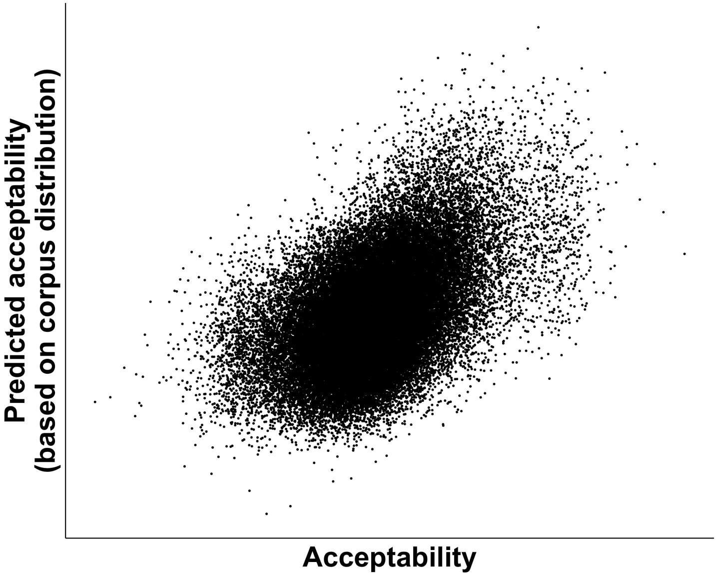

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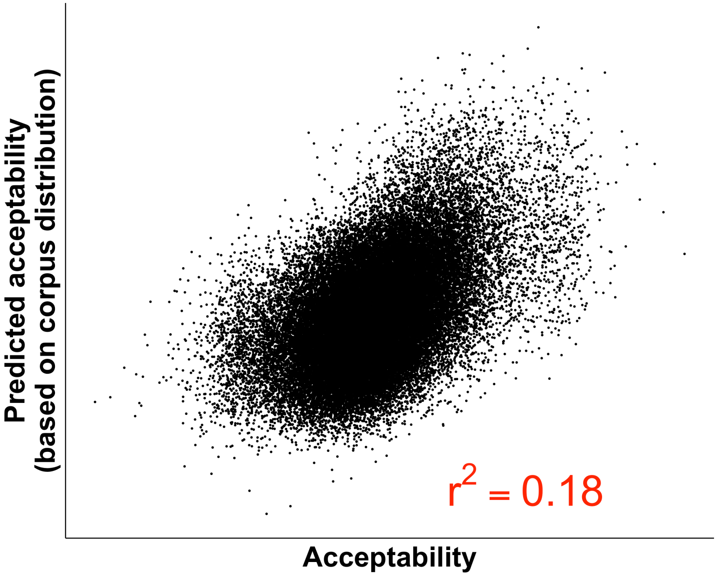

Acceptability v. corpus counts

Question

Is this due to noisy parsing and extraction?

Acceptability v. corpus counts

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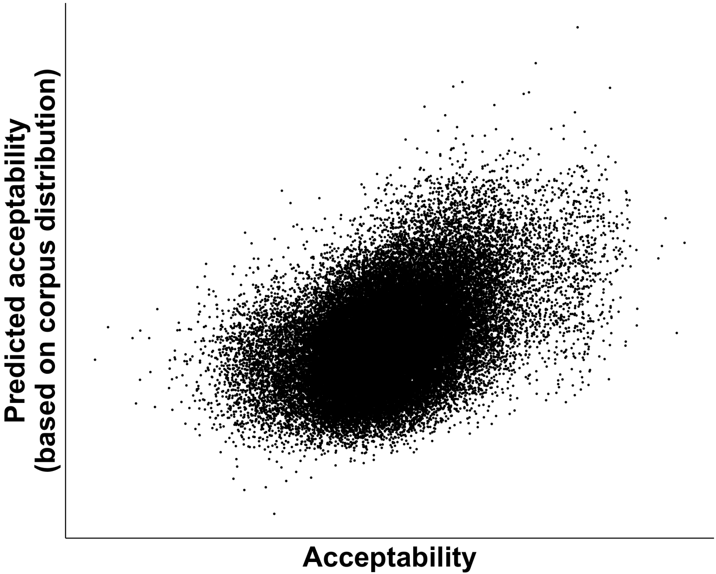
Question

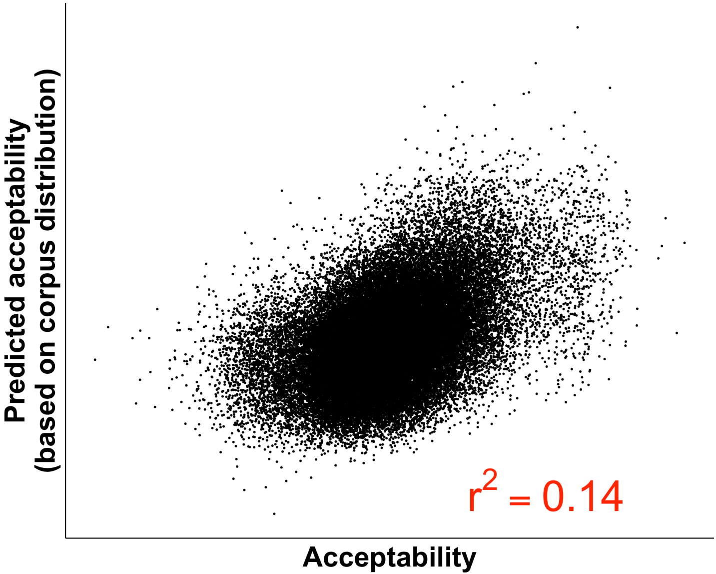
Probably not; purportedly very clean (but smaller) frequency datasets like VALEX (Korhonen et al., 2006) actually have slightly worse cross-validated r^2

Acceptability v. VALEX corpus counts

Acceptability v. VALEX corpus counts



Acceptability v. VALEX corpus counts



Note #1

Does not imply that frequency and acceptability unrelated

Predicting acceptability

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Acceptability is derived in part from frequency data

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Point

Frequency and acceptability are likely not related at the level of syntactic structure

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Solution

We likely need some sort of abstraction that clears away noise

Acceptability v. corpus-based type signatures

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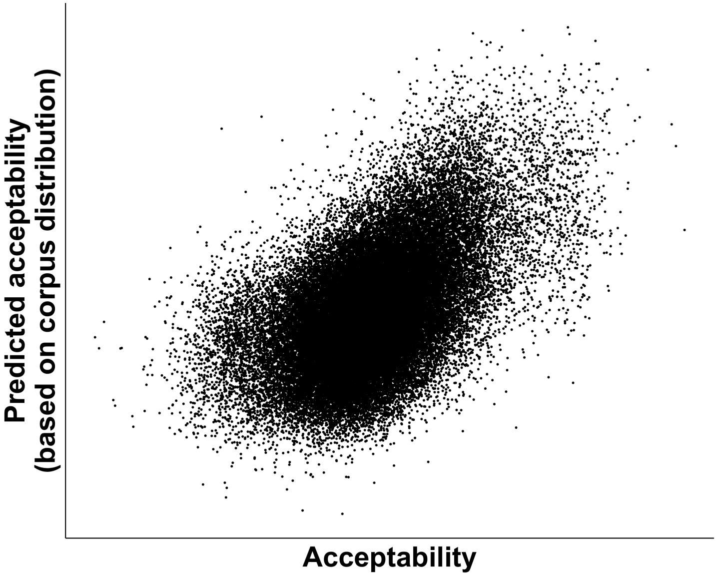
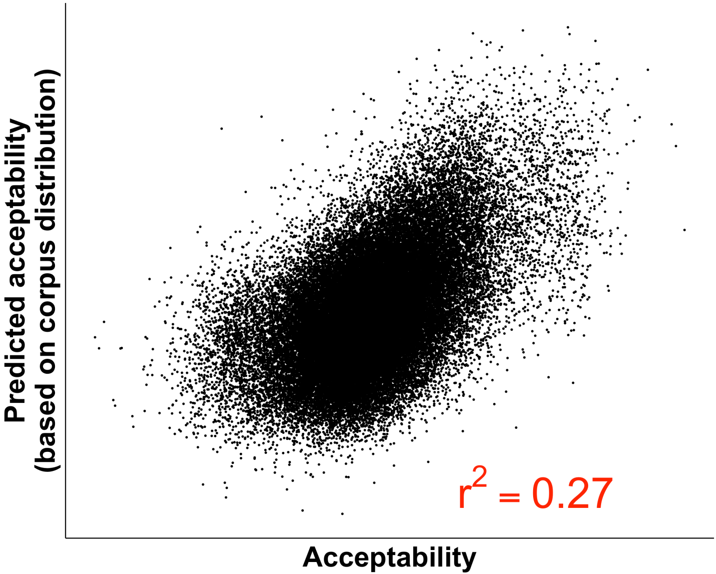


Acceptability v. corpus-based type signatures



Testing correlation

Measurement of syntactic distribution

MegaAcceptability dataset (White and Rawlins, 2016a)

Measurement of veridicality

MegaVeridicality dataset (White and Rawlins, 2018)

Task

…you will be given a statement and a question related to that statement. Your task will be to respond *yes*, *maybe or maybe not*, or *no* to the question, assuming that the statement is true. (cf. Karttunen et al., 2014)

Task

61. **Someone knew that a particular thing happened.**

Did that thing happen?

no	maybe or maybe not	yes
○	○	○

*How acceptable is the **bolded** sentence?*

terrible	2	3	4	5	6	perfect
○	○	○	○	○	○	○

68. **Someone didn't know that a particular thing happened.**

Did that thing happen?

no	maybe or maybe not	yes
○	○	○

*How acceptable is the **bolded** sentence?*

terrible	2	3	4	5	6	perfect
○	○	○	○	○	○	○

Stimuli

517 verbs from the MegaAttitude based on their acceptability in the [NP _ that S] and [NP was _ed that S] frames

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Stimuli

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- 348 verbs only in the active frame

Stimuli

517 verbs from the MegaAttitude based on their acceptability in the [NP _ that S] and [NP was _ed that S] frames

- 348 verbs only in the active frame
- 142 only in the passive frame

Stimuli

517 verbs from the MegaAttitude based on their acceptability in the [NP _ that S] and [NP was _ed that S] frames

- 348 verbs only in the active frame
- 142 only in the passive frame
- 27 in both

Stimuli

517 verbs from the MegaAttitude based on their acceptability in the [NP _ that S] and [NP was _ed that S] frames

- 348 verbs only in the active frame
- 142 only in the passive frame
- 27 in both

1,088 items randomly partitioned into 16 lists of 68

Active

(6) a. Someone thought that a particular thing happened.
b. Someone didn't think that a particular thing happened.

Stimuli

Active

(6) a. Someone thought that a particular thing happened.
    b. Someone didn't think that a particular thing happened.

Passive

(7) a. Someone was told that a particular thing happened.
    b. Someone wasn't told that a particular thing happened.

Stimuli

Active

(6) a. Someone thought that a particular thing happened.
b. Someone didn't think that a particular thing happened.

Passive

(7) a. Someone was told that a particular thing happened.
b. Someone wasn't told that a particular thing happened.

(8) a. Someone was bothered that a particular thing happened.
b. Someone wasn't bothered that a particular thing happened.

Participants

160 unique participants through Amazon's Mechanical Turk

Participants

160 unique participants through Amazon's Mechanical Turk

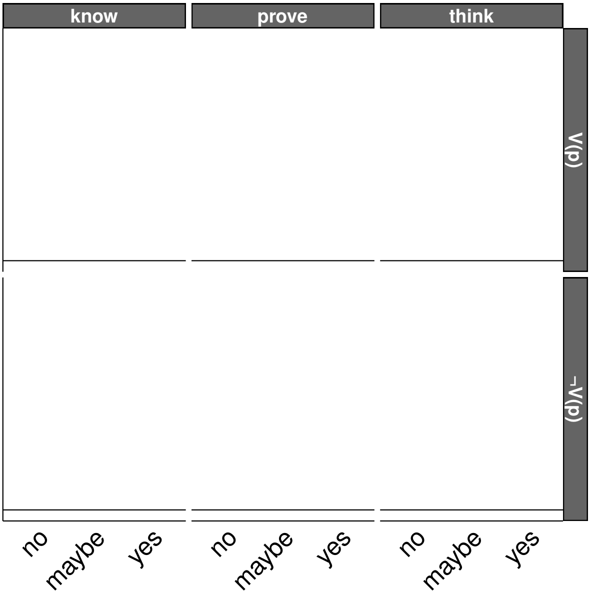
- 10 ratings per item...

Participants

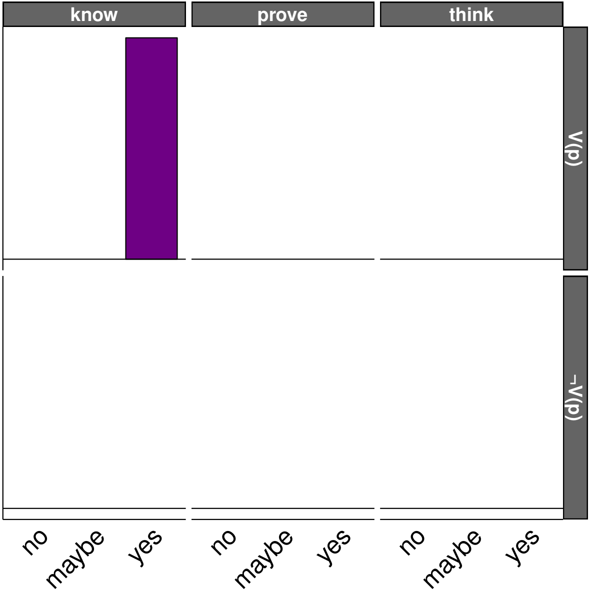
160 unique participants through Amazon’s Mechanical Turk

- 10 ratings per item…
- …given by 10 different participants

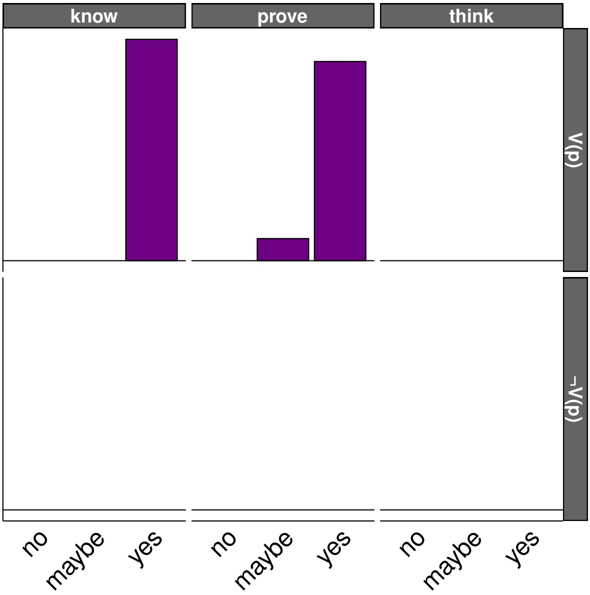
Raw responses



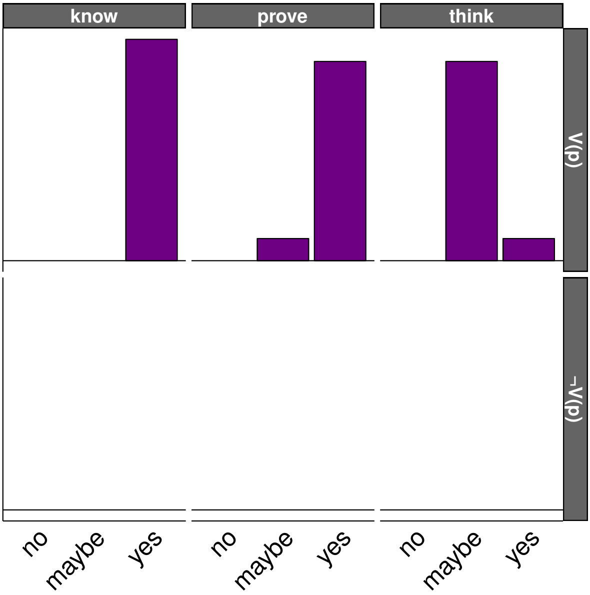
Raw responses



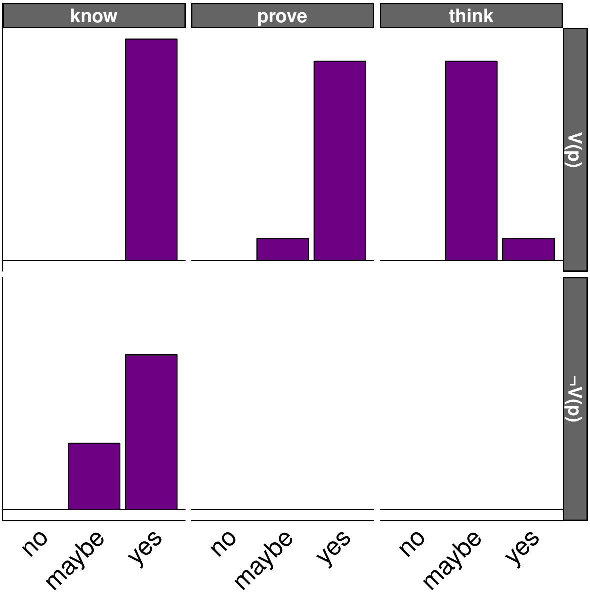
Raw responses



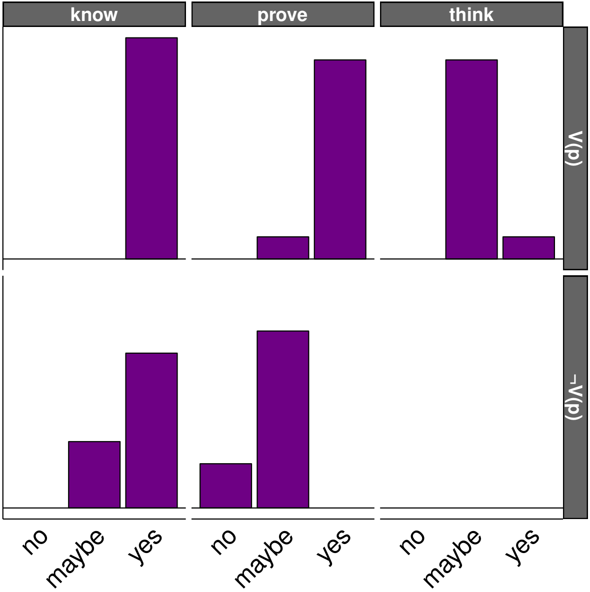
Raw responses



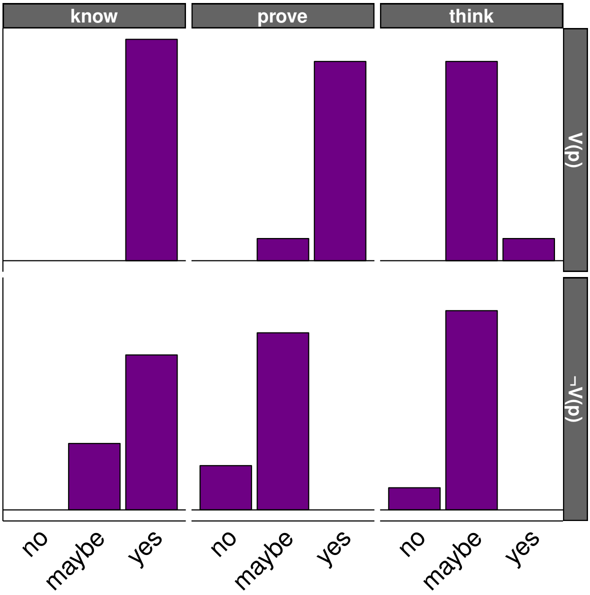
Raw responses



Raw responses



Raw responses

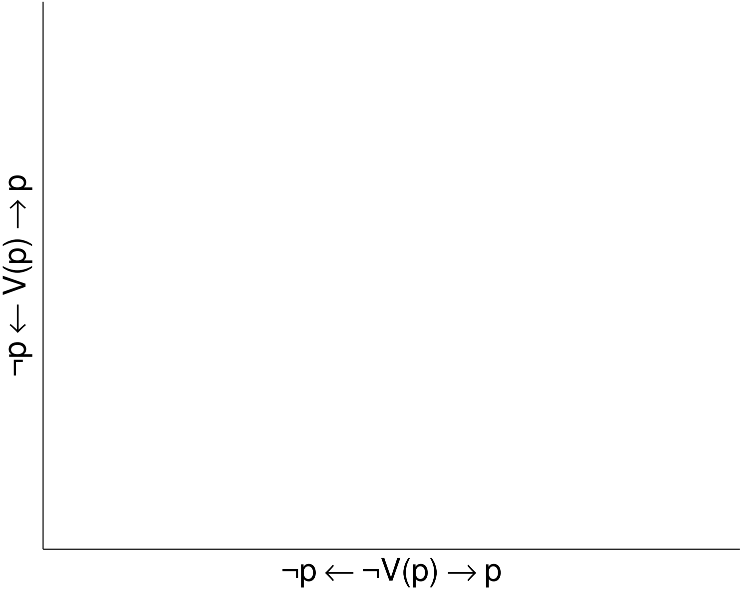


Normalization

Transformation (roughly)

Map each verb to single two-dimensional point by assigning -1 to *no*, 0 to *maybe*, and 1 to *yes*, then take the mean.

Normalized responses



Normalization

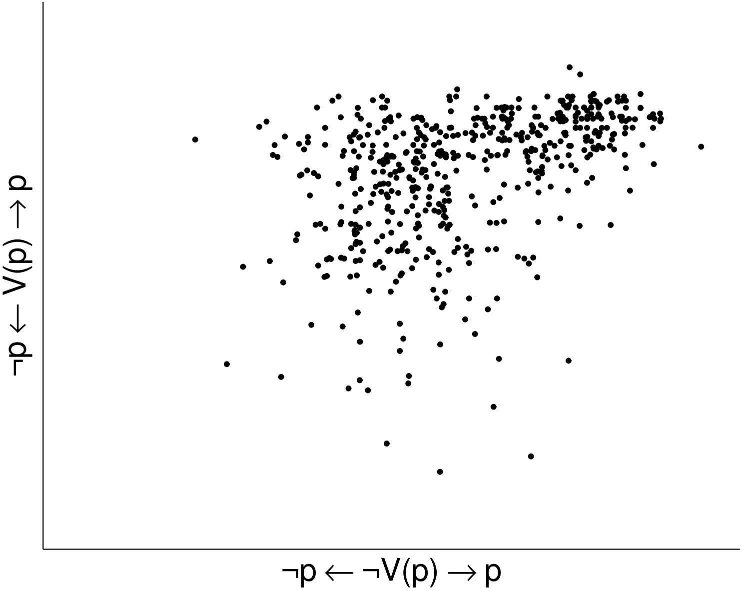
Transformation (roughly)

Map each verb to single two-dimensional point by assigning -1 to *no*, 0 to *maybe*, and 1 to *yes*, then take the mean.

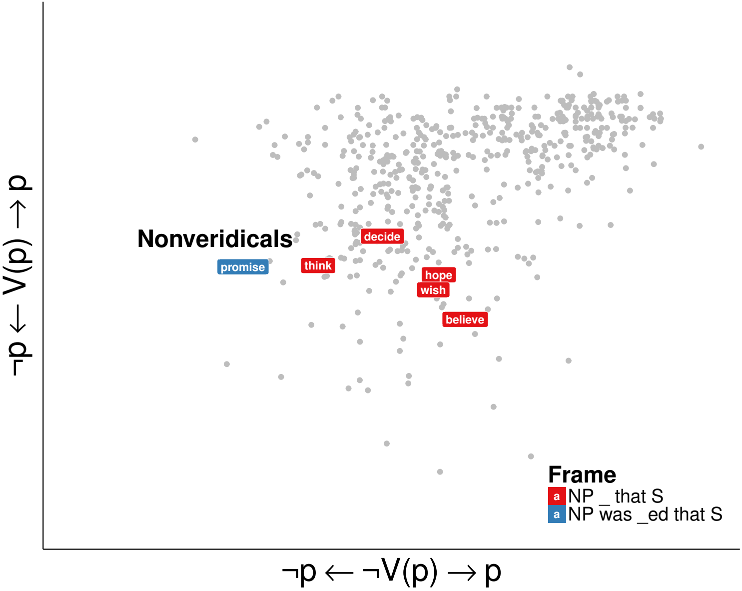
Normalize

Use ridit scoring to normalize for how often a particular participant gives a particular response.

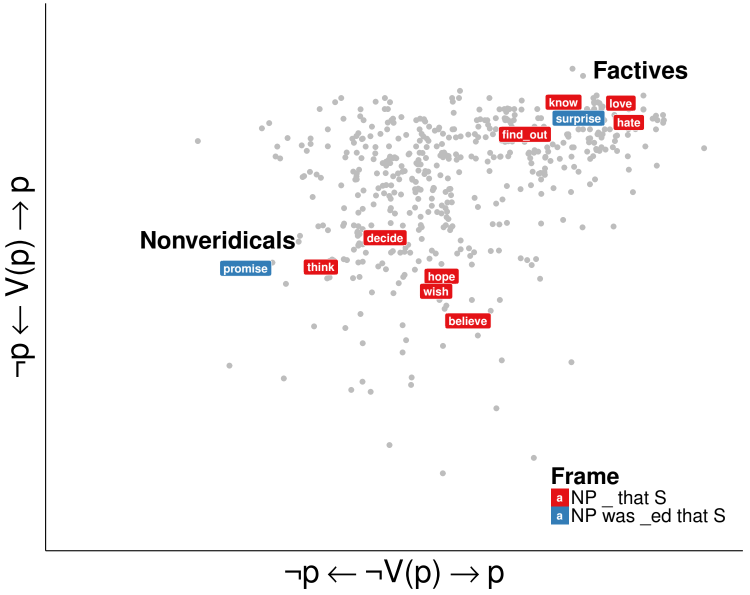
Normalized responses



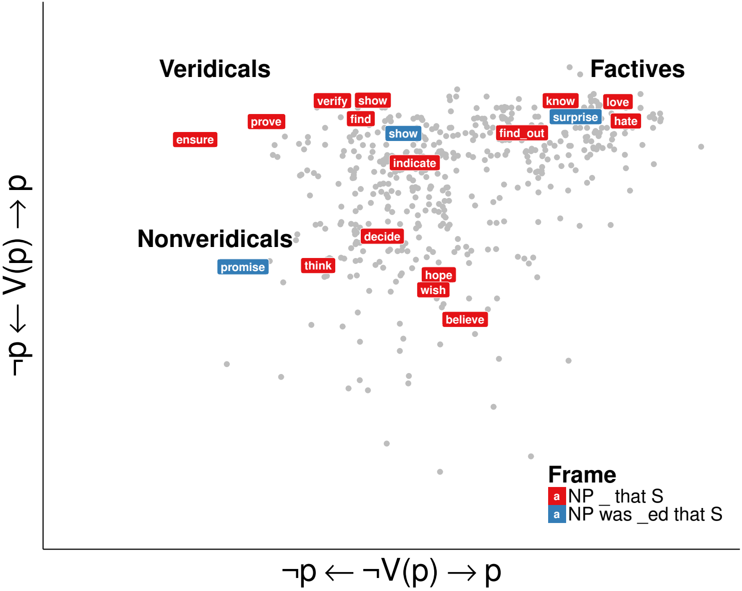
Normalized responses



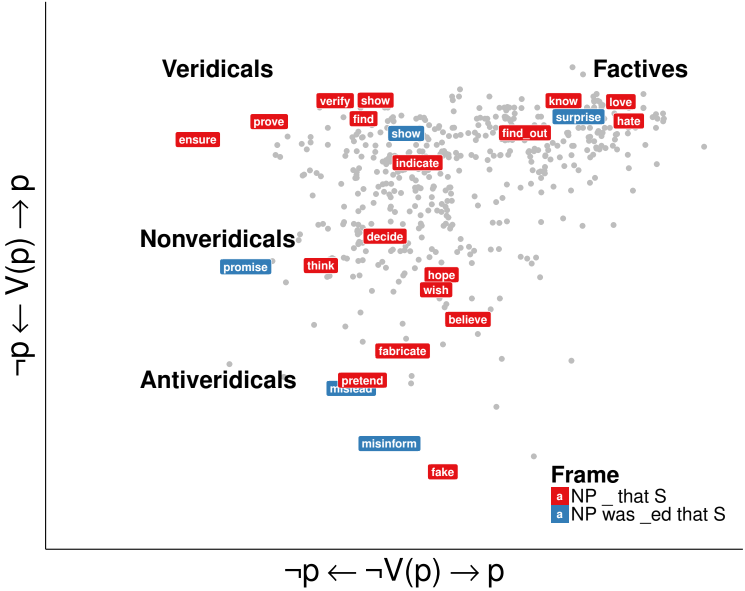
Normalized responses



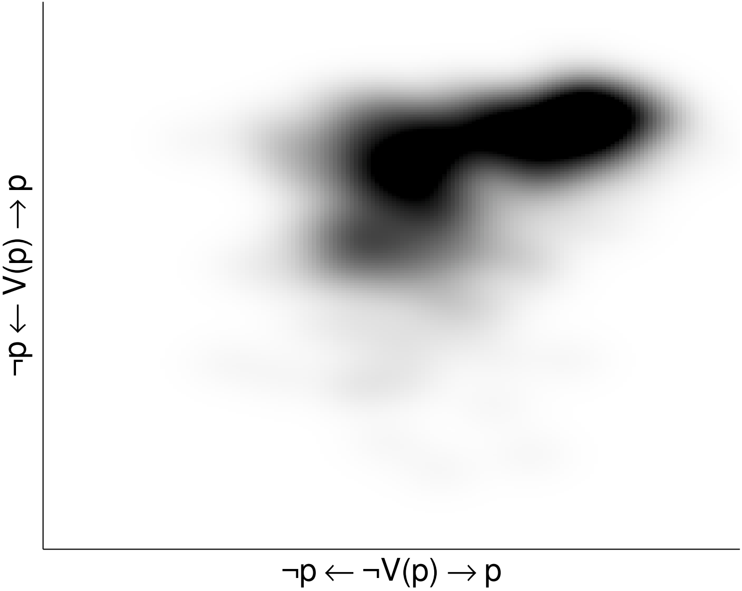
Normalized responses



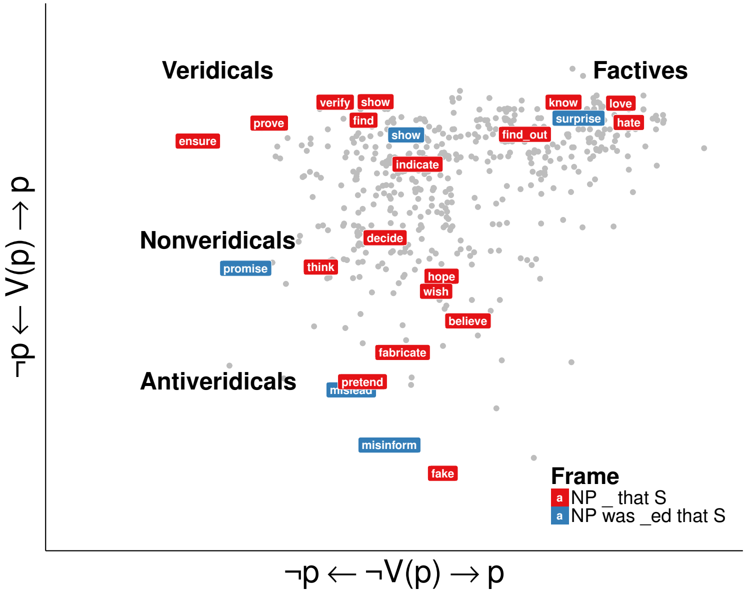
Normalized responses



Normalized responses



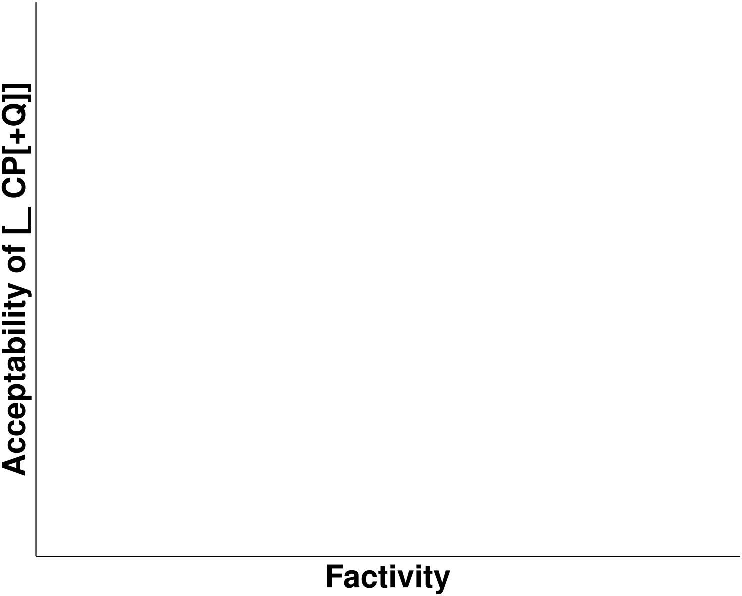
Normalized responses



Question

Do factivity/veridicality positively correlate with question-taking?

Correlation: factivity and question-taking



Measure of question selection

Acceptability of [___CP[+Q]]

For a particular verb, maximum acceptability over all frames that contain an interrogative complement.

Measure of question selection

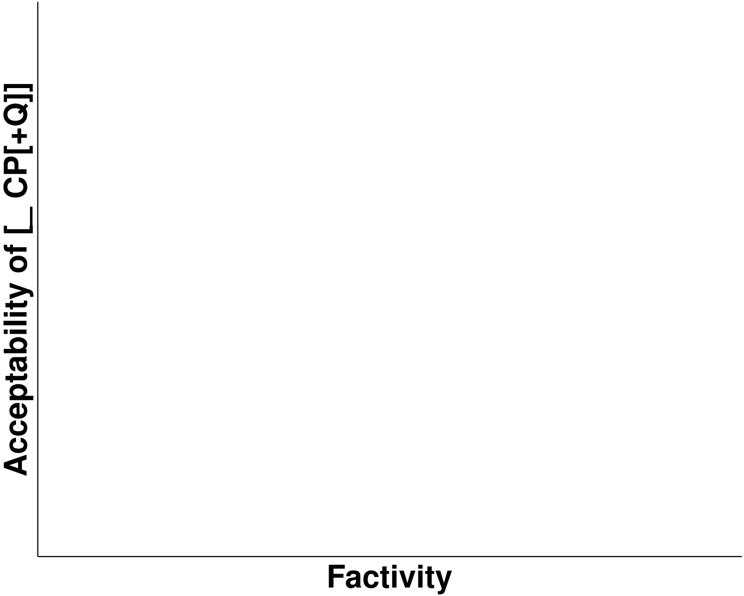
Acceptability of [___CP[+Q]]

For a particular verb, maximum acceptability over all frames that contain an interrogative complement.

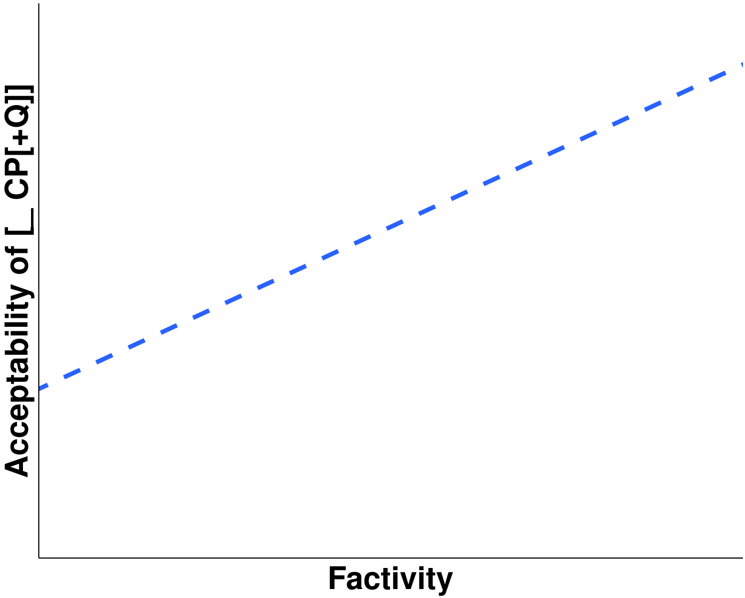
Intuition

If a verb is acceptable in some frame that contains an interrogative complement, it is acceptable with interrogatives.

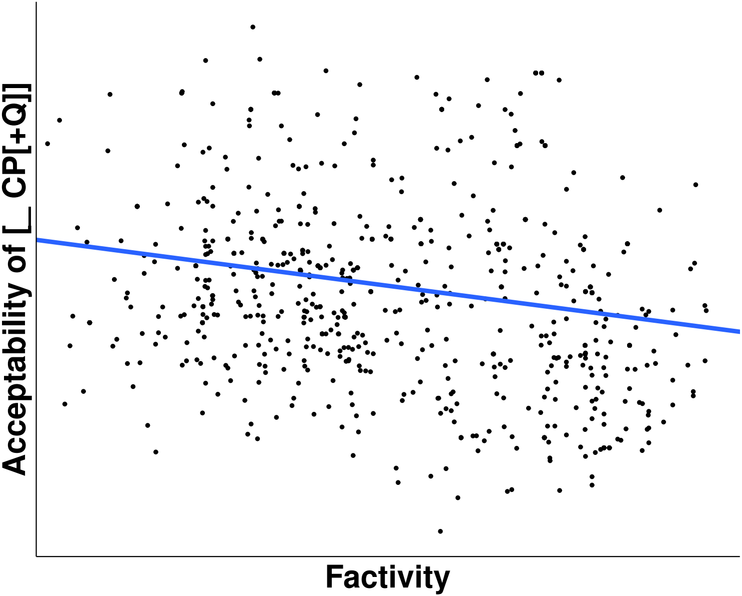
Correlation: factivity and question-taking



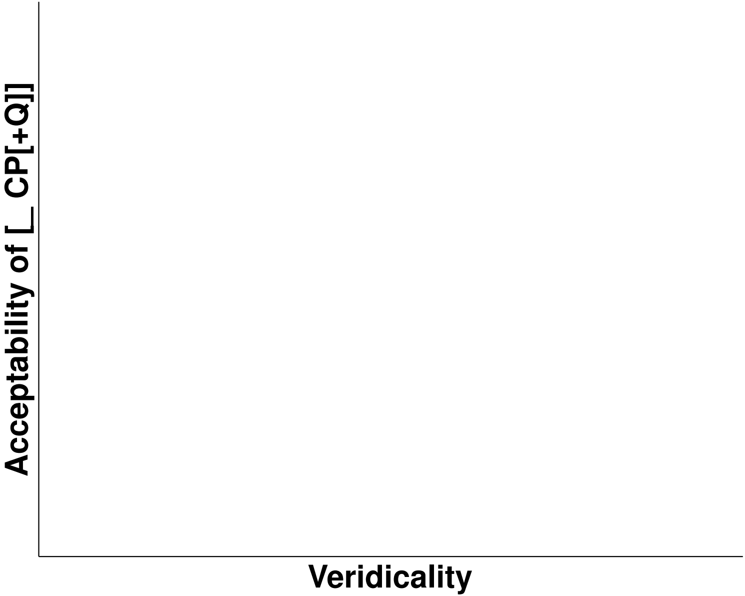
Correlation: factivity and question-taking



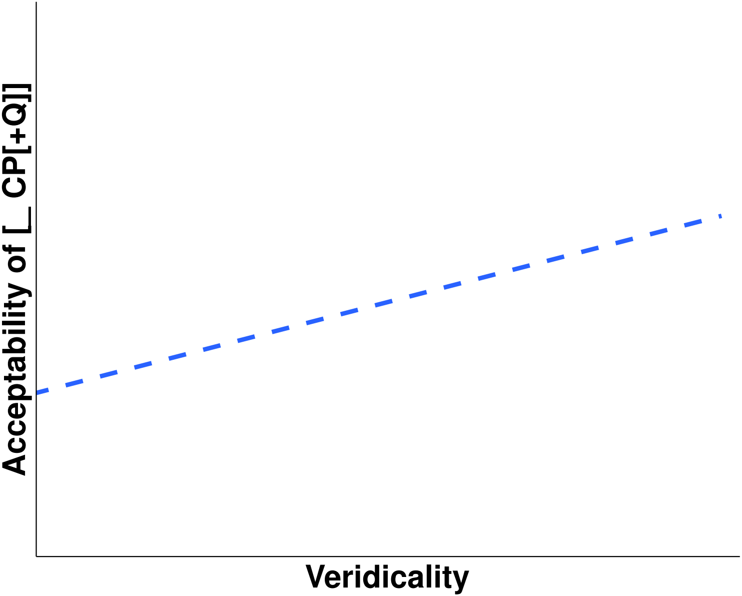
Correlation: factivity and question-taking



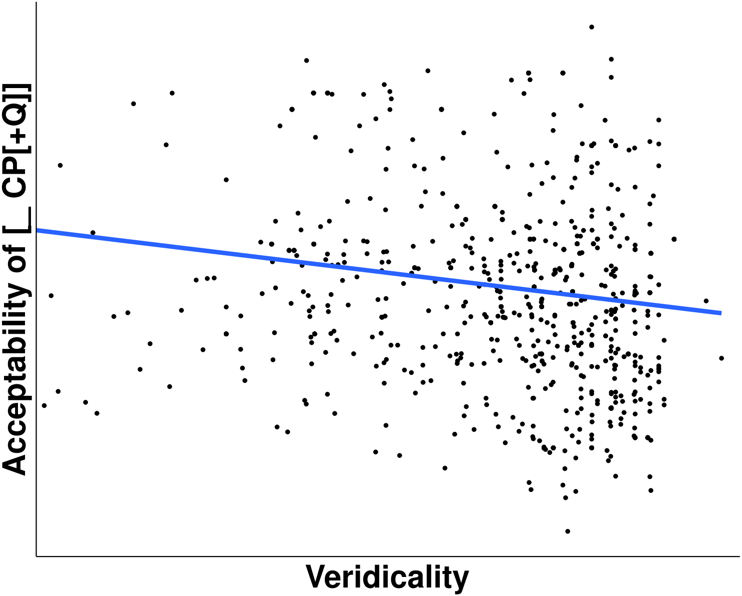
Correlation: veridicality and question-taking



Correlation: veridicality and question-taking



Correlation: veridicality and question-taking



What’s going on?

Question

How could we have gotten the direction of correlation so wrong?

What’s going on?

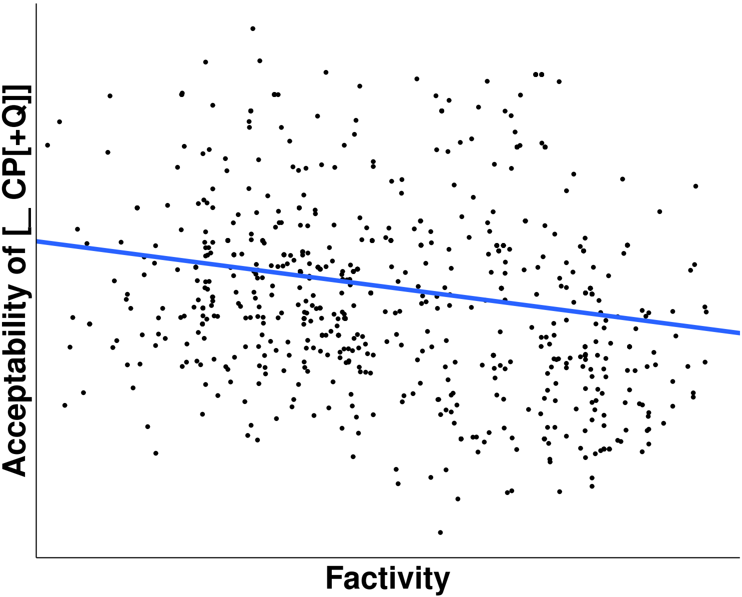
Question

How could we have gotten the direction of correlation so wrong?

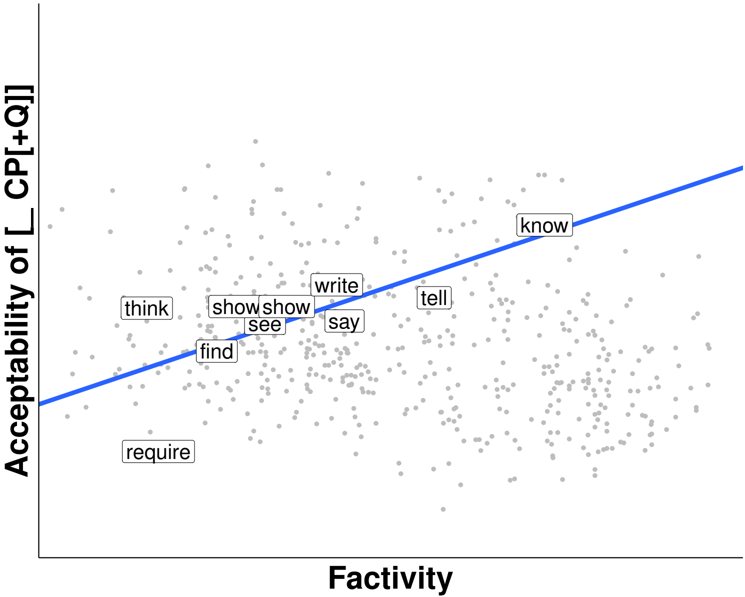
Two hypotheses

1. Previous analyses were biased by verb frequency.

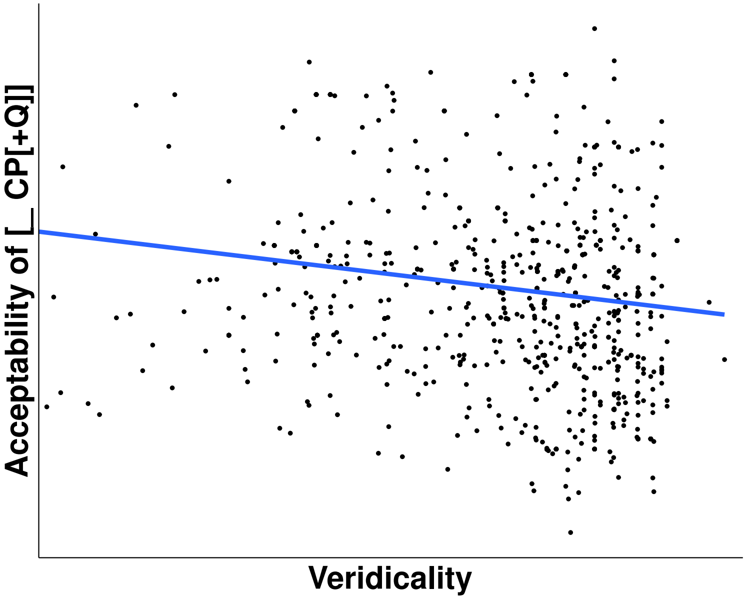
Correlation: factivity with all verbs



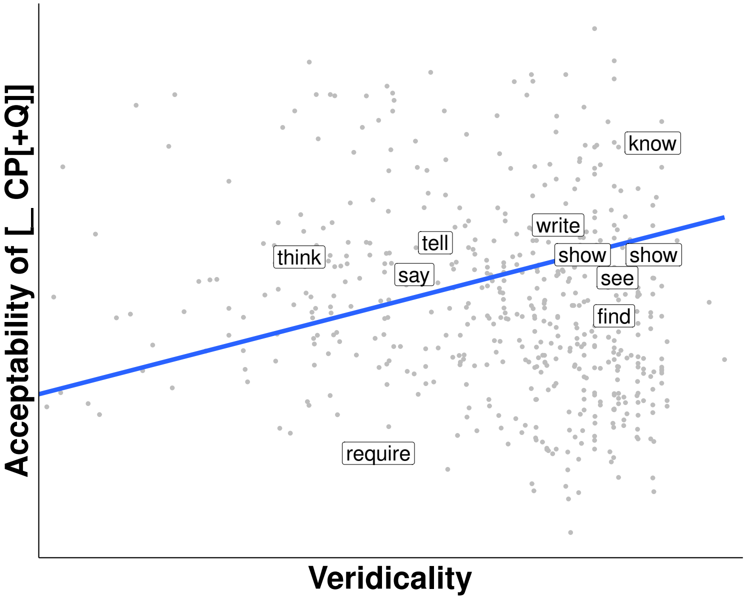
Correlation: factivity with high-frequency verbs

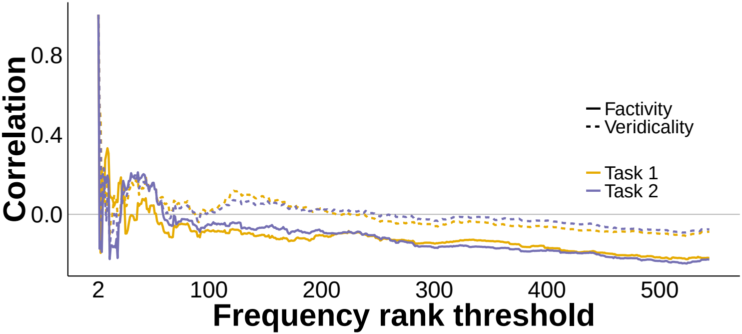


Correlation: veridicality with all verbs



Correlation: veridicality with high-frequency verbs





Correlation
0.8
0.4
0.0
Factivity
Veridicality
Task 1
Task 2
2
100
200
300
400
500
Frequency rank threshold

What's going on?

Question

How could we have gotten the direction of correlation so wrong?

Two hypotheses

1. Previous analyses were biased by verb frequency.
2. Analysis missed subregularities due to verb class.

What's going on?

Question

How could we have gotten the direction of correlation so wrong?

Two hypotheses

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Moving forward

Limitation

Because prior generalizations focus on **finite** interrogatives & declaratives, prior dataset covered only finite complements.

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Because prior generalizations focus on **finite** interrogatives & declaratives, prior dataset covered only finite complements.

But there is substantial variability in the **veridicality inferences** generated with different complements – even for the same verb.

Moving forward

(9) a. Jo_i forgot that she_i bought tofu.

Moving forward

(9) a. Jo_i forgot that she_i bought tofu. $\rightarrow$ Jo bought tofu.

Moving forward

(9) a. Jo_i forgot that she_i bought tofu. $\rightarrow$ Jo bought tofu.
b. Jo forgot to buy tofu.

(9) a. Jo_i forgot that she_i bought tofu. $\rightarrow$ Jo bought tofu.
b. Jo forgot to buy tofu. $\rightarrow$ Jo didn't buy tofu.

Moving forward

(9) a. Jo_i forgot that she_i bought tofu. $\rightarrow$ Jo bought tofu.
b. Jo forgot to buy tofu. $\rightarrow$ Jo didn't buy tofu.

(10) a. Jo_i knew that she_i bought tofu.

Moving forward

(9) a. Jo_i forgot that she_i bought tofu. $\rightarrow$ Jo bought tofu.
b. Jo forgot to buy tofu. $\rightarrow$ Jo didn't buy tofu.

(10) a. Jo_i knew that she_i bought tofu. $\rightarrow$ Jo bought tofu.

Moving forward

(9) a. Jo_i forgot that she_i bought tofu. $\rightarrow$ Jo bought tofu.
b. Jo forgot to buy tofu. $\rightarrow$ Jo didn't buy tofu.

(10) a. Jo_i knew that she_i bought tofu. $\rightarrow$ Jo bought tofu.
b. Jo knew to buy tofu.

Moving forward

(9) a. Jo_i forgot that she_i bought tofu. $\rightarrow$ Jo bought tofu.
b. Jo forgot to buy tofu. $\rightarrow$ Jo didn't buy tofu.

(10) a. Jo_i knew that she_i bought tofu. $\rightarrow$ Jo bought tofu.
b. Jo knew to buy tofu. $\not\rightarrow$ Jo {bought, didn't buy} tofu.

Limitation

Because prior generalizations focus on **finite** interrogatives & declaratives, prior dataset covered only finite complements.

But there is substantial variability in the **veridicality inferences** generated with different complements – even for the same verb.

Moving forward

Limitation

Because prior generalizations focus on **finite** interrogatives & declaratives, prior dataset covered only finite complements.

But there is substantial variability in the **veridicality inferences** generated with different complements – even for the same verb.

Aim

Measure **veridicality inferences** across a wide variety of syntactic contexts.

Predicting distribution from veridicality

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)

Stimuli

NP _ed for NP to VP

(11) a. Someone wanted for a particular thing to happen.
b. Someone didn't want for a particular thing to happen.

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)

Stimuli

NP _ed for NP to VP

(11) a. Someone wanted for a particular thing to happen.
b. Someone didn’t want for a particular thing to happen.

NP _ed NP to VP[+ev]

(12) a. Someone told a particular person to do a particular thing.
b. Someone didn’t tell a particular person to do a particular thing.

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)

Stimuli

NP _ed for NP to VP

(11) a. Someone wanted for a particular thing to happen.
b. Someone didn't want for a particular thing to happen.

NP _ed NP to VP[+ev]

(12) a. Someone told a particular person to do a particular thing.
b. Someone didn't tell a particular person to do a particular thing.

NP _ed NP to VP[-ev]

(13) a. Someone believed a particular person to have a particular thing.
b. Someone didn't believe a particular person to have a particular thing.

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)

Stimuli

Expand MegaVeridicality with **603 verb types** from MegaAcceptability based on acceptability in **7 frames** involving **infinitival complements**:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)
- [NP was _ed NP to VP[+ev]] (278 verbs)

NP was _ed to VP[+ev]

(14) a. A particular person was ordered to do a particular thing.
b. A particular person wasn't ordered to do a particular thing.

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)
- [NP was _ed NP to VP[+ev]] (278 verbs)

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)
- [NP was _ed NP to VP[+ev]] (278 verbs)
- [NP was _ed NP to VP[-ev]] (256 verbs)

Stimuli

NP was _ed to VP[+ev]

(14) a. A particular person was ordered to do a particular thing.
b. A particular person wasn’t ordered to do a particular thing.

NP was _ed to VP[-ev]

(15) a. A particular person was overjoyed to have a particular thing.
b. A particular person wasn’t overjoyed to have a particular thing.

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)
- [NP was _ed NP to VP[+ev]] (278 verbs)
- [NP was _ed NP to VP[-ev]] (256 verbs)

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)
- [NP was _ed NP to VP[+ev]] (278 verbs)
- [NP was _ed NP to VP[-ev]] (256 verbs)
- [NP _ed to VP[+ev]] (217 verbs)

NP _ed to VP[+ev]

(16) a. A particular person decided to do a particular thing.
b. A particular person didn't decide to do a particular thing.

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
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- [NP was _ed NP to VP[+ev]] (278 verbs)
- [NP was _ed NP to VP[-ev]] (256 verbs)
- [NP _ed to VP[+ev]] (217 verbs)

Stimuli

Expand MegaVeridicality with **603 verb types** from MegaAcceptability based on acceptability in **7 frames** involving **infinitival complements**:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)
- [NP was _ed NP to VP[+ev]] (278 verbs)
- [NP was _ed NP to VP[-ev]] (256 verbs)
- [NP _ed to VP[+ev]] (217 verbs)
- [NP _ed to VP[-ev]] (165 verbs)

Stimuli

NP _ed to VP[+ev]

(16) a. A particular person decided to do a particular thing.
b. A particular person didn’t decide to do a particular thing.

NP _ed to VP[-ev]

(17) a. A particular person hoped to have a particular thing.
b. A particular person didn’t hope to have a particular thing.

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)
- [NP was _ed NP to VP[+ev]] (278 verbs)
- [NP was _ed NP to VP[-ev]] (256 verbs)
- [NP _ed to VP[+ev]] (217 verbs)
- [NP _ed to VP[-ev]] (165 verbs)

Stimuli

Expand MegaVeridicality with 603 verb types from MegaAcceptability based on acceptability in 7 frames involving infinitival complements:

- [NP _ed for NP to VP] (184 verbs)
- [NP _ed NP to VP[+ev]] (197 verbs)
- [NP _ed NP to VP[-ev]] (128 verbs)
- [NP was _ed NP to VP[+ev]] (278 verbs)
- [NP was _ed NP to VP[-ev]] (256 verbs)
- [NP _ed to VP[+ev]] (217 verbs)
- [NP _ed to VP[-ev]] (165 verbs)

2,850 items randomly partitioned into 50 lists of 57

Note

Mixed-effects ordinal model-based normalization to control for variability in how participants use the response scale. (see Agresti, 2014)

Results

Note

Mixed-effects ordinal model-based normalization to control for variability in how participants use the response scale. (see Agresti, 2014)

Applied to both veridicality and acceptability judgments.

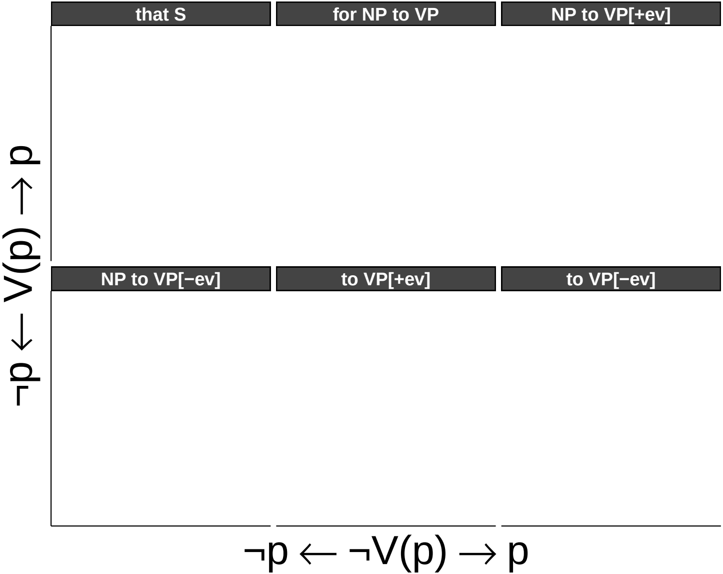
Results

Note
Mixed-effects ordinal model-based normalization to control for variability in how participants use the response scale. (see Agresti, 2014)

Applied to both veridicality and acceptability judgments.

Intuition
Like *z*-scoring, but better models response behavior.

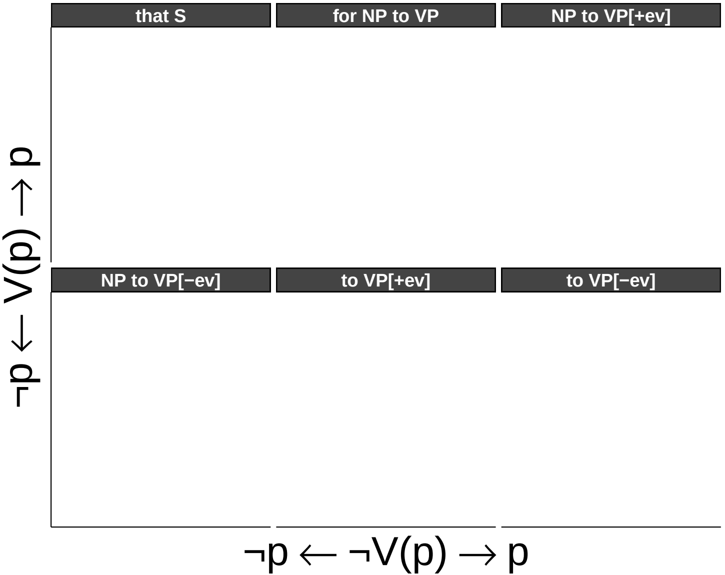
Results


that S
for NP to VP
NP to VP[+ev]
NP to VP[−ev]
to VP[+ev]
to VP[−ev]
¬p ← V(p) → p
¬p ← ¬V(p) → p

Example: *x*-axis

A particular person didn't forget to do a particular thing.

Results


that S
for NP to VP
NP to VP[+ev]
NP to VP[−ev]
to VP[+ev]
to VP[−ev]
¬p ← V(p) → p
¬p ← ¬V(p) → p

Results

Example: *x*-axis

A particular person didn't forget to do a particular thing.

Results

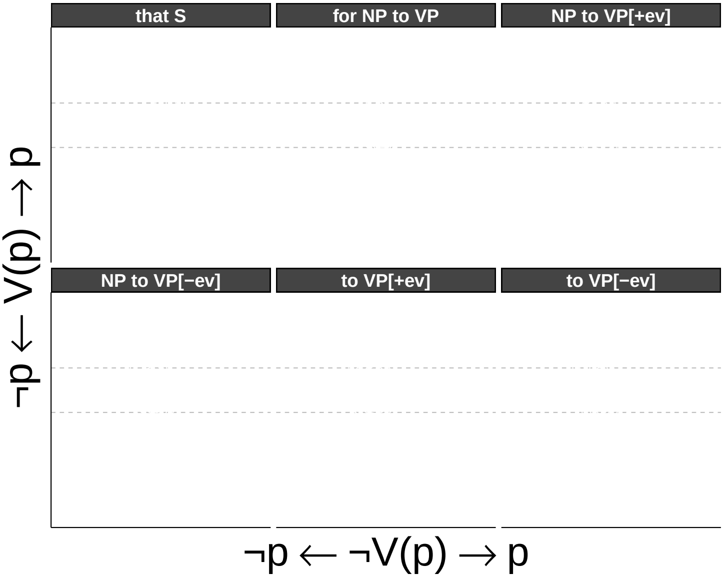
Example: x-axis

A particular person didn’t forget to do a particular thing.

Example: y-axis

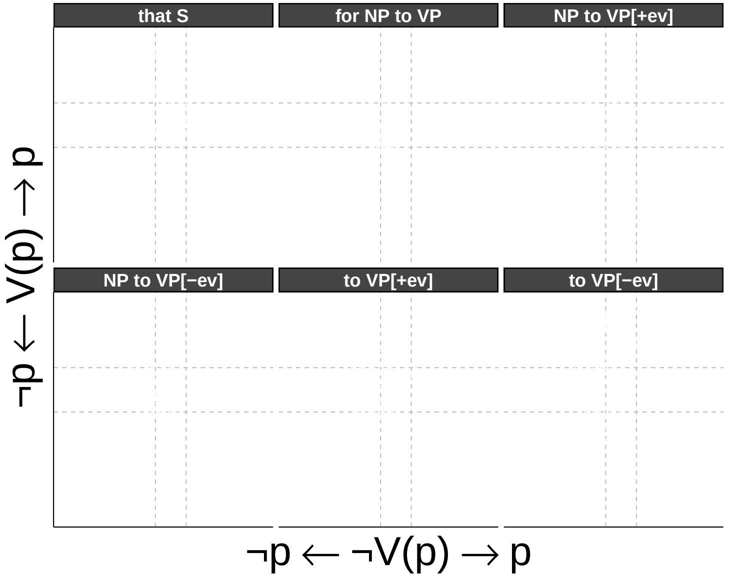
A particular person forgot to do a particular thing.

Results



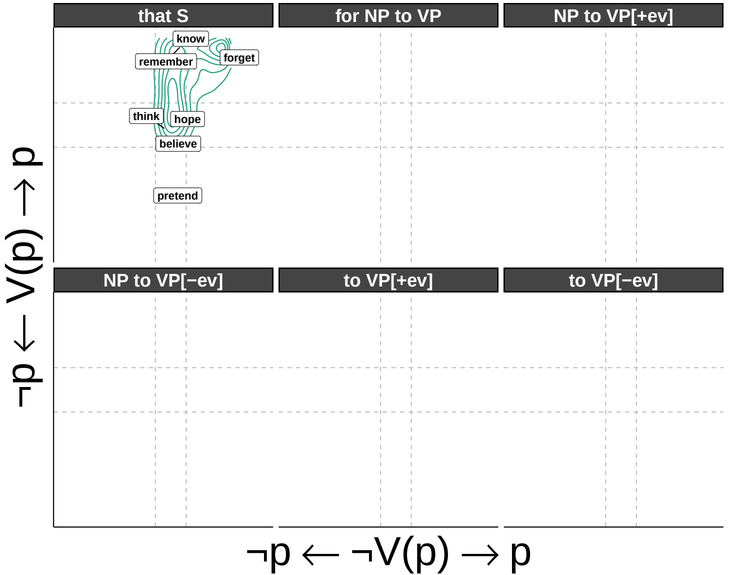
that S
for NP to VP
NP to VP[+ev]
NP to VP[−ev]
to VP[+ev]
to VP[−ev]
¬p ← V(p) → p
¬p ← ¬V(p) → p

Results



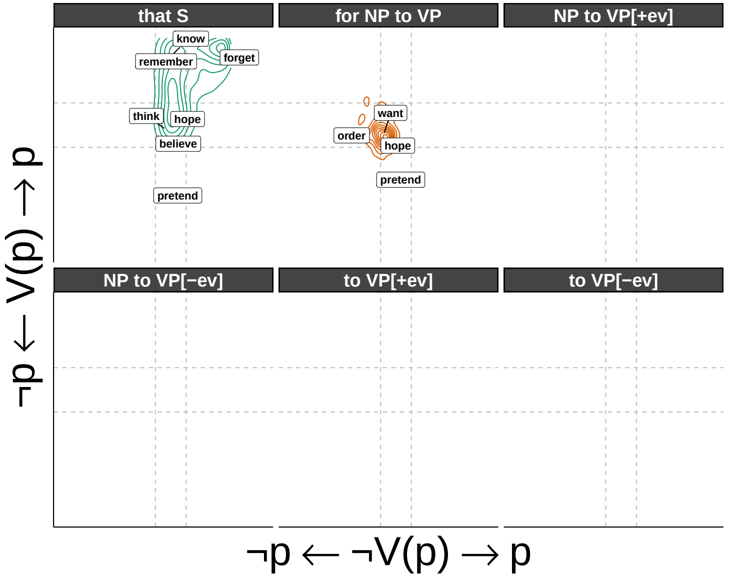
that S
for NP to VP
NP to VP[+ev]
NP to VP[−ev]
to VP[+ev]
to VP[−ev]
¬p ← V(p) → p
¬p ← ¬V(p) → p

Results



that S
for NP to VP
NP to VP[+ev]
NP to VP[−ev]
to VP[+ev]
to VP[−ev]
know
remember
forget
think
hope
believe
pretend
¬p ← ¬V(p) → p
¬p ← V(p) → p

Results



that S
for NP to VP
NP to VP[+ev]
know
remember
forget
think
hope
believe
pretend
want
order
hope
pretend
NP to VP[−ev]
to VP[+ev]
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¬p ← V(p) → p
¬p ← ¬V(p) → p

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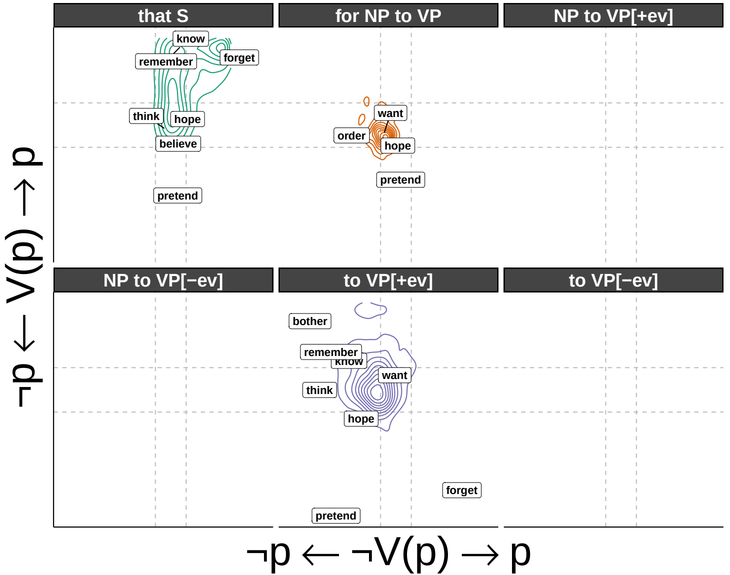
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think
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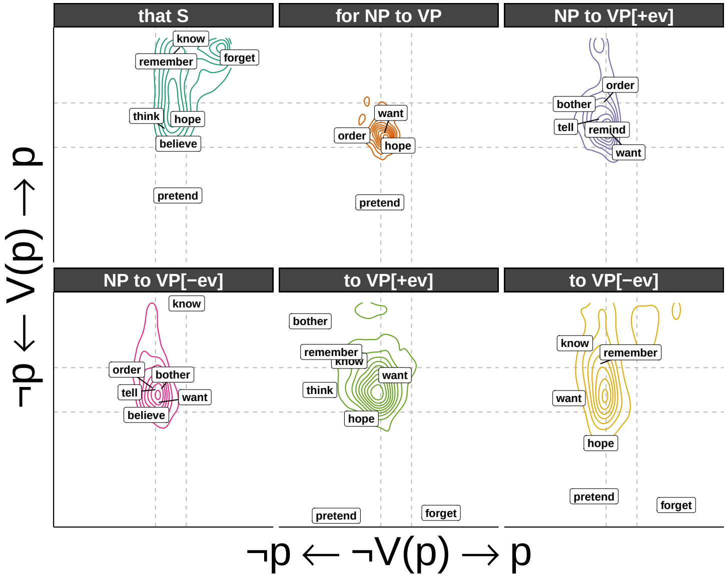
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remind
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What about frequency?

Question

Did you really need to go to all this trouble to collect veridicality judgments? Couldn't you just get it from annotated corpora?

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Veridicality corpus annotations

1. FactBank (Saurí and Pustejovsky, 2009, 2012)

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Necessarily yes. Because learners do it.

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Necessarily yes. Because learners do it.

Answer 2

Practically no. At least not without a model that's effectively equivalent to whatever the learner uses.

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Veridicality corpus annotations

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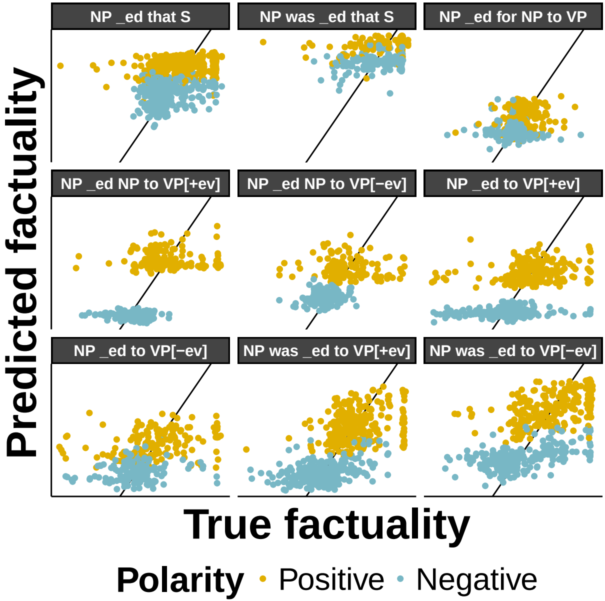
Current state-of-the-art

Hybrid linear-chain/tree structured neural model. (Rudinger et al., 2018)

Predicting veridicality



Sentence	True	Predicted
someone faked that something happened .	-3.15	0.86
someone was misinformed that something happened .	-2.62	1.37
someone neglected to do something .	-3.07	-0.02
someone pretended to have something .	-2.96	0.05
someone was misjudged to have something .	-2.46	0.55
someone forgot to have something .	-3.18	-0.17
someone neglected to have something .	-2.93	0.07
someone pretended that something happened .	-2.11	0.86
someone declined to do something .	-3.18	-0.22
someone was refused to do something .	-3.16	-0.22
someone refused to do something .	-3.12	-0.20
someone pretended to do something .	-3.02	-0.11
someone disallowed someone to do something .	-2.56	0.34
someone was declined to have something .	-2.36	0.55
someone declined to have something .	-3.12	-0.23
someone did n't hesitate to have something .	1.84	-0.96
someone ceased to have something .	-2.22	0.57
someone did n't hesitate to do something .	1.86	-0.92
someone lied that something happened .	-1.99	0.78
someone feigned to have something .	-3.07	-0.31

Goal

Extract patterns of inference – e.g. factive, veridical, or implicative.

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Use an automated method to discover inference patterns across verbs by decomposing veridical data into underlying factors.

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Preliminaries

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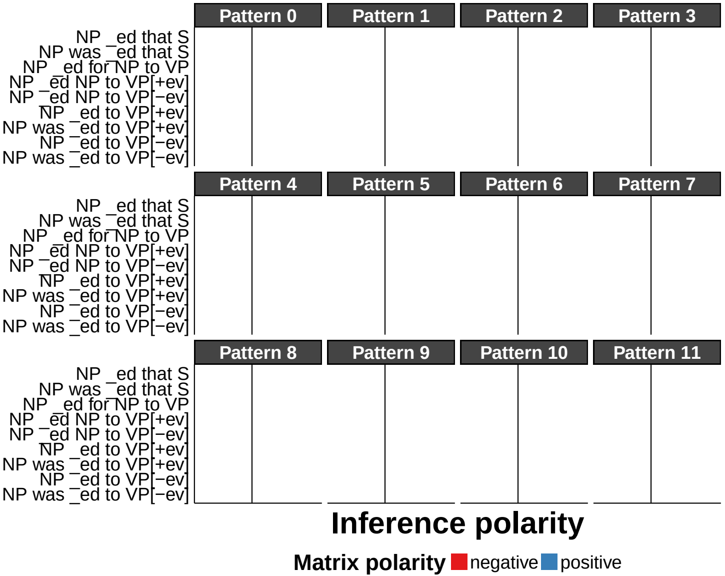
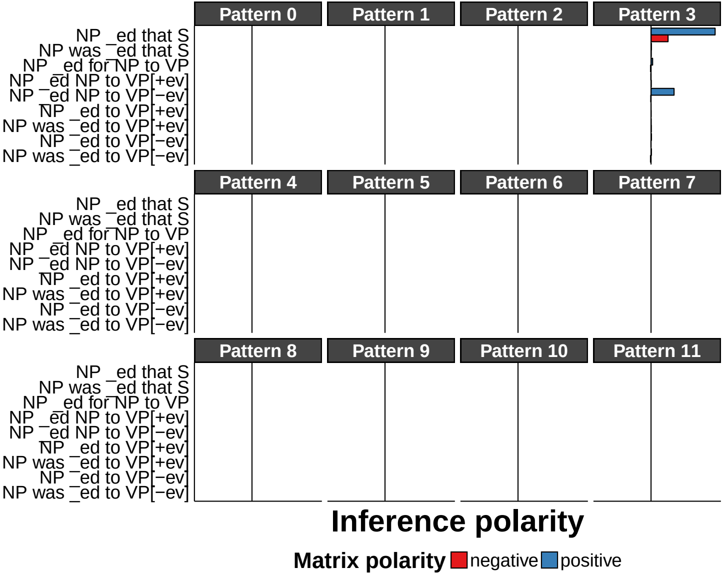
(Ask about specifics after the talk.)

Inference patterns



Inference patterns



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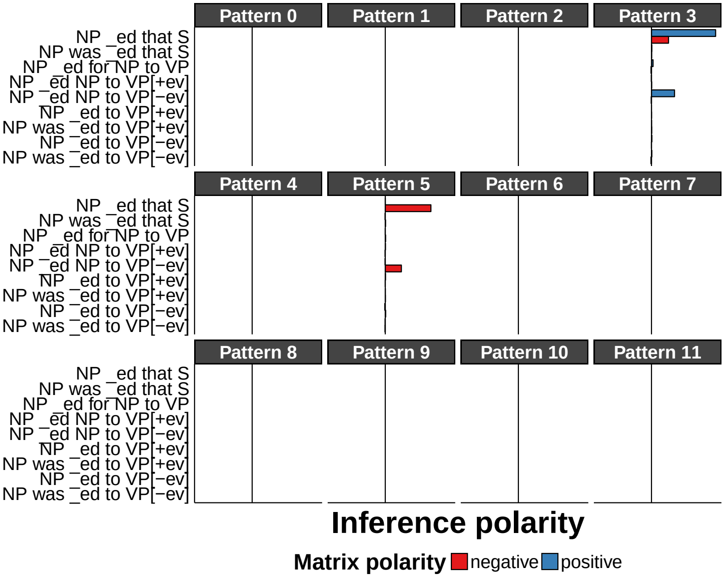

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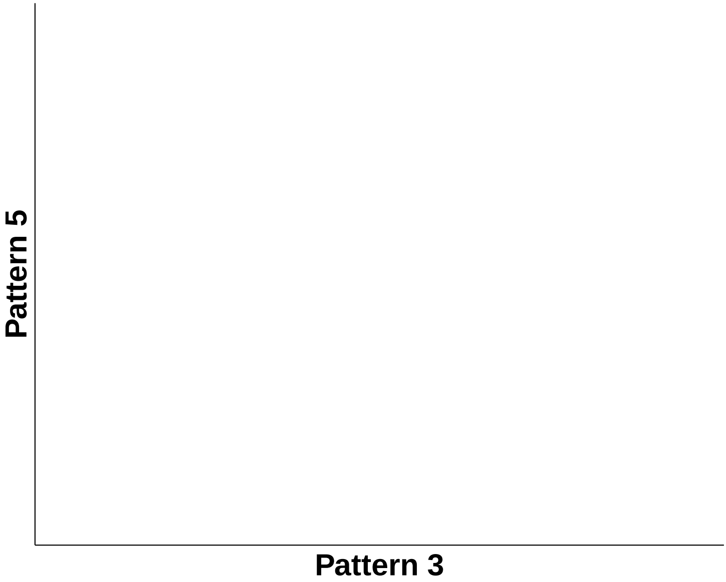

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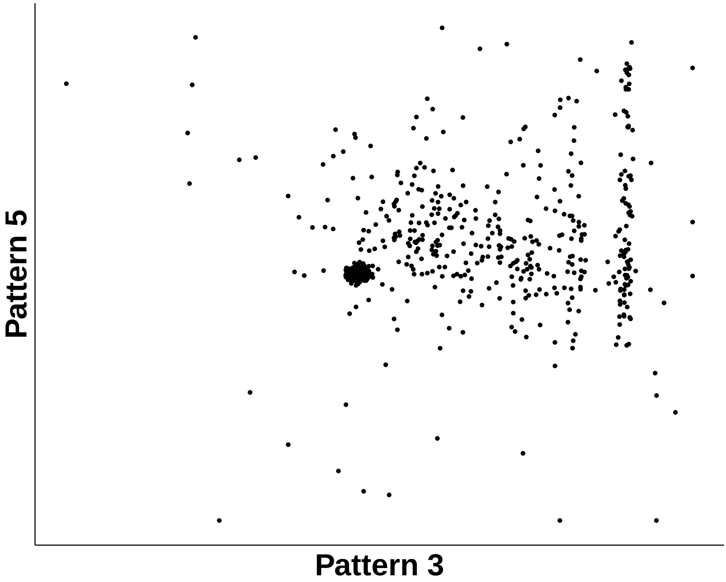
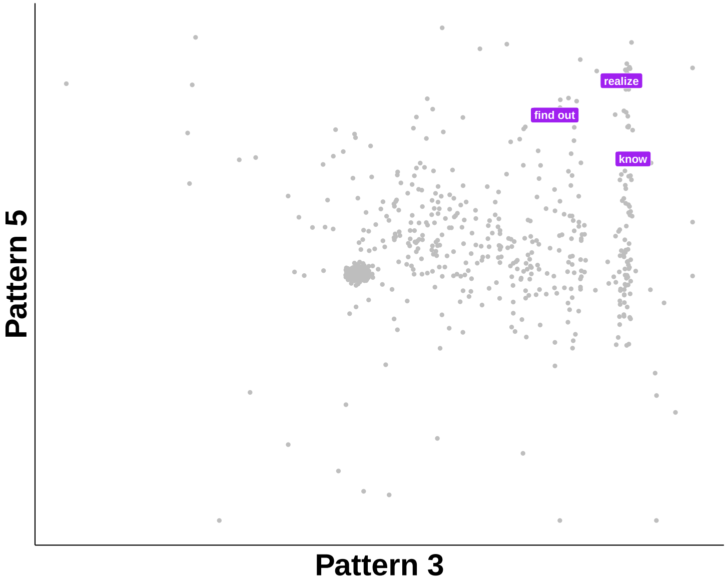


Inference patterns: factivity/veridicality



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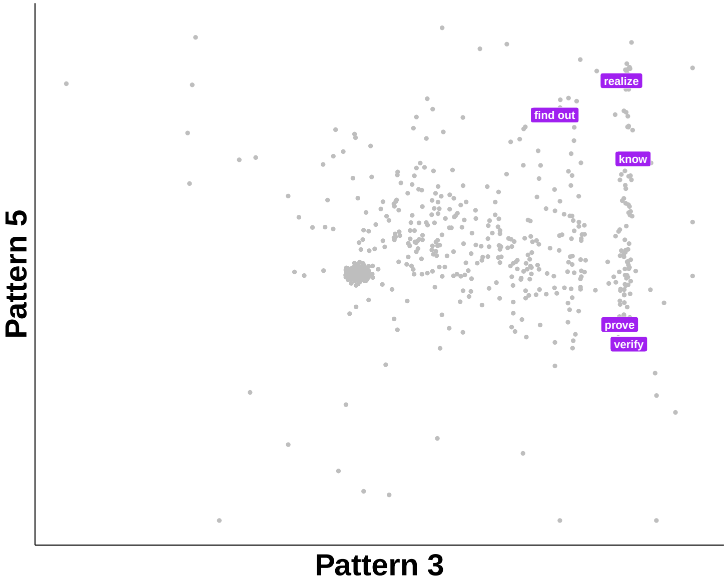
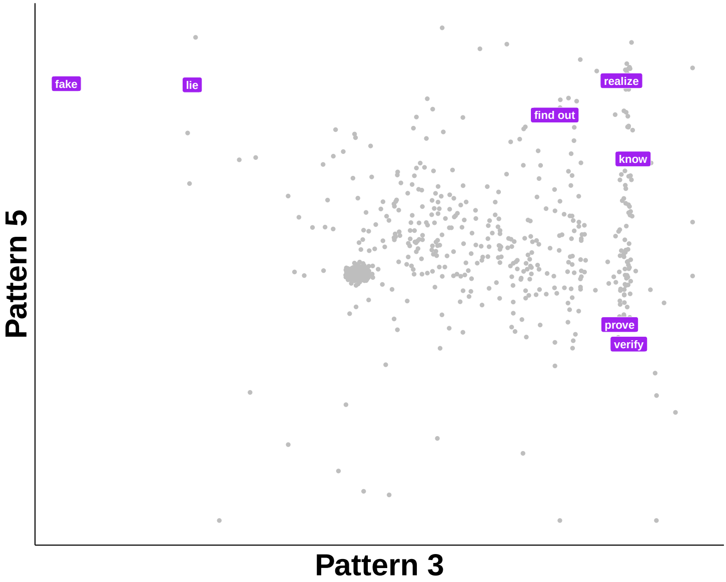
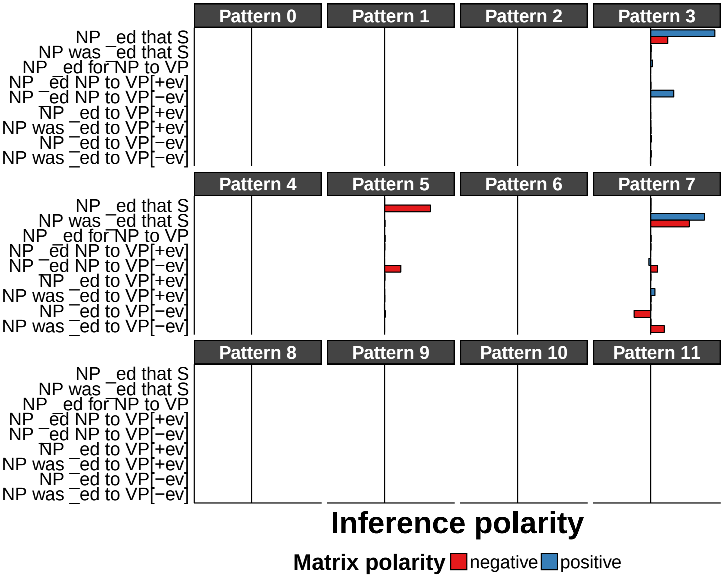
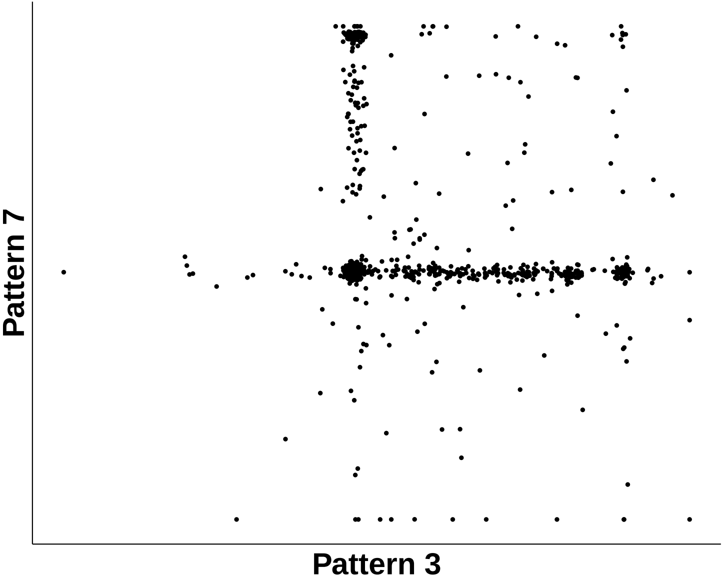


Inference patterns: factivity/veridicality

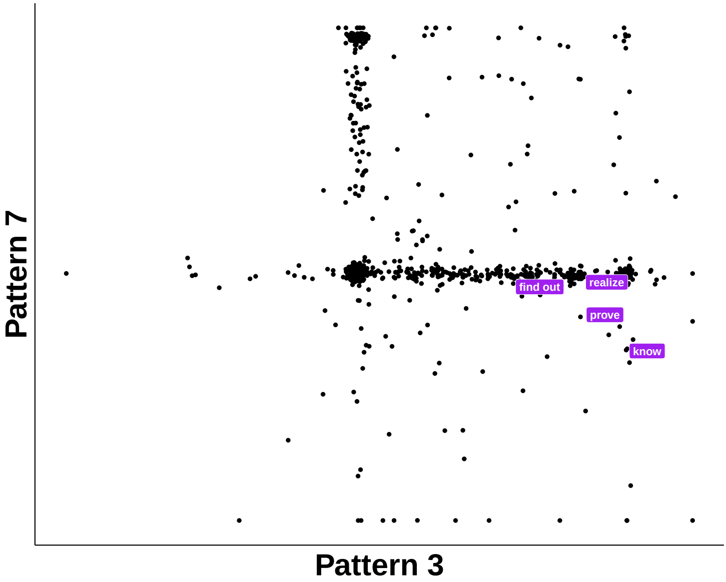


Inference patterns

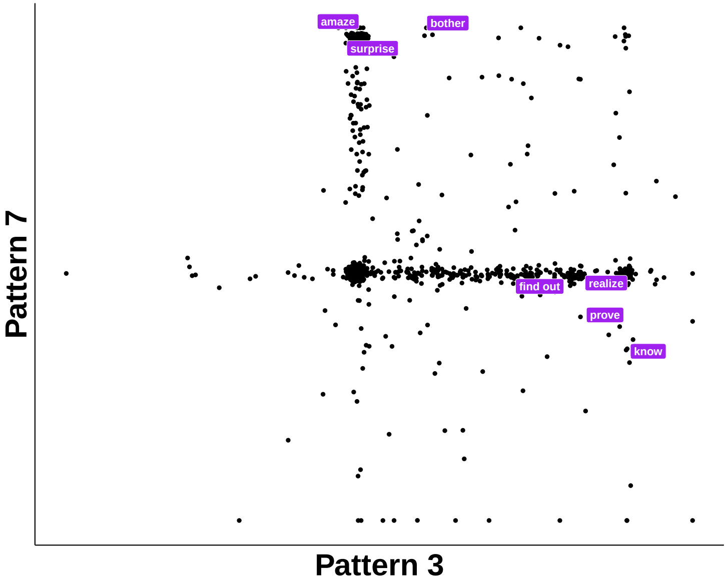



Pattern 7
Pattern 3

Inference patterns



Inference patterns: factivity/veridicality



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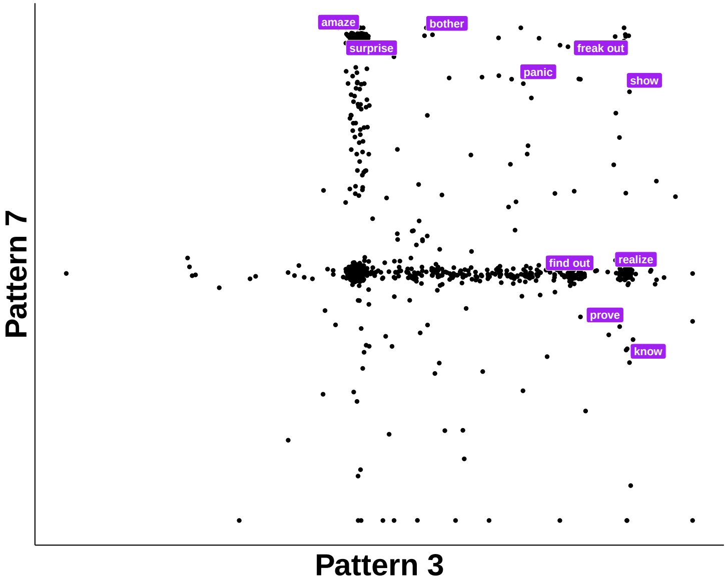

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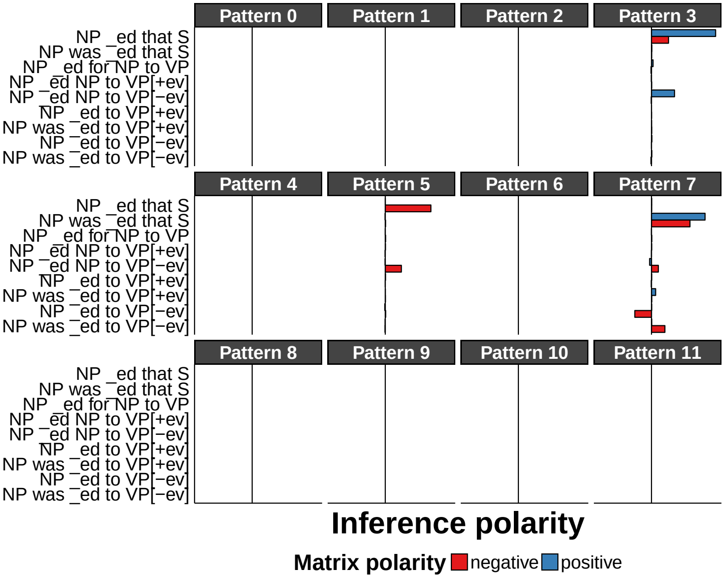

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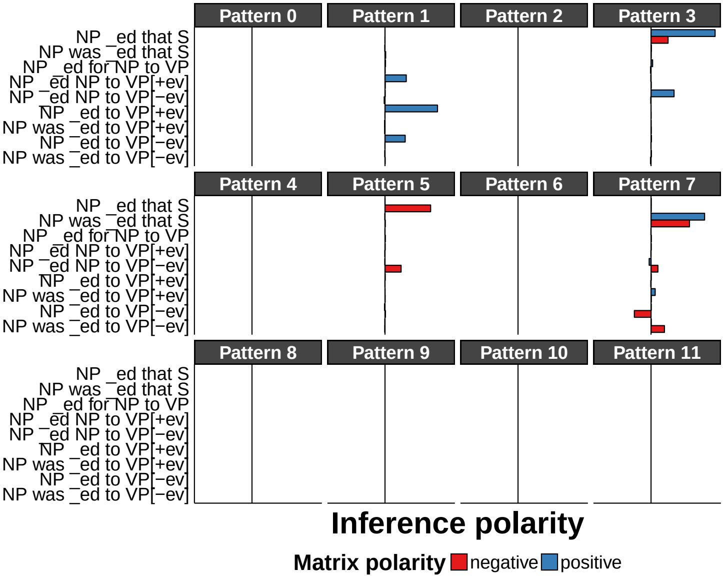

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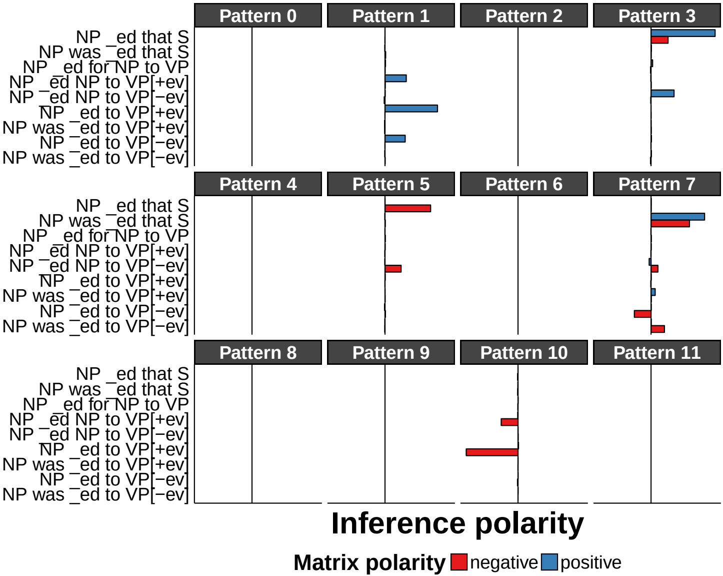
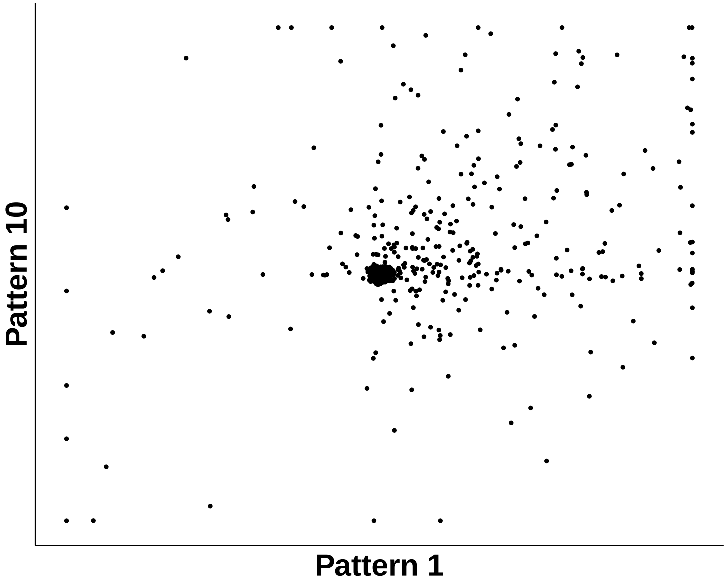


Inference patterns: implicatives



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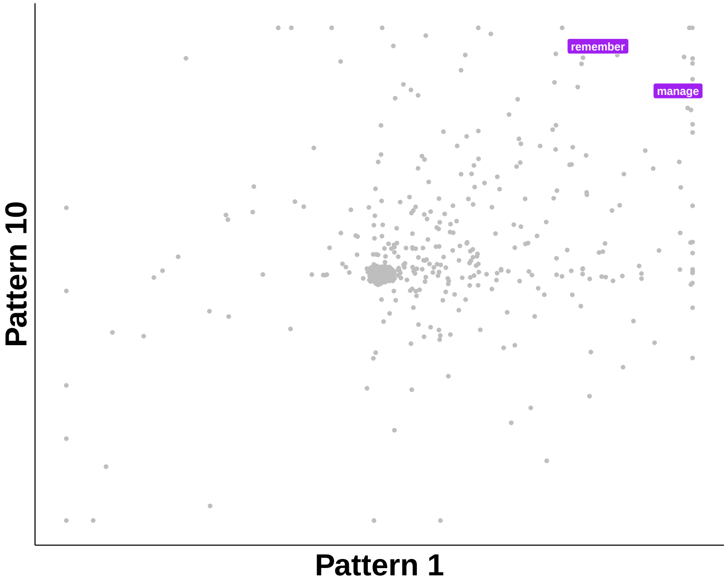
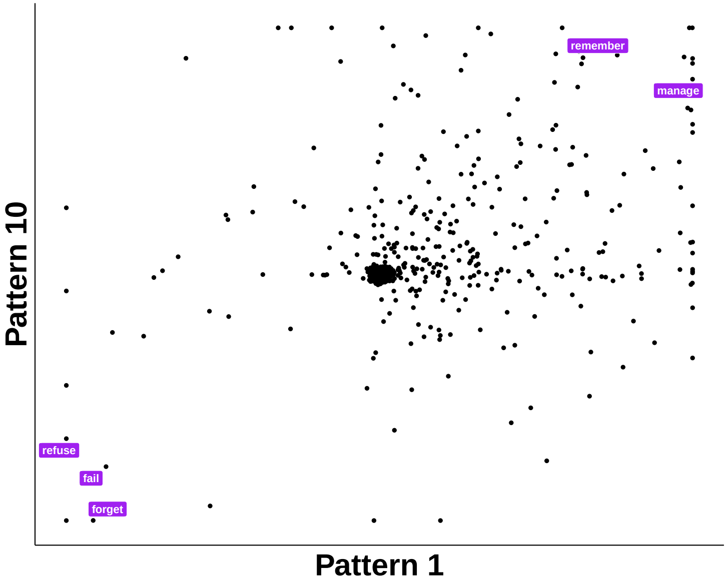
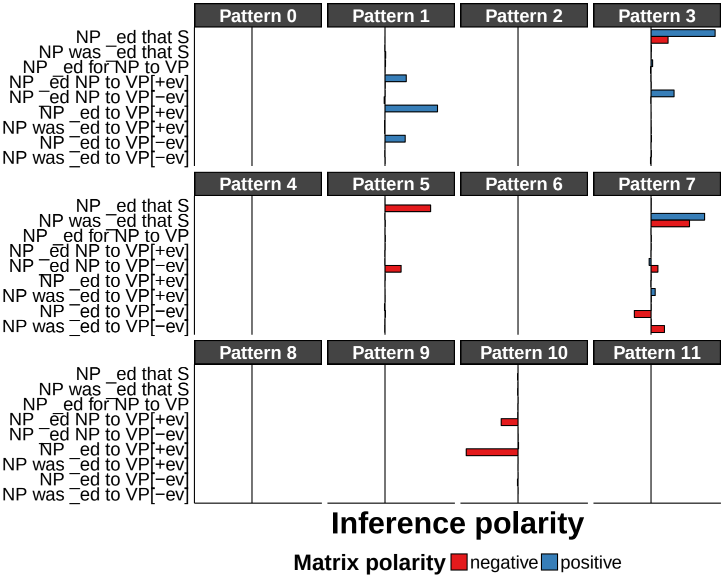


Inference patterns: implicatives



Inference patterns



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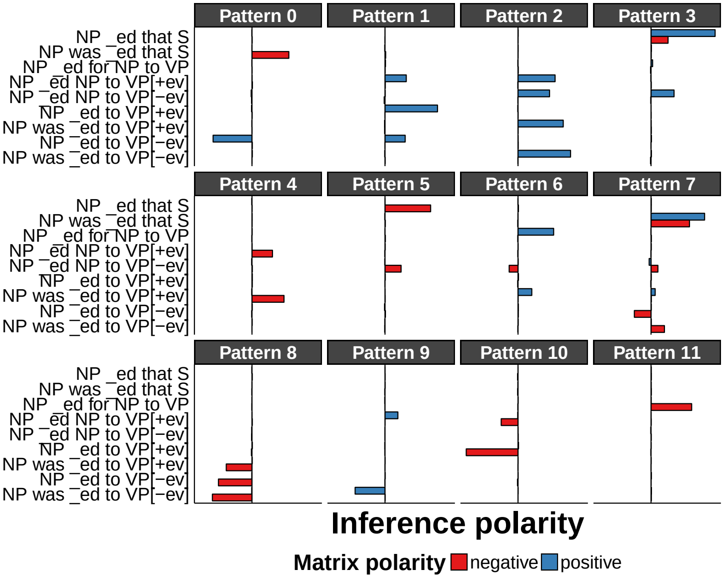

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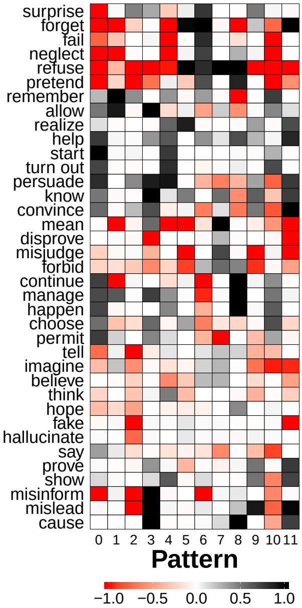

Predicting distribution from inference

Question

Can we predict syntactic distribution directly from veridicality inference patterns?

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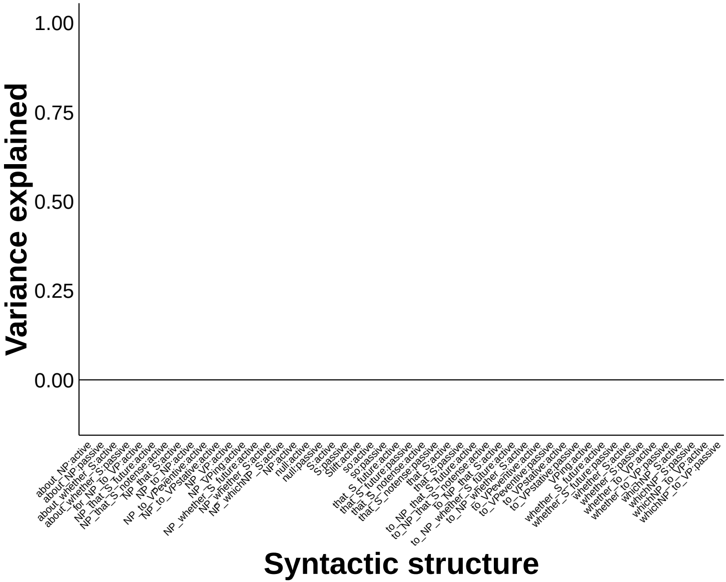
Finding

Across all frames in MegaAcceptability, this mapping explains about 20% of the variance in the acceptability judgments.


Variance explained
1.00
0.75
0.50
0.25
0.00
about_NP:active
about_NP:passive
about_whether_S:active
about_whether_S:passive
for_NP_to_VP:active
NP_that_S_future:active
NP_that_S_notense:active
NP_that_S:active
NP_to_NP:active
NP_to_VPeventive:active
NP_to_VPstative:active
NP_VP:active
NP_VPing:active
NP_whether_S_future:active
NP_whether_S:active
NP_whichNP_S:active
NP:active
null:active
null:passive
S:active
S:passive
Slift:active
so:active
so:passive
that_S_future:active
that_S_future:passive
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that_S:passive
to_NP_that_S_future:active
to_NP_that_S_notense:active
to_NP_that_S:active
to_NP_whether_S_future:active
to_NP_whether_S:active
to_VPeventive:active
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to_VPstative:active
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whether_S:passive
whether_to_VP:active
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whichNP_S:active
whichNP_S:passive
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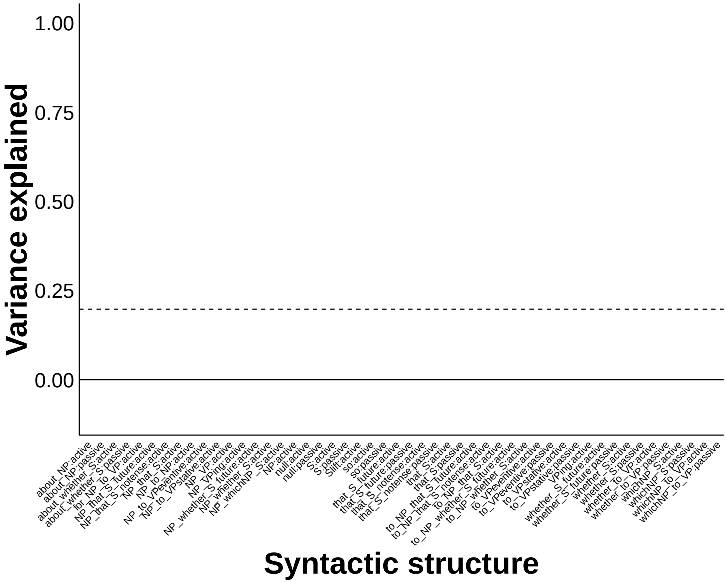
Syntactic structure

Predicting distribution from inference



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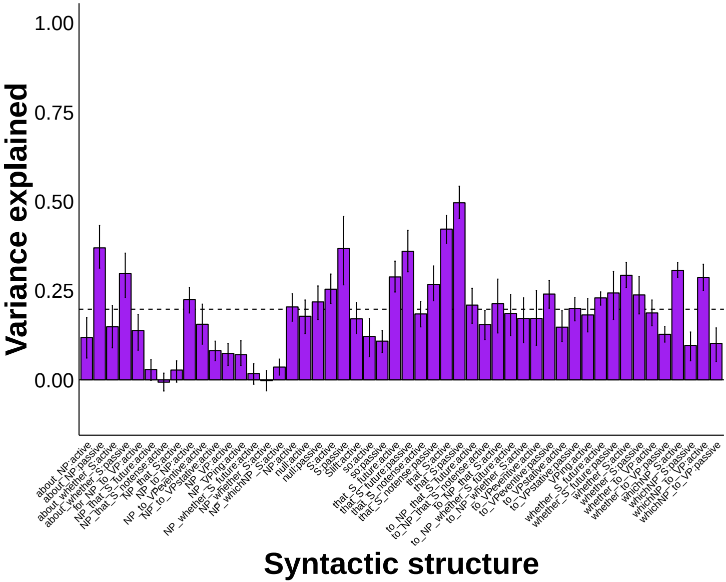

Predicting distribution from inference

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   1.1 Caveat: It’s hard to tell how much explanation is driven by syntactic information encoded in the patterns.

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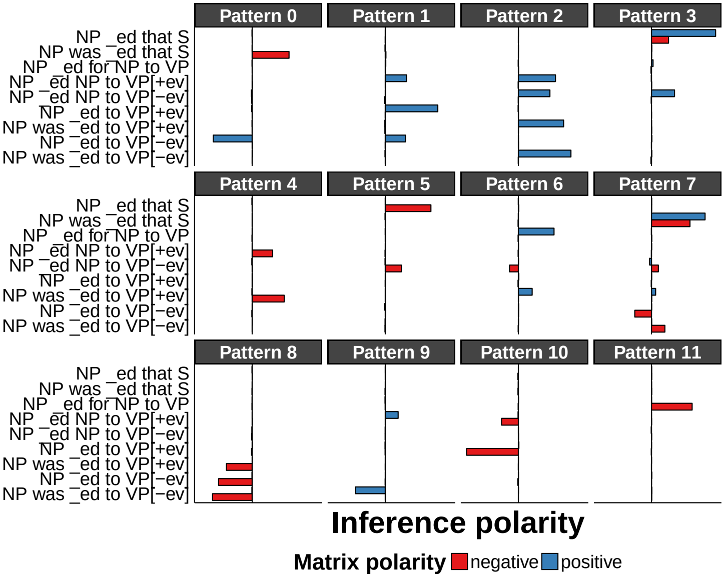

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Predicting distribution from inference

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1. Some amount of information about syntactic distribution carried in veridicality inferences.
   1.1 **Caveat:** It's hard to tell how much explanation is driven by syntactic information encoded in the patterns.
2. Not nearly enough information to base a generalization on.

Exploratory analysis

Question

What drives the relationship between veridicality and distribution?

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Possibility

The relationship is indirect, mediated by underlying features that explain both distribution and veridicality.

Exploratory analysis

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Motivation

Relationship may be mediated by non-contentful properties of contentful events Kratzer 2006; Hacquard 2006; Moulton 2009; Anand and Hacquard 2013, 2014; Rawlins 2013; Bogal-Allbritten 2016; White and Rawlins 2016b a.o.

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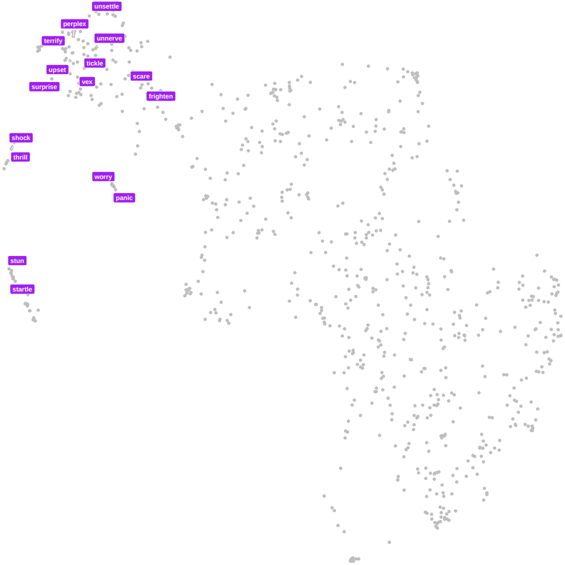
Approach

Use Uniform Manifold Approximation and Projection (UMAP) to visualize the topological structure of the distribution and veridicality data. McInnes and Healy 2018

Exploratory analysis

Exploratory analysis



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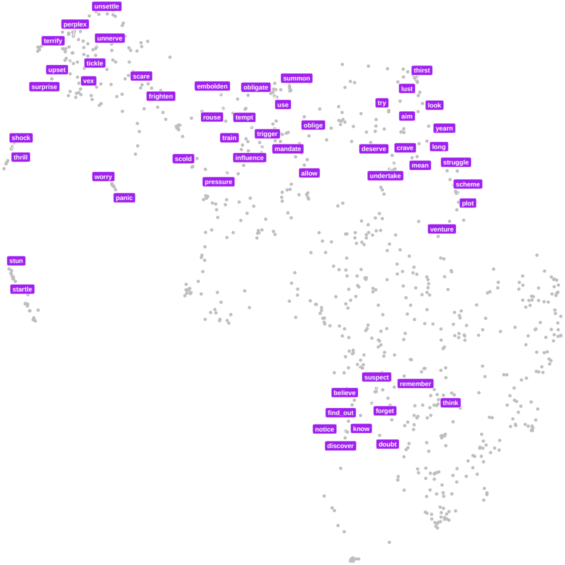

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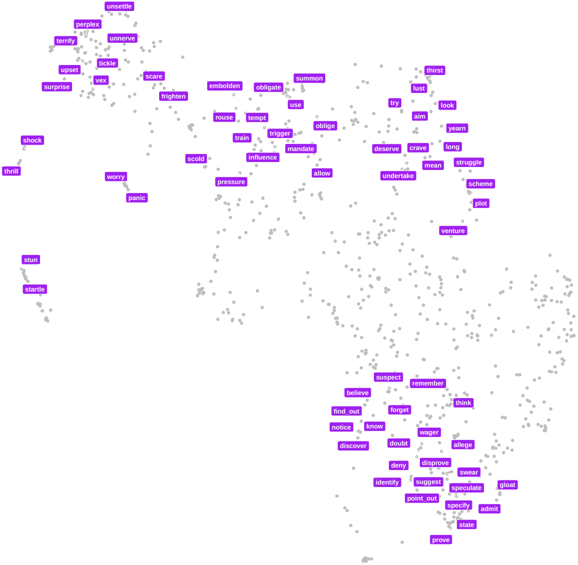

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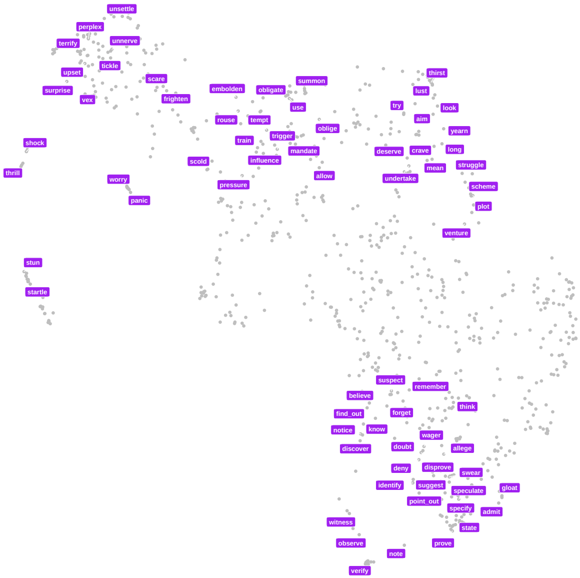

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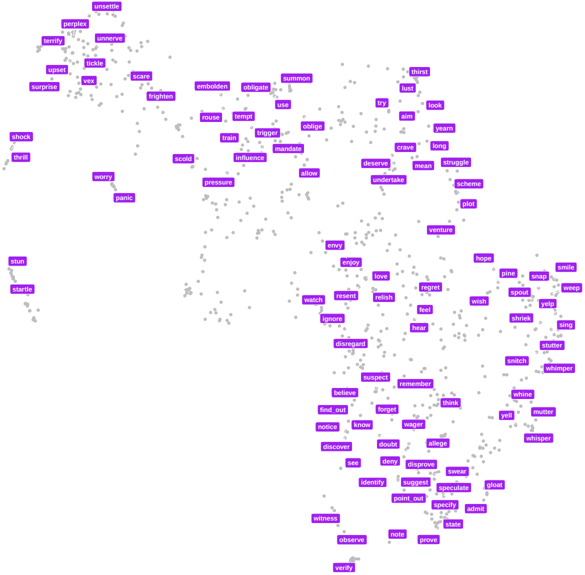

Finding

Fine-grained clusters like verb classes among ‘action’ verbs

Interim discussion

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What could explain distributional properties like responsivity?

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Possibility 2

More abstract semantic properties relevant to thematic roles – e.g. affectedness, existence, creation/destruction, …

Case study: decision predicates

Why decision predicates?

Observation

Decision predicates are one of multiple classes of responsive verbs that are not **veridical** (Beck and Rullmann, 1999; Lahiri, 2002; Egré, 2008)

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(20) a. Jo_i **decided** PRO_i to leave. $\not\to$ Jo will leave.
b. Jo_i **decided** whether PRO_i to leave.

Why decision predicates?

Decide is part of a nontrivial class of Change-of-mental-state (CoMS) responsives not captured by standard theories of responsivity

(21) decide, judge, estimate, determine, assess, conclude, resolve, choose, assess, evaluate, appraise, rate, select, infer, diagnose, opt, elect

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Minimal pair

Change-of-mental-state (CoMS) **decide** v. stative **intend**

(22) a. Jo **decided** (whether) to go out.
b. Jo **intended** (*whether) to go out.

Why decision predicates?

Overarching claim

Responsivity is licensed by CoMS

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Argument outline

1. Interpretation of decision predicates with embedded questions is not captured by standing theories.

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Argument outline

1. Interpretation of decision predicates with embedded questions is not captured by standing theories.
2. Capturing the interpretations of decision predicates must make explicit reference to the structure of selection events.

Two notions of veridicality

P-veridicality

A verb V is (P-)veridical iff $\forall x, p : [\![V]\!]^{w_@}(x, p) \rightarrow p(w_@)$

(23) Jo **knew** that Bo was alive $\rightarrow$ Bo was alive

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A verb V is Q-veridical iff $\forall x, Q : [\![\mathrm{V}]\!]^{w_@}(x, Q) \rightarrow [\![\mathrm{V}]\!]^{w_@}(x, \textsc{ans}_{w_@}(Q))$

(24) Jo **knew** whether Bo was alive
$\rightarrow$ Jo **knew** the true answer to "was Bo alive?"

A verb V is Q-**non**veridical if it is not Q-veridical.

Spector and Egré's (2015) observation

High correlation between Q-veridicality and P-veridicality

Spector and Egré's (2015) proposal

Q-veridicality is derived from P-veridicality

Spector and Egré's (2015) formalization

When a Q-agnostic predicate takes a question Q, it relates an attitude holder to some possible (complete) answer to Q

(cf. Hamblin, 1973; Groenendijk and Stokhof, 1984; Beck and Rullmann, 1999; Lahiri, 2002)

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But if a verb V is P-veridical, then...

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When a Q-agnostic predicate takes a question *Q*, it relates an attitude holder to some possible (complete) answer to *Q*

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But if a verb *V* is P-veridical, then...

$$\begin{bmatrix} \forall x, p' : & [\![\mathrm{V}]\!]^{w_@}(x, p') \rightarrow p'(w_@) \wedge \\ \exists p \in Q : & [\![\mathrm{V}]\!]^{w_@}(x, p) \end{bmatrix} \implies \exists p'' \in Q : p''(w_@) \wedge [\![\mathrm{V}]\!]^{w_@}(x, p'')$$

Moving forward

System

Adopt Spector and Egré's proposal that embedded interrogatives denote possible complete answers (exhaustified Hamblin Qs)

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Adopt Spector and Egré's proposal that embedded interrogatives denote possible complete answers (exhaustified Hamblin Qs)

Goal

Some explanation of Q-agnostic predicates that are neither P-veridical nor Q-veridical – e.g. CoMS predicates

Possible v. true answers

Hamblin (1973) questions

Sets of **possible** answers (cf. Beck and Rullmann, 1999; Spector and Egré, 2015)

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(25) a. $[\![\text{whether Jo left}]\!] = \lambda p.p \in \{[\![\text{Jo left}]\!], \neg[\![\text{Jo left}]\!]\}$

b. $[\![\text{who left}]\!] = \lambda p.\exists x : p = \lambda w.[\![\text{left}]\!]^w(x)$

Possible v. true answers

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Sets of **possible** answers (cf. Beck and Rullmann, 1999; Spector and Egré, 2015)

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Karttunen (1977b) questions

Sets of **true** answers (cf. Groenendijk and Stokhof, 1984; Heim, 1994)

(26) a. $[\![\text{whether Jo left}]\!] = \lambda p.p(w_{@}) \wedge p \in \{[\![\text{Jo left}]\!], \neg[\![\text{Jo left}]\!]\}$

b. $[\![\text{who left}]\!] = \lambda p.p(w_{@}) \wedge \exists x : p = \lambda w.[\![\text{left}]\!]^{w}(x)$

The proposal

Plan

Show that...

1. ...Spector and Egré's proposal makes no wrong predictions about CoMS verbs, but it undergenerates entailments
2. ...to strengthen their predictions without overgenerating, reference to CoMS is necessary

Two contexts

	Selecting	Alternating

Two contexts

	Selecting	Alternating
decide to		

Two contexts

	Selecting	Alternating
decide to		
decide whether to		

Selecting contexts

DECIDER selects an intention from set of possible intentions

Context 1: selecting

Selecting contexts

DECIDER selects an intention from set of possible intentions

(27) a. Before 3pm, Jo was considering whether to leave.
b. → It's false that Jo intended to leave before 3pm.
c. → It's false that Jo intended not to leave before.

(28) At 3pm, Jo decided to leave at 5pm.

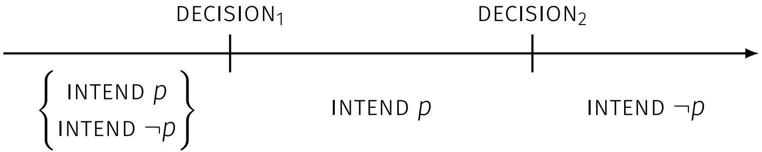
Context 2: alternating

Alternating contexts

DECIDER changes intention from mutually exclusive intention

(29) At 3pm, Jo decided to leave at 5pm.

(30) At 4pm, Jo changed her mind and decided not to leave.



Two contexts

	Selecting	Alternating
decide to	✓	✓
decide whether to		

Selecting v. switching contexts

Possibility

Given only the (prototypical) selecting contexts...

(31) At 3pm, Jo decided to leave at 5pm.

a. $\rightarrow$ Jo intended to leave after 3pm.
b. $\overset{?}{\rightarrow}$ It's F that Jo intended to leave before 4pm
c. $\overset{?}{\rightarrow}$ It's F that Jo intended not to leave before 4pm

Selecting v. switching contexts

Conclusion

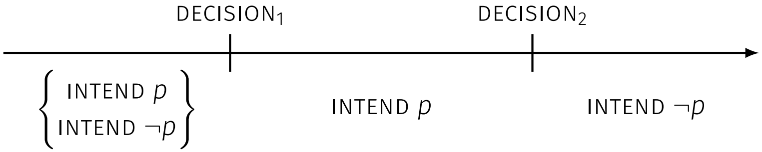
The availability of alternating contexts suggests...

(32) At 4pm, Jo decided not to leave at 5pm.

a. $\rightarrow$ Jo intended not to leave after 4pm.

b. $\rightarrow$ It's F that Jo intended to leave before 4pm

c. $\not\rightarrow$ It's F that Jo intended not to leave before 4pm



An initial try

A CoMS denotation

Suggests a very straightforward CoMS denotation for **decide to** (simplified to capture just entailments of interest)

(33) $[\![\text{decide S}]\!]^t = \lambda x.\neg\textsc{intend}(x, [\![\text{S}]\!], < t) \wedge \textsc{intend}(x, [\![\text{S}]\!], \geq t)$

Question

What predictions does Spector and Egré's (2015) proposal make?

(34) Jo decided whether to leave.

Answer 1

Predicts everything correctly for post-states

(35) Either Jo intended to leave or she intended not to leave.

Question

What predictions does Spector and Egré's (2015) proposal make?

(36) At 4pm, Jo decided whether to leave at 5pm.

Answer 2

For pre-states, where it makes predictions, they are correct

Question

What predictions does Spector and Egré's (2015) proposal make?

(36) At 4pm, Jo decided whether to leave at 5pm.

Answer 2

For pre-states, where it makes predictions, they are correct

(37) Before 4pm, either it's false that Jo decided to leave at 5pm or it's false that she decided not to leave at 5pm.

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What predictions does Spector and Egré's (2015) proposal make?

(36) At 4pm, Jo decided whether to leave at 5pm.

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(37) Before 4pm, either it's false that Jo decided to leave at 5pm or it's false that she decided not to leave at 5pm.

(38) $\exists p \in Q : \neg\textsc{intend}(x, p, < t) \wedge \textsc{intend}(x, p, \geq t)$

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What predictions does Spector and Egré's (2015) proposal make?

(36) At 4pm, Jo decided whether to leave at 5pm.

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(37) Before 4pm, either it's false that Jo decided to leave at 5pm or it's false that she decided not to leave at 5pm.

(38) $\exists p \in Q : \neg\textsc{intend}(x, p, < t) \wedge \textsc{intend}(x, p, \geq t)$

But this prediction is too weak

Observation

While **decide to** is licensed in selecting and alternating contexts, **decide whether to** is only licensed in selective contexts

(39) a. Before 3, Jo intended neither to leave nor not to.
b. At 3, Jo decided whether to leave.

(40) a. Before 4, Jo intended either to leave or not to.
b. #At 4pm, Jo decided whether to leave at 5pm

Intuition

(40-b) $\rightarrow$ Jo have no intention with respect to leaving before 4pm

Two contexts

	Selecting	Alternating
decide to	✓	✓
decide whether to		

Two contexts

	Selecting	Alternating
decide to	✓	✓
decide whether to	✓	#

Consequence

We need (42), rather than (41) for CoMS embedded questions.

(41) $\exists p \in Q : \neg\text{INTEND}(x, p, < t) \land \text{INTEND}(x, p, \geq t)$

(42) $\forall p \in Q : \neg\text{INTEND}(x, p, < t) \land \exists p \in Q : \text{INTEND}(x, p, \geq t)$

Observation

The pre-state conjunct is equivalent to the negation of the post-state conjunct (*modulo* tense)

(43) $\forall p \in Q : \neg\text{INTEND}(x, p) \leftrightarrow \neg\exists p \in Q : \text{INTEND}(x, p)$

Idea

Apply Spector and Egré's (2015) proposal to each conjunct

(44) $Q = [\![\text{whether S}]\!] = \{[\![\text{S}]\!], \neg[\![\text{S}]\!]\} = \{p, \neg p\}$

(45) $[\![\text{decide whether S}]\!]^t = \lambda x.\neg\textsc{intend}(x, Q, < t) \wedge \textsc{intend}(x, Q, \geq t)$

(46) $[\![\text{decide whether S}]\!]^t = \lambda x.\neg\exists p \in Q : \textsc{intend}(x, p, < t) \wedge$
$\exists p \in Q : \textsc{intend}(x, p, \geq t)$

Problem

Mysterious why we shouldn't be able to do this for **intend**

(47) a. Jo hasn't **decided** whether to go out.
b. *Jo didn't **intend** whether to go out.

$$\begin{aligned}[\![\text{intend whether S}]\!] &= \lambda x.\textsc{intend}(x, [\![\text{whether S}]\!]) \\ &= \lambda x.\exists p \in [\![\text{whether S}]\!] : \textsc{intend}(x, p)\end{aligned}$$

Observation

Problem doesn't arise for CoMS veridicals

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(48) a. Jo doesn't **figure out** (whether) Bo left.
b. Jo doesn't **know** (whether) Bo left.

Observation

Problem doesn't arise for CoMS veridicals

(48) a. Jo doesn't **figure out** (whether) Bo left.
b. Jo doesn't **know** (whether) Bo left.

$$\begin{aligned}[\![\text{know whether S}]\!] &= \lambda x.\textsc{know}(x, [\![\text{whether S}]\!]) \\ &= \lambda x.\exists p \in [\![\text{whether S}]\!] : \textsc{know}(x, p)\end{aligned}$$

Upshot

Only target certain event types (e.g. intentions) in CoMS structure

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Only target certain event types (e.g. intentions) in CoMS structure

Proposal

Make interrogative-taking dependent on CoMS

Minimal requirements

For **decide to**, something of the form in (49)

(49) $\ldots \neg\textsc{intend}(x, [\![S]\!], < t) \wedge \textsc{intend}(x, [\![S]\!], \geq t)$

For **decide whether to**, something of the form in (50)

(50) $\ldots \forall p \in Q : \neg\textsc{intend}(x, p, < t) \wedge \exists p \in Q : \textsc{intend}(x, p, \geq t)$

Implementation

Core idea

Q-agnostic predicates undergo a regular polysemy

Lexical abstraction		DECIDE
Polysemy rules		
Lexicon	DECIDE_Q	DECIDE_p

$$\begin{tikzcd} & \text{DECIDE} \arrow[dl] \arrow[dr] & \\ \text{DECIDE}_Q & & \text{DECIDE}_p \end{tikzcd}$$

Core idea

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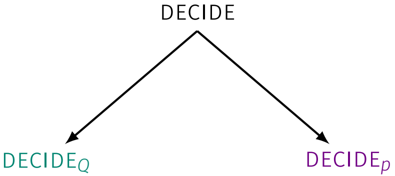
Lexical abstraction

Polysemy rules

Lexicon



George’s (2011) Twin Relations Theory

Goal

A polysemy approach for Q-agnostics

$$\begin{tikzcd}
\text{Elementary relations} & R_{\forall} \arrow[dd] \arrow[ddrr] & & R_{\exists} \arrow[dd] \arrow[ddll] \\
\text{Lexical templating} & & & \\
\text{Lexicon} & R_{\text{QUES}} & & R_{\text{PROP}}
\end{tikzcd}$$

Lexical templates

Proposition-taking variant passes p to elementary relations

$$R_{\text{PROP}} \equiv \lambda w.\lambda x.\lambda p.R_{\forall}(x,p,w) \wedge R_{\exists}(x,p,w)$$

Question-taking variant passes $p \in Q$ to elementary relations

$$R_{\text{QUES}} \equiv \lambda w.\lambda x.\lambda Q.\forall p \in Q : R_{\forall}(x,p,w) \wedge \exists p \in Q : R_{\exists}(x,p,w)$$

Veridicality arises from $R_{\forall}$

$$\text{KNOW}_{\forall}(x,p,w) \equiv \text{BELIEVE}(x,p,w) \rightarrow p(w)$$

R_{PROP} corresponds to the form we need for **decide to**, and
R_{QUES} corresponds to the form we need for **decide whether to**

(51) $\text{DECIDE}_{\forall} = \neg\text{INTEND}$

(52) $\text{DECIDE}_{\exists} = \text{INTEND}$

$R_{\forall} = R_{pre}$ characterizes pre-states
$R_{\exists} = R_{post}$ charatcerizes post-states

Basic approach

Hacquard's (2010) neo-Davidsonian event content approach

(cf. Kratzer, 2006; Moulton, 2009; Bogal-Allbritten, 2016)

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(cf. Kratzer, 2006; Moulton, 2009; Bogal-Allbritten, 2016)

(53) $\textsc{con}(e) = \{w : w \text{ is compatible with the contents of } e\}$

(54) $[\![[\text{V S}]_{VP}]\!] = \lambda e.P_V(e) \wedge \forall w \in \textsc{con}(e) : [\![\text{S}]\!](w)$

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Champollion's (2015) verb-as-event-quantifier approach

(55) $[\![\text{VP}]\!] = \lambda f.\exists e : f(e) \wedge \ldots$

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Champollion's (2015) verb-as-event-quantifier approach

(55) $[\![\text{VP}]\!] = \lambda f.\exists e : f(e) \wedge \ldots$

Attitude denotations

(56) $[\![[\text{V S}]_{VP}]\!] = \lambda f.\exists e : P_V(e) \wedge f(e) \wedge \forall w \in \textsc{con}(e) : [\![\text{S}]\!](w)$

Implementation

$$e_{pre} \xrightarrow{\text{DECIDE}} e_{post}$$

Implementation

$$\begin{tikzcd} e_{pre} \arrow[r, "\text{DECIDE}"] \arrow[d, "\text{CONTENT}"] & e_{post} \\ \{\text{INTEND } p_1, \text{INTEND } p_2, \ldots\} & \end{tikzcd}$$

INQUISITIVE

Implementation

$$
\begin{tikzcd}
e_{pre} \arrow[rr, "\text{DECIDE}"] \arrow[d, "\text{CONTENT}"] & & e_{post} \arrow[d, "\text{CONTENT}"] \\
\{\text{INTEND } p_1, \text{INTEND } p_2, \ldots\} & & \text{INTEND } p_i \\
\text{INQUISITIVE} & & \text{INFORMATIVE}
\end{tikzcd}
$$

Defining decision

Define DECISION to relate a pre-state and a post-state

(57) $\textsc{decision}(e, e_{pre}, e_{post}) \equiv e$ is a decision with
pre-state e_{pre} and post-state e_{post}

Define constraint on inquisitive pre-state

(58) $R_{pre}(e, p) = \neg\forall w \in \textsc{con}(e) : p(w)$

Define constraint on informative post-state

(59) $R_{post}(e, p) = \forall w \in \textsc{con}(e) : p(w)$

As expected for a change-of-state verb

(60) $\forall e, p : R_{pre}(e, p) \longleftrightarrow \neg R_{post}(e, p)$

Defining lexical templates

As expected for a change-of-state verb

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Extend George's lexical templates to events

(61) a. $[\![\text{decide}_{\text{PROP}}]\!] = R_{\text{PROP}}(\text{DECISION}) = \text{(62-a)}$
b. $[\![\text{decide}_{\text{QUES}}]\!] = R_{\text{QUES}}(\text{DECISION}) = \text{(62-b)}$

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(62) a. $\lambda p.\lambda f.\exists e, e_{pre}, e_{post} : \text{DECISION}(e, e_{pre}, e_{post}) \wedge f(e)$

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$\wedge R_{pre}(p)(e_{pre}) \wedge R_{post}(p)(e_{post})$

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b. $\lambda Q.\lambda f.\exists e, e_{pre}, e_{post} : \text{DECISION}(e, e_{pre}, e_{post}) \wedge f(e)$

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$\wedge \forall p \in Q : R_{pre}(p)(e_{pre})$
$\wedge \exists p \in Q : R_{post}(p)(e_{post})$

Full denotations

When **decide** takes a declarative...

$[\![\text{Jo decide}_{\text{PROP}}\ \text{S}]\!] = \exists e, e_{pre}, e_{post} : \textsc{decision}(e, e_{pre}, e_{post}) \wedge \textsc{agent}(j, e)$

Full denotations

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$$[\![\text{Jo decide}_{\text{PROP}}\ \text{S}]\!] = \exists e, e_{pre}, e_{post} : \textsc{decision}(e, e_{pre}, e_{post}) \wedge \textsc{agent}(j, e) \\ \wedge \neg \forall w \in \textsc{con}(e_{pre}) : [\![\text{S}]\!](w)$$

Full denotations

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$$
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$$

Full denotations

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When **decide** takes an interrogative...

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Full denotations

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\wedge \forall p \in [\![?\text{S}]\!] : \neg \forall w \in \textsc{con}(e_{pre}) : p(w)
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Full denotations

When **decide** takes a declarative...

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$$\begin{aligned}[\![\text{Jo decide}_{\text{QUES}}\ ?\text{S}]\!] = \exists e, e_{pre}, e_{post} : \textsc{decision}(e, e_{pre}, e_{post}) \wedge \textsc{agent}(j, e) \\ \wedge \forall p \in [\![?\text{S}]\!] : \neg\forall w \in \textsc{con}(e_{pre}) : p(w) \\ \wedge \exists p \in [\![?\text{S}]\!] : \forall w \in \textsc{con}(e_{post}) : p(w)\end{aligned}$$

Embedded modality

Remaining question

Where does the intention entailment come from?

Remaining question

Where does the **intention** entailment come from?

Possible answer

Decision pre-states just **are** intentional states

Evidence

Always(?) intention for infinitivals

(63) Jo {determined, decided, chose} whether to leave.

Evidence

Always(?) intention for infinitivals

(63) Jo {determined, decided, chose} whether to leave.

Otherwise dependent on content of finite complement

(64) a. Jo decided whether she would leave.
b. Jo decided whether Bo could leave.

Remaining question

Where does the **intention** entailment come from?

Possible answer

Decision pre-states just **are** intentional states

Answer

Modality in the embedded clause (Bhatt, 1999; Grano, 2012; Wurmbrand, 2014; White, 2014)

Wrapping up

Question

Why would pre-state entailments be like veridicality entailments?

Wrapping up

Question

Why would pre-state entailments be like veridicality entailments?

Relevant observation

Pre-state entailments are generally backgrounded (cf. start, stop)

(Roberts, 1996; Simons, 2001; Abusch, 2002; Simons et al., 2010; Abusch, 2010; Abrusán, 2011; Romoli, 2011; Anand and Hacquard, 2014)

A generalization

Tentative generalization

No monomorphemic verb characterizes a relation between an informative pre-state and an inquisitive post-state (*undecide)

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Relevance

Suggests an asymmetry between pre-states and post-states that we don't currently encode

A generalization

Tentative generalization

No monomorphemic verb characterizes a relation between an informative pre-state and an inquisitive post-state (*undecide)

Possible exception: **forget**

Relevance

Suggests an asymmetry between pre-states and post-states that we don't currently encode

Suggestion

Whatever gives rise to pre-state backgrounding for other CoS predicates also gives rise to this asymmetry

Direction 1

Reducing the relationship between veridicality and Q-agnosticism to a relationship between CoMS and Q-agnosticism

Future directions

Direction 1

Reducing the relationship between veridicality and Q-agnosticism to a relationship between CoMS and Q-agnosticism

Direction 2

Explaining remaining nonveridicals in terms of event structure

Observation

Many verbal veridicals besides the stative know are CoMS

remember, forget, discover, find out, figure out, realize, recognize, …

Reducing to CoMS

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Timid reduction

Most verbal veridicals explained by CoMS; know stipulated

Reducing to CoMS

Observation

Many verbal veridicals besides the stative **know** are CoMS

remember, forget, discover, find out, figure out, realize, recognize, ...

Timid reduction

Most verbal veridicals explained by CoMS; **know** stipulated

Aggressive reduction

Know has a bipartite structure involving a knowledge state (fact contents) and a belief state (proposition contents) (Kratzer, 2002)

Conclusion

Overarching question

How are a verb's **semantic properties** related to its **syntactic distribution**? Gruber 1965; Fillmore 1970; Zwicky 1971; Jackendoff 1972; Grimshaw 1979, 1990; Pesetsky 1982, 1991; Pinker 1989; Levin 1993

Overarching question

How are a verb's **semantic properties** related to its **syntactic distribution**? Gruber 1965; Fillmore 1970; Zwicky 1971; Jackendoff 1972; Grimshaw 1979, 1990; Pesetsky 1982, 1991; Pinker 1989; Levin 1993

Semantic Properties

$$\begin{bmatrix} + & \text{TELIC} \\ - & \text{DURATIVE} \\ - & \text{STATIVE} \\ & \ldots \end{bmatrix}$$

Overarching question

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Semantic Properties $\longleftrightarrow$ Syntactic Distribution

$$\begin{bmatrix} + & \text{TELIC} \\ - & \text{DURATIVE} \\ - & \text{STATIVE} \\ & \ldots \end{bmatrix} \qquad \begin{Bmatrix} [\_\_\_\text{NP}] \\ [\_\_\_\text{S}] \\ [\_\_\_\text{VP}] \\ \ldots \end{Bmatrix}$$

What could matter?

Factors claimed to affect the distribution of nominals

Sensitive to event structural properties like stativity, telicity, durativity, causativity, transfer, etc. (see Levin and Rappaport Hovav 2005)

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Factors claimed to affect the distribution of nominals

Sensitive to event structural properties like stativity, telicity, durativity, causativity, transfer, etc. (see Levin and Rappaport Hovav 2005)

Factors claimed to affect the distribution of clauses

Sensitive to 'content-dependent' properties like representationality, preferentiality, factivity/veridicality, communicativity, etc. Bolinger 1968; Hintikka 1975; Hooper 1975; Stalnaker 1984; Farkas 1985; Villalta 2000, 2008; Kratzer 2006; Egré 2008; Scheffler 2009; Moulton 2009; Anand and Hacquard 2013; Rawlins 2013; Portner and Rubinstein 2013; Anand and Hacquard 2014; Spector and Egré 2015; Bogal-Allbritten 2016; Theiler et al. 2017

Hypothesis

The distribution of clauses is determined by the same semantic properties as the distribution of nouns (cf. Koenig and Davis 2001)

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Not properties dependent on having propositional content

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The distribution of clauses is determined by the **same** semantic properties as the distribution of nouns (cf. Koenig and Davis 2001)

Not properties dependent on having propositional content

(White and Rawlins, 2017, 2018)

Intuition

Predicates that take clauses characterize neo-Davidsonian eventualities, like any other verb. (Kratzer 2006; Hacquard 2006; Moulton 2009; Anand and Hacquard 2013, 2014; Rawlins 2013; Bogal-Allbritten 2016; White and Rawlins 2016b a.o.)

Case study

Question

How direct is the relationship between content-dependent properties and syntactic distribution?

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Focus

Two content-dependent properties – factivity and veridicality – that are argued to determine selection of interrogatives & declaratives

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Claim

There is no direct relationship between factivity and veridicality (*qua* semantic properties) and syntactic distribution

Case study

Question

How direct is the relationship between content-dependent properties and syntactic distribution?

Focus

Two content-dependent properties – factivity and veridicality – that are argued to determine selection of interrogatives & declaratives

Claim

There is no direct relationship between factivity and veridicality (*qua* semantic properties) and syntactic distribution

The relationship is mediated by event structural properties.

Thanks!

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Data available at

megaattitude.io decomp.io

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