The role of veridicality and factivity in clause selection

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Slides available at aswhite.net
Introduction
Overarching question

Overarching question


**Semantic Properties**

\[
\begin{array}{c}
+ \\ - \\ - \\
TELIC \\ DURATIVE \\ STATIVE \\
\ldots
\end{array}
\]
Overarching question


**Semantic Properties**

+ TELIC
- DURATIVE
- STATIVE

...  

**Syntactic Distribution**

\[
\begin{align*}
&\{ [\_\_NP] \\
&\{ [\_\_S] \\
&\{ [\_\_VP] \\
&... \\
\end{align*}
\]
An apparent split

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

Distribution of clauses
Sensitive to intentional properties like representationality, preferentiality, factivity/veridicality, communicativity, etc.

An apparent split

Distribution of nominals

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An apparent split

Distribution of **nominals**
Sensitive to event structural properties like stativity, telicity, durativity, causativity, transfer, etc. (see Levin & Rappaport Hovav 2005)

Distribution of **clauses**
Overarching Hypothesis

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

Intentional properties require that an eventuality have informational content, but not all eventualities have such content, resulting in a piece-wise semantic-to-syntax mapping.
Hypothesis

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

Hypothesis

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

Not intentional properties (cf. White & Rawlins 2017)
Hypothesis

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

Not intentional properties (cf. White & Rawlins 2017)

Intuition

Intentional properties require that an eventuality have informational content, but not all eventualities have such content, resulting in a piece-wise semantic-to-syntax mapping
Today’s talk

Focus

Two intentional properties—**factivity** and **veridicality**—that are argued to determine **selection of interrogatives & declaratives**

Claims

Use experiments that measure (i) syntactic distribution and (ii) factivity/veridicality for all clause-embedding verbs to show that...

1. ...selection doesn't directly traffic in these properties.
2. ...apparent correlations between selection and factivity and veridicality arise from...
   2.1 ...only analyzing frequent verbs.
   2.2 ...lack of attention to confounding event structural variables like transfer and stativity.
Today’s talk

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Introduction
Outline

Introduction

Background: veridicality & factivity
Outline

Introduction

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Measuring syntactic distribution
Outline

Introduction

Background: veridicality & factivity

Measuring syntactic distribution

Measuring veridicality and factivity
Outline

Introduction

Background: veridicality & factivity

Measuring syntactic distribution

Measuring veridicality and factivity

Results and analysis
Outline

Introduction

Background: veridicality & factivity

Measuring syntactic distribution

Measuring veridicality and factivity

Results and analysis

Conclusion
Background: veridicality & factivity
Veridicality and factivity

Veridicality

A verb $v$ is **veridical** iff $\text{NP } v \text{ entails } s$ Karttunen 1971a, Egré 2008, Karttunen 2012, Spector & Egré 2015 a.o.

Factivity

A verb $v$ is **factive** iff $\text{presupposes } s$ Kiparsky & Kiparsky 1970, Karttunen 1971b et seq.
Veridicality and factivity

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(1) a. Jo **knew** that Bo was alive $\rightarrow$ Bo was alive

Factivity

A verb $v$ is **factive** iff $\text{NP } v \text{ presupposes } S$ Kiparsky & Kiparsky 1970, Karttunen 1971b et seq

(2) a. Jo didn’t **know** that Bo was alive $\not\rightarrow$ Bo was alive
Veridicality and factivity

Veridicality

A verb $v$ is **veridical** iff $\text{NP } V \text{ s entails s}$


(1) a. Jo **knew** that Bo was alive $\rightarrow$ Bo was alive

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

A verb $v$ is **factive** iff $\text{NP} \; v \; s$ presupposes $s$ Kiparsky & 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
Responsivity (Lahiri 2002)

A verb is **responsive** iff it takes interrogatives and declaratives

see also Karttunen 1977a,b, Groenendijk & 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)\}


(4)  

a. Jo *knew* \{**that, whether**\} Bo was alive.  
b. Jo *thought* \{**that, *whether**\} Bo was alive.
Predicted correlation

Responsivity

Factivity/Veridicality
Measuring syntactic distribution
Measuring syntactic distribution

MegaAttitude dataset (White & Rawlins 2016)

Ordinal (1-7 scale) acceptability ratings
Measuring syntactic distribution

MegaAttitude dataset (White & Rawlins 2016)

Ordinal (1-7 scale) acceptability ratings for 1000 clause-embedding verbs
MegaAttitude dataset (White & Rawlins 2016)

Ordinal (1-7 scale) acceptability ratings
for
1000 clause-embedding verbs
×
50 syntactic frames
MegaAttitude verbs
Sentence construction

**Challenge**

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

- **know** + NP _ed {that, whether} S
  Someone knew {that, whether} something happened.
- **tell** + NP _ed NP {that, whether} S
  Someone was told {that, whether} something happened.
- **bother** + NP was _ed {that, which NP} S
  Someone was bothered {that something, which thing} happened.
Sentence construction

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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
Sentence construction

Challenge
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

(5) a. *know* + NP _ed {that, whether} S
Someone knew {that, whether} something happened.
Sentence construction

Challenge
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

(5) a. \(know + \text{NP}_\text{ed} \{\text{that, whether}\} S\)
Someone knew \{that, whether\} something happened.

b. \(tell + \text{NP}_\text{ed} \text{NP} \{\text{that, whether}\} S\)
Someone was told \{that, whether\} something happened.
Sentence construction

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

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Construct semantically bleached frames using indefinites

\[(5)\]

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

b.  *tell* + NP _ed NP \{that, whether\} S
Someone was told \{that, whether\} something happened.

c.  *bother* + NP was _ed \{that, which NP\} S
Someone was bothered \{that something, which thing\} happened.
Sentence construction

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   Someone knew {that, whether} something happened.

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   Someone was told {that, whether} something happened.

c. *bother* + NP was _ed {that, which NP} S  
   Someone was bothered {that something, which thing} happened.
Measuring veridicality and factivity
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)
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
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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- 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 \([NP \_ \text{that} S]\) and \([NP \text{was} \_\text{ed} \text{that} S]\) 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
Stimuli

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.
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
160 unique participants through Amazon’s Mechanical Turk

• 10 ratings per item...
160 unique participants through Amazon’s Mechanical Turk

- 10 ratings per item...
- ...given by 10 different participants
Results and analysis
Raw responses

- know
- prove
- think

- no
- maybe
- yes

- no
- maybe
- yes

- no
- maybe
- yes

- (d)
- (d)

V(p)
¬V(p)

- no
- maybe
- yes

- no
- maybe
- yes

- no
- maybe
- yes

- (d)
- (d)

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Raw responses

![Diagram showing responses to questions about knowledge, proving, and thinking. The diagram includes bars for 'know', 'prove', and 'think' with options 'no', 'maybe', and 'yes'.]
Raw responses

![Bar chart showing responses to know, prove, and think with 'no', 'maybe', and 'yes' options.](chart.png)
Raw responses

<table>
<thead>
<tr>
<th></th>
<th>know</th>
<th>prove</th>
<th>think</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
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<tr>
<td>maybe</td>
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(d)(d)
Raw responses
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</table>

\(V(p)\) \(\neg V(p)\)
Normalization

Transformation (roughly)
Map each verb to a 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. (Similar to z-scoring.)
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.
\[ \neg p \leftarrow V(p) \rightarrow p \]
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

\[ \neg p \leftarrow \neg V(p) \rightarrow p \]

\[ \neg p \leftarrow V(p) \rightarrow p \]
Normalized responses

Nonveridicals

\[ \neg p \leftarrow \neg V(p) \rightarrow p \]

\[ \neg p \leftarrow V(p) \rightarrow p \]

Frame

NP _ that S
NP was _ed that S
Normalized responses

Nonveridicals

Factives

Frame

\[ \neg p \leftarrow \neg V(p) \rightarrow p \]
Normalized responses

Veridicals

Nonveridicals

Factives

Frame

\[ \neg p \leftarrow \neg V(p) \rightarrow p \]
Normalized responses

Veridicals
- believe
- decide
- hope
- promise
- think
- wish

Nonveridicals
- believe
- decide
- find_out
- hate
- hope
- know
- love
- promise
- surprise
- think
- wish

Factives
- believe
- decide
- ensure
- find
- find_out
- hate
- hope
- indicate
- love
- prove
- show
- show
- surprise
- think
- verify
- wish

Antiveridicals
- believe
- decide
- ensure
- fake
- fabricate
- pretend
- misinform
- mislead

Frame

\[
\neg p \leftarrow \neg V(p) \rightarrow p
\]
Normalized responses

```
\[ \neg p \leftarrow \neg V(p) \rightarrow p \]
```

- **Veridicals**
  - believe
  - decide
  - hope
  - promise
  - think
  - wish

- **Nonveridicals**
  - find_out
  - hate
  - know
  - love
  - promise
  - think
  - wish

- **Factives**
  - ensure
  - find
  - indicate
  - prove
  - show
  - verify
  - think
  - verify
  - wish

- **Antiveridicals**
  - fabricate
  - fake
  - misinform
  - mislead
  - pretend

- **Antifactives?**
  - hallucinate

Frame
- a NP _ that S
- a NP was _ed that S
Normalized responses

\[ \neg p \leftarrow \neg V(p) \rightarrow p \]

\[ \neg p \leftarrow V(p) \rightarrow p \]
Relating factivity, veridicality, and question-taking

Question

Do factivity/veridicality positively correlate with question-taking?
Correlation: factivity and question-taking

Acceptability of \([\_ \_ CP[+Q]]\)

Factivity
Acceptability of [___CP[+Q]]

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

Factivity

Acceptability of \[ CP[+Q]\]
Correlation: factivity and question-taking

Acceptability of \([CP^{+Q}]\) vs. Factivity
Correlation: factivity and question-taking

Acceptability of [-CP[+Q]]
Correlation: veridicality and question-taking
Correlation: veridicality and question-taking

![Graph showing the correlation between acceptability of CP[+Q] and veridicality. The x-axis represents veridicality, and the y-axis represents acceptability of CP[+Q]. The line shows an increasing trend as veridicality increases.]
Correlation: veridicality and question-taking

Acceptability of \[\_ \text{CP}^+Q\_\]
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.
Two findings

Finding #1
If we look at only the most frequent verbs, the correlations flip.

Finding #2
There are subregularities, but they don't validate the purported correlation.
Two findings

Finding #1
If we look at only the most frequent verbs, the correlations flip.
Correlation: factivity with all verbs
Correlation: factivity with high-frequency verbs

Acceptability of [CP[+Q]]

Factivity

think, show, see, say, tell, require, find, write, know
Correlation: veridicality with all verbs
Correlation: veridicality with high-frequency verbs

Acceptability of [CP,[+Q]]
Question
How could we have gotten the direction of correlation so wrong?

Two hypotheses
1. Previous analyses were biased by verb frequency.
2. Our analysis missed subregularities due to verb class.
Finding #1

If we look at only the most frequent verbs, the correlations flip.
Finding #1
If we look at only the most frequent verbs, the correlations flip.

Finding #2
There are subregularities, but they don’t validate the purported correlation.
Aim

Find overlapping clusters of verbs that best explain both...
Aim

Find overlapping clusters of verbs that best explain both...

1. veridicality/factivity
Aim

Find overlapping clusters of verbs that best explain both...

1. **veridicality/factivity**
2. **full syntactic distribution** (not just question-taking)
Aim

Find overlapping clusters of verbs that best explain both...

1. **veridicality/factivity**
2. **full syntactic distribution** (not just question-taking)

Possibility

The question-taking correlation holds in some clusters.
MegaAttitude frames

Syntactic type

NP

ACTIVE PASSIVE

PP

COMP

S

TENSE

that [+Q] for ⌀ [+FIN] [-FIN]

whether which NP -ed would to ⌀ -ing
Canonical Correlation Analysis (CCA)

Intuition

Find best way of simultaneously mapping...

Veridicality

Distributional representation

Veridicality judgments

Acceptability judgments
Canonical Correlation Analysis (CCA)

Intuition
Find best way of simultaneously mapping...

1. veridicality/factivity to syntactic distribution
Canonical Correlation Analysis (CCA)

Intuition

Find best way of simultaneously mapping...

1. veridicality/factivity to syntactic distribution
2. syntactic distribution to veridicality/factivity
Canonical Correlation Analysis (CCA)

Intuition

Find best way of simultaneously mapping...

1. veridicality/factivity to syntactic distribution
2. syntactic distribution to veridicality/factivity

Veridicality judgments  Acceptability judgments
Canonical Correlation Analysis (CCA)

Intuition

Find best way of simultaneously mapping...

1. veridicality/factivity to syntactic distribution
2. syntactic distribution to veridicality/factivity

Veridicality representation

Veridicality judgments

Distributional representation

Acceptability judgments
Canonical Correlation Analysis (CCA)

Intuition

Find best way of simultaneously mapping...

1. veridicality/factivity to syntactic distribution
2. syntactic distribution to veridicality/factivity

Veridicality representation  <->  Distributional representation

Veridicality judgments  <->  Acceptability judgments
Canonical Correlation Analysis (CCA)

Intuition
Find best way of simultaneously mapping...

1. veridicality/factivity to syntactic distribution
2. syntactic distribution to veridicality/factivity

Veridicality representation

VERIDICALITY JUDGMENTS

Distributional representation

ACCEPTABILITY JUDGMENTS
CCA verb scores

CCA Component 1
CCA Component 2
CCA verb scores

CCA Component 1
CCA Component 2
Class
communicative
emotive
neither
CCA verb scores

CCA Component 1
CCA Component 2
Class
communicative
eotive
neither

Class
- communicative
- emotive
- neither
CCA frame loadings
CCA feature loadings

CCA Component 1

CCA Component 2

npanim[T.to]
npinanim[T.bare]

complementizer[which]
complementizer[that]
complementizer[null]
complementizer[aboutwhether]
complementizer[for]
progressive[T.TRUE]
infinitival[T.TRUE]
eventivity[T.stative]
eventivity[T.eventive]
other[T.about]
other[T.so]
npanim[T.about]
npanim[T.bare]
tense[T.null]
tense[T.future]
etivity[T.stative]
etivity[T.eventive]
other[T.about]
Negative finding

Veridicality/factivity does not correlate with question-taking
Discussion

Negative finding
Veridicality/factivity does not correlate with question-taking

Positive finding
Veridicality/factivity correlates with NP- and PP-taking (Goal / Experiencer arguments)
Possibility #1

Veridicality/factivity can be reduced to semantic properties that control NP- and PP-taking.
Possibility #1

Veridicality/factivity can be reduced to semantic properties that control NP- and PP-taking.

Possibility #2

Question selection can be reduced to semantic properties that control NP- and PP-taking.
Conclusion
Conclusion

Distribution of nominals

Sensitive to event structural properties like stativity, telicity, durativity, causativity, transfer, etc.
Conclusion

Distribution of nominals
Sensitive to event structural properties like stativity, telicity, durativity, causativity, transfer, etc.

Distribution of clauses
Sensitive to intentional properties like representationality, preferentiality, factivity/veridicality, communicativity, etc.
Hypothesis

The distribution of clauses is determined by the same semantic properties as the distribution of nouns.
Hypothesis

The distribution of clauses is determined by the same semantic properties as the distribution of nouns.

Not intentional properties.
Hypothesis

The **distribution of clauses** is determined by the **same semantic properties** as the **distribution of nouns**

Not intentional properties

Intuition

Intentional properties require that an eventuality have **informational content**, but not all eventualities have such content
Focus

Two intentional properties—factivity and veridicality—that are argued to determine selection of interrogatives & declaratives
Conclusion

Focus
Two intentional properties—factivity and veridicality—that are argued to determine selection of interrogatives & declaratives

Findings

1. Veridicality and factivity do not correlate with question-taking
Conclusion

Focus

Two intentional properties—factivity and veridicality—that are argued to determine selection of interrogatives & declaratives

Findings

1. Veridicality and factivity do not correlate with question-taking
2. Veridicality and factivity correlate with NP- and PP-taking
Limitation

We didn’t distinguish between factivity and semifactivity.
Future directions

Limitation
We didn’t distinguish between factivity and semifactivity.

Approach
Attempt to explicitly measure semifactivity.
Old prompt
Someone _ed that a particular thing happened. Did that thing happen?

New prompt
If someone _ed that a particular thing happened, did that thing happen?
Measuring semifactivity

- Veridicals
- Factives
- Nonveridicals
- Antiveridicals
- Antifactives

\[ \neg p \leftarrow \neg V(p) \rightarrow p \]

\[ \neg p \leftarrow V(p) \rightarrow p \]

Frame

NP _ that S
NP was _ed that S
Measuring semifactivity

\[ \neg p \leftarrow \neg V(p) \rightarrow p \]

Frame

- NP _ that S
- a NP was _ed that S
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