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TRUTHFUL RESOLUTIONS

A new perspective on false-answer sensitivity

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Preface: traditional readings of embedded questions

(1) John knows **who called.**

Assume the set of answers to the embedded question in (1) is the Hamblin set:

$$A = \textsc{ans}(\text{who called}) = \{d \text{ called} \mid d \in D\}$$

❶ **Mention-some (Groenendijk & Stokhof, 1984; George, 2011):**
For at least one true answer $p \in A$, John knows that p is true.

❷ **Weakly exhaustive (Karttunen, 1977):**
For all true answers $p \in A$, John knows that p is true.

❸ **Strongly exhaustive (Groenendijk & Stokhof, 1984):**
For all true answers $p \in A$, John knows that p is true;
and for all false answers $p \in A$, he knows that p is false.

Preface: FA sensitive readings of embedded questions

However, we also need sensitivity to false answers for the weaker readings:

- FA sensitive weak exhaustivity, aka **intermediate exhaustivity**
  - Spector, 2005
  - Klinedinst & Rothschild, 2011
- FA sensitive **mention-some**
  - George, 2011
  - Uegaki, 2015

Responsive verbs and the reductive approach

- **Responsive verbs** like *know* can take either a declarative or an interrogative complement.

(2) John knows that Mary called.

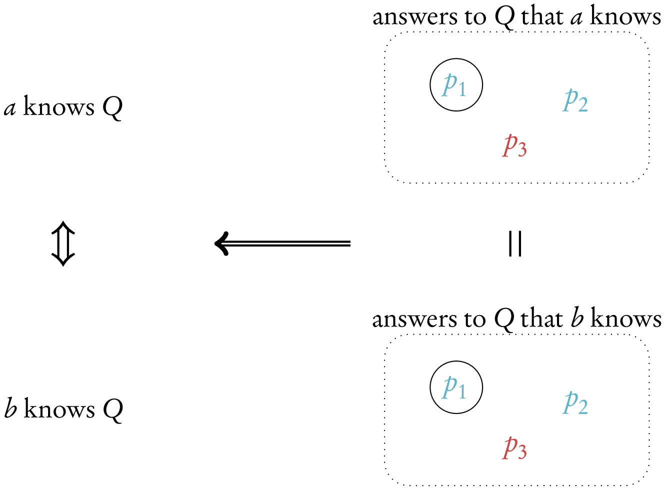
(3) John knows who called.

- **Reductive approach**: interrogative knowledge is completely determined by declarative knowledge.

- **In the mention-some case:**

$$[\![\text{know-wh}]\!](Q)(x) \quad \text{iff} \quad \exists p.(\textsc{ans}(Q)(p) \wedge [\![\text{know-that}]\!](p)(x))$$

Responsive verbs and the reductive approach



George (2013)'s challenge

Interrogative knowledge doesn't only depend on declarative knowledge, but also on **possibly false belief**.

Italian-newspaper scenario:

	Newstopia	Paperworld
facts	✓	✗
Janna	✓	?
Rupert	✓	✓

(4) Janna knows where one can buy an Italian newspaper. [true]

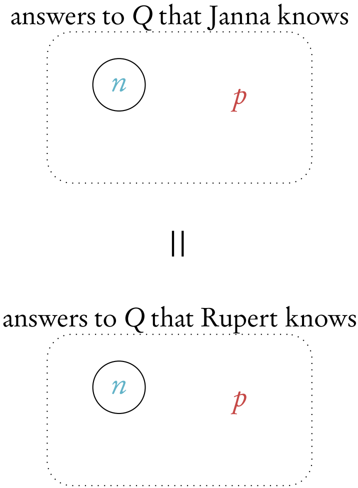
(5) Rupert knows where one can buy an Italian newspaper. [false]

Responsive verbs and the reductive approach

Janna knows Q

$\not\Updownarrow$

Rupert knows Q



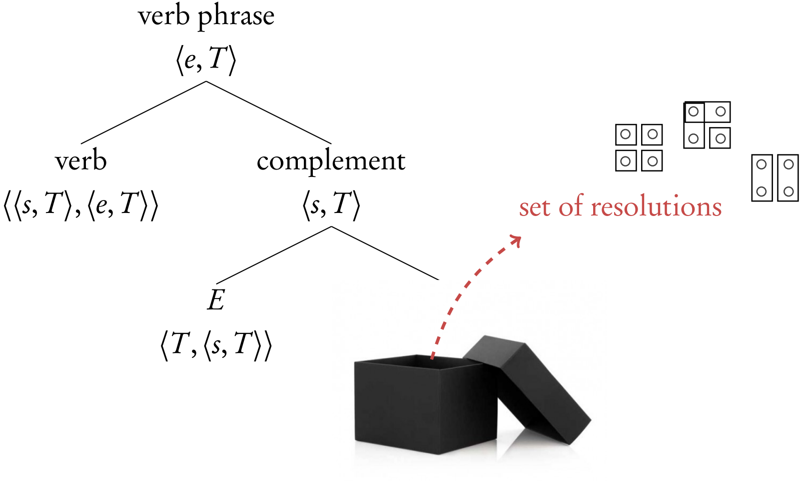
UNIFORM ACCOUNT

We'll assume a *single lexical entry* for the embedding verb, which can apply to declarative and interrogative complements alike.

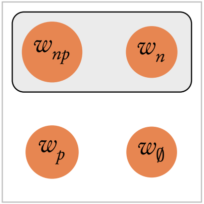
$$[\![\text{know-wh}]\!] = [\![\text{know-that}]\!]$$

Roadmap

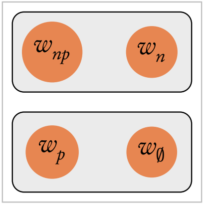
1. **Global syntactic assumptions**
2. **Interrogative complements**
    - False answer sensitivity
    - George's challenge solved
3. **Declarative complements**
    - Veridicality implications
4. **Extensional vs. intensional verbs**
5. **Conclusion**


verb phrase
⟨e, T⟩
verb
⟨⟨s, T⟩, ⟨e, T⟩⟩
complement
⟨s, T⟩
E
⟨T, ⟨s, T⟩⟩
set of resolutions

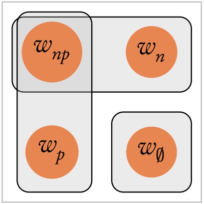
Nucleus meaning: set of resolutions



Newstopia sells
Italian newspapers.



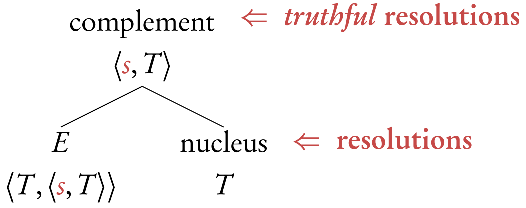
Does Newstopia sell
Italian newspapers?



Where can one get
an Italian newspaper?

Interrogatives: the complement

World-dependence à la Karttunen comes into play at the complement level.



Truthful resolutions are **resolutions**, but with additional conditions:

- providing enough **true** information
- but no false, **misleading** information.

Interrogatives: the E operator

The 'enough information' part:

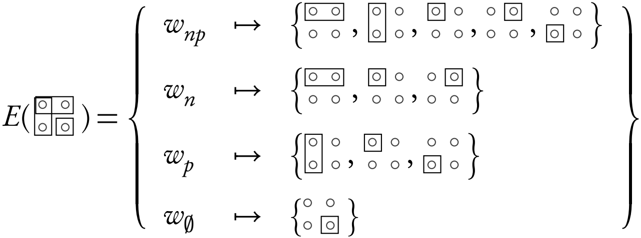
Let P be a sentence meaning and w a possible world. A proposition is a **truthful resolution** of P in w iff

- it is consistent and
- **entails at least one alternative** in P that is true in w.

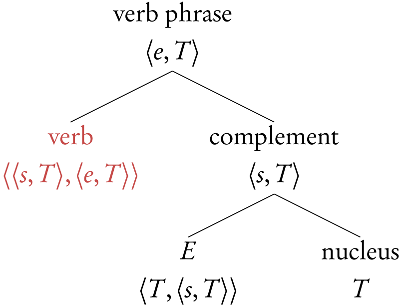
Translated into a preliminary definition of the E operator:

$$E \quad := \quad \lambda P_T.\lambda w.\lambda p_{\langle s,t\rangle}.p \neq \emptyset \wedge \exists q \in \text{ALT}(P).(q(w) \wedge p \subseteq q)$$

Interrogatives: the E operator



Embedding verbs: a lexical entry for *know*



$$[\![\text{know}]\!] := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\forall w \in p:\ \boldsymbol{\sigma}_x^w \in f(w)$$

- Notice the 'exact-match semantics'!

Comparison with the standard account

$$[\![\mathsf{know}]\!]_{\text{std}} = \lambda q.\lambda x.\lambda w.\ \sigma_x^w \subseteq q$$

$$[\![\mathsf{know}]\!] := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\forall w \in p:\ \sigma_x^w \in f(w)$$

	standard	here
complement	not ↓-closed	↓-closed
verb	$\subseteq$	$\in$

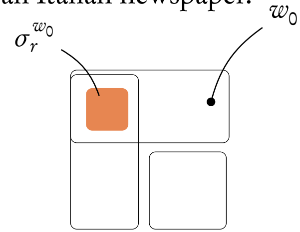
Wait, so this is equivalent to the standard account, right?
—Yes, *so far* it still is.

Vanilla downward-closedness doesn't do the job

We don't derive the desired FA sensitivity:

(6) Rupert knows where one can buy an Italian newspaper.

	Newstopia	Paperworld
facts	✓	✗
Janna	✓	?
Rupert	✓	✓



Under the preliminary definition, Rupert's information state is a truthful resolution.

Restricted downward-closedness

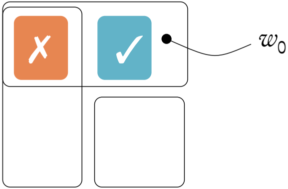
Adding the 'no false, misleading information' condition:

$$E \quad := \quad \lambda P_T.\lambda w.\lambda p.\begin{pmatrix} p \neq \emptyset \wedge \\ \exists q \in \textsc{alt}(P).(q(w) \wedge p \subseteq q) \wedge \\ \neg \exists q \in \textsc{alt}(P).(\neg q(w) \wedge p \subseteq q) \end{pmatrix}$$

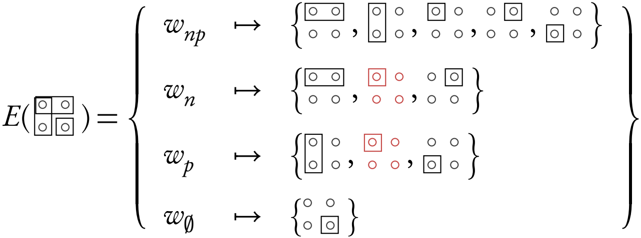
Truthful resolution ≠ true resolution

A truthful resolution doesn't have to be true.

- It only has to be true "with respect to" the embedded question:



Restricted downward-closedness



Restricted downward-closedness

No longer equivalent to the standard account!

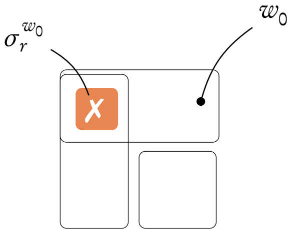
	standard	here
complement	no $\downarrow$-closedness	restricted $\downarrow$-closedness
verb	$\subseteq$	$\in$

Predictions for George's scenario

This gives us the desired FA sensitivity:

(7) Rupert knows where one can buy an Italian newspaper.

	Newstopia	Paperworld
facts	✓	✗
Janna	✓	?
Rupert	✓	✓

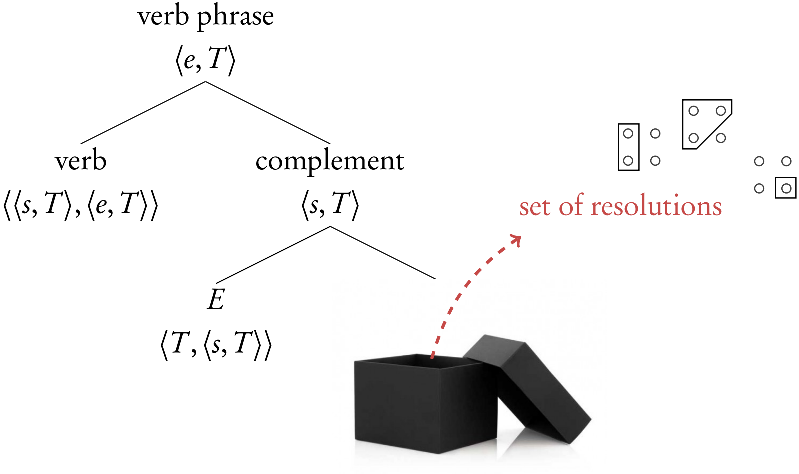


Under the new definition, Rupert's information state is **not** a truthful resolution.

UNIFORM ACCOUNT

We'll assume a *single lexical entry* for the embedding verb, which can apply to declarative and interrogative complements alike.

$$[\![\text{know-wh}]\!] = [\![\text{know-that}]\!]$$

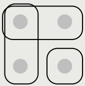

verb phrase
$\langle e, T \rangle$
verb
$\langle \langle s, T \rangle, \langle e, T \rangle \rangle$
complement
$\langle s, T \rangle$
E
$\langle T, \langle s, T \rangle \rangle$
set of resolutions

Declaratives: veridicality implications

Recall the definition of E:

$$E \quad := \quad \lambda P_T.\lambda w.\lambda p.\left(\begin{array}{l} p \neq \emptyset \wedge \\ \exists q \in \text{ALT}(P).(q(w) \wedge p \subseteq q) \wedge \\ \neg\exists q \in \text{ALT}(P).(\neg q(w) \wedge p \subseteq q) \end{array} \right)$$

If P is an **interrogative** nucleus, it covers the entire logical space, for example:



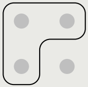
- For interrogative nuclei, there's **always** a "true alternative".
- It's never the case that $E(P)(w) = \emptyset$.

Declaratives: veridicality implications

Recall the definition of E:

$$E \quad := \quad \lambda P_T.\lambda w.\lambda p.\left(\begin{array}{l} p \neq \emptyset \wedge \\ \exists q \in \textsc{alt}(P).(q(w) \wedge p \subseteq q) \wedge \\ \neg\exists q \in \textsc{alt}(P).(\neg q(w) \wedge p \subseteq q) \end{array}\right)$$

If P is a **declarative** nucleus, it contains a single alternative p, for example:



- For declarative nuclei, $E(P)(w) = \emptyset$ if w is not contained in the single alternative in the nucleus meaning.

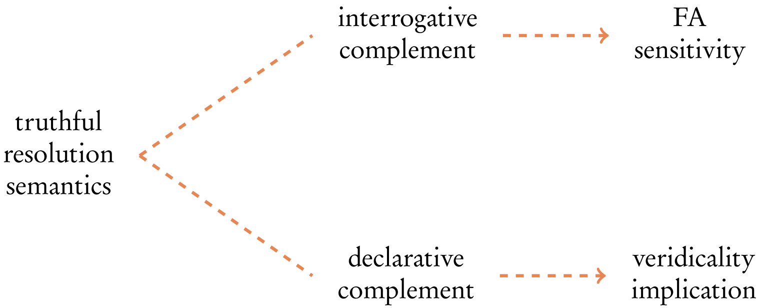
Declaratives: veridicality implications

$$[\![\mathsf{know}]\!] = \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\, \forall w \in p : \sigma_x^w \in f(w)$$

Assume $[\![\mathsf{know}]\!]$ applies to a declarative complement $f = E(P)$.

- There are worlds w such that $f(w) = \emptyset$.
- $[\![\mathsf{know}]\!](f)(x)$ contains only p such that, for all $w \in p$, w is contained in the single alternative from P.
- This is a **veridicality implication**.

Declarative vs. interrogative complements



The effect of the truthful resolution semantics depends on whether the complement is declarative or interrogative.

More embedding verbs

interrogative-embedding verbs

- **extensional**
  know, remember, forget, discover, be surprised…
- **intensional**
  - **responsive**
    be certain, agree on …
  - **rogative**
    wonder, investigate, depend on …

Responsive intensional verbs: *be certain*

Intensional verbs like *be certain* don't exhibit FA sensitivity.

(8) Rupert is certain where one can buy an Italian newspaper.

- (8) is true even though Rupert believes a false answer.

Intensional verbs also don't give rise to veridicality implications.

(9) Rupert is certain that one can buy an Italian newspaper at Paperworld.
$\not\therefore$ One can buy an Italian newspaper at Paperworld.

Lack of false answer sensitivity as a world-shift

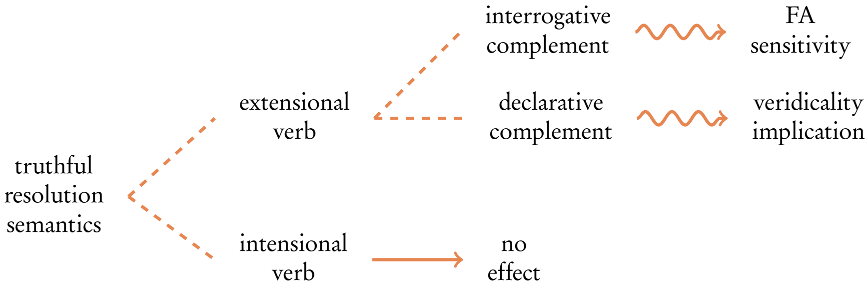
- **Extensional verbs** express a relation to the complement's extension, here: the set of truthful resolutions in the **world of evaluation**.

$$[\![\text{know}]\!] := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\forall w \in p : \sigma_x^w \in f(w)$$

- For every resolution p to a question Q, there exist worlds in which p is a truthful resolution to Q.
- **Intensional verbs** express a relation to the complement's intension, which determines the set of **all possible** truthful resolutions.

  $[\![\text{be certain}]\!] = \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\forall w \in p : \forall w' \in \boldsymbol{\sigma}_x^w\!: \ \sigma_x^w \in f(w')$
  (Uegaki, 2015)

Comparison: extensional and intensional verbs



Conclusion

Uniform account of responsive verbs

- captures the **common core** of the different kinds of complements in a transparent way
  - **same lexical entry** for verb and embedding operator
  - **same mechanism for FA sensitivity** across all levels of exhaustive strength
- derives the **differences** between the different kinds of complements from few and general parameters
  - properties of interrogative/declarative complements independently motivated by semantics of root interrogatives/declaratives
  - FA sensitivity and veridicality implications as consequences of the semantic properties of the complement meaning

THANK YOU!

More verbs

$$\text{tell}'_{[+\text{ext}]} := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda y.\lambda p.\forall w \in p : \tau^{w}_{x,y} \in f(w)$$

$$\text{tell}'_{[-\text{ext}]} := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda y.\lambda p.\forall w \in p : \tau^{w}_{x,y} \in \bigcup_{v \in W} f(v)$$

$$\text{be right}' := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\underline{\forall w \in p : \sigma^{w}_{x} \in \bigcup_{v \in \sigma^{w}_{x}} f(v)}.\forall w \in p : \sigma^{w}_{x} \in f(w)$$

$$\text{be wrong}' := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\underline{\forall w \in p : \sigma^{w}_{x} \in \bigcup_{v \in \sigma^{w}_{x}} f(v)}.\forall w \in p : \sigma^{w}_{x} \notin f(w)$$

$$\text{wonder}' := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\forall w \in p : (\sigma^{w}_{x} \notin \bigcup_{v \in \sigma^{w}_{x}} f(v) \wedge \Sigma^{w}_{x} \subseteq \bigcup_{v \in \sigma^{w}_{x}} f(v))$$

$$\text{believe}' := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\underline{\forall w \in p : \sigma^{w}_{x} \in \bigcup_{v \in \sigma^{w}_{x}} f(v) \vee \sigma^{w}_{x} \in \neg \bigcup_{v \in \sigma^{w}_{x}} f(v)}.$$
$$\forall w \in p : \sigma^{w}_{x} \in \bigcup_{v \in \sigma^{w}_{x}} f(v)$$