

Reducing declarative-embedding to question-embedding: Arguments from content nouns, selectional restrictions and '(non-)reducibility'

Wataru Uegaki
wuegaki@mit.edu

NYU workshop on clausal complements
February 21st, 2015

0. Introduction

Selectional restriction of attitude predicates

- (1) a. John **knows** {that Sue came / who came} to the party.
- b. John **believes** {that Sue came / *who came} to the party.
- c. John **asked** me/**wonders** {*that Sue came / who came} to the party.

Overarching question

Whether and how can the selectional restrictions of attitude predicates be explained in terms of their lexical semantics?

The question addressed in this talk

How is the selectional restriction of the *know*-type predicates (RESPONSIVE PREDICATES; RESPs) explained? How can we account for their compatibility with both declarative and interrogative complements?

The traditional answer

- ▶ The basic denotation of ResPs selects for a **proposition**, which is the meaning of declarative clauses.
- ▶ There is some form of **reduction from the meaning of embedded interrogatives to propositions** (Karttunen 1977, Groenendijk & Stokhof 1984).

Example: Groenendijk & Stokhof (1984)

- ▶ The intension of an interrogative clause is a propositional concept. Thus, the extension of an interrogative clause is a proposition, which can be combined with a ResP.
 - ▶ ResPs select for **propositions** $\langle s, t \rangle$.
 - ▶ interrogative complement: **propositional concept** $\langle s, st \rangle$
extensionalize → **proposition** $\langle s, t \rangle$

Three problems with the traditional answer

- Interpretation of nominal complements** The traditional view does not account for the contrast in the **interpretation of nominal complements** of ResPs and *believe*-type predicates. (e.g., *John knows the rumor that p* vs. *John believes the rumor that p*).
- Selectional restrictions** Unless further stipulations are made, the traditional view incorrectly predicts that ***believe*-type verbs would embed interrogatives**.
- 'Non-reducibility'** (George 2011) There are cases where the interpretation of *know-wh* cannot be reduced to the interpretation of *know-that*.

This talk: ResPs always take questions

The claim to be made

The basic denotation of ResPs select for a **question**, rather than a **proposition**. The embedding of declaratives by ResPs is a **limiting case** of question-embedding, where the question is **trivial**.

- ▶ ResPs select for a **set of propositions**.
 - ▶ Interrogative complements denote sets of propositions. (Hamblin 1973).
 - ▶ Declarative complements are **coerced into singleton questions**.
- ▶ *believe*-type predicates select for **propositions**.
- ▶ A difference between *know* and *believe* in their **combinatorial possibilities**.
- ▶ This view enables straightforward solutions to the three problems with the traditional analysis.
- ▶ The analysis is formulated in **Montagovian formal semantics**.

0. Introduction
1. Motivating the proposal: The puzzle of 'content' DPs
(Problem 1)
2. Selectional restrictions of attitude predicates (Problem 2)
3. George's 'non-reducibility' (Problem 3)
4. Conclusions

0. Introduction
1. **Motivating the proposal: The puzzle of 'content' DPs**
(Problem 1)
2. Selectional restrictions of attitude predicates (Problem 2)
3. George's 'non-reducibility' (Problem 3)
4. Conclusions

Contrast in more general terms

The contrast is between attitude verbs that **only embed a declarative clause**, and those that can embed **both a declarative and an interrogative clause**:

(3) a. John **believes** the rumor that Mary left.

⊨ John **believes** that Mary left.

Patterns with: *accept, trust, deny, confirm, (dis)prove, validate*

b. John **knows** the rumor that Mary left.

⊭ John **knows** that Mary left.

Patterns with: *discover, remember, report, predict, be certain, surprise*

- ▶ (3a): PROPOSITION-TAKING PREDICATES (PROPs)
- ▶ (3b): RESPONSIVE PREDICATES (RESPs)
- ▶ **Note:** Factivity is independent from this classification.
 - ▶ Non-factive ResPs: *report, communicate* etc.
 - ▶ Factive ProPs: *regret, resent*

Positing a general mechanism for the entailment fact

Positing a general mechanism that captures the entailment of ProPs would lead to a wrong prediction for ResPs.

- ▶ E.g.,: giving a propositional meaning to *the rumor that p*

$$(4) \quad \llbracket \text{the rumor that } p \rrbracket^w = \iota p' [\mathbf{rumor}(p') \wedge p' = p]$$

$$(5) \quad \llbracket \text{believe} \rrbracket^w = \lambda p_{\langle s,t \rangle} \lambda x_e. \text{DOX}_x^w \subseteq p \quad (\text{Hintikka 1962})$$

$$(6) \quad \llbracket \text{John believes the rumor that Mary left} \rrbracket^w = 1 \text{ iff} \\ \text{DOX}_j^w \subseteq \iota p [\mathbf{rumor}(p, w) \wedge p = \text{'that Mary left'}]$$

$$(7) \quad \llbracket \text{know} \rrbracket^w = \lambda p_{\langle s,t \rangle} \lambda x_e. \text{EPIS}_x^w \subseteq p$$

$$(8) \quad \llbracket \text{John knows the rumor that Mary left} \rrbracket^w = 1 \text{ iff} \\ \text{EPIS}_j^w \subseteq \iota p [\mathbf{rumor}(p, w) \wedge p = \text{'that Mary left'}]$$

- ▶ (8) incorrectly entails that John knows that Mary left.

Stipulating the entailment in the lexical denotations

- ▶ Content DPs denote non-propositional objects (type a).
- ▶ Distinct denotations for the knowledge *know* and the acquaintance *know*. (e.g., *kennen* vs. *wissen*).

$$(9) \quad \llbracket \text{know}_K \rrbracket^w = \lambda p_{\langle s,t \rangle} \lambda x. \text{EPIS}_x^w \subseteq p$$

$$(10) \quad \llbracket \text{know}_A \rrbracket^w = \lambda \alpha_a \lambda x_e. \mathbf{acquainted}(x, \alpha, w)$$

- ▶ Content DPs only combine with *know_A* due to its type.
- ▶ Being acquainted with α with propositional content p does not entail knowing that p .
- ▶ In contrast, the denotation of *believe* can access the propositional content of the abstract obj it combines with.

$$(11) \quad \llbracket \text{believe}_{cont} \rrbracket^w = \lambda \alpha_a \lambda x_e. \llbracket \text{believe} \rrbracket^w(\mathcal{F}_{cont}(\alpha))(x)$$

where \mathcal{F}_{cont} is a function $D_a \mapsto D_{\langle s,t \rangle}$ that **maps an abstract object to its content**.

Problems with lexical stipulations

- ▶ Stipulating lexical entries does not **explain** why the possibility of interrogative-embedding correlates with the contrast, i.e., why ResPs do not license the entailment while ProPs do.
- ▶ In other words, the account does not answer why the knowledge *know* lacks the denotation that is parallel to *believe_{cont}*, as in the hypothetical verb in (12), which would incorrectly derive the entailment.

$$(12) \quad \llbracket *know_{cont} \rrbracket^w = \lambda\alpha_a \lambda x_e. \llbracket know_K \rrbracket^w(\mathcal{F}_{cont}(\alpha))(x)$$

$$(11) \quad \llbracket believe_{cont} \rrbracket^w = \lambda\alpha_a \lambda x_e. \llbracket believe \rrbracket^w(\mathcal{F}_{cont}(\alpha))(x)$$

- ▶ We need a principled way to block (12).
- ▶ However, since *know_K* is semantically a proposition-taking predicate just like *believe*, there is no obvious reason why (12) is not available if (11) is.

Summary of the puzzle

Two approaches to the contrast in between ResPs and ProPs:

1. Posit a **general compositional mechanism** (e.g., propositional denotation of content DPs) **that derives the entailment** fact of ProPs with its standard denotation.
2. Encode the contrast in the entailment in the **lexical denotations** of ResPs and ProPs.

Whether we choose 1 or 2, we face problems as long as we take into account the following assumption:

- (*) ResPs select for the **same kind of object** that ProPs select for (such as a **proposition**).
- ▶ 1 + (*) **over-generates** the relevant entailment for ResPs.
- ▶ 2 + (*) forces us to give **stipulative** lexical semantic difference between ResPs and ProPs that cannot be explained by their selectional properties.

Proposal: ResPs are question-taking

Proposal

ResPs semantically select for a question, not for a proposition.

- ▶ Below is the **only** denotation for *know*, which will be used both declarative-embedding and interrogative-embedding.

$$(13) \quad \llbracket \text{know}_K \rrbracket^w = \lambda Q_{\langle st, t \rangle} \lambda x_e. \exists p \in Q [p(w) \wedge \text{EPIS}_x^w \subseteq p]$$

- ▶ (13) directly combines with the denotation of interrogative complements (that are either exhausted or non-exhausted).
- ▶ (13) also combines with a proposition denoted by a declarative-clause via the following type-shifter:

$$(14) \quad \llbracket \text{IDENT} \rrbracket^w = \lambda p. \{p\} \quad (\text{cf. Partee 1986})$$

$$(15) \quad \llbracket \text{John knows [IDENT [that Ann came]]} \rrbracket^w = 1 \\ \text{iff } \exists p \in \{ \text{'Ann came'} \} [p(w) \wedge \text{EPIS}_j^w \subseteq p] \\ \text{iff 'Ann came' is true in } w \wedge \text{EPIS}_j^w \subseteq \text{'Ann came'}$$

The gist of the solution to the puzzle

- ▶ Content DPs denote **entities** (of type e).
- ▶ When a ProP or a ResP is combined with a content DP, a **type-mismatch** arises.
- ▶ Both cases of type-mismatch are resolved by **type-shift**, but in different ways:
 - ▶ ProP + DP is resolved by **entity-to-content** type-shift.
 - ▶ ResP + DP is resolved by **entity-to-question** type-shift
(\Rightarrow Concealed Question reading).
- ▶ Only the former results in the relevant entailment pattern.

ProP + Content DP

- ▶ Content DPs denote **individuals** of type e :

$$(16) \quad \llbracket \text{the rumor that Mary left} \rrbracket^w = \\ \iota x [\mathbf{rumor}(x)(w) \wedge \mathcal{F}_{cont}(x) = \text{'that Mary left'}]$$

- ▶ A ProP like *believe*, which selects for a proposition, is combined with (16) via the **entity-to-content** type shift:

$$(5) \quad \llbracket \text{believe} \rrbracket^w = \lambda p_{\langle s,t \rangle} \lambda x_e. \text{DOX}_x^w \subseteq p \quad (\text{Hintikka 1968})$$

$$(17) \quad \llbracket \text{CONT} \rrbracket^w = \mathcal{F}_{cont}$$

- ▶ The resulting truth conditions of *John believes the rumor that Mary left* entails that John believes that Mary left:

$$(18) \quad \llbracket \text{John believes CONT[the rumor that Mary left]} \rrbracket^w = 1 \\ \text{iff } \text{DOX}_j^w \subseteq \mathcal{F}_{cont}(\iota x [\mathbf{rumor}(x)(w) \wedge \mathcal{F}_{cont}(x) = \\ \text{'that Mary left'}])$$

The need for CONT outside attitude verbs

- ▶ Data like (19) suggest that adjectives such as *true* and *false* denote **predicates of propositions**.

(19) That Mary left is **true/false**.

- ▶ Given this, we need CONT to account for (20), in which *true/false* is predicated of the content of the rumor.

(20) The rumor is **true/false**.

(21) CONT[The rumor] is **true/false**.

- ▶ Similar arguments can be made with predicates like *compatible/contradict*:

(22) That John saw Mary {**is compatible with / contradicts**} what she said.

(23) The rumor {**is compatible with / contradicts**} what she said.

(cf. King 2002)

ResPs + DP (i): Concealed Questions

- ▶ A ResP is question-taking, not proposition-taking:

$$(13) \quad \llbracket \text{know} \rrbracket^w = \lambda Q_{\langle st, t \rangle} \lambda x_e. \exists p \in Q [p(w) \wedge \text{EPIS}_x^w \subseteq p]$$

- ▶ Thus, when it is combined with a DP, the type-shifter **Cont cannot resolve the type-mismatch**.
- ▶ The relevant type-shifter resolving the mismatch is the **Concealed Question (CQ) type-shifter** which turns an individual into its corresponding concealed question.

(24) John knows the capital of Canada.

(**CQ reading**: 'John knows **what the capital of Canada is**'.)

- ▶ Any plausible theory of CQ should capture the fact that the CQ reading of *x knows the rumor that p* is 'x knows which object is the rumor that p'.
- ▶ This interpretation clearly doesn't entail 'x knows that p'.

CQ type-shifter adapted from Aloni (2008)

- ▶ Aloni (2008): *John knows the winning card* in its CQ reading roughly means ‘John knows that c is the winning card’, where c is an **individual concept** in a contextually salient **conceptual cover** (Aloni 2001).
- ▶ Example of **conceptual covers**:
 - ▶ {the left card, the right card}
 - ▶ {the ace of spades, the ace of hearts}

(25) $\llbracket \text{CQ} \rrbracket^{\text{Cov}} := \lambda x_e. \{ 'c \text{ identifies } x' \mid c \in \text{Cov} \}$
where Cov is a contextually salient conceptual cover.

- ▶ $\llbracket \text{CQ}[\text{the winning card}] \rrbracket =$ the set of propositions that specify **which concept identifies the winning card (WC)**.
 - ▶ {the left card is the WC, the right card is the WC}
 - ▶ {the ace of spades is the WC, the ace of hearts is the WC}

CQ reading of *John knows the rumor that p*

$$(26) \quad \llbracket \text{John knows CQ}[\text{the rumor that } p] \rrbracket^{w, Cov} \\ = \llbracket \text{know} \rrbracket^w (\{ 'c \text{ identifies the rumor that } p' \mid c \in Cov \}) (\mathbf{j})$$

- ▶ Example of a Cov : {the rumor that Ann told, the rumor that Bill told, ... }
- ▶ (26) does not entail *John knows that p*.
 - ▶ We can construct a model such that **(i)** John knows that the rumor that Ann told (and nothing else) is the rumor that p (and hence (26) is true), but **(ii)** John does not believe the content p of the rumor (hence *John knows that p* is false)
- ▶ **Any plausible theory of CQs (not just Aloni's) should account for the lack of the relevant entailment.**

ResPs + DP (ii): Acquaintance

- ▶ Another way in which a ResP can be combined with a DP: through the **acquaintance** reading.

$$(10) \quad \llbracket \text{know}_A \rrbracket^w = \lambda y_e \lambda x_e . \mathbf{acquainted}(x, y, w)$$

- ▶ As stated before, being acquainted with entity x with propositional content p does not entail knowing that p .
- ▶ Thus, the entailment doesn't hold also in this case.

Digression: What *know the rumor that p* actually means

- ▶ *wissen* is **infelicitous** in the German counterpart of the 'know the rumor that p' construction:

(27) Ich kenne/#weiß das Gerücht, dass Maria
I know_A/know_K the rumor that Maria
weggegangen ist.
left is.

- ▶ The type-shifter CQ predicts that the CQ reading is possible in principle, but there are further pragmatic conditions on CQ.
- ▶ The identifying concept has to be more '**prominent**' than the identified concept. (see Aloni & Roelofsen 2012)

(28) a. John knows the current president of US. (✓CQ)
b. John knows Obama. (*CQ)

(29) a. John knows the rumor which Mary told. (✓CQ)
b. John knows the rumor that Mary left. (*CQ)

ResPs + DP (ii): Acquaintance (cont.)

- ▶ Other ResPs have different denotations that select for an individual argument.

$$(10) \quad \llbracket \text{discover}_A \rrbracket^w = \lambda y_e \lambda x_e. \mathbf{discoverEntity}(x)(y)(w)$$

- ▶ Again, discovering object y with propositional content p does not entail discovering that p .
- ▶ I cannot give a general schema in which the question-taking denotation of a ResP is related to the acquaintance/entity-taking denotation.
- ▶ What is crucial: there is **no general mechanism** (e.g., type-shifter) that licenses the problematic entailment in the acquaintance/entity-relating reading.

A potential issue

(30) The inventory of type shifters

a. IDENT: $\langle s, t \rangle \rightarrow \langle st, t \rangle$

b. CONT: $e \rightarrow \langle s, t \rangle$

c. CQ: $e \rightarrow \langle st, t \rangle$

► **Issue:** Combining CONT and IDENT.

(31) $\llbracket \text{IDENT} [\text{CONT the rumor}] \rrbracket^w = \{ \mathcal{F}_{\text{cont}}(\llbracket \text{the rumor} \rrbracket^w) \}$

(32) $\llbracket \text{John knows IDENT}[\text{CONT}[\text{the rumor that Mary left}]] \rrbracket^w$

$\Rightarrow \exists p \in \{ \text{'that Mary left'} \} [p(w) \wedge \text{EPIS}_x^w \subseteq p]$

$\Rightarrow w \in \text{'that Mary left'} \wedge \text{EPIS}_x^w \subseteq \text{'that Mary left'}$

► Problematic entailment!

A principle on Type-shifter application

Economy condition on Type-shifting

A structure involving successive applications of multiple type-shifters α and β to the form φ i.e., $[\beta [\alpha \varphi]]$, is ruled out if there is a basic type-shifter γ such that the semantic type of $[\gamma \varphi]$ is the same as that of $[\beta [\alpha \varphi]]$.

- ▶ In the current case, this principle applies to the following two structures:
 - ▶ [IDENT [CONT DP]]
 - ▶ [CQ DP]
- ▶ Given the principle, the former structure is 'blocked' by the latter.
- ▶ Conceptual similarity to Chierchia's (1998) 'Type-shifting as Last Resort'.

Interim summary

- ▶ Fundamental type distinction between ProPs and ResPs:
 - ▶ ProPs take $\text{Type-}\langle s, t \rangle$ complement.
 - ▶ ResPs take $\text{Type-}\langle st, t \rangle$ complement.
- ▶ Three type shifters:
 - ▶ IDENT: $\langle s, t \rangle \rightarrow \langle st, t \rangle$ (proposition-to-singleton)
 - ▶ CONT: $e \rightarrow \langle s, t \rangle$ (entity-to-content)
 - ▶ CQ: $e \rightarrow \langle st, t \rangle$ (entity-to-CQ)
- ▶ The type-mismatch in *John believes the rumor that p* is resolved by CONT.
 - ▶ The result entails *John believes that p*.
- ▶ *John knows the rumor that p* is interpreted in one of the following two ways. Both don't license the relevant entailment.
 - ▶ CQ reading with CQ.
 - ▶ 'Acquaintance'/entity-relating readings.

Outline

1. Motivating the proposal: The puzzle of 'content' DPs
2. **Selectional restrictions of attitude predicates**
3. George's 'non-reducibility'
4. Conclusions

The 'backward' reduction

- ▶ ProPs select for a Type- $\langle s, t \rangle$ argument.
⇒ only embed declarative complement.
- ▶ ResPs select for a Type- $\langle st, t \rangle$ argument.
⇒ embed interrogatives as well as declaratives via the IDENT type-shifter.

'Backward' reduction

In the current picture, proposition-embedding of ResPs is reduced to question-embedding.

- ▶ This is the opposite of a more standard picture, where
 - ▶ ResPs take propositions, and
 - ▶ question-embedding by ResPs is reduced to proposition-embedding (Groenendijk & Stokhof 1984; Lahiri 2002)

Inquisitive verbs

The issue with inquisitive verbs

The current analysis predicts predicates such as *ask* and *wonder* (**inquisitive verbs** in Karttunen's (1977) classification) to be able to embed declaratives.

- ▶ Due to IDENT, we appear to (wrongly) predict that they can embed a declarative complement just like *know* does.
- ▶ However, this problem can be avoided since exclusively interrogative-embedding verbs are characterized by the **non-triviality presupposition**:

Non-triviality presupposition of inquisitive verbs

$\llbracket \text{wonder/ask/inquire} \rrbracket^w(Q)(x)$ is defined only if Q is non-singleton.

Inquisitive verbs (cont.)

- ▶ This rules out the embedding of declaratives under inquisitive verbs via IDENT.

$$(33) \quad \llbracket \text{asked} [\text{IDENT} [\text{that } p]] \rrbracket^w = \llbracket \text{asked} \rrbracket^w(\{p\})$$

- ▶ The non-triviality requirement can be **derived** if we assume that inquisitive verbs involve the meaning of **'want to know'**.

- (34) a. ??John wants to know that Mary came.
b. John wants to know who came.

Three assumptions:

1. 'x wants φ ' presupposes that x does not believe φ .
2. 'x wants φ_π ' presupposes that x believes π .
(φ_π stands for φ with the presupposition π)
3. If one believes φ , then she believes that she knows that φ
(Principle of Positive Certainty; van der Hoek 1993).

Deriving the non-triviality requirement

- (34) a. ??John wants to know that Mary came.
b. John wants to know who came.

1. 'x wants φ ' presupposes that x does not believe φ .
2. 'x wants φ_π ' presupposes that x believes π .
3. If one believes φ , then she believes that she knows that φ .
 - ▶ (35a) presupposes that John does not believe that he know that Mary came. —(i)
 - ▶ (35a) presupposes that John believes that Mary came. —(ii)
 - ▶ By (ii) and 3, John believes that he knows that Mary came. —(iii)
 - ▶ (iii) contradicts (i).

Deriving the non-triviality requirement

(35) a. ??John wants to know that Mary came.

b. John wants to know who came.

1. 'x wants φ ' presupposes that x does not believe φ .
2. 'x wants φ_π ' presupposes that x believes π .
3. If one believes φ , then she believes that she knows that φ .
 - ▶ (35b) presupposes that John does not believe that he knows who came. —(i)
 - ▶ (35a) presupposes that John believes that someone came.—(ii)
 - ▶ By (ii) and 3, John believes that he knows that someone came —(iii)
 - ▶ (iii) is consistent with (i).

Upshot: Inquisitive verbs have non-triviality requirement, which prevents them from embedding declarative complements.

Comparison with the traditional view

- ▶ **Current talk:** ResPs take questions. Proposition-embedding is reduced to question-embedding
- ▶ **Traditional view:** ResPs take propositions. Question-embedding is reduced to proposition-embedding.

	embed decl.	not embed decl.
embed inter.	<i>know, be certain, tell</i> etc.	<i>ask, wonder</i> etc.
not embed inter.	<i>believe, think</i> etc.	—

- ▶ Both approaches have cases that cannot be accounted for by the types alone:
 - ▶ **Current view:** *ask/wonder* class.
 - ▶ **Traditional view:** *believe/think* class.

Comparison with the traditional view (cont.)

- ▶ An independent semantic explanation for why *ask*-type verbs cannot embed a declarative: the **non-triviality requirement**.
- ▶ On the other hand, it is difficult to account for selectional restriction of *believe*-type verbs on independent semantic grounds. Consider e.g., *believe* vs. *be certain*.
- ▶ Note, however, that the existence of *believe*-type verbs is not problematic for the proposed analysis: *believe*-type verbs take propositions, and there is no general operation by which question-embedding is reduced to proposition-embedding.

Assymetry between the two approaches to selectional restrictions

Current: Type distinction between *believe* and *know*. Semantic content-based distinction between *know* and *ask* **Easy!**

Traditional: Type distinction between *know* and *ask*. Semantic content-based distinction between *believe* and *be certain* **Tough!**

Outline

1. Motivating the proposal: The puzzle of 'content' DPs
2. Selectional restrictions of attitude predicates
3. **George's non-reducibility**
4. Conclusions

George's non-reducibility problem

Non-reducibility (George 2011)

The meaning of a *know-wh* sentence cannot be reduced to the meaning of *know-that* sentences.

Situation:

- ▶ Store A sells an Italian newspaper, but store B doesn't.
- ▶ John knows that A sells an Italian newspaper.
- ▶ John is unopinionated about whether B sells an Italian newspaper.
- ▶ Mary knows that A sells an Italian newspaper.
- ▶ Mary wrongly believes that B sells an Italian newspaper.
- ▶ John and Mary have exactly the same beliefs except for whether B sells an Italian newspaper.

(36) John knows where one can buy an Italian newspaper. **T**

(37) Mary knows where one can buy an Italian newspaper. **F**

George's non-reducibility problem (cont.)

- ▶ In the scenario, John and Mary have exactly the same set of relevant declarative knowledge: that A sells an Italian newspaper and nothing else.
- ▶ However, they have different *wh*-knowledge: John knows where one can buy an Italian newspaper, but Mary doesn't.
- ▶ This poses a problem for reducing *know-wh* to *know-that*.
- ▶ There is no way to describe the correct truth conditions of *know-wh* just in terms of *know-that* sentences.
- ▶ Similar examples can be constructed with other ResPs, such as *forget*.

Sensitivity to false beliefs

- ▶ More specifically, what cannot be described with *know-that* in the meaning of *know-wh* is its **sensitivity to false beliefs**

Sensitivity to false beliefs

x knows Q is true only if x does not *believe* any false answer to Q .

- ▶ In the earlier example, Mary believed the false answer 'one can buy an Italian newspaper at Store B'.
- ▶ **In the current analysis, sensitivity to false answers can simply be encoded in the meaning of *know*.**

$$(38) \quad \llbracket \text{know} \rrbracket^w = \lambda Q \lambda x. \exists p [p(w) \wedge \text{EPIS}_x^w \subseteq p] \\ \wedge \forall p' \in Q [\text{DOX}_x^w \subseteq p' \rightarrow p'(w)]$$

Sensitivity to false beliefs (cont.)

$$(39) \quad \llbracket x \text{ knows } Q \rrbracket^w = 1 \text{ iff} \\ \exists p \in Q [p(w) \wedge \text{EPIS}_x^w \subseteq p] \wedge \forall p' \in Q [\text{DOX}_x^w \subseteq p' \rightarrow p'(w)]$$

- ▶ This prevents Mary from having the relevant knowledge-*wh* since not all answers that Mary believes are true.
- ▶ In the declarative case, the underlined condition would be **vacuous**, i.e., it would be entailed by the ordinary condition for knowledge.

$$(40) \quad \llbracket x \text{ knows IDENT [that } p \rrbracket^w = 1 \text{ iff} \\ [p(w) \wedge \text{EPIS}_x^w \subseteq p] \wedge [\text{DOX}_x^w \subseteq p \rightarrow p(w)]$$

- ▶ The second conjunct is entailed by the first.
- ▶ In Uegaki (2015), I derive the 'sensitivity to false beliefs' from the general theory of **exhaustive interpretations** (e.g., Chierchia et al. 2012)

Interim summary

- ▶ George's example is problematic for the traditional semantics of ResPs because it shows that the meaning of *know-wh* cannot be reduced to that of *know-that*.
- ▶ In the current analysis, the problem does not arise because it does not commit to the reduction from *know-wh* to *know-that*.
- ▶ In the current analysis, George's example can be accounted for by adding the condition on the sensitivity to false beliefs in the meaning of *know*.

Outline

1. Motivating the proposal: The puzzle of 'content' DPs
2. Selectional restrictions of attitude predicates
3. George's non-reducibility
4. **Conclusions**

Conclusions: Solutions to the three problems

The claim of this talk

The basic denotation of ResPs select for a *question*, rather than a *proposition*. The embedding of declaratives by ResPs is a subcase of question-embedding, where the question is trivial.

- ▶ Equipped with independently motivated type-shifting operations, the proposal provides a novel account of the contrast in entailment between ResPs and ProPs when they take a content DP.
- ▶ It avoids the problematic prediction of the traditional treatment that any declarative-embedding verb should be able to embed an interrogative complement.
- ▶ George's non-reducibility problem can be given a solution simply because the direction of the reduction is the opposite.

5. Appendix

Exhaustivity

- ▶ The proposed system derives a mention-some reading of embedded questions by default.
- ▶ The strongly-exhaustive reading is optionally derived by converting a Hamblin-denotation into the corresponding partition of worlds using the following covert operator.

$$(41) \quad \llbracket \text{PART} \rrbracket^w = \lambda Q \in D_{\langle st, t \rangle} \cdot \{p \mid \exists w [p = \lambda w' \forall p' \in Q [p'(w) = p'(w')]]\}$$

$$(42) \quad \llbracket \text{PART who left} \rrbracket^w = \{p \mid \exists w [p = \lambda w' \cdot \forall x [\mathbf{left}(x)(w) \leftrightarrow \mathbf{left}(x)(w')]]\}$$

$$(43) \quad \llbracket \text{know [Part who left]} \rrbracket^w \\ = \lambda x. \exists p [\exists w [p = \lambda w' \cdot \forall x [\mathbf{left}(x)(w) \leftrightarrow \mathbf{left}(x)(w')]] \wedge [p(w) = 1 \wedge \text{DOX}_x^w \subseteq p]]$$

know the fact that p

(44) John knows the fact that Mary left.
 \models John knows that Mary left.

▶ This can be captured in the current analysis given the following two assumptions:

1. x is acquainted with $y \models x$ believes that y exists.
2. The ontology of content-bearing objects is such that their properties are **essential** across worlds where they exist.

- ▶ The rumor that p is a rumor in any world where it exists.
- ▶ The fact that p is a fact in any world where it exists.

(cf. Moltmann 2013 on attitudinal objects)

(45) $\llbracket \text{John knows the fact that Mary left} \rrbracket^w$ entails

- ▶ John believes that the fact that Mary left exists.
- ▶ That Mary left is a fact in any world where it exists.

\Rightarrow John believes that Mary left is a fact.