On the projection of the uniqueness presupposition of *wh*-complements

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1 Introduction

Goal

To refine the current semantic account of **veridicality of embedded questions** by examining the **projection behaviors of the existential and uniqueness presuppositions of *wh*-complements**.

Claims to be made

(i) **Veridical** and **non-veridical** question-embedding predicates project existential and uniqueness presuppositions of their *wh*-complements (Dayal 1996) in different ways.

(ii) Spector and Egré's (2015) treatment of the veridicality of question-embedding predicates employing **existential quantification over potential answers** faces a challenge in explaining this fact.

(iii) **Theoretical alternative**: integrating...

- Dayal's (1996) analysis, which takes *wh*-complements to be **definite description of a true answer**, with
- Groenendijk and Stokhof's (1984) distinction between **extensional** and **intensional** question-embedding predicates.

Empirical focus: RESPONSIVE PREDICATES—the predicates that can embed both declarative and interrogative complements (Lahiri 2002).

(1) John { **knows** / **is surprised** / **told** me / **is certain** / **agrees** with Mary } which students came to the party.

2 The issue of veridicality

- A question-embedding predicate is VERIDICAL WRT ITS INTERROGATIVE COMPLEMENT if its interpretations refer to the *true* answer of the question expressed by the interrogative complement.
- Question-embedding predicates vary in veridicality.

(2) a. John **knows** which students came.
⇒ For some true answer p to 'Which students came?', John knows p. (Veridical)

b. John **is certain** which students came.
⇏ For some true answer p to 'Which students came?', John is certain that p. (Non-veridical)

The traditional empirical picture

Veridicality with respect to interrogative-embedding does not completely align with veridicality with respect to declarative-embedding (Karttunen 1977; Groenendijk and Stokhof 1984).

(3) a. John **is certain** that Ann came.
⇏ Ann came. (Non-veridical)

b. John **told** me that Ann came.
⇏ Ann came. (Non-veridical)

(4) a. John **is certain** which students came.
⇏ For some true answer p to 'Which students came?', John is certain that p. (Non-veridical)

b. John **told** me which students came.
⇒ For some true answer p to 'Which students came?', John told me that p. (**Veridical**)

- However, the judgment in (4b) is challenged by Tsohatzidis (1993) and Spector and Egré (2015).

(5) a. John told me which students came, but he turned out to be wrong.
b. Old John told us whom he saw in the fog, but it turned out that he was mistaken (the person he saw was Mr. Smith, not Mr. Brown). (Tsohatzidis 1993)
c. Every day, the meteorologists tell the population where it will rain the following day, but they are often wrong. (Spector and Egré 2015)

- Uncontroversially veridical predicates, such as *know*, do not exhibit the same defeasibility:

(6) a. # John knew which students came, but he turned out to be wrong.
b. # Old John knew whom he saw in the fog, but it turned out that he was mistaken (the person he saw was Mr. Smith, not Mr. Brown).
c. # Every day, the meteorologists know where it will rain the following day, but they are often wrong.

Spector and Egré's generalization
A predicate is veridical with respect to interrogative-embedding iff it is veridical with respect to declarative-embedding.

- *tell* is ambiguous between the veridical version and the non-veridical version.

Cross-linguistic evidence Veridical and non-veridical pairs of predicates that otherwise minimally differ in lexical semantics
⇒ Veridical in declarative-embedding aligns with veridicality in interrogative-embedding.

Hungarian, *mond* vs. *el-mond* 'tell' (M. Abrusan p.c. to S&E)

(7) Declarative-embedding

a. Péter azt **mondta** Marinak, hogy az Eiffel-torony össze
Peter it.ACC told Mary.DAT that the Eiffel-tower PRT
fog dölni.
will collapse.
'Peter told Mary that the Eiffel tower will collapse'.
⇏ The Eiffel tower will in fact collapse. (**Non-veridical**)

b. Péter **el-mondta** Marinak, hogy az Eiffel-torony össze fog
Peter EL-told Mary.DAT that the Eiffel-tower PRT will
dölni.
collapse.
'Peter told Mary that the Eiffel tower will collapse.'
⇒ The Eiffel tower will in fact collapse. (**Veridical**)

(8) Interrogative-embedding

a. Péter (azt) **mondta** Marinak, hogy ki fog nyerni.
Peter it.ACC told Mary.DAT, that who will win.INF
'Peter told Mary who will win.'
⇏ Peter told the truth. (**Non-veridical**)

b. Péter **el-mondta** Marinak, hogy ki fog nyerni.
Peter EL-told Mary.DAT, that who will win.INF
'Peter told Mary who will win.'
⇒ Peter told the truth. (**Veridical**)

Japanese, *yosoku-suru* 'predict' vs. *yochi*-suru 'foresee'

(9) Declarative-embedding

a. Sono kenkyusya-wa shigatsu-ni jishin-ga okoru-to
that researcher-TOP April-in earthquake-NOM occur-COMP
yosoku-shita.
predict-did
'That researcher predicted that an earthquake would occur in April.'
⇏ An earthquake occurred in April. (**Non-veridical**)

b. Sono kenkyusya-wa shigatsu-ni jishin-ga okoru-to
that researcher-TOP April-in earthquake-NOM occur-COMP
yochi-shita.
foresee-did
'That researcher foresaw that an earthquake would occur in April.'
⇒ An earthquake occurred in April. (**Veridical**)

(10) Interrogative-embedding

a. Sono kenkyusya-wa itsu jishin-ga okoru-ka
that researcher-TOP when earthquake-NOM occur-Q.COMP
yosoku-shita.
predict-did
'That researcher predicted when an earthquake would occur.'
⇏ That researcher predicted the correct time when an earthquake occurred. (**Non-veridical**)

b. Sono kenkyusya-wa itsu jishin-ga okoru-ka
that researcher-TOP when earthquake-NOM occur-Q.COMP
yochi-shita.
foresee-did
'That researcher foresaw when an earthquake would occur.'
⇒ The researcher foresaw the correct time when an earthquake occurred. (**Veridical**)

English, *figure* vs. *figure out*

(11) Declarative-embedding

a. From what was remaining in the room, John **figured** that Ann came in while he was away.
⇏ Ann came in while he was away. (**Non-veridical**)

b. From what was remaining in the room, John **figured out** that Ann came in while he was away.
⇒ Ann came in while he was away. (**Veridical**)

(12) Interrogative-embedding

a. From what was remaining in the room, John **figured** who came in while he was away.
⇏ John inferred that the person who actually came in did.
(**Non-veridical**)

b. From what was remaining in the room, John **figured out** who came in while he was away.
⇒ John figured out that the person who actually came in did.
(**Veridical**)

- Similar pairs: *raten* vs. *erraten* 'guess' in German (I. Heim p.c.); *predire* vs. *deviner* in French (S&E).

The problems of veridicality

- The standard semantics of question-embedding rests on the **traditional empirical picture** of veridicality. How can we re-analyze the compositional semantics of question-embedding so that **S&E's generalization** is captured?
- Why do communication predicates exhibit a *default* veridical inference when they embed an *interrogative* complement although the same inference is absent when they embed a *declarative* complement?

Note on S&E's generalization and factivity:

- In the literature, sometimes the term 'S&E's generalization' refers to the generalization that a responsive predicate is veridical wrt interrogative-embedding iff it is *factive* wrt declarative-embedding.
- For example, this is the case in Roelofsen et al. (2014). Also, S&E themselves suggest that this generalization in fact holds in a footnote.
- The two generalizations make distinct claims about non-factive veridical responsive predicates. Although Spector and Egré (2015) do not discuss these possibilities, Egré (2008) discusses the following examples as non-factive veridical predicates:

(13) a. John **proved** which nationality he has. (Veridical)

b. John didn't **prove** that he is Canadian. (Non-factive)

(14) a. It is **clear** who the culprit is. (Veridical)

b. It is not **clear** that Sue is the culprit. (Non-factive)

- Assuming that Egré (2008) is correct about these data, I conclude that the empirically correct generalization is that veridicality wrt declarative-embedding aligns with veridicality wrt interrogative-embedding, rather than factivity aligns with veridicality wrt interrogative-embedding.

3 Spector and Egré (2015)

- Spector and Egré (2015) derive their generalization using the following general meaning postulate for responsive predicates.

(15) $[\![\mathrm{P}_{int}]\!]^w = \lambda Q \lambda x. \exists p \in pot(Q)[[\![\mathrm{P}_{decl}]\!]^w(p)(x) = 1]$

where $pot(Q)$ denotes the set of *potential complete answers* of Q.

(16) $[\![x\ \mathrm{P}_{int}\ Q]\!]^w = 1$ iff $x\ P_{decl}$ *some* potential complete answer to Q.

- This analysis straightforwardly captures S&E's generalization:
  - If a predicate P_{decl} is veridical, a potential complete answer p that satisfies the statement in the scope of the existential quantification in (15) has to be a true one. So, P_{int} is veridical as well.

(17) $[\![\mathrm{know}_{int}]\!]^w = \lambda Q \lambda x. \exists p \in pot(Q)[[\![\mathrm{know}_{decl}]\!]^w(p)(x) = 1]$

  - On the other hand, if a predicate P_{decl} is *not* veridical, then the answer p that satisfies (15) can be either true or false, meaning that P_{int} is not veridical.

(18) $[\![\mathrm{be\ certain}_{int}]\!]^w = \lambda Q \lambda x. \exists p \in pot(Q)[[\![\mathrm{be\ certain}_{decl}]\!]^w(p)(x) = 1]$

- Spector and Egré (2015) refine their meaning postulate so that it can deal with the presuppositional behavior of responsive predicates.[1]

[1] S&E also discuss ways to refine their analysis to account for the different strength of *exhaustivity* in embedded questions, but I will stay away from the issue of exhaustivity in this talk.

(19) $[\![\mathrm{P}_{int}]\!]^w = \lambda Q \lambda x : \exists p \in pot(Q)[[\![\mathrm{P}_{decl}]\!]^w(p)(x) \text{ is defined}].$
$\exists p \in pot(Q) \left[\begin{array}{c} [\![\mathrm{P}_{decl}]\!]^w(p) \text{ is defined } \& \\ [\![\mathrm{P}_{decl}]\!]^w(p)(x) = 1 \end{array} \right]$

(20) $[\![x\ \mathrm{P}_{int}\ Q]\!]^w$

- *presupposes* that there is some potential complete answer p to Q such that $[\![x\ P_{decl}\ p]\!]^w$ is defined.
- *is True iff* there is some potential complete answer p to Q such that $[\![x\ P_{decl}\ p]\!]^w$ is defined and true.

- One of the reasons why Spector and Egré (2015) encode the presupposition for P_{int} as in (19) is the behavior of *agree*.

(21) John agrees with Mary that it is raining.
Presupposition: Mary believes that it is raining.

(22) John agrees with Mary on whether it is raining.
Presupposition: Mary has an opinion about whether it is raining.
$\Leftrightarrow$ Mary believes that it is raining or Mary believes that it is not raining.

(23) $[\![\text{John agrees}_{int} \text{ with Mary on whether it is raining}]\!]^w$

- *presupposes* that there is some potential complete answer p to 'whether it is raining' such that $[\![\text{John agrees with Mary that } p]\!]^w$ is defined.
- *is True iff* there is some potential complete answer p to 'whether it is raining' such that $[\![\text{John agrees with Mary that } p]\!]^w$ is defined and true.

4 Existential and uniqueness presuppositions of *wh*-complements

4.1 Dayal (1996)

- It is standard to assume that *wh*-complements presuppose that their Hamblin denotation *contains a true answer* (e.g., Katz and Postal 1964; Karttunen and Peters 1979; Comorovski 1989; Dayal 1996).

- Dayal (1996) further observes that *singular which*-questions presuppose that *exactly one member* of their Hamblin denotation is true.

(24) a. Which students came to the party?
Presupposition: Some student came to the party.[2]
b. Which student came to the party?
Presupposition: Exactly one student came to the party.

- Dayal (1996) gives a unified analysis of these data by analyzing *wh*-complements as a sort of *definite descriptions*: they presuppose a *most informative true* answer, and refers to such an answer.

- Assuming that answers to a *plural which*-question (e.g., *which students*...) is closed under conjunction, the above presupposition is met as long as the denotation contains a true answer. i.e., it boils down to just existential presupposition.

- Since a *singular which*-question (e.g., *which student*...) only contains atomic answers (that are mutually logically independent), the above presupposition is met if and only if exactly one answer is true.

(25) $[\![\mathsf{Ans_d}]\!]^w := \lambda Q_{\langle st,t\rangle}.$
$$\begin{cases} \iota p \in Q\left[\begin{array}{c} p(w) \wedge \\ \forall p' \in Q[p'(w) \rightarrow p \subseteq p'] \end{array}\right] & \text{if } \exists! p \in Q\left[\begin{array}{c} p(w) \wedge \\ \forall p' \in Q[p'(w) \rightarrow p \subseteq p' \end{array}\right] \\ \text{undefined} & \text{otherwise} \end{cases}$$

4.2 Projection of the existential and uniqueness presuppositions

- The existential and uniqueness presuppositions seem to exhibit different projection behaviors under different embedding predicates.

(26) *know*
a. John doesn't know which student came to the party.
b. Does John know which student came to the party?

[2] *Who*-questions seem to have 'weaker' existential presupposition. That is, at least for some speakers, *Who came?* is perfectly felicitous even if it is possible that no one came. This could be accounted for if *who* but not *which NP* ranges over generalized quantifier meanings. That is, the Hamblin denotation of a *who*-question already includes an answer of the form 'No one came', but that of a *which*-question doesn't (Spector 2007) (Danny Fox p.c.).

c. Sue doubts that John knows which student came to the party.
$\rightsquigarrow$ Exactly one student came.

(27) *be certain*

a. John is not certain which student came to the party.

b. Is John certain which student came to the party?

c. Sue doubts that John is certain which student came to the party.
$\rightsquigarrow$ **John believes that** exactly one student came to the party.

(28) *be certain* using sluicing

a. John believes that there were either one or two students who came to the party. # He is not certain which student.

b. John believes that there was only one student who came to the party. He is not certain which student.

(29) *tell* (non-veridical version)

a. Bill told Mary which student came to the party although he turned out to be wrong; John didn't ~~tell Mary which student came to the party~~.

b. Bill told Mary which student came to the party although he turned out to be wrong; Did John ~~tell Mary which student came to the party~~?

c. Bill told Mary which student came to the party although he turned out to be wrong; Sue doubts that John did ~~tell Mary which student came to the party~~.
$\rightsquigarrow$ **(None)**

(30) *agree*

a. John doesn't agree with Mary on which student came to the party.

b. Does John agree with Mary on which student came to the party?

c. Sue doubts that John agrees with Mary on which student came to the party.
$\rightsquigarrow$ Mary (and also John?) believes that exactly one student came.

4.3 Challenge for Spector and Egré (2015)

- The presupposition for the examples in (27), *John is not certain which student came* predicted by S&E is the following:

(31) $\exists p \in pot(\llbracket \text{which student came} \rrbracket^w)$
[$\llbracket \text{be certain} \rrbracket^w(p)(\mathbf{j})$ is defined]

(32) There is a potential complete answer p to *which student came* such that (the semantic value of) *John is certain that p* is defined.

- If *x is certain that p* is not presuppositional, (31) is vacuous as long as the question contains a potential answer.
- If *x is certain that p* presupposes that *x* considers *p* possible, (31) would mean that John considers some answer possible.
- Both are irrelevant to the presupposition we observed above.

- On the other hand, if all responsive predicates simply combine with the proposition returned by Dayal's $\mathsf{Ans_d}$ via Functional Application, all predicates would be veridical, contrary to S&E's generalization.
- We need some way to extend Dayal's analysis in explaining the projection of the presupposition of *wh*-complements while preserving an account of S&E's generalization at the same time.
- Combining Dayal (1996) and Spector and Egré (2015) seems conceptually difficult since the former analyzes question-embedding in terms of *definite* answers while the latter analyzes it in terms of *existential quantification* over answers.

5 Proposal

5.1 Extending Dayal (1996) to non-veridical predicates

- I follow Dayal in treating *wh*-complements as a kind of definite descriptions: they presuppose a maximally informative true answer, and refers to such an answer.

(33) $\llbracket \mathsf{Ans_d} \rrbracket^w := \lambda Q_{\langle st,t \rangle}.$
$$\begin{cases} \iota p \in Q \left[\begin{array}{c} p(w) \wedge \\ \forall p' \in Q[p'(w) \rightarrow p \subseteq p'] \end{array} \right] & \text{if } \exists! p \in Q \left[\begin{array}{c} p(w) \wedge \\ \forall p' \in Q[p'(w) \rightarrow p \subseteq p' \end{array} \right] \\ \text{undefined} & \text{otherwise} \end{cases}$$

- Factive predicates like *know* simply combines with this answer proposition.

(34) $[\![\text{know}]\!]^w = \lambda p_{\langle s,t\rangle}\lambda x.\mathbf{know}(x,p,w)$

- On the other hand, non-factive predicates like *be certain* are **intensional** (e.g., Groenendijk and Stokhof 1984): they combine with a *propositional concept*. Specifically, the **function from worlds to the most informative answer of the question true in that world**.

- This enables us to explain the projection behavior of the uniqueness/existential presuppositions above (except for *agree* which I will come back later).

(35) a. $[\![\text{be certain}]\!]^w = \lambda\mathcal{P}_{\langle s,st\rangle}\lambda x.\forall w'[w' \in \mathbf{DOX}_x^w \rightarrow \mathbf{DOX}_x^w \subseteq \mathcal{P}(w')]$

b. $[\![\text{John is certain which student came}]\!]^w$
$\Leftrightarrow \forall w'[w' \in \mathbf{DOX}_{\mathsf{j}}^w \rightarrow \mathbf{DOX}_{\mathsf{j}}^w \subseteq [\![\mathsf{Ans_d}]\!]^{w'}([\![\text{which student came}]\!]^w)]$

- Roughly, *x is certain Q* iff *x* believes all the answers to *Q* that are compatible with *x*'s belief.

- Assuming *universal projection* of presuppositions from the scope of a universally quantified statement, (35b) ends up presupposing the following:

(36) $\forall w'[w' \in \mathbf{DOX}_{\mathsf{j}}^w \rightarrow [\![\mathsf{Ans_d}]\!]^{w'}([\![\text{which student came}]\!]^w)$ is defined]
$\Leftrightarrow$ John believes that exactly one student came

- Another virtue of the analysis: the lexical semantics of *be certain* guarantees the strong exhaustivity.

- On the other hand, the non-veridical use of communication predicates can be analyzed as involving an existential quantification.

(37) $[\![\text{tell}_{[\text{+ver}]}]\!]^w = \lambda p_{\langle s,t\rangle}\lambda y\lambda x.\mathbf{tell}(x,y,p,w)$

(38) $[\![\text{tell}_{[\text{-ver}]}]\!]^w = \lambda\mathcal{P}_{\langle s,st\rangle}\lambda y\lambda x.\exists w'[\mathbf{tell}(x,y,\mathcal{P}(w'),w)]$

(39) $[\![\text{John tells}_{[\text{-ver}]}\text{ Mary }[\mathsf{Ans_d}\text{ which student came}]]\!]^w$
$\Leftrightarrow \exists w'[\mathbf{tell}(\mathbf{j},\mathbf{m},[\![\mathsf{Ans_d}]\!]^{w'}([\![\text{which student came}]\!]^w),w)]$

- Assuming *existential projection* of presuppositions from the scope of a existentially quantified statement, (39) ends up presupposing the following:

(40) $\exists w'[[\![\mathsf{Ans_d}]\!]^{w'}([\![\text{which student came}]\!]^{w})$ is defined]
⇔ It is possible that exactly one student came.

- Thus, the projection behavior of the existential and uniqueness presuppositions can be accounted for.
- But, what about S&E's generalization?

5.2 Factivity as a limiting case of existential presupposition

- I propose that declarative complements, too, always involve the $\mathsf{Ans_d}$ operator, and declarative complements denote **singleton questions**.
- One way to implement this is to say that all responsive predicates are decomposed into a 'core' predicate and $\mathsf{Ans_d}$.

(41) know $\rightsquigarrow R_{know}$ + $\mathsf{Ans_d}$

(42) be certain $\rightsquigarrow R_{certain}$ + $\mathsf{Ans_d}$

- I defend the same picture from independent grounds in Uegaki (to appear) using interpretations of nominal complements of attitude predicates as evidence.
- According to this picture, factivity is derived as the *limiting case of existential presupposition*. I.e., the presupposition that a question contains a true answer boils down to factivity when the question is a singleton.

(43) John knows which student came to the party.

Presupposition There is a unique most informative true answer in $[\![\text{which student came to the party}]\!]^{w}$
⇔ There is exactly one student who came to the party.

(44) John knows that Ann came.

Presupposition There is a unique most informative true answer in {'Ann came'}. ⇔ 'Ann came' is true.

- Thus, **proposition**-taking (i.e., 'extensional') predicates like *know* (rather than **propositional-concept**-taking (i.e., 'intensional') predicates like *be certain*) is *veridical* wrt interrogative-embedding and *factive* (and hence veridical) wrt declarative-embedding.

- On the other hand, the lexical-semantic format for **propositional-concept**-taking predicates does not guarantee veridicality. Whether they are veridical depends on the definition of the metalanguage predicate such as **DOX** and **tell**:

(45) $[\![\text{John is certain that Ann came}]\!]^w$
$\Leftrightarrow \forall w'[w' \in \mathbf{DOX}_{\mathbf{j}}^w \rightarrow \mathbf{DOX}_{\mathbf{j}}^w \subseteq [\![\mathsf{Ans_d}]\!]^{w'}(\{[\![\text{that Ann came}]\!]^w\})]$
$\Leftrightarrow \mathbf{DOX}_{\mathbf{j}}^w \subseteq$ 'Ann came'

(46) $[\![\text{John tell}_{[\text{-ver}]} \text{ Mary } [\mathsf{Ans_d} \text{ that Ann came}]]\!]^w$
$\Leftrightarrow \exists w'[\mathbf{tell}(\mathbf{j}, \mathbf{m}, [\![\mathsf{Ans_d}]\!]^{w'}(\{[\![\text{that Ann came}]\!]^w\}), w)]$
$\Leftrightarrow \mathbf{tell}(\mathbf{j}, \mathbf{m}, \text{'Ann came'})$

- If the metalanguage predicate is non-veridical, it is non-veridical wrt both declarative and interrogative complements.
- Non-factive veridical predicates like *prove* can be analyzed as having a similar format as $tell_{[\text{-ver}]}$, but involving a veridical metalanguage predicate:

(47) $[\![\text{prove}]\!]^w = \lambda\mathcal{P}_{\langle s,st\rangle}\lambda y\lambda x.\exists w'[\mathbf{prove}(x, y, \mathcal{P}(w'), w)]$

6 Consequences

Deriving the preference for the veridical reading of communication predicates

- A sentence with $tell_{[\text{+ver}]}$ is stronger than that with $tell_{[\text{-ver}]}$ when they embed interrogative complements. The former is true iff telling happens of the *true* answer while the latter is true iff telling happens of *some* answer.
- However, the difference in strength is collapsed in the declarative case since there is only one answer to begin with.
- Strongest Meaning Hypothesis (Dalrymple et al. 1998) predicts that $tell_{[\text{+ver}]}$ is preferred over $tell_{[\text{-ver}]}$ in the interrogative-embedding case, but not in the declarative-embedding case.
- Prediction: in DE environments, the preference switches.

(48) John didn't tell me which student came.
$\rightsquigarrow$ Non-veridical reading is preferred.

Factivity entails question-embeddability

- The current analysis of factivity as the limiting case of existential presupposition associated with $\mathsf{Ans_d}$ opens up a possibility of explaining an arguably universal constraint on the lexical semantics of embedding predicates: factivity entails question-embeddability.[3]

(49) **Generalization: factivity entails question-embeddability**
A predicate is factive only if it can embed an interrogative complement.

- Here's why: once we assume that $\mathsf{Ans_d}$ is the only source of factivity, a predicate wouldn't be factive without being able to embed questions.

- An immediate question that arises here concerns factive non-responsive predicates such as *regret* and *resent*.

(50) a. John {regrets/resents} that Mary left him.
b. John doesn't {regret/resent} that Mary left him.
c. Does John {regret/resent} that Mary left him?
⇒ Mary left him.

- Despite the appearance of factivity, however, several authors have claimed that these predicates only presuppose that the subject believes the complement, instead of the complement being true (Klein 1975; Huddleston and Pullum 2002; Sæbø 2007).

(51) John mistakenly believed that Mary was gone, and he {regretted/resented} that she left him.

(52) Falsely believing that he had inflicted a fatal wound, Oedipus regretted killing the stranger on the road to Thebes. (Klein 1975)

(53) Ed believed that he had offended his parents and very much regretted that he had done so, but it turned out that he had been mistaken: they had not in the least been offended. (Huddleston and Pullum 2002)

[3]Similar generalizations are advocated by a number of authors such as Hintikka (1975), Sæbø (2007) and Egré (2008) although they discuss slightly different generalizations from (49). For example, Hintikka (1975) and Sæbø (2007) aim to explain why *believe* cannot take a question based on the generalization that only factive predicates can take questions, which is the converse of (49). Also, Egré (2008) discusses the generalization that *veridicality* as opposed to factivity entails question-embeddability. See Egré (2008) and references therein for related recent studies.

7 Conclusions

- Question-embedding predicates project existential and uniqueness presuppositions of their *wh*-complements in different ways.
- This fact can be properly analyzed by combining
  - Dayal's (1996) analysis, which takes *wh*-complements to be **definite description of a true answer**, with
  - Groenendijk and Stokhof's (1984) **distinction between extensional and intensional question-embedding predicates**
- At the same time, S&E's generalization can be derived by analyzing declarative complements as limiting cases of embedded questions.

8 Remaining issues

The presupposition of *be certain that*

(45) $[\![\text{John is certain that Ann came}]\!]^w$
$\Leftrightarrow \forall w'[w' \in \mathbf{DOX}_j^w \rightarrow \mathbf{DOX}_j^w \subseteq [\![\mathsf{Ans_d}]\!]^{w'}(\{[\![\text{that Ann came}]\!]^w\})]$

- If the projection is universal, we predict that (45) would presuppose that John believes that Ann came, which is exactly the same as its assertion!
- One could argue that in cases where a projection of a presupposition ends up being equivalent to its assertion, the presupposition is locally accommodated.
- The problem is that this still does not get the actual presupposition of *be certain that* quite right.

(54) Is John certain that it is raining?
$\rightsquigarrow$ It is compatible with John's belief that it is raining.

- It seems that there is existential projection in the case of *be certain that*.
- Another possibility: Strong Kleene:

(55) $\forall x[\varphi(x) \rightarrow \psi(x)_{\pi(x)}] = \begin{cases} 1 & \text{if } \forall x[\varphi(x) \rightarrow \pi(w) \wedge \psi(x)] \\ 0 & \text{if } \exists x[\varphi(x) \wedge \pi(w) \wedge \neg\psi(x)] \\ \# & \text{otherwise} \end{cases}$

(56) **The projected presupposition of a universal statement**:
$\forall x[\varphi(x) \rightarrow \pi(w)] \vee \exists x[\varphi(x) \wedge \pi(w) \wedge \neg\psi(x)]$

(57) a. John is certain that Ann came.

b. **Translation**: $\forall w'[w' \in \mathbf{DOX}_{\mathbf{j}}^{w} \rightarrow \mathbf{DOX}_{\mathbf{j}}^{w} \subseteq [\![\mathsf{Ans_d}]\!]^{w}(w')(\{A\})]$

c. **Presupposition**: $\forall w'[w' \in \mathbf{DOX}_{\mathbf{j}}^{w} \rightarrow A(w')] \vee \exists w'[w' \in \mathbf{DOX}_{\mathbf{j}}^{w} \wedge A(w') \wedge \mathbf{DOX}_{\mathbf{j}}^{w} \not\subseteq A] \Leftrightarrow \exists w'[w' \in \mathbf{DOX}_{\mathbf{j}}^{w} \wedge A(w')]$

agree

(58) John agrees with Mary on which student came.
$\rightsquigarrow$ Mary (and also John?) believes that exactly one student came.

A possible analysis:

- Make $\mathsf{Ans_d}$ sensitive to an arbitrary restrictors. (Cremers 2015)

(59) $[\![\mathsf{Ans_d}]\!]^{w} := \lambda C_{\langle s,\langle s,t\rangle\rangle}\lambda Q_{\langle st,t\rangle}.$
$\begin{cases} \iota p \in Q\left[\begin{array}{c} C(w) \subseteq p \wedge \\ \forall p' \in Q[C(w) \subseteq p \rightarrow p \subseteq p'] \end{array}\right] & \text{if } \exists! p \in Q\left[\begin{array}{c} C(w) \subseteq p \wedge \\ \forall p' \in Q[C(w) \subseteq p \rightarrow p \subseteq p' \end{array}\right] \\ \text{undefined} & \text{otherwise} \end{cases}$

- The previous $\mathsf{Ans_d}$ is a special case of (59) where $C = \lambda w.\{w\}$

(60) $[\![\text{John agrees with Mary on which student came}]\!]^{w} = 1$
iff $\mathbf{DOX}_{\mathbf{j}}^{w} \subseteq [\![\mathsf{Ans_d}]\!]^{w'}(\lambda w''.\mathbf{DOX}_{\mathbf{m}}^{w''})([\![\text{which student came}]\!]^{w})$

(61) Presupposition:
$[\![\mathsf{Ans_d}]\!]^{w}(\lambda w''.\mathbf{DOX}_{\mathbf{m}}^{w''})([\![\text{which student came}]\!]^{w})$ is defined
$\Leftrightarrow \exists! p \in [\![\text{which student came}]\!]^{w}\left[\begin{array}{c} \mathbf{DOX}_{\mathbf{m}}^{w'} \subseteq p \wedge \\ \forall p' \in Q[\mathbf{DOX}_{\mathbf{m}}^{w'} \subseteq p \subseteq p'] \end{array}\right]$
$\Leftrightarrow$ Mary believes that there is exactly one student who came.

- The question is how to compositionally derive (60).

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