

Predicting the variation in exhaustivity of embedded interrogatives

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1 Introduction

1.1 Exhaustivity of embedded questions

- Exhaustivity of embedded questions has played a central role in the development of the semantics of interrogatives. (e.g., Karttunen 1977; Groenendijk and Stokhof 1984; Heim 1994)
- One important observation in this domain: Predicates vary with respect to the *strength* of exhaustivity involved in the interpretation of their interrogative complements.

VERBS OF KNOWLEDGE, CONJECTURE, OPINION (e.g., *know*, *predict*, *be certain*) select for STRONGLY EXHAUSTIVE (SE) interpretations by default. (Groenendijk and Stokhof 1984)

EMOTIVE FACTIVES (e.g., *surprise*, *annoy*, *please*) select for WEAKLY EXHAUSTIVE (WE) interpretations. (e.g., Heim 1994; Beck and Rullmann 1999)

1.2 Current literature

- The existence of the two readings (SE and WE) has led authors to allow a flexibility in the interpretation of embedded questions. (e.g., Heim 1994; Beck and Rullmann 1999)
 - Relatively few accounts (Guerzoni 2007; Nicolae 2013) aim to *predict* the exhaustivity of embedded questions given the lexical semantics of embedding predicates.
 - **Recent observation:** INTERMEDIATE EXHAUSTIVITY (IE) existing at least with Verbs of Knowledge and Conjecture. (Spector 2005; Klinedinst and Rothschild 2011; Cremers and Chemla 2014)
- (1) $\llbracket \text{John predicted who came} \rrbracket^w = 1$ (under IE) iff
(i) John predicted that every individual x who came in w came, and (ii) for every individual y who didn't come in w , *it is not the case that* John predicted that y came.

Goal: To present a semantic theory of embedded questions that can predict their variation in the possible exhaustive interpretations (including IE), based on the lexical semantics of embedding predicates.

1.3 Plot

1. The default interpretation of embedded questions is a weakly-exhaustive (WE) reading.
2. IE is derived from the application of EXH_Q above the predicate (Klinedinst & Rothschild 2011).
3. The effect of EXH_Q depends on the monotonicity property of the embedding predicate.
 - IE is derived if the embedding predicate is monotonic.
 - Vacuous if the embedding predicate is non-monotonic.

4. Emotive predicates are non-monotonic (e.g., Heim 1992; Villalta 2008; Anand and Hacquard 2013)
5. EXH_Q always scopes above the embedding predicate (pace Klinedinst & Rothschild 2011).
6. SE readings are derived from IE, together with an opinionated assumption wrt the attitude holder.

2 Exhaustivity of embedded questions

2.1 Strong and weak exhaustivity of question-interpretations

We start with the Hamblin-denotation of interrogative complements (Hamblin 1973):

$$(2) \quad \llbracket \text{who came} \rrbracket = \{ p \mid \exists x[p = \lambda w.\text{came}(w)(x)] \}$$

Weakly-exhaustive (WE) answer of Q in w The conjunction of all propositions in Q that are true in w .

Strongly-exhaustive (SE) answer of Q in w The conjunction of (i) the WE answer of Q in w and (ii) the proposition that all propositions in Q that are false in w are false.

2.2 Examples

Situation Ann but not Bill was at the party in w .

- (3) WE/SE-answers of ‘Who was at the party’ in w
 - a. $\llbracket \text{who was at the party} \rrbracket = \{ \text{Ann was at the party, Bill was at the party} \}$
 - b. WE-answer: Ann was at the party.
 - c. SE-answer: Ann was at the party, but Bill wasn’t.
- (4) WE/SE-answers of ‘Who wasn’t at the party’ in w
 - a. $\llbracket \text{who wasn’t at the party} \rrbracket = \{ \text{Ann wasn’t at the party, Bill wasn’t at the party} \}$

- b. WE-answer: Bill wasn't at the party.
- c. SE-answer: Bill wasn't at the party, but Ann was.

2.3 *Know* selects for a SE-answer

Situation Among Ann and Bill, John believes that both Ann and Bill were at the party. In fact, Ann but not Bill was at the party.

- (5) # John knows who was at the party.
- (6) # John knows who wasn't at the party.
(Groenendijk and Stokhof 1984)

2.4 *Surprise* selects for a WE-answer

Situation Among Ann and Bill, John expected that both Ann and Bill would be at the party. At the party, Ann but not Bill showed up.

- (7) # It surprised John who was at the party.
- (8) It surprised John who was not at the party.
(Heim 1994)

2.5 *Be happy (about)* selects for a WE-answer

Situation John will be happy if Ann comes to the party, and he will also be happy if Bill comes to the party. He does not care if both come or not. At the party, Ann but not Bill showed up.

- (9) # John was happy about who wasn't at the party.
- (10) John was happy about who was at the party.

3 Intermediate exhaustivity

3.1 Intermediate exhaustivity (IE)

Intermediate exhaustivity (IE) Stronger than WE, but weaker than SE.

- (11) $\llbracket \text{John predicted who came} \rrbracket^w = 1$ (under IE) iff
(i) John predicted that every individual x who came in w came, and (ii) for every individual y who didn't come in w , *it is not the case that* John predicted that y came.

- Claimed to exist by Klinedinst & Rothschild (2011).
- Cremers & Chemla (2014) experimentally validate the existence of IE readings for *predict* and *know*.

3.2 IE of factive predicates

- In the case of *know*, the observed IE reading involves 'believe' as opposed to 'know' in the second clause of the paraphrase.
- (12) $\llbracket \text{John knows who came} \rrbracket^w = 1$ (under IE) iff
(i) John knows that every individual x who came in w came, and (ii) for every individual y who didn't come in w , *it is not the case that* John BELIEVES that y came.

- Klinedinst & Rothschild (2011) deny IE readings for factive predicates.
- Claimed to exist by Spector (2005) and validated by Cremers & Chemla (2014).
- I follow Cremers & Chemla (2014), and assume that factives have IE readings, as in (12).

3.3 IE of emotive factives

- The IE reading for emotive factives has not been investigated.

- Difficulties concerning the pre-theoretical characterization of IE readings, especially how a factive predicate is interpreted.

A conceivable IE reading for *be happy*:

- (13) $\llbracket \text{John is happy about who came} \rrbracket^w = 1$ (under IE)
iff
(i) John is happy that every individual x who came in w came, and (ii) for every individual y who didn't come in w , *it is not the case that* John would have preferred y to come.
- We will come back to the empirical status of this reading later.

4 Klinedinst & Rothschild's (2011) analysis of IE

4.1 The EXH_Q-operator

- K&R give an analysis of IE readings of non-factive predicates like *predict* by positing the EXH_Q-operator at the matrix level:

- (14) $[\text{EXH}_Q [\text{John predicted who came}]]$.

- EXH_Q asserts its prejacent and negates all alternatives that are stronger than the prejacent.

- (15) $\llbracket \text{EXH}_Q \varphi \rrbracket^w$
 $\Leftrightarrow \llbracket \varphi \rrbracket^w \wedge \forall p \in \llbracket \varphi \rrbracket^{\text{Alt}} [p \subset \llbracket \varphi \rrbracket \rightarrow p(w) = 0]$

4.2 The ordinary and alternative semantic values

- The ordinary semantic value and the alt-semantic value of an interrogative clause are defined as follows:

- (16) $\llbracket \text{who came} \rrbracket^w = \lambda w'. \forall x [\text{came}(x)(w) \rightarrow \text{came}(x)(w')]$
 (The *actual* WE answer: “All people who actually came came”.)
- (17) $\llbracket \text{who came} \rrbracket^{\text{Alt}} = \{ p \mid \exists w [p = \lambda w'. \forall x [\text{came}(x)(w) \rightarrow \text{came}(x)(w')]] \}$
 (The set of *possible* WE answers: “All people who came in w came”.)
- The alt-value is composed by Point-wise Function Application:
- (18) $\llbracket \text{John predicted who came} \rrbracket^{\text{Alt}} = \{ p \mid \exists w [p = \lambda w''. \text{predicted}(j, \lambda w'. \forall x [\text{came}(x)(w) \rightarrow \text{came}(x)(w')], w'')] \}$
 (The set of propositions of the form: “John predicted p ”, where p is a possible WE answer.)

4.3 Deriving IE for non-factive predicates

- (19) $[\text{EXH}_Q \llbracket \text{John predicted who came} \rrbracket]$.
- EXH_Q asserts the prejacent and negates all the alternatives stronger than the prejacent.
 - Thus, (19) is true in w (where Ann came and Bill didn't) iff
 - John predicted Ann to come, and
 - it is not the case that John predicted Ann and Bill to come.
 - This is exactly the IE reading.

4.4 K&R's analysis and factive predicates

- K&R's analysis does not directly extend to factive predicates since an application of EXH_Q above a factive predicate is vacuous (or presupposition failure, depending on the definition of the negation involved in EXH_Q).

- (20) $\llbracket \text{EXH}_Q [\text{John knows who came}] \rrbracket = 1$ in w (where Ann came and Bill didn't) iff
- John knows that Ann came, and
 - it is not the case that John knows that Ann and Bill came.
- The second clause is trivially true since 'Ann and Bill came' is false.
 - We want 'believe' instead of 'know' in the second clause.
 - To avoid this problem, let us here assume that the alternatives do not involve factivity. We will come back to this issue in Section 7.

5 Prediction for emotive factives

5.1 General property of EXH_Q

- Since EXH_Q is defined to negate logically stronger alternatives, the outcome of an EXH_Q -application depends on the monotonicity property of the embedding predicate.
- In particular, if the embedding predicate is non-monotonic, the application of EXH_Q is predicted to be vacuous.

Situation Ann came, but Bill didn't in w . ($A(w) = 1, B(w) = 0$)

- (21) $\llbracket \text{EXH}_Q [\alpha [\text{who came}]] \rrbracket$.
- (22) $\llbracket (21) \rrbracket^w \Leftrightarrow \alpha(A)(w) \wedge \forall p \in \{\alpha(A), \alpha(B), \alpha(A \wedge B)\} [p \subset \alpha(A) \rightarrow p(w) = 0]$

5.2 Non-monotonicity of emotive factives

- (23) John is happy that Ann and Bill came. $\not\models_s$ John is happy that Bill came.
- (24) John is happy that Ann came. $\not\models_s$ John is happy that Ann and Bill came.

($\models_s$: STRAWSON-ENTAILMENT; von Stechow 1999)

- Non-monotonicity of emotive predicates has been defended by Asher (1987), Heim (1992), and more recently, Lassiter (2011) and Anand & Hacquard (2013).
- A non-monotonic analysis of *be happy* based on the ordering-based semantics for desire verbs by Heim (1992):

- (25) $\llbracket \text{be happy} \rrbracket^w(p)(x)$ is
- defined only if $p(w) = 1$ and x believes that p , and
 - True iff $\forall w' \in \text{DOX}_w^x[\text{Sim}_{w'}(p) >_{x,w} \text{Sim}_{w'}(\neg p)]$
- (26) $\text{Sim}_w(p) := \{w' \in W \mid w' \in p \text{ and } w' \text{ resembles } w \text{ no less than any other world in } p\}$

5.3 Prediction of EXH_Q for emotive factives

- We thus predict that EXH_Q -application for emotive factives is vacuous, and that they lack IE readings.
 - What are the facts? Hypothetical IE reading for *be happy* entertained earlier:
- (27) $\llbracket \text{John is happy about who came} \rrbracket^w = 1$ iff **(i)** John is happy that every individual x who came in w came, and **(ii)** for every individual y who didn't come in w , *it is not the case that* John would have preferred y to come.
- (28) (**Situation:** John will be happy if Ann comes to the party. He will also be happy if Bill comes. Ann but not Bill in fact showed up.)
John was happy about who came to the party.
- The second clause of (27) is false under the situation in (28) despite the fact that (28) sounds true.
 - This fact is compatible with our prediction that emotive factives lack IE.

6 Strongly exhaustive readings

6.1 SE readings in K&R

- K&R derive SE readings by placing EXH_Q in the embedded position, as in (30).

(29) EXH_Q [John predicted [who came]].

(30) John predicted [EXH_Q who came].

- However, if this were possible, SE readings would exist regardless of the embedding predicate.
- Thus, I claim that EXH_Q cannot scope below the embedding predicate, i.e., (29) is the only possible LF with EXH_Q.

6.2 SE readings via IE readings

- There is no designated LF for SE readings.
- An SE reading arises from an IE reading via strengthening mediated by the opinionatedness assumption with respect to the subject.

(31) (**Situation:** Ann came, but Bill didn't.)

EXH_Q [John predicted who came].

- i. **IE:** John predicted that Ann came and it is not the case that he predicted that Bill came.
- ii. **Opinionatedness of John:** John had predictions about whether Ann came and whether Bill came.
- iii. **Therefore:** John predicted that Ann came and he predicted that Bill didn't come. (= SE)

- SE readings arise only if IE readings are available.
- Thus, emotive factives don't receive SE readings, given that they lack IE readings.

6.3 SE judgments in the previous literature

- The data purporting to show SE in the previous literature either (i) don't distinguish between IE and SE, or (ii) tacitly involve the opinionatedness assumption.

(32) (From Groenendijk & Stokhof 1984)

- a. John believes that Bill and Suzy walk. Only Bill walks. $\models$ John doesn't know who walks. (case i)
- b. John knows who walks. $\models$ John knows who doesn't walk. (case ii)
- c. (John knows who walks. Suzy doesn't walk. $\models$ John knows that Suzy doesn't walk.) (case ii)

6.4 What is the source of opinionatedness?

- No clear picture yet, but I claim that it is the same as what underlies the neg-raising property of attitude verbs.
- One theory: encode opinionatedness as a lexical presupposition.

(33) $\llbracket \text{know} \rrbracket^w = \lambda p \lambda x : [\text{DOX}_w^x \subseteq p \vee \text{DOX}_w^x \subseteq \neg p] : \dots$

- However, if this were the only lexical entry of *know*, we would predict that an IE reading is impossible. The lexical presupposition has to be 'soft'. (Gajewski 2007)
- Relevant result from C&C: Large majority of subjects accepted *know/predict+wh* sentences when the sentence is true under IE, and the agent is unopinionated about some of the false answers.
- But, small but significant population rejected the items under the same scenarios.

7 Issues

7.1 Two stipulations

1. EXH_Q negates *stronger* alternatives, rather than *non-weaker* alternatives.
2. EXH_Q applies only *above* the predicate.

- These features are reminiscent of the Gricean theory of quantity implicatures.
- However, it is not clear if the Gricean perspective is viable here since the EXH_Q -operator does not seem to scope above the subject:

(34) At least one student predicted who came.

(K&R: 16)

- If EXH_Q is globally applied to (34), it is predicted to be true only if no student made any actually false prediction about who came. This reading seems to be unavailable.
- Given this, I assume the scope of EXH_Q to be the matrix VP.

Summary of the system so far

1. EXH_Q is optionally adjoined to the VP.
 - Without EXH_Q , the LF gives rise to a WE reading.
 - With EXH_Q , the LF gives rise to an IE reading *if the embedding predicate is monotonic*.
2. SE is derived from an LF with EXH_Q , together with the attitude holder's opinionatedness about false answers.
3. Since emotive factives are non-monotonic, EXH_Q doesn't give rise to IE. Hence, no SE either.

7.2 Implicature with declarative embedding

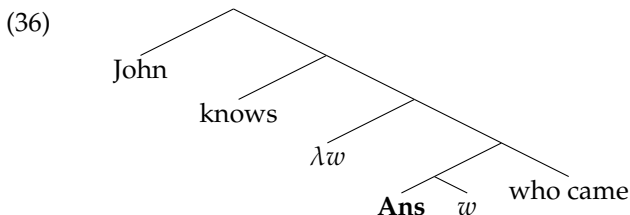
Emotives do generate implicatures in declarative embedding:

- (35) John is pleased that Ann came.
 $\leadsto$ John is not pleased that Bill came.

- The grammatical mechanism is in play for generating this implicature i.e., there is an operator O that negates all non-weaker and innocently excludable alternatives (Fox 2007).
- However, we claim that O leads to a trivial implicature in interrogative embedding:
 - O is sensitive to *structural alternatives* (Katzir 2007), which is the set of singular replacement of *who* in the case of *who came*.
 - But any of these alternatives are not innocently excludable given the existence presupposition associated with the interrogative clause.

7.3 Dealing with factive predicates

- Klinedinst & Rothschild's analysis doesn't straightforwardly extend to factive predicates since the application of EXH above them is predicted to be vacuous (or presupposition failure).
- This problem can be avoided by making the **Ans**-operator responsible for factivity, rather than the embedding predicate.
- See Theiler (2014) for similar ideas.



$$(37) \quad \llbracket \text{know} \rrbracket^w = \lambda \mathcal{P}_{\langle s, st \rangle} \lambda x : [\text{DOX}_w^x \subseteq \mathcal{P}(w) \vee \text{DOX}_w^x \subseteq \neg \mathcal{P}(w)]. \text{DOX}_w^x \subseteq \mathcal{P}(w)$$

$$(38) \quad \llbracket \mathbf{Ans} \rrbracket(w)(Q) \text{ is defined if} \\ \exists! p \in Q[p(w) \wedge \forall p' \in Q[p'(w) \rightarrow p \subseteq p']]. \\ \text{If defined, } \llbracket \mathbf{Ans} \rrbracket(w)(Q) = \{p \in Q[p(w) \wedge \forall p' \in Q[p'(w) \rightarrow p \subseteq p']]\}$$

- **Ans** is involved in a structure with a declarative complement as well, where declarative complements denote singleton sets of propositions.
- Derivation of factivity:

$$(39) \quad \llbracket \text{John knows that } p \rrbracket^w \\ \Leftrightarrow \llbracket \text{know} \rrbracket^w(\lambda w'. \llbracket \mathbf{Ans} \rrbracket(w')(\{p\}))(\mathbf{j}) \\ \Leftrightarrow \text{DOX}_w^{\mathbf{j}} \subseteq \llbracket \mathbf{Ans} \rrbracket(w)(\{p\}) \\ \text{This is defined only if } p \text{ is true in } w.$$

- *know* itself doesn't trigger factivity, but *know that* *p* presupposes that *p* is true due to the presupposition of **Ans**.
- The alternative-semantic value of structures like (36) is generated by replacing the world variable with other world variables.

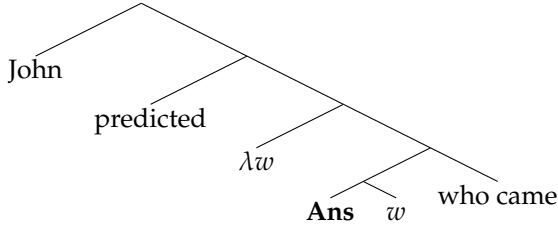
$$(40) \quad \llbracket (36) \rrbracket^{alt} = \{p \mid \exists w'[p = \lambda w. \text{DOX}_w^{\mathbf{j}} \subseteq \llbracket \mathbf{Ans} \rrbracket(w')(\llbracket \text{who came} \rrbracket)]\}$$

- Since the verb doesn't trigger factivity, the propositions in (40) are not guaranteed to be false.

7.4 Non-veridical predicates

- The above treatment straightforwardly extends to non-veridical predicates like *predict* and *be certain*.
- The truth-conditions involve existential quantification over the world in which the propositional concept is evaluated. (Égré and Spector to appear)
- This is in contrast to the factive/veridical case where the propositional concept is evaluated at the actual world.

(41)



$$(42) \quad \llbracket \text{predicted} \rrbracket^w = \lambda \mathcal{P}_{\langle s, st \rangle} \lambda x : \exists w' [\text{PRD}_w^x \subseteq \mathcal{P}(w') \vee \text{PRD}_w^x \subseteq \neg \mathcal{P}(w')]. \exists w' [\text{PRD}_w^x \subseteq \mathcal{P}(w')]$$

- Derivation of non-factivity:

$$(43) \quad \begin{aligned} & \llbracket \text{John predicted that } p \rrbracket^w \\ & \Leftrightarrow \llbracket \text{predict} \rrbracket^w (\lambda w'. \llbracket \text{Ans} \rrbracket (w') (\{p\})) (j) \\ & \Leftrightarrow \exists w' [\text{PRD}_w^x \subseteq \llbracket \text{Ans} \rrbracket (w') (\{p\})] \\ & \text{Defined without } p \text{ being true in } w. \end{aligned}$$

- This formulation correctly captures Égré and Spector's (to appear) generalization that a predicate is factive wrt declarative-embedding iff it is veridical wrt interrogative-embedding.

8 Conclusions and implications

- This paper presented a semantic theory of embedded questions that can predict the variation in their exhaustive interpretations, based on the lexical semantics of embedding predicates.
- The result shows another empirical domain in which the distinction between representational and non-representational/emotive attitudes (e.g., *know* vs. *be happy*) (Bolinger 1968) is crucial in accounting for selectional properties of attitude predicates (Villalta 2008, Anand & Hacquard 2013).
- I proposed a new perspective on SE readings that they are parasitic on IE readings. This is in line with Cremers & Chemla's (2014) result on the RT of two readings: SE readings appear to be accessed later than IE readings.

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