Predicates of relevance and theories of question embedding

Patrick D. Elliott[1], Nathan Klinedinst[1], Yasutada Sudo[1] and Wataru Uegaki[2]
[1]University College London and [2]Universiteit Leiden

1. Introduction

Lahiri (2002) classifies question embedding predicates into two major types, *rogative* and *responsive predicates*. Rogative predicates like *wonder* are only compatible with interrogative complements, while responsive predicates like *know* are also compatible with declarative complements.

It is generally considered that the declarative-embedding and interrogative-embedding uses of each responsive predicate should be accounted for with a single lexical item.[1] Empirical support for this view comes from the fact that an interrogative and declarative complement can be coordinated under a single responsive predicate, as in (1).

(1)   Mary knows which student came and that none of the professors came.

If the complement clauses here are really coordinated, *know* must have a meaning that is compatible with both interrogative and declarative complements. Furthermore, even if (1) is somehow derived from two occurrences of *know,* as in (2), it needs to be explained why the second occurrence of *know* can be elided, if the two occurrences have different lexical meanings.

(2)   Mary knows which student came, and ~~she knows~~ that none of the professors came.

In addition, the declarative and interrogative uses of responsive predicates are generally expressed by the same lexical item not just in English, but also in typologically unrelated languages, e.g. Japanese, as demonstrated in (3) with two responsive predicates *sitteiru* 'know' and *kinisiteiru* 'care'.

(3)   a.   Hanako-wa   dono   gakusei-ga   kita-ka   sitteiru/kinisiteiru.
                Hanako-TOP   which   student-NOM   came-Q   know/care
                'Hanako knows/cares which student came.'
        b.   Hanako-wa   Taro-ga   kita   koto-o   sitteiru/kinisiteiru.
                Hanako-TOP Taro-NOM   came   fact-ACC   know/care
                'Hanako knows/cares (the fact) that Taro came.'

In fact, we are not aware of a language that morphologically distinguishes the declarative-embedding and interrogative-embedding uses of the same responsive predicate by some marking on the predicate itself. If there is no such language, it is more appealing to analyze the two uses with the same lexical entry.

---

[1] Several ambiguity theories that postulate separate lexical entries for the two uses have been proposed, e.g. Karttunen (1977), Nathan (2006), George (2011), etc. We return to them in Section 2.

There are two types of approaches that assign single denotations to the declarative-embedding and interrogative-embedding uses of responsive predicates. The *question-to-proposition reduction approach,* which seems to be more widely espoused in the literature, holds that responsive predicates semantically always select for propositions and that both declarative and interrogative complements to them denote propositions (Heim 1994, Dayal 1996, Lahiri 2002, Spector & Egré 2015). On the other hand, the *proposition-to-question reduction approach* (Groenendijk and Stokhof 1984, Theiler, Roelofsen & Aloni. 2015, Uegaki 2015) assumes that responsive predicates semantically always select for question denotations and declarative complements denote resolved questions. If one assumes (as we do here) that questions denote sets of propositions, then declarative complements denote singleton sets of propositions.

In this paper we argue that predicates of relevance (PoRs) such as *care, matter, be relevant* are responsive predicates that cannot be adequately dealt with under the question-to-proposition approach, and therefore, at least some responsive predicates semantically select for question denotations, rather than propositions. We build on Groenendijk & Stokhof (1984:94), who propose a version of the proposition-to-question reduction approach where both interrogative and declarative complements denote propositional concepts (rather than propositions), and suggest that PoRs are problematic for a variant of the question-to-proposition approach, such as Karttunen (1977). Our contribution is two-fold. First, we make explicit the problems that PoRs pose for question-to-proposition reduction, in any guise.[2] The argument focuses on the presuppositions of PoRs. Second, we provide an explicit proposition-to-question reduction analysis which does not face these problems.

2. Problems from PoRs for the question-to-proposition reduction approach

PoRs are responsive predicates, according to Lahiri's classification, in that they are compatible with both declarative and interrogative complements, as shown in (4).[3]

(4) a. Mary cares which student left.
     b. Mary cares that John left.

Notice that the declarative embedding use in (4b) presupposes that the complement clause is true, and that Mary knows it. In contrast, (4a) does not presuppose that Mary believes any answer to the embedded question.

---

[2] George (2011, 2013) raises another argument against question-to-proposition reduction. Our argument here is independent from his.

[3] Some PoRs seem to be polysemous. For example, *matter* has a reading with similar presuppositions as *care,* which we call a cognitive reading, but it also has a non-cognitive reading similar in meaning to *affect*. The latter reading is forced when the dative phrase is inanimate, as in *It matters to the success of the project that Mary is on board.* Since this polysemy obscures the judgments of our main data, which crucially use cognitive readings, we will stick to *care* in our examples. We thank two anonymous reviewers who independently brought this issue to our attention with helpful examples. We would also like to add here that those PoRs that have non-cognitive uses like *matter* generally allow questions as both arguments, as in *Which relatives will come to the party matters for what kind of food to prepare,* while those that do not have non-cognitive uses like *care* do not (e.g. *Which relatives will come cares what kind of food to prepare*), suggesting that cognitive and non-cognitive readings are due to different uses of the verbs with different selectional properties (see Rawlins 2013 for discussion related to this).

This difference between (4a) and (4b) appears difficult to capture under the question-to-proposition reduction approach. It would analyze (4a) as meaning Mary cares that p, where p is a propositional answer to the embedded question. There are several theoretical options as to which notion of answerhood to employ (e.g. a Hamblin-Karttunen answer, a weakly exhaustive answer, or a complete/strongly exhaustive answer), but regardless of this question, (4a) is wrongly predicted to presuppose that Mary believes p, for some answer p.

The factive inference of *care* with a declarative complement poses a further potential problem for the question-to-proposition reduction approach. Suppose that the only thing that Alice cares about is whether her student John left. Suppose also that only Bill left. Then, (5a) is true, but (5b) does not seem to be true (Lahiri 2002:41 makes essentially the same observation; see also Groenendijk & Stokhof 1984:94 and Nathan 2006:130–131).[4]

(5)   a.   Alice cares who left.
        b.   Alice cares that Bill left.

If the embedded question of (5a) denoted a weakly exhaustive answer, i.e. the proposition that x left, for x the person or people that actually left, then given the factivity of declarative-embedding *care,* (5a) should mean the same thing as (5b) in this context, and thus should not be true.

Would it help the question-to-proposition approach to assume that the embedded clause in (5a) denotes a strongly exhaustive answer, i.e. that x and only x left? This accounts for the difference between (5a) and (5b) in the context described above, but it runs into a different problem; namely, it fails to account for the contrast between (6a) and (6b):

(6)   a.   #Betty cares that Bill left, but she doesn't care which student left.
        b.   Betty cares that Bill left, but she doesn't care that Bill and only Bill left.

If the embedded question in (6a) had a strongly exhaustive reading, (6a) should be as felicitous as (6b).

These observations suggest that the interrogative complement to *care* is not reducible to a propositional answer to the question, and thus that PoRs resist the question-to-proposition reduction analysis. On the other hand, if PoRs are grouped with rogative predicates, the possibility of declarative embedding will call for an independent explanation.

Could one simply postulate two independent lexical entries of *care* for declarative and interrogative complements? Such an ambiguity theory would run into the problem of coordination, as in (7), which is parallel to (1).

---

[4] We use *who* in (5), which is number-neutral,, instead of a singular *wh*-phrase like *which student,* as in (4a), in order to show that the factive presupposition poses a problem that is independent from the problem of the belief presupposition. That is, if one's theory predicts a belief presupposition for (5a) that Alice believes a true answer, then together with the singular presupposition triggered by the singular *wh*-phrase, (5a) does seem to entail (5b).

(7)   Mary cares which student came and that he wore a suit.

This suggests that *care* has a meaning that is compatible with both interrogative and declarative complements.

Besides this empirical problem, it seems to us that a conceptually attractive ambiguity theory is hard to come by. The cross-linguistic facts about the lack of morphological distinction mentioned above (cf. (3)) suggests that the two uses of responsive predicates should be at least systematically related. None of the existing ambiguity theories, however, can deal with PoRs successfully. For example, Karttunen (1977) proposes that the two uses of *know* have separate lexical items that are related via a meaning postulate in (8). Q here is assumed to be the set of true answers to the embedded question in w.[5]

(8) $[[know_{int}]]^w(Q)(x) \leftrightarrow \forall p \in Q\, [[[know_{dec}]]^w(p)(x)]$

When extended to *care,* however, this runs into the exact same problem of predicting the wrong presuppositions that the proposition-to-question reduction approach runs into. Our observations above show that the interrogative-embedding use cannot be paraphrased in terms of the declarative-embedding use, but the meaning postulate in (8) does exactly that.

George (2011) puts forward another ambiguity theory that systematically relates the two uses of responsive predicates. For George, the relation between the two uses is indirect and both of them are defined in terms of core meanings according to a general rule. We do not go into the details of George's analysis here, but it can be shown that when extended to *care,* it also runs into the same problem as the proposition-to-question reduction approach and Karttunen's theory.

It is certainly a logical possibility to assume that a different meaning postulate applies to *care* than to *know* (cf. Nathan 2006:130)*,* but such a view with multiple meaning postulates would not be conceptually appealing. We will demonstrate below that a more uniform analysis is feasible under the proposition-to-question reduction approach.

3. An analysis of PoRs under the proposition-to-question reduction approach

We propose that the proposition-to-question approach gives a natural account of PoRs as a (type of) rogative predicate. Specifically, *care* can be analyzed as (9).[6] Here, for the sake of presentation, we

---

[5] Karttunen's (1977:fn.11) original formulation has a conjunct saying that when $Q = \varnothing$, x knows that there is no true answer. However, it is generally assumed today that questions presuppose that there is at least one true answer, so we leave out this conjunct here. It is also orthogonal to the point we are making here.

[6] It is an analytical possibility that the presupposition $\textbf{believe}_w(x, \lambda w's.\ \exists p \in Q[p(w')])$ here is not triggered by *care* itself, but is projected from a presupposition of the complement clause that there is a true proposition in the set of propositions. This is perhaps more attractive, given that all PoRs seem to have the same presupposition, but it is not clear to us whether it is tenable across all embedding predicates, given the existence of predicates like *(un)certain,* whose declarative use does not seem to have a belief presupposition.

assume that Q is the set of possible answers to the embedded question, e.g. for (4a), {x left: x is a girl in w} (under the *de re* reading of the *which*-phrase).[7]

(9) $[[\text{care}]]^w = \lambda Q_{\langle st,t\rangle}: \exists p \in Q[p(w)]. \lambda x_e: \textbf{believe}_w(x, \lambda w'_s. \exists p \in Q[p(w')]). \textbf{care}_w(x,Q)$

This predicts that (4a) presupposes that one student actually left, and that Mary believes that some student left (but not that x left, for any particular student x). These are the correct presuppositions for (4a).

With a declarative complement as in (4b), we follow Uegaki (2015) and assume that the declarative complement gets type-lifted by ID (Partee 1987).[8]

(10) $\text{ID} := \lambda p_{st}. \{p\}$

Therefore, the declarative complement to *care* will be a singleton {p}, and the presupposition will be that p is true and x believes p. More concretely, (4b) will presuppose that Bill left and Mary believes/knows that Bill left. These are the correct presuppositions for (4b).

4. Other interrogative-embedding predicates

It should be noted that predicates like *know* do not distinguish the two approaches under discussion. According to the question-to-proposition reduction approach, the interrogative complement to *know* denotes a proposition representing the answer to the embedded question. There are several theoretical choices regarding the notion of answerhood, but regardless of this issue, the denotation of *know* under this approach looks like (11).

(11) $[[\text{know}]]^w = \lambda p_{\langle s,t\rangle}. \lambda x_e: p(w). \textbf{know}_w(x,p)$

On the other hand, according to Uegaki's (2015) proposition-to-question reduction analysis, responsive predicates like *know* always embed sets of propositions (see also Uegaki (to appear) for arguments for this analysis). More concretely, *know* can be given the following denotation.[9]

---

[7] The general view should also be compatible with equating Q with the set of possible weakly exhaustive answers, or the set of possible strongly exhaustive answers, although it should not be the singleton set of the true weakly or strongly exhaustive answer (given that *care* is not a veridical predicate in its interrogative use). More concretely, Groenendijk & Stokhof (1984) takes the denotation of an interrogative complement to be a propositional concept which maps each possible world to the strongly exhaustive answer in that possible world. Under this assumption, (8) can be re-written as follows (where W is the set of possible worlds): $\lambda P_{\langle s,st\rangle}: \exists p \in \{P(w')|w' \in W\}[p(w)]. \lambda x_e: \textbf{believe}_w(x, \lambda w'_s. \exists p \in \{P(w')|w' \in W\}[p(w')]). \textbf{care}_w(x, \{P(w')|w' \in W\})$.
[8] It is important to note that this implementation using ID is just one of many analytic possibilities for the proposition-to-question approach, whose crucial idea is to analyze responsive predicates as semantically question-taking. As an alternative to ID, one could assume, for example, that declarative complements simply denote a singleton set of a proposition without any type-shifting (see Theiler et al. 2016 for a concrete analysis that largely follows this route), or take the complementizer to denote the same function as ID.
[9] (11) only accounts for the so-called weakly exhaustive reading, but it is easy to tweak it to yield the strongly exhaustive reading (cf. Heim 1994).

(12) $[[\text{know}]]^w = \lambda Q_{\langle st,t\rangle}.\lambda x_e:\ \exists p\in Q[p(w)].\ \forall p\in Q[p(w)\rightarrow\textbf{know}_w(x,p)]$

Importantly, in both of these analyses, the interrogative-embedding use of *know* involves extraction of the answer proposition from the question semantics, although where and how that happens is different. Under the question-to-proposition reduction approach, the complement clause undergoes question-to-proposition shift, while under Uegaki's proposition-to-question reduction analysis, the shift takes place within the lexical semantics of *know*. Given that it is always possible to turn a question into a proposition representing the answer to the question (cf. Heim 1994), the proposition-to-question reduction approach can always emulate the question-to-proposition reduction analysis of responsive predicates.

On the other hand, there is one crucial property of the proposition-to-question reduction approach that its alternative does not share, namely, reference to the question denotation. We claim that this is exactly what is needed to properly account for PoRs. Our arguments above show that the interrogative-embedding use of *care* cannot be paraphrased in terms of the declarative-embedding use of *care,* due to the latter's factive presupposition, while, as demonstrated by the lexical entry in (9) above, the declarative-embedding use of *care* can be accounted for in terms of its interrogative-embedding use.

As for canonical rogative predicates like *wonder*, the question-to-declarative reduction approach to responsive predicates explains their inability to embed declaratives, by simply assuming that they semantically select for questions. The proposition-to-question reduction approach, too, can explain this as a matter of lexical semantics, but a more fine-grained one: the meaning of *wonder*—but not that of *care*—is semantically incompatible with singleton (i.e. resolved) questions. See Ciardelli & Roelofsen (2015) and Uegaki (2015) for specific proposals.

5. Final Remarks

Recall Lahiri's (2002) typology of interrogative-embedding predicates. He proposed two classes, defined in syntactic terms according to compatibility with declarative complements. Those interrogative-embedding predicates compatible with declarative complements, he termed *responsive*, and those incompatible with declarative complements, *rogative*.

The proposition-to-question reduction approach allows for a refined perspective on the typology of interrogative embedding predicates, by semantically classifying such predicates according to reducibility to the declarative-embedding use. Among syntactically responsive predicates, the interrogative-embedding use of *know* is semantically reducible to its declarative-embedding use, as demonstrated above, so we can say that it is semantically responsive as well. Canonical rogative predicates like *wonder* are syntactically rogative, and trivially, also semantically rogative, as it does not have a declarative-embedding use. PoRs, on the other hand, are syntactically responsive, but semantically rogative predicates, as they express relations that are irreducibly between individuals and questions, but are still compatible with declarative complements. Such predicates cannot exist under the question-to-proposition reduction approach to responsive predicates.

Admittedly, our argument does not deny the question-to-proposition analysis of predicates like *know,* because, as discussed above, the treatment of such predicates is essentially identical under both approaches, and it is logically possible that predicates like *know* always select for propositions, as in (11), while PoRs always select for question denotations, as in (9). Although we have no knockdown argument against such an eclectic analysis, we think that a uniform treatment like the one we pursue here is conceptually more appealing.

References

Ciardelli, Ivano & Floris Roelofsen (2015) Inquisitive dynamic epistemic logic. *Synthese* 192:1643–1687

Dayal, Veneeta (1996) *Locality in WH Quantification: Questions and Relative Clauses in Hindi.* Dordrecht: Kluwer.

George, Benjamin (2011) *Question Embedding and the Semantics of Answers*. Ph.D. dissertation, UCLA.

George, Benjamin (2013) Knowing-wh, mention-some readings, and non-reducibility. *Thought: A Journal of Philosophy,* 2(2): 166–177.

Groenendijk, Jeroen & Martin Stokhof (1984) *Studies on the Semantics of Questions and the Pragmatics of Answers.* Ph.D. dissertation, Universiteit van Amsterdam.

Heim, Irene (1994) Interrogative semantics and Karttunen's semantics for *know.* In *Proceedings of IATL 1.* 183–221.

Karttunen, Lauri (1977) Syntax and semantics of questions. *Linguistics and Philosophy,* 1(1): 3–44.

Lahiri, Utpal (2002) *Questions and Answers in Embedded Contexts.* Oxford: Oxford University Press.

Nathan, Lance (2006) *On the Interpretation of Concealed Questions.* Ph.D. dissertation, MIT.

Partee, Barbara (1987) Noun phrase interpretation and type-shifting principles. In Jeroen Groenendijk, Dick de Jongh, and Martin Stokhof (eds.), *Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers.* Dordrecht: Foris. 115–144.

Rawlins, Kyle (2013) (Un)conditionals. *Natural Language Semantics,* 21(2): 111–178.

Spector, Benjamin & Paul Egré (2015) A uniform semantics for embedded interrogatives: *An* answer, not necessarily *the* answer. *Synthese,* 192: 1729–1784.

Theiler, Nadine, Floris Roelofsen, and Maria Aloni, A truthful resolution semantics for declarative and interrogative complements. Ms, ILLC UvA, April 2016.

Uegaki, Wataru (2015) *Interpreting Questions under Attitudes.* Ph.D. dissertation, MIT.

Uegaki, Wataru (to appear) Content nouns and the semantics of question-embedding. To appear in *Journal of Semantics.*