CONTENT NOUNS AND THE SEMANTICS OF QUESTION-EMBEDDING PREDICATES*

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1 Introduction

Let us start with an observation. In (1) below, we see that *believe* and *know* have different entailment patterns when they are combined with a DP with a propositional complement, such as *the rumor that Mary left*.

(1) a. John **believes** the rumor that Mary left. $\models$ John **believes** that Mary left.
b. John **knows** the rumor that Mary left. $\not\models$ John **knows** that Mary left.

In (1), it is shown that *believe* can, but *know* cannot, license the entailment from *x Vs the rumor that p* to *x Vs that p* (Vendler 1972, Ginzburg 1995). As I will argue in detail below, in the standard assumption that *know* has a proposition-taking denotation, an additional stipulation will be needed to block whatever the mechanism that licenses the entailment of *believe* in the case of *know*.

In this paper, I propose an analysis of this contrast by arguing that predicates embedding either a declarative or an interrogative, such as *know*, never take a proposition, but only take a proposition-set (e.g., a question-denotation) as a semantic argument. The fact that they can embed a declarative is accounted for by the role of the declarative complementizer that turns a proposition into a singleton question. The resulting view of question/proposition-embedding captures the fact that exclusively interrogative-embedding verbs, such as *ask* and *wonder*, form a semantically natural class while avoiding the problematic prediction of the standard question-to-proposition reduction (e.g., Karttunen 1977, Groenendijk & Stokhof 1984) that any declarative-embedding verb should be able to embed an interrogative unless further stipulations.

2 The puzzle of 'content' DPs

The central puzzle dealt with in the present paper is how to account for the contrast as shown in (2-3). The contrast is between attitude verbs that only embed a declarative *that*-clause, such as

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believe, and those that can embed either a declarative or an interrogative clause, such as *know*: They have different entailment patterns when they combine with 'content' DPs that take a propositional complement, such as *the rumor* or *the story* (Vendler 1972; Ginzburg 1995). I refer to the former class of predicates as EXCLUSIVELY PROPOSITION-TAKING PREDICATES (henceforth ProPs) and to the latter class of predicates as RESPONSIVE PREDICATES (from Lahiri 2002; henceforth ResPs). Note that factivity cross-cuts this distinction as verbs like *report*, *guess* and *tell* are non-factive ResPs.[1]

(2) a. John {**believes / accepted / denied**} the rumor that Mary left.
$\models$ John {**believes / accepted / denied**} that Mary left.

b. John {**knows / discovered / reported**} the rumor that Mary left.
$\not\models$ John {**knows / discovered / reported**} that Mary left.

(3) a. John {**believes / accepted / denied**} the rumor.
$\models$ John {**believes / accepted / denied**} that the rumor is true.

b. John {**knows / discovered / reported**} the rumor.
$\not\models$ John {**knows / discovered / reported**} that the rumor is true.

The contrast above can be intuitively described in the following way: ProPs like *believe* can establish the relevant attitude relation between the attitude holder and the 'content' of the DP in the object position, but there is no parallel reading of ResPs that establishes the entailment. The puzzle is why there is such a contrast between the two types of predicates. More roughly, the question is why *know* cannot do what *believe* can do.[2]

To see the problem more clearly, let us assume a concrete denotation for the content noun *rumor*. Below, I describe two plausible denotations for a content noun, one deriving the entailment with ProPs (e.g., *believe*) straightforwardly, and the other deriving the non-entailment with ResPs (e.g., *know*) straightforwardly. I will argue that the contrast above cannot be given an explanatory account with either denotation, as long as we assume that ResPs like *know* take propositions.

The entailment of *believe* as basic First, let us assume the following propositional denotation for *rumor* in (a), with which we can derive the correct entailment with *believe* based on its standard denotation in (b).

[1] A possible counterexample to the generalization is *tell*. Although *tell* is a ResP, it seems that there is a reading of (i) that entails that John told me that Mary left.

(i) John told me the rumor that Mary left.

In this paper, I tentatively assume that *tell* is ambiguous between the ResP version, which can embed an interrogative, and the ProP version, which cannot embed an interrogative but licenses the entailment in question. I would like to leave further investigation of the behavior of *tell* for future research.

[2] One might wonder whether the 'anti-factive' meaning/implication associated with *rumor* has to do with the non-entailment in the case of *know*. Specifically, one might suggest that the factivity of *know* is incompatible with the 'anti-factivity' of *rumor*, and thus *x knows the rumor* can only be interpreted as an acquaintance, which is why the entailment does not hold. However, this hypothesis does not account for the fact that the entailment does not hold for a non-factive verb *report*, either. Also, this hypothesis incorrectly predicts that if the noun is neutral in factivity, as *claim* or *hypothesis*, the entailment goes through. However, this is not the case:

(i) John knows the claim/hypothesis that Mary left. $\not\models$ John knows that Mary left.

See Section 4.1 for cases where the noun is factive, as *fact* or *truth*, and an account of them.

(4) a. $[\![\text{rumor}]\!]^w = \lambda q \in D_{\langle s,t\rangle} \lambda p \in D_{\langle s,t\rangle}.\mathbf{rumor}(p,w) \wedge p = q$
b. $[\![\text{believe}]\!]^w = \lambda p \in D_{\langle s,t\rangle} \lambda x.\text{DOX}_{x,w} \subseteq p$

(5) $[\![\text{John believes the rumor that Mary left}]\!]^w = 1$ iff
$\text{DOX}_{\mathbf{j},w} \subseteq \iota p[C(p) \wedge \mathbf{rumor}(p,w) \wedge p = \{w' \mid \mathbf{left}(\mathbf{m})(w')\}]$ (C is a contextual restriction)

Here, *believe* has its standard denotation taking a propositional argument, while the denotation of *rumor* takes a complement proposition and returns a predicate of propositions that is true of a proposition satisfying the description **rumor** and identical to the complement proposition. As a result, as in (5), *John believes the rumor that Mary left* is true iff John believes the contextually salient unique proposition that is a rumor and identical to the proposition that Mary left, which is true only when John believes that Mary left. Thus, giving the standard denotations to ProPs and a propositional denotation to content DPs, as in (4), captures the correct entailment pattern.

However, the problem arises when we replace the standard proposition-taking denotation for *know* with that of *believe*: we would incorrectly predict exactly the same entailment as in the case of *believe*. Below, it is shown that given the simplified proposition-taking meaning for *know* in (6) (i.e. *believe* + factivity),[3] we would predict the truth conditions of *John knows the rumor that Mary left* in (7), which is true only when John believes that Mary left, and that it is true that Mary left (due to the factivity presupposition, underlined in (7)). This entails that John knows that Mary left, contrary to the fact.

(6) $[\![\text{know}]\!]^w = \lambda p \in D_{\langle s,t\rangle} : [p(w)=1] \lambda x.\ \text{DOX}_{x,w} \subseteq p$

(7) $[\![\text{John knows the rumor that Mary left}]\!]^w = 1$ iff
$\text{DOX}_{\mathbf{j},w} \subseteq \iota p[\mathbf{rumor}(p,w) \wedge p = \{w' \mid \mathbf{left}(\mathbf{m})(w')\}] \wedge \underline{\mathbf{left}(\mathbf{m})(w)}$

In fact, the argument here does not hinge on the exact implementation of the meaning of content nouns assumed here. The problem applies to any compositional implementation that derives the entailment with the standard denotation for ProPs. As long as there is a general compositional mechanism deriving the entailment of *believe*, we would predict that the same mechanism holds for *know*, given the standard assumption that both verbs have proposition-taking denotations.[4]

The non-entailment of *know* as basic The way the problem is stated above assumes a simplistic denotation for *the rumor* so that the entailment of *believe* goes through with its standard denotation while the non-entailment of *know* is problematic. Another plausible way to look at the contrast is to regard the entailment as problematic while the non-entailment as basic. The non-entailment fact straightforwardly comes out if we assume that a content DP denotes some kind of non-propositional

[3] In this paper, I model presuppositions including factivity in terms of partial functions. A clause after a colon in a lambda term indicates a restriction on the domain of the function that the lambda term expresses.

[4] I categorize the treatment of content nouns by Kratzer (2006) and Moulton (2008) as a variant of the approach considered here, as their compositional system is constructed in such a way that the entailment fact with *believe* is predicted straightforwardly. In their system, a content DP like *the rumor* denotes an abstract object called a 'content' from which its propositional information can be retrieved. Their denotation for *believe* is such that it takes a content argument and the subject believes whatever the propositional information of this content. It is clear that this system correctly predicts the entailment fact with *believe*, but it over-generates the entailment if we simply generalize their denotation for *believe* to *know* by adding factivity. Hence their treatment faces the same problem as the approach considered here. It should be emphasized, however, that the analysis of ResPs is outside the scope of Kratzer and Moulton, and so this is not a problem with their analysis of content nouns *per se*.

abstract object and that *know* is ambiguous between the proposition-taking variant for 'knowledge' and the non-proposition taking variant for 'acquaintance', the distinction (roughly) corresponding to that between *wissen* and *kennen* in German. The denotation for the former variant of *know* is given in (6) and the latter in (8), where α is a variable over the non-propositional (type *a*) objects, whose instance a content DP denotes.

(8) $[\![\text{know}_\text{A}]\!]^w = \lambda\alpha \in D_\text{a}\lambda x \in D.\textbf{acquainted}(x)(\alpha)(w)$

Under this system, since a content DP like *the rumor* is compatible only with the 'acquaintance' *know* in (8), and 'being acquainted' with a certain object does not entail propositional knowledge of its content, the non-entailment fact comes out naturally. Here, I stay away from detailed model-theoretic characterization of the type *a* objects and the relation **acquainted** in order to make the argument general. The only assumption needed to derive the non-entailment is that *x*'s being acquainted with α with propositional content *p* does not entail *x*'s knowing that *p*. Another possibly distinct reading of *know* + a content DP is a Concealed Question (henceforth CQ) reading, but it is clear that it does not have the relevant entailment, either. This is because knowing an answer to the CQ 'What is α?' does not entail the knowledge of α's content however we formalize CQ readings.

Now, the problem is how to account for the entailment fact with *believe*. A possible way out is to stipulate the lexical semantics of *believe* in a way so that it can access the propositional content of the abstract object it combines with, as shown in (9). In (9), *believe* establishes the believing-relation between the subject and the propositional content retrieved from its first argument by the function $\mathscr{F}_\text{cont}$.

(9) $[\![\text{believe}]\!]^w = \lambda\alpha \in D_\text{a}\lambda x \in D.\text{DOX}_{x,w} \subseteq \mathscr{F}_\text{cont}(\alpha)$
where $\mathscr{F}_\text{cont}$ is a function $D_\text{a} \mapsto D_{\langle\text{s,t}\rangle}$ that maps an abstract object to its content.

Indeed, this might be a descriptively adequate analysis of the contrast in (2,3). However, simply stipulating lexical entries like these does not *explain* why the (im)possibility of embedding an interrogative complement correlates with the contrast, ie. why ResPs do not license the entailment while ProPs do. Another way to state the problem is that the account does not answer why *know* does *not* have the denotation involving $\mathscr{F}_\text{cont}$ as in (10) instead of (8), incorrectly deriving the entailment. Similarly, it does not answer why *believe* is not ambiguous like *know* between the standard proposition-taking version and the other version along the lines of (11) without $\mathscr{F}_\text{cont}$ (so to speak, the 'acquaintance' version of *believe*), incorrectly predicting the non-entailment fact.

(10) $[\![*\text{know}_\text{cont}]\!]^w = \lambda\alpha \in D_\text{a}:[\mathscr{F}_\text{cont}(\alpha)(w)=1]\lambda x \in D.\text{DOX}_{x,w} \subseteq \mathscr{F}_\text{cont}(\alpha)$

(11) $[\![*\text{believe}_\text{A}]\!]^w = \lambda\alpha \in D_\text{a}\lambda x \in D.\mathbf{R}(x)(\alpha)(w)$
where $\mathbf{R}$ is a relation such that $\mathbf{R}(x)(\alpha)(w) \not\models \text{DOX}_{x,w} \subseteq \mathscr{F}_\text{cont}(\alpha)$

In sum, the contrast in (2,3) is problematic whether we assume a denotation for a content noun that predicts the entailment fact of *believe* straightforwardly, or we assume one that predicts the non-entailment fact of *know* straightforwardly, with its 'acquaintance' reading. Generally speaking, the problem with the former approach is that the combination of assumptions (i) and (ii) below over-generates the relevant entailment for ResPs. On the other hand, the problem with the latter approach is that, when we assume both (i) and (iii), we are forced to give stipulative lexical semantic difference between ResPs and ProPs that cannot be explained by their independent properties viz. the ability to embed an interrogative complement.

(i) ResPs select for the same kind of object that ProPs select for (normally a proposition).

(ii) A general compositional mechanism (e.g., propositional denotation of content DPs) derives the entailment fact of ProPs with its standard denotation.

(iii) A general compositional mechanism (e.g., non-propositional denotation of content DPs + 'acquaintance' reading) derives the non-entailment fact of ResPs.

The proposal I will put forth in this paper agrees with assumption (iii), but it further gives a general constraint on the lexical semantics of attitude verbs that explains the crucial lexical semantic difference between ResPs and ProPs in terms of their ability to embed an interrogative complement. The proposal is fairly simple: it denies assumption (i).

3 Proposal

The central proposal of the current paper is that ResPs do not take a proposition, but only take a proposition-set as their complement. In this section, after presenting the basic compositional semantics, I illustrate how this proposal leads to the solution to the puzzle of content DPs described in the previous section. In the last subsection, I will discuss the general constraint on the lexical semantics of attitude verbs arising from the proposal, especially in relation to exclusively interrogative-embedding verbs, such as *ask* and *wonder*.

3.1 ResPs only take a question complement

As stated above, I propose that ResPs only select for a question, but not for a proposition. For instance, below is the *only* denotation for *know*.

(12) $[\![\text{know}]\!]^w = \lambda Q{\in}D_{\langle \text{st,t}\rangle}{:}[\exists p{\in}Q[p(w){=}1]]\lambda x.\forall p \in Q[p(w){=}1 \rightarrow \text{DOX}_{x,w} \subseteq p]$

Following Hamblin (1973), I assume that the denotation of an interrogative complement is the set of possible answers to the question (including false ones), as exemplified below.

(13) $[\![\text{who left}]\!]^w = \{p \mid \exists x[p = \lambda w'.\textbf{left}(x)(w')]\}$

The denotation in (12) takes a set of propositions, e.g., a question-denotation, and returns true iff the subject believes all the true propositions in the set. Also, there is an additional factivity presupposition that at least one of the propositions in the proposition-set is true. Thus, when (12) is combined with a *wh*-complement, the weakly-exhaustive reading is predicted just as in Karttunen's (1977) analysis. I assume that the strongly-exhaustive reading arises by type-shifting a Hamblin-denotation into a partition of worlds with a covert operator along the lines of Heim's (1994) Answer2.

When *know* takes a declarative complement, I assume that the special complementizer in (14) turns the proposition denoted by the embedded clause into the singleton set containing it.[5] Combining this singleton set with (12), the resulting truth conditions of a sentence in which *know* embeds a declarative clause will be the standard one, as shown in (15). (Again, the underlined conjunct is projected from the factivity presupposition of *know*.)

[5]This rather stipulative assumption can be eliminated in the framework of Alternative Semantics and Inquisitive Semantics since the semantic type of a clause is already a set of propositions in these frameworks. Instead, in such a formulation, the denotation of *believe* will involve the operation of taking the union of a proposition set. In Uegaki (to appear), I argue for an independent reason to employ Alternative/Inquisitive Semantics in the analysis of *know*.

(14) $[\![\text{that*}]\!]^w = \lambda p.\{p\}$

(15) $[\![\text{John knows that* Mary left}]\!]^w = 1$
iff $\forall p \in \{\lambda w'.\mathbf{left}(\mathbf{m})(w')\}[p(w)=1 \rightarrow \text{DOX}_{x,w} \subseteq p] \wedge \underline{\exists p \in \{\lambda w'.\mathbf{left}(\mathbf{m})(w')\}[p(w)=1]}$
iff $\text{DOX}_{x,w} \subseteq \{w' \mid \mathbf{left}(\mathbf{m})(w')\} \wedge \underline{\mathbf{left}(\mathbf{m})(w)}$

On the other hand, I assume that ProPs have standard denotations, as the following denotation for *believe*, repeated from the previous section.

(b) $[\![\text{believe}]\!]^w = \lambda p \in D_{\langle s,t\rangle} \lambda x.\text{DOX}_{x,w} \subseteq p$

3.2 The solution to the puzzle

In this section, I illustrate how the proposal above can give a solution to the puzzle of content DPs. The analysis assumes a non-propositional denotation for content DPs, and basically follows the 'non-entailment as basic' approach above, but avoids the problem of stipulation pointed out in the previous section. The proposal that ResPs only take a question complement offers an explanation for the difference in the entailment patterns between ResPs and ProPs.

The gist of the proposal is the following: when an attitude verb, whether it is a ResP or a ProP, is combined with a content DP, the abstract object denoted by the DP is type-shifted into a corresponding object which the attitude verb normally selects as its complement, viz. a question for ResPs, and a proposition for ProPs. The type-shift for the former maps an object into a concealed question about it while the one for the latter maps an object into its propositional content, both of which are motivated independently. Thus, the difference in entailment between ResPs and ProPs comes out as the result of the type-shift forced by the selectional property of each type of verbs.

3.2.1 The entailment of ProPs

First of all, I claim that content DPs such as *the rumor that Mary left* denotes an individual of type e as shown in (16).

(16) $[\![\text{the rumor that Mary left}]\!]^w = \iota x[C(x) \wedge \mathbf{rumor}(x)(w) \wedge \mathscr{F}_{\text{cont}}(x) = \{w' \mid \mathbf{left}(\mathbf{m})(w')\}]$

Since a ProP like *believe* wants a proposition as its complement, as in (b), (16) cannot be combined with it directly. However, the type-shifting operation in (17) is available, which turns an abstract informative individual into its propositional content.

(17) $[\![\Uparrow]\!]^w = \mathscr{F}_{\text{cont}}$

Thus, the result of the application of (17) to (16) can be combined with *believe*, and yields the truth conditions in (18). It is easy to see that (18) entails (19), capturing the entailment fact.

(18) $[\![\text{John believes } \Uparrow \text{ the rumor that Mary left}]\!]^w = 1$ iff
$\text{DOX}_{\mathbf{j},w} \subseteq \mathscr{F}_{\text{cont}}(\iota x[C(x) \wedge \mathbf{rumor}(x)(w) \wedge \mathscr{F}_{\text{cont}}(x) = \{w' \mid \mathbf{left}(\mathbf{m})(w')\}])$

(19) $\text{DOX}_{\mathbf{j},w} \subseteq \{w' \mid \mathbf{left}(\mathbf{m})(w')\}$

The existence of the type-shifter $\Uparrow$ in (17) is motivated independently of the behavior of attitude verbs. Data like (20) suggest that adjectives such as *true* or *false* denote predicates of propositions. Given this, we need $\Uparrow$ to account for (21), in which *true/false* is predicated of the propositional content of the rumor. That is, *true/false* is predicated of the denotation of $\Uparrow$ *the rumor*.

(20) That Mary left is true/false.

(21) The rumor is true/false.

3.2.2 The non-entailment of ResPs

Let us move on to the case of ResPs. Also in this case, the proposed denotation of a ResP, which is question-taking, cannot be combined with (16). Again, a type-shifting operation is needed to make the composition go through, but this time the operation is one that turns an individual into a question, rather than a proposition. I argue that this operation is carried out by $\uparrow$, a type-shifter which turns an individual into a corresponding CQ. Due to this operation, the truth conditions of *John knows the rumor that Mary left* (more precisely, *John knows* $\uparrow$ *the rumor that Mary left*) will be, roughly, that John knows which object is the rumor that Mary left. It is clear that this does not entail that John knows that Mary left. It can very well be that John can identify the rumor that Mary left while he does not believe that Mary left, and thus he does not know that Mary left.

For my purpose, an exact implementation of the concealed question reading is of secondary issue. This is because any plausible theory of concealed questions should be able to capture the fact that the CQ reading of *x knows the rumor that p* has the paraphrase '*x* knows which object is the rumor that *p*', and non-entailment from this to '*x* knows that *p*' is intuitively clear. However, for completeness, I adopt Aloni's (2008) analysis of CQs,[6] slightly modifying it to fit the compositional setup of this paper.

What follows is a small digression on the semantics of CQs with some background, based on Aloni (2008). In Aloni's analysis, *John knows the winning card* in its CQ reading roughly means 'John knows that *x* is the winning card', where *x* is an individual concept in a contextually salient CONCEPTUAL COVER (Aloni 2001), a set of individual concepts with the constraint that each individual in the set is mapped from each world by exactly one cover.[7] Examples of a cover are the sets A and B in the following, the former identifies a card by position while the latter by suit.

(22) a. A = {the card on the left, the card on the right}
b. B = {the Ace of Spades, the Ace of Hearts}

The CQ reading of *John knows the winning card* differs depending on which cover is contextually given. If the position cover, A, is salient, the sentence means that John knows that *x* is the winning card, where *x* is a concept in *A*, ie. he can identify the winning card based on its position. On the other hand, if the suit cover, B, is salient, the sentence means that John can identify the winning card based on its suit.

To derive this meaning of CQs, we posit a type-shifting operator $\uparrow$ that turns an individual into the corresponding CQ, as follows. (The detail is modified from Aloni's original version.)

(23) $[\![\uparrow]\!]^{w,\mathrm{C}} = \lambda x.\{p \mid \forall w', w'' \in p \forall c \in \mathscr{R}_{\mathrm{C}}[c(w') = x \Leftrightarrow c(w'') = x], p \text{ is maximal}\}$
where $\mathscr{R}_{\mathrm{C}}$ is a conceptual cover given by context C

In prose, this operator turns an individual x into a partition of worlds such that each class in the partition agrees on whether the individual is identified by each concept in the cover that is

[6] In Aloni and Roelofsen (to appear), a number of problems with Aloni (2008) is addressed, and a modification is proposed. However, since the simpler analysis of Aloni (2008) suffices for my purpose, I adopt Aloni's version here.

[7] Formally, a conceptual cover is a set of functions $W \mapsto D$ such that $\forall w \in W[\forall d \in D[\exists! c \in CC[c(w) = d]]]$

contextually salient. In other words, (23) returns a partition of worlds based on the equivalence in the concept by which x can be identified. Applying (23) to the content DP denotation (16), we get the CQ denotation in (24). The resulting truth conditions of the sentence *John knows the rumor that Mary left* will be (25). (Here, we let (16), the denotation of *the rumor that Mary left*, be **r**.)

(24) $[\![\uparrow \text{the rumor that Mary left}]\!]^{w,C}$
$= \{p' \mid \forall w, w' \in p' \forall c \in \mathscr{R}_C[c(w) = \mathbf{r} \Leftrightarrow c(w') = \mathbf{r}], p' \text{ is maximal}\}$ (Let this set be **Q**)

(25) $[\![\text{John knows} \uparrow \text{the rumor that Mary left}]\!]^{w,C} = 1$ iff $\forall p \in \mathbf{Q}[p(w){=}1 \rightarrow \text{DOX}_{\mathbf{j},w} \subseteq p]$

For illustration, suppose that the contextually salient cover is the one in (26), and further suppose that the rumor that Mary left was told by Sue in the actual world, but not by others.

(26) R_C = {the rumor that Sue told, the rumor that Bill told, ... }

Then, the truth conditions of *John knows the rumor that Mary left* predicted by (25) is that John correctly believes that the rumor that Mary left is the one told by Sue, but not the other ones in (26). This captures the intuitive meaning of the CQ reading. Also, it is clear that the truth conditions in (25) do not entail that John knows that Mary left since we can easily construct John's belief state so that a particular concept (e.g., the rumor that Sue told) identifies the rumor that p, but he does not believe that p.

So much for the implementation of the CQ reading. Now, what about the acquaintance reading? I claim that an acquaintance reading is an instance of a CQ reading with a particular cover. In other words, being acquainted with x is to know a particular way of identifying x. Thus, there is no independent 'reading' of acquaintance for *know*, and the explanation for the non-entailment fact in CQ carries over to the intuitive 'reading' of acquaintance.

But, what kind of covers are used in acquaintance readings? If the relevant individual is a person, the cover for acquaintance can be that of appearance, characteristics or social roles. If the relevant individual is a non-animate object (e.g., a building, a city) the cover can be a spatio-temporal location of the object. Also, if the individual is an abstract object like a rumor, I suggest that it is often how the object has come about. I admit that I am somewhat vague here, but the point is that the formalization of the CQ reading described above allows wide range of covers ie. ways of identification, so that it encompasses what have informally been called acquaintance readings.[8]

One *prima facie* problem is the acquaintance reading concerning 'existence'. For example, *She knows Jim* can be true when she knows that Jim *exists* although she might not be able to identify Jim based on any notable characteristics.[9] At first sight, it might seem difficult to find a cover that correctly captures this weak reading. Nevertheless, this reading can be captured if we choose the cover based on the description of the relevant DP itself. For example, in *She knows Jim*, it is the cover based on names, as the following.

(27) N = {the person named 'Jim', the person named 'Bill', the person named 'Sue'... }

[8]Accounting for the cross-linguistic patterns of the lexicalization of the acquaintance version of *know* and the knowledge version of *know* is outside the scope of this paper. But, here I suggest that the lexical difference between the two versions of *know* in languages like German or French can be accounted for when we analyze the acquaintance version as lexicalizing 'know' + $\uparrow$ (probably with certain restrictions on the cover to be used) while the knowledge version as lexicalizing 'know' without $\uparrow$.

[9]For some reason, it appears that verbs like *report* or *tell* allow only this kind of 'existence' acquaintance reading if they have a CQ reading at all. I have to leave why this is the case as an open question.

Based on the cover in (27), the CQ reading of *She knows Jim* is roughly paraphrased as "She correctly believes that the person named 'Jim' is Jim" (where the definite description is read *de dicto* while the name *Jim* rigidly refers to the individual Jim) or 'She can identify Jim based on his name.' I claim that this analysis captures the weak 'existence' reading of *know* and other ResPs.

In sum, the contrast in the entailment patterns between ResPs and ProPs can be explained based on their basic selectional properties, once we adopt the current proposal: ResPs only select for questions while ProPs only select for propositions. When attitude verbs are combined with a content DP, the abstract individual denoted by the content DP has to be type-shifted to fit the type that the verbs want. Assuming that only the type shifters $\uparrow$ (the CQ type-shifter) and $\Uparrow$ (denoting $\mathscr{F}_{\text{cont}}$) can fulfill the need of converting an individual into questions and propositions, respectively, the difference in the entailment falls out straightforwardly. The acquaintance reading of ResPs is accounted for as an instance of CQ readings. Note that the present account does not need to stipulate the difference in the entailment patterns in the lexical semantics of the two types of attitude verbs in a way that is independent from the ability to embed interrogatives. The contrast is accounted for by the interaction between the basic denotations of ResPs/ProPs and the independently motivated type shifting operations that are applied to resolve the type mismatch.

3.3 On exclusively interrogative-embedding verbs

The proposal of the current paper in a general form is the following: if a predicate can embed either a declarative or an interrogative clause, it is semantically (only) question-taking. On the other hand, if a predicate only embeds a declarative clause, it is semantically proposition-taking. Thus, schematically, an attitude verb *R* can have one of the two denotations in the following.

(28) a. $\text{R}_\text{P} = \lambda p{\in}D_{\langle \text{s,t}\rangle}\lambda x.\text{R}{*}_{\text{x},w} \subseteq p$

b. $\text{R}_\text{Q} = \lambda Q{\in}D_{\langle \text{st,t}\rangle}\lambda x.\forall p{\in}Q[C_\text{R}(p) \rightarrow \text{R}{*}_{\text{x},w} \subseteq p]$

where $\text{R}{*}_{\text{x},w}$ is a set of worlds that are compatible with the relevant attitude of the attitude holder x in w and C_R is a lexically-determined restriction on the propositions

A predicate having the denotation in (b) can embed a declarative complement as well as an interrogative complement with the help of *that** in (14).

An immediate question that one would raise against the current proposal is what to do with exclusively interrogative-embedding verbs like *ask* and *wonder* (INQUISITIVE VERBS in Karttunen's (1977) classification). If these verbs have the schematic denotation in (b), we wrongly predict that they can embed a declarative complement just like *know* does, with the help of *that**.

I argue that this problem can be avoided since exclusively interrogative-embedding verbs are characterized by what I will refer to as the NON-TRIVIALITY PRESUPPOSITION, which requires the proposition set in the complement to be non-singleton. The presupposition is stated below.

(29) $[\![\text{wonder/ask/inquire}]\!]^w(Q)(x)$ is defined iff x can believe both of the following:

a. $\lambda w.\exists p{\in}Q[p(w) = 1]$ (In prose, there is a true proposition in Q)

b. $\lambda w.\exists p{\in}Q[p(w) = 0]$ (In prose, there is a false proposition in Q)

Intuitively, Inquisitive verbs presuppose that it is possible that the subject believes the question to be non-trivial, in the sense that one can either correctly or incorrectly answer the question.

I will leave the exact formulation of the interpretation of the modal 'can' in (29) unspecified, but whatever formulation we choose for the possibility modal, clearly (29) cannot be satisfied if Q

is a singleton given that a single proposition cannot be both true and false in a particular world. The net result is that the singleton set of a proposition denoted by a *that**-clause cannot be combined with an Inquisitive verb like *ask* or *wonder*, as it will necessarily result in a presupposition failure.

This non-triviality presupposition can be tested independently of the possibility of embedding a declarative. In the following examples, it is shown that *know* + a singleton *wh*-question can be a coherent utterance while *wonder* + a singleton *wh*-question sounds odd, which can be accounted for as arising from the presupposition failure of the non-triviality presupposition in (29).

(30) (Situation: the speakers are discussing whether each instructor knows/wonders which of their students are linguistics-majors. John has only one student while Sue has ten students, and both know the number of their students.)

a. John knows which student of his is a linguistics-major since he knows that his unique student is a linguistics-major.

b. #John wonders which student of his is a linguistics-major since he wonders whether his unique student is a linguistics-major or not.

c. Sue wonders which student of hers is a linguistics-major since she wonders whether one of her students is a linguistics-major or not.

The *wh*-clause in (a) probably has the implicature that John has multiple students, but the implicature can be canceled by the *since*-clause, which explicitly states that John has a single student. On the other hand, we see that a parallel 'cancellation' of the oddity of the first clause of (b) is impossible. Note that the acceptability of example (c), which forms a minimal pair with (b), shows that wondering whether one student is a linguistics-major can suffice one to wonder which student among multiple students is a linguistics major. Thus, the oddity of (b) really comes from the fact that the question denoted by the *wh*-clause is singleton.

To sum up, exclusively interrogative-embedding verbs, such as *wonder* and *ask*, do not constitute counterexamples to the current proposal. This is because they have a characteristic presupposition requiring the question-denotation of the complement to be 'non-trivial', which explains their impossibility to combine with a singleton question denoted by a *that**-clause.[10]

4 Comparison with alternative approaches

4.1 Ginzburg (1995)

To my knowledge, Ginzburg (1995) is the only compositional semantic account of the contrast in the entailment patterns between ResPs and ProPs given in (2). Ginzburg accounts for the contrast by arguing that ProPs select for a proposition but factive ResPs select for a 'fact', a different object from a proposition in his ontology (originally due to Russell 1918/1919). According to him, a declarative complement of *know* denotes a fact while the question-denotation of an interrogative

[10] A related problem is how to account for the contrast between ResPs and Inquisitive verbs shown in (i).

(i) a. John **knows** the question of who left. $\not\models$ John **knows** who left.

b. John **asked** her the question of who left. $\models$ John **asked** her who left. (cf. Ginzburg 1995).

Accounting for this contrast is one of the biggest open questions of the current paper. I here tentatively assume that Inquisitive verbs lexically encode a function that converts an individual into the question in its content. I leave an explanation of this aspect of the lexical semantics of the Inquisitive verbs for future study.

complement can be turned into a fact that *resolves* the question by the mechanism of semantic coercion. Factive predicates like *know* are combined with a fact resulting from this coercion.

Specifically, assuming that a content DP like *the rumor* denotes a proposition, Ginzburg argues that a sentence of the form *x knows the rumor* only has a CQ (or an acquaintance) reading. On the other hand, a declarative complement of *know* can denote a fact, and be combined with *know*. Hence the entailment does not go through. In contrast, ProPs such as *believe* select for a proposition. Since *the rumor* denotes a proposition which is identical to the denotation of its complement, the entailment from *x believes the rumor that p* to *x believes that p* is straightforward.

He supports his claim about ResPs by the observation that the entailment of the form in (2) does hold when the nominal is factive, such as *fact* or *truth*, as shown below.

(31) John knows the {fact/truth} that Mary left. $\models$ John knows that Mary left.

Factive DPs such as *the fact* or *the truth* denote facts. Therefore, it is predicted that a fact-selecting verb such as *know* can license the entailment when they take a factive DP object, just as in the case where a proposition-selecting verb such as *believe* takes a proposition-denoting DP object.

This analysis by Ginzburg, however, has several problems. First of all, his account of the lack of the entailment applies only to *factive* responsive ResPs, but not to *non-factive* ResPs, such as *report* or *communicate*. Ginzburg argues that non-factive ResPs select for a proposition, and thus predicts that the problematic entailment goes through when they take a content DP like *the rumor*. However, as Lahiri (2002: 290–291) notes, this prediction is not borne out, as shown below.[11]

(32) John {**reported/communicated**} the rumor/hypothesis that Mary left.
$\not\models$ John {**reported/communicated**} that Mary left.

Also, there is a problem of overgeneration due to the coercion mechanisms that he posits. In accounting for the declarative-embedding of factive ResPs, Ginzburg actually assumes a mechanism of coercion that converts a proposition denoted by a declarative clause into a fact that *proves* the proposition, in addition to the coercion from questions to facts. But, once we had this coercion mechanism, it is not clear why it does not apply to content DPs like *the rumor*, and licenses the problematic entailment. That is, if *know* is combined with the result of applying the proposition-to-fact coercion to *the rumor*, *John knows the rumor that p* would mean 'John knows a fact proving the rumor that *p*', which in turn means that John knows that *p*. This is exactly the entailment that we want to prevent from arising, but it is not clear how it is blocked in Ginzburg's system.[12] Ginzburg addresses this problem in his paper (pp.597–598). However, he only suggests that an alternative CQ reading is available in these sentences, but does not discuss why the problematic reading that I sketched above is blocked.[13]

[11] Another non-factive ResP *tell* does not seem to behave exactly in the same way as *report* or *communicate*. See fn. 1. This behavior of *tell* is not a problem for Ginzburg unlike *report*. However, the current account might need to assume that *tell* is ambiguous between a proposition-taking and a question-taking version to account for it.

[12] A similar problem arises in example (i).

(i) John **knows** the question of who left. $\not\models$ John **knows** who left.

Given that the DP *the question...* denotes a question just as an interrogative complement does, as Ginzburg assumes, the coercion from a question to a fact resolving the question should license the entailment, contrary to the data. It follows from 'John knows a fact that resolves the question of who left' that 'John knows who left'.

[13] On the other hand, in the proposed system, it is impossible to apply *that**-operator to the result of first applying $\mathscr{F}_{\text{cont}}$ to the denotation of a content DP. This is because *that** is not a syntactically null operator that can be freely

Furthermore, other things being equal, a general process of coercion from questions to facts predicts that a verb must be able to embed a question if a verb can embed a fact (ie. it is factive). However, there are counterexamples to this prediction: verbs such as *regret* and *resent* are factive, but they do not embed an interrogative, as the following example shows.

(33) John regrets {that he cannot accept the invitation/*who can accept the invitation}.

Ginzburg needs independent stipulations to account for the behavior of these verbs.

Lastly, the data that the entailment goes through for ResPs when the nominal is factive does not favor Ginzburg's analysis over my analysis. This is because the data can be straightforwardly captured in the current analysis as a result of the CQ reading with *de dicto* interpretation of the description *the fact*, given that factive nominals predicate of the complement as true, as follows.

(34) $[\![\text{fact}]\!]^w = \lambda x \in D.\mathscr{F}_{\text{cont}}(x)(w) = 1$

Below, I sketch the derivation of the entailment in (31) in an informal fashion. See the appendix for the proof of the entailment in a more formal setting. In my account, the left hand side of (31), *John knows the fact that Mary left*, has the CQ reading 'John knows which object is identical to the fact that Mary left', where each proposition in the CQ presupposes that Mary left due to the entailment of the nominal *fact* and the presupposition triggered by the definite article. Since John correctly believes this proposition, he believes that Mary left, and by the factivity of 'know', it is true that Mary left. Hence, John knows that Mary left.

Thus, I argue that the current proposal has advantages over Ginzburg's (1995) account. Furthermore, it is worthwhile to note that the current proposal succeeds in capturing the data in an ontology that is more conservative than Ginzburg's, who assumes quite a rich ontology including 'facts' and 'questions' as primitives distinct from 'propositions'.

4.2 Question-to-proposition reduction theories

In this section, I compare the current analysis with a more standard approach to ResPs where their question-taking meanings are reduced to their proposition-taking meanings. (Karttunen 1977; Groenendijk and Stokhof 1984; Lahiri 2002, among others) An interesting property of the current proposition-to-question reduction analysis is that it involves the opposite reduction from the standard approach. In the standard approach, the proposition-embedding meaning of a ResP is basic, from which question-embedding is derived in some way or other. On the other hand, in the current analysis, the proposition-embedding meaning of a ResP is basic, from which the embedding of declaratives is derived.

The two analyses differ in the variety of embedding possibilities they allow for a single predicate. Specifically, as stated in Section 3.3, the current theory predicts that there would be no verb that exclusively embeds an interrogative. On the other hand, the standard question-to-proposition reduction theory predicts that there would be no exclusively proposition-taking predicate unless further stipulations. This is because, for any proposition-taking denotation, there must in principle be a corresponding question-taking denotation if the reduction from question-embedding to proposition-embedding is general. Take, for example, Groenendijk & Stokhof's (1984) theory. In their analysis, the extension of an interrogative clause is a proposition, and thus it can be combined with *know*,

applied in the LF, but really is a declarative complementizer encoding a specific operation, which is syntactically unavailable in a DP.

which selects for a proposition. However, unless there is an additional stipulation, it is predicted that *believe* can embed an interrogative clause in the same way.

At first glance, both of these predictions seem to be problematic, as can be seen in the actual embedding patterns of attitude predicates summarized below.

(35)

	embed declaratives	not embed declaratives
embed interrogatives	*know, be certain, tell* etc.	*ask*, *wonder* etc.
not embed interrogatives	*believe*, *think* etc.	—

The exclusively interrogative-embedding verbs such as *ask* and *wonder* are *prima facie* problematic for the current analysis, and so are the exclusively declarative-embedding verbs such as *believe* and *think* for the standard question-to-proposition reduction analysis. However, as argued in Section 3.3, there is an independent semantic explanation for why verbs such as *ask* or *wonder* cannot embed a declarative: they presuppose that the proposition-set they combine with is non-singleton.

On the other hand, it is difficult to account for the existence of exclusively declarative-embedding verbs on independent semantic grounds. That is, the set of verbs that exclusively embed a declarative does not seem to be characterized by any independent lexical semantic property. One argument comes from the lexical semantic similarity between *believe* and *be certain*. Assuming that there is no independently testable lexical semantic difference between *believe* and *be certain*, it is hard to explain from their meanings why *believe* does not embed an interrogative complement while *be certain* does. Note, however, that the existence of exclusively declarative-embedding predicates (and the fact that they cannot be independently characterized) is not problematic for the proposed analysis. This is because the proposed constraint on the lexical denotation allows an attitude verb to have a proposition-taking denotation, and there is no general operation by which a question-taking denotation is created out of this proposition-taking denotation.

Hence, the prediction of the current proposal is borne out, but that of the standard analysis is not. Exclusively question-taking verbs form a semantically natural class in having the non-triviality presupposition, so that their behavior can be explained away within the proposed theory. On the other hand, exclusively proposition-taking verbs are difficult to characterize semantically, and thus they require extra stipulations in the question-to-proposition reduction theories.[14]

5 Conclusions

In this paper, I have argued that Responsive Predicates (ResPs) only take a set of propositions as a semantic argument, based on the contrast between ResPs and Exclusively Proposition-taking Predicates (ProPs) in the entailment patterns involving a content DP. When a ResP embeds a declarative complement, the complementizer turns the proposition denoted by the complement into a trivialized question, giving rise to correct truth conditions.

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. The account has empirical and conceptual advantage over Ginzburg's (1995) existing analysis. Also, the proposed reduction from declarative-embedding to interrogative-embedding captures the fact that Exclusively Interrogative-embedding predicates, such as *ask* or *wonder*, form a semantically natural class. On the other hand, the proposal avoids the problematic prediction of the standard

[14] See George (2011) for other problems with the question-to-proposition reduction theories.

reduction from interrogative-embedding to declarative-embedding, ie. the prediction that any declarative-embedding verb should be able to embed an interrogative unless further stipulations.

Appendix: A proof of the entailment with *fact*

We assume the following denotation for *the fact that p*

(36) $[\![\text{the fact that } p]\!]^{w,C} = \iota x[\mathscr{F}_{\text{cont}}(x)(w) = 1 \wedge \mathscr{F}_{\text{cont}}(x) = p$

By the definition of $\uparrow$, $[\![\text{John knows} \uparrow \text{the fact that } p]\!]^{w,C} = 1$ iff John correctly believes (37) in w.

(37) $\lambda w'.\forall c \in \mathscr{R}_C[c(w) = \iota x[\mathscr{F}_{\text{cont}}(x)(w) = 1 \wedge \mathscr{F}_{\text{cont}}(x) = p] \Leftrightarrow c(w') = \iota x[\mathscr{F}_{\text{cont}}(x)(w') = 1 \wedge \mathscr{F}_{\text{cont}}(x) = p]]$

By the presupposition of ι, (37) is defined only for worlds w' such that there is a (unique) object x with $\mathscr{F}_{\text{cont}}(x)(w') = 1 \wedge \mathscr{F}_{\text{cont}}(x) = p$. This is true only if $p(w') = 1$. Since John believes this proposition in w, for all doxastic alternatives w' of John's, $p(w') = 1$. Therefore, he believes that p in w. Similarly, by the other instance of ι, (37) is defined only if w is such that there is a (unique) object x with $\mathscr{F}_{\text{cont}}(x)(w) = 1 \wedge \mathscr{F}_{\text{cont}}(x) = p$, which in turn entails that $p(w) = 1$. Therefore, it is true that p in w. Hence John believes that p and p is true in w. It follows that John knows that p in w. □

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