Towards a uniform account of responsive verbs

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Responsive verbs like *know* can embed both declarative or interrogative complements. Standard accounts of such verbs (Karttunen, 1977; Groenendijk and Stokhof, 1984; Lahiri, 2002; Spector and Egré, 2015) are reductive: they assume that whether an individual x stands in a knowledge-*wh* relation to some question is completely determined by whether x stands in a knowledge-*that* relation to some answer to the question. George (2013) observed that x's knowledge-*wh*, however, not only depends on her knowledge-*that*, but also on her possibly false beliefs—a fact that reductive accounts cannot capture.

In this talk, we will develop an account of responsive verbs that is not reductive, but *uniform*, in the sense that it assumes a single entry for the interrogative-embedding and the declarative-embedding uses of a verb. The key insight that will allow us to account for the belief-dependency of knowledge-*wh* is that extensional responsive verbs are sensitive to both true *and* false answers to the embedded question. Formally, this will be captured through a novel, fine-grained way of representing the meaning of a clausal complement in terms of so-called *truthful resolutions*. The resulting analysis will give us a unifying perspective, under which false-answer sensitivity comes out as a common characteristic of *all* levels of exhaustive strength.

Responsive verbs are verbs like *know* and *remember* that can take either a declarative or an interrogative complement. Our general aim is to develop an account of such verbs that is *uniform* in the sense that it assumes a single entry for each verb, which works independently of whether the complement is declarative or interrogative. Our more specific aim in this paper is to articulate a concrete argument that such an account is to be prefered over the standard *reductive* approach, building on an observation by George (2013).

The reductive approach

Standard accounts of responsive verbs (e.g., Karttunen, 1977; Groenendijk and Stokhof, 1984; Lahiri, 2002; Spector and Egré, 2015) are *reductive* in nature in that they assume that the meaning of sentences of the form XVQ, where X is a subject, V a responsive verb, and Q an interrogative complement, is completely determined by the meaning of sentences of the form XVP, where P is an answer to Q. This means in particular that, if X and Y are two subjects such that for every answer P to Q, X *knows* P if and only if Y *knows* P, then X *knows* Q should hold just in case Y *knows* Q.

George's challenge

Consider the following scenario. Italian newspapers are only sold at Newstopia. Janna knows that Italian newspapers are sold at Newstopia, and does not have beliefs concerning the availability of Italian newspapers elsewhere. Rupert knows that Italian newspapers are sold at Newstopia, but he also falsely believes they are sold at Paperworld. So, of all the possible answers P to the mention-some question where one can buy an Italian newspaper (at Newstopia, at Paperworld, etc.), *Janna knows* P iff *Rupert knows* P. However, George observes that (1) below is true in the given scenario, while (2) is false.

(1) Janna knows where one can buy an Italian newspaper. $\Rightarrow$ **true**

(2) Rupert knows where one can buy an Italian newspaper. $\Rightarrow$ **false**

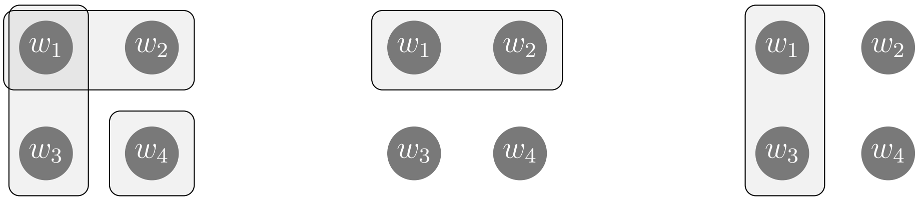
He argues that therefore X *knows* Q cannot be reduced to constructions of the form X *knows* P, because besides what X actually knows, it also possibly matters what X **falsely believes**.

Below we will sketch a uniform account of responsive verbs, fleshed out in much more detail in the paper, which overcomes this challenge for the reductive approach.

Proposal

Following Hamblin (1973), we assume that both declarative and interrogative matrix clauses express sets of propositions. In our framework, this means they are of type $\langle\langle s,t\rangle,t\rangle$, which we abbreviate as T. The meanings of the interrogative and declarative clauses relevant in George's scenario are depicted below (where w_1 and w_2 are worlds where one can buy an Italian newspaper at Newstopia, and w_1 and w_3 ones where one can buy an Italian newspaper at Paperworld; w_2 is the actual world). The meaning of the interrogative *where can one buy an Italian newspaper* in the leftmost diagram is the set of its possible answers: the propositions that one can buy an Italian newspaper at Newstopia, that one can buy an Italian newspaper at Paperworld, and that one can buy an Italian newspaper at none of these places.

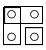
Where can one buy an Italian newspaper? | One can buy an Italian newspaper at Newstopia. | One can buy an Italian newspaper at Paperworld.



Following Heim (1994) and others we assume that embedded clauses involve an operator, denoted here as E, which takes the embedded clause as its input and feeds its output to the verb. Crucially, however, our account diverges from previous approaches in two respects: (i) E applies uniformly to declarative and interrogative clauses ψ of type T; and (ii) E yields a function of type $\langle s, T\rangle$ that maps every world w to the set of **consistent** propositions that **entail** at least one element of $[\psi]$ that is **true** in w, and do **not entail** any element of $[\psi]$ that is **false** in w. We call the propositions in $E(\psi)(w)$ **truthful resolutions** of ψ in w. Formally:

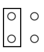
(3) $$E := \lambda S_T.\lambda w.\lambda p. \left(\begin{array}{l} p \neq \emptyset \wedge \\ \exists q \in S.(q(w) \wedge p \subseteq q) \wedge \\ \neg\exists q \in S.(\neg q(w) \wedge p \subseteq q) \end{array} \right)$$

If ψ is an interrogative, $E(\psi)(w)$ amounts to the set of consistent propositions that entail at least one true answer and do not entail any false answer, e.g.:

(4) E(where can one buy an Italian newspaper)(w_2)
$= E($  $)(w_2) = \{$  ,  $\}$

If ψ is a declarative that is true in w, $E(\psi)(w)$ amounts to the set of consistent propositions that entail ψ. If ψ is a declarative that is false in w, $E(\psi)(w)$ is empty.

(5) E(one can buy an Italian newspaper at Newstopia)(w_2)
$= E($  $)(w_2) = \{$  ,  ,  $\}$

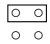
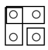
(6) E(one can buy an Italian newspaper at Paperworld)(w_2)
$= E($  $)(w_2) = \emptyset$

Now we turn to the semantics for *know*. For every individual x and every world w, let σ_x^w denote the information state of x in w, i.e., the set of worlds compatible with what x takes herself to know in w. Then we define:

(7) $[\![\text{know}]\!] := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\forall w \in p : \sigma_x^w \in f(w)$

In words, *know* takes the denotation of the complement, which is a function f from worlds to sets of propositions, and an individual x; and it yields the set of propositions p such that for every $w \in p$, the information state of x in w is an element of $f(w)$. In other words, the information state of x in w has to **exactly match** a truthful resolution of the complement in w. By virtue of this 'exact match' semantics, we capture that x should have **enough** information, but **not too much**. This is crucial to distinguish between Janna and Rupert in George's scenario: they both have enough information, but Rupert has too much.

Predictions

Assume that, as in George's scenario, $\sigma^{w_2}_{\text{Janna}} =$  and $\sigma^{w_2}_{\text{Rupert}} =$ . Then (1) is correctly predicted to be true in w_2 because Janna's information state coincides with a truthful resolution to the embedded clause in w_2, i.e., $\sigma^{w_2}_{\text{Janna}} \in E($  $)(w_2) = \{$  ,  $\}$. In contrast, (2) is correctly predicted to be false in w_2 because Rupert's information state does not coincide with a truthful resolution of the embedded clause in w_2, i.e., $\sigma^{w_2}_{\text{Rupert}} \notin E($  $)(w_2) = \{$  ,  $\}$. As for declarative complements, it is predicted that in w_2 both Janna and Rupert know that one can buy an Italian newspaper at Newstopia, since their respective information states in w_2 both match a truthful resolution in w_2, i.e., $\sigma^{w_2}_{\text{Rupert/Janna}} \in E($  $)(w_2) = \{$  ,  ,  $\}$.

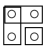
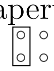
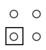
Extending the proposal to intensional responsive verbs

Interestingly, intensional verbs like *be certain* differ from extensional verbs like *know* in that they do not exhibit the 'false-answer sensitivity' that George observed. For example, (8) is true in George's scenario although Rupert believes a false answer.

(8) Rupert is certain where one can buy an Italian newspaper. $\Rightarrow$ **true**

Our account of intensional verbs like *be certain* allows for a world shift: it doesn't require that c^w_x, the set of worlds that are compatible with what x is certain about in w, matches a truthful resolution in w, i.e., an element of $f(w)$, but also allows for a match with a truthful resolution in some other world v, i.e., with an element of $f(v)$:

(9) $[\![\text{be certain}]\!] := \lambda f_{\langle s,T\rangle}.\lambda x.\lambda p.\exists \boldsymbol{v}.\forall w \in p : c^w_x \in f(\boldsymbol{v})$

It follows from this treatment that intensional verbs don't exhibit false-answer sensitivity. In our example, what Rupert is certain about in w_2, i.e., that Italian newspapers are sold at Newstopia and Paperworld, is a truthful resolution in w_1, i.e., $c^{w_2}_{\text{Rupert}} =$  $\in E($  $)(w_1) = \{$  ,  ,  ,  ,  $\}$. So, (8) comes out true.

Conclusion

The uniform account sketched here overcomes George's challenge for the standard reductive approach. The full account presented in the paper is implemented in a compositional inquisitive semantics (Theiler, 2014; Ciardelli and Roelofsen, 2015). The E operator is parametrized, which allows us to derive not only mention-some readings, as demonstrated here, but also intermediate exhaustive readings (Spector, 2005; Klinedinst and Rothschild, 2011) and strongly exhaustive readings (Groenendijk and Stokhof, 1984). It is shown that the false-answer sensitivity involved in all these readings can be given a unified account. The lexical entries given here are refined to derive factivity presuppositions for factive verbs with declarative complements. And finally, the account is extended to non-responsive interrogative-embedding verbs like *wonder*.

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