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The *whether Puzzle

Floris Roelofsen, Michele Herbstritt and Maria Aloni

1 Introduction*

The first issue that Karttunen (1977) considers in his seminal article on embedded questions is whether all such questions should be taken to belong to the same syntactic category. In particular, should *wh*-questions, which begin with an interrogative noun phrase or adverb like *what*, *which girl*, *why*, or *how*, be treated as belonging to the same syntactic category as *whether*-questions, which are prefixed with *whether* or *if*? Karttunen (p. 5) writes:

These two types of questions have virtually the same syntactic distribution. Nearly all verbs which take *wh*-questions as complements also take *whether*-questions. A verb which doesn't allow embedded *wh*-questions in general doesn't complement with *whether*-questions either. This is illustrated in (1) and (2).

- (1) a. John knows what they serve for breakfast.
 b. John knows whether they serve breakfast.
- (2) a. *John assumes what they serve for breakfast.
 b. *John assumes whether they serve breakfast.

There are two classes of exceptions to this generalization, both of which seem marginal to me. So-called 'emotive factives', such as *amaze*, *surprise*, and *bother* take *wh*-questions but do not allow *whether*-questions. Dubitative verbs, such as *doubt*, *question*, and *be dubious*, have the opposite characteristic. This is shown in (3) and (4).

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- (3) a. It is amazing what they serve for breakfast.
 b. *It is amazing whether they serve breakfast.
- (4) a. *I doubt what they serve for breakfast.
 b. I doubt whether they serve breakfast.

The ungrammaticality of (3b) and the grammaticality of (4b) pose problems for me and require some special treatment. Nevertheless, it seems correct to assume, in the light of the great majority of cases of overlapping distribution, that *wh*-questions and *whether*-questions should be assigned to the same syntactic category.

In much subsequent work on questions, Karttunen's conclusion has been taken to heart. However, if *wh*-questions and *whether*-questions are indeed taken to be of the same syntactic category, a semantic or pragmatic explanation is needed for the contrasts in (3) and (4). Our main focus will be on the first type of contrast, i.e., on emotive factive verbs like *amaze*, *surprise*, *bother*, *disappoint*, *be happy*, etcetera, which can take *wh*-questions as their complement but not *whether*-questions. We will refer to this phenomenon as the **whether* puzzle.¹ Several accounts of the puzzle have been suggested; some semantic in nature (d'Avis, 2002; Abels, 2004; Nicolae, 2013; Romero, 2015), others pragmatic (Guerzoni, 2007; Sæbø, 2007). We will argue, however, that each of these proposals still has certain shortcomings.

In particular, as already noted by Egré (2008), one of the assumptions that is crucial for the pragmatic approaches, namely the assumption that emotive factives involve so-called *speaker factivity* (Guerzoni & Sharvit, 2007), faces systematic counterexamples. Furthermore, we will show that these approaches do not account for examples that are slightly more complex than the ones above, e.g., ones like (5) where the subject is quantificational rather than a referential expression.

- (5) *Every guest was amazed whether he got breakfast.

¹ A semantic explanation of the second type of contrast, involving verbs like *doubt*, has been suggested in Pruitt & Roelofsen (2011); Farkas & Roelofsen (2012); Biezma & Rawlins (2012). However, as soon as we look beyond English such a semantic explanation becomes highly problematic, since the cross-linguistic behavior of verbs like *doubt* is far from stable. For instance, as pointed out to us by Henk Zeevat, Dutch *betwijfelen* is much better with *whether*-complements than with *that*- or *wh*-complements (although the latter are occasionally attested in corpora as well). On the other hand, Italian *dubitare* only licenses *that*-complements, no *whether*- or *wh*-complements.

On the other hand, while the semantic approach suggested by d'Avis (2002) and further developed by Abels (2004) accounts for the fact that emotive factives do not take plain polar *whether*-questions as their complement, it does not account for the fact that such verbs do not take *alternative questions* as their complement either, as illustrated in (6).

(6) *It is amazing whether they serve eggs for breakfast, or cereals.

Finally, the semantic accounts of Nicolae (2013) and Romero (2015) predict that emotive factives are not only incompatible with *whether*-complements, but also with *wh*-complements receiving a strongly exhaustive interpretation. It has been assumed by several authors (e.g., Guerzoni & Sharvit, 2007) that a strongly exhaustive reading is indeed not available for *wh*-complements under emotive factives, but Cremers & Chemla (2016) show experimentally that it *is* available. This is unexpected on Nicolae's and Romero's explanations of the **whether* puzzle.

We will offer an account of the puzzle that explains the unacceptability of plain polar questions and alternative questions, including cases with quantificational subjects, which does not need to assume speaker factivity, and which does not rule out *wh*-complements with a strongly exhaustive reading under emotive factives.

We proceed as follows. Section 2 provides a more detailed discussion of previous work, Section 3 presents our own account, and Section 4 offers some concluding remarks.

2 Previous Work

We start with a discussion of the pragmatic approaches of Guerzoni (2007) and Sæbø (2007) in Section 2.1, then turn to the semantic approach of d'Avis (2002) and Abels (2004) in Section 2.2, and finally consider the semantic accounts of Nicolae (2013) and Romero (2015) in Section 2.3.

2.1 Pragmatic Approaches

Guerzoni (2007) and Sæbø (2007) both try to explain why emotive factives cannot embed *whether*-complements on the basis of Gricean maxims governing cooperative conversational behavior.² Both accounts crucially rely on the

² Guerzoni (2007) claims that *whether*-complements are not only incompatible with emotive

assumption that emotive factives are, in Guerzoni & Sharvit's (2007) terminology, *speaker factive*: whenever they embed a question *Q*, the resulting sentence presupposes that the speaker knows the true answer to *Q*. For example, in order for the sentences in (7) (adapted from Guerzoni, 2007) to be felicitous, it seems that the speaker needs to know who passed the exam.

- (7) a. It will surprise Bill who passed the exam.
 b. It won't surprise Bill who passed the exam.

Let us see how this assumption leads to the prediction that emotive factives do not accept whether-complements on Guerzoni's account – Sæbø's account is similar in nature and also prone to the objections that we will raise below. Consider a case where surprise takes a whether-complement.

- (8) *It surprised John whether Bob called.

The semantic entry for *surprise* given by Guerzoni ensures that (8) is asymmetrically entailed by both (9) and (10).

- (9) It surprised John that Bob called.
 (10) It surprised John that Bob didn't call.

Thus, by standard pragmatic reasoning, an utterance of (8) would generate the implicature that the speaker is not in a position to utter (9) or (10), i.e., that she is not certain as to whether John was surprised that Bob called or surprised that

factives like *amaze* and *surprise*, but also with 'epistemic factives' like *realize* and *anticipate*. She provides the following example:

- (i) *Mary realized whether Bill called.

However, as pointed out to us by Donka Farkas, many examples can be found in corpora and on the web where verbs like *realize* and *anticipate* do license whether-complements. For instance:

- (ii) It's important to realize whether you are actually missing the person or just the memories.
 (iii) At what point do you realize whether a book is good enough to keep reading?
 (iv) You have to try to anticipate whether the figures will be large or small.
 (v) Is it possible to anticipate whether a wastewater disposal activity will trigger earthquakes?

We will focus here on emotive factives, which are categorically incompatible with whether-complements, leaving an investigation of the precise conditions under which verbs like *realize* and *anticipate* license whether-complements for another occasion.

Bob did not call. The quantity implicature can be expressed as follows (where B_x stands for *the speaker believes that ...*, S_j stands for *John is surprised that ...*, and C_b stands for Bob called).

$$(11) \neg B_x(S_j C_b) \wedge \neg B_x(S_j \neg C_b)$$

Moreover, given Guerzoni's semantic entry for surprise, the Gricean Quality maxim requires that if someone were to utter (8) she must believe that John was either surprised that Bob called or surprised that Bob did not call:

$$(12) B_x(S_j C_b \vee S_j \neg C_b)$$

Finally, by speaker factivity, (8) presupposes that the speaker knows the answer to the embedded question, hence she is certain as to whether Bob actually called or not:

$$(13) B_x C_b \vee B_x \neg C_b$$

Now, (12) and (13) together with the factivity of *surprise* entail (14).

$$(14) B_x(S_j C_b) \vee B_x(S_j \neg C_b)$$

But (14) contradicts the quantity implicature in (11). Under the assumption that the quantity implicature cannot be suspended it follows that (8) inevitably results in a contradiction, hence the sentence is not felicitous.³

This account has at least two shortcomings, which also apply to that of Sæbø (2007). First, as already noted by Egré (2008, p. 12), it seems difficult to defend that verbs like surprise indeed generally involve speaker factivity. Egré provides the following counterexample.

(15) I met John this morning. He was very surprised by who had failed the exam in his class. I did not dare ask him which students had failed, but he seemed to be really disappointed.

The qualification "I did not dare ask which students had failed" clearly conveys that the speaker does not know who failed the exam. Wataru Uegaki (p.c.) independently provided a similar example:

³ A similar argument can be constructed if the embedded question is an alternative question.

(16) I don't know who called, but it surprised John: I could see it in his face.

A second problem is that the approach does not apply, at least not without further stipulations, to somewhat more complex constructions, like cases where the verb has a quantificational subject binding a pronoun in the whether-complement.

(17) *Every boy was surprised whether his mother called.

The reasoning followed above is based on a comparison of the given sentence to pragmatic alternatives. What are the pragmatic alternatives of (17)? Perhaps the following:

(18) Every boy was surprised that his mother called.

(19) Every boy was surprised that his mother did not call.

But certainly these pragmatic alternatives would not lead us to the desired conclusion, and it is difficult to see which other possible pragmatic alternatives would.

2.2 *First Semantic Approach: Abels and d'Avis*

A purely semantic account of the whether puzzle has been developed by Abels (2004), building on a more informal proposal by d'Avis (2002). The account has two components:

1. a non-standard semantic treatment of polar questions, and
2. a specific treatment of the verb surprise.

Following Hamblin (1973), Abels assumes that questions express sets of propositions. More specifically (and here Abels departs from Hamblin), he assumes that the meaning of a *polar* question $?p$ is a singleton set containing the proposition expressed by p (Hamblin would also include the complement of this proposition).

$$(20) \llbracket ?p \rrbracket = \{ \llbracket p \rrbracket \}$$

Furthermore, following Heim (1994), Abels defines the *weakly exhaustive answer* to a question Q in a world w as the intersection of the propositions in $\llbracket Q \rrbracket$ that are true in w :

$$(21) \text{ans}_w(Q) = \bigcap \{ \alpha \in \llbracket Q \rrbracket \mid w \in \alpha \}$$

One consequence of this definition is that in a world where none of the propositions in $\llbracket Q \rrbracket$ are true, the weakly exhaustive answer to the question is the *trivial* proposition, i.e., the set of all worlds, denoted as W .⁴ This is particularly relevant for polar questions. Namely, in a world where p is true, the weakly exhaustive answer to $?p$ is just $\llbracket p \rrbracket$, but in a world where p is false, no proposition in $\llbracket ?p \rrbracket$ holds, so the weakly exhaustive answer is W .

As for the semantics of surprise, Abels' essential assumptions can be summarized as follows.⁵ Consider a sentence of the form x is surprised by Q , where x is an individual and Q a question. For any world w , let $B_{x,w}$ stand for the set of worlds that are compatible with what x believes in w , and let $E_{x,w}$ stand for the set of worlds that are compatible with x 's expectations in w . Then, what is required for x is surprised by Q to be true in w is the following. First, x should believe the weakly exhaustive answer to Q in w :

$$(22) B_{x,w} \subseteq \text{ans}_w(Q)$$

Second, this answer should be incompatible with x 's expectations:

$$(23) E_{x,w} \cap \text{ans}_w(Q) = \emptyset$$

And third, in every world that is compatible with x 's expectations in w , the weakly exhaustive answer to Q must be non-trivial:

$$(24) \text{For all } w' \in E_{x,w}: \text{ans}_{w'}(Q) \neq W$$

Now, if Q is a polar question $?p$, then these three conditions can only be simultaneously satisfied if $E_{x,w}$ is empty, i.e., if x 's expectations in w are inconsistent. To see this, first suppose that p is true in w . Then $\text{ans}_w(?p) = \llbracket p \rrbracket$. We must have that $E_{x,w} \cap \text{ans}_w(?p) = \emptyset$. So $E_{x,w}$ can only contain worlds that are not in $\llbracket p \rrbracket$, i.e., worlds where p is false. But we must also have that for all $w' \in E_{x,w}$: $\text{ans}_{w'}(?p) \neq W$. This means that $E_{x,w}$ can only contain worlds where p is true. But if all worlds in $E_{x,w}$ must be ones where p is both true and false, then $E_{x,w}$ has to be empty.

4 This follows from the definition of the generalized intersection operator. Namely, for any set of propositions S , we have that $\bigcap S = \{w \in W \mid w \in \alpha \text{ for all } \alpha \in S\}$. Thus, if S is empty, then $\bigcap S = W$.

5 Abels' actual semantic treatment of surprise is a bit more involved, but we believe that this is not essential for his account of the *whether puzzle.

Now suppose that p is false in w . Then we have that $\text{ans}_w(?p) = W$. But it is required that $E_{x,w} \cap \text{ans}_w(?p) = \emptyset$. This immediately implies, again, that $E_{x,w}$ has to be empty. This explains the infelicity, on Abels' account, of sentences where surprise takes a polar question as its complement.

While this proposal avoids the problematic assumption of speaker factivity, and applies straightforwardly to quantified cases like (17) above, it has a number of shortcomings as well. First, it relies on a non-standard notion of weakly exhaustive answers, which seems difficult to justify independently. Certainly, this notion does not correspond to our intuitions about answerhood or resolution conditions of polar questions, according to which the most basic true resolving answer to $?p$ in a world where p is false is $\neg p$; to be sure, a tautology would not qualify as a resolving answer in this case.

Even if we were to accept Abels' assumption that the meaning of a plain polar question like (25) below consists of just one proposition – in this example, the set of all worlds where the door is open – we would certainly not want to endorse this assumption for a question like (26), which is equivalent to (25) in terms of resolution conditions but where both alternatives are made explicit.

(25) Is the door open?

(26) Is the door open or closed?

We have to assume that the meaning of (26) consists of two propositions – the set of all worlds where the door is open, and the set of all worlds where the door is closed. There are no grounds for giving one of these two propositions a different status than the other. But this means that (26), unlike (25), is predicted by Abels' account to be licensed under verbs like surprise, contrary to fact.

(27) *Bill was surprised whether the door was open or closed.

Indeed, more generally, Abels' proposal does not account for the infelicity of *alternative questions* under verbs like surprise.

(28) *Bill was surprised whether they served eggs for breakfast, or cereals.

Under the assumption that the meaning of an alternative question contains two disjoint propositions, the three requirements that surprise induces can be satisfied without $E_{x,w}$ having to be inconsistent.

A final problem is that the account is specifically targeted at the verb *surprise*. It is not clear how it could be extended to other emotive factives like *bother* and *be happy*.

2.3 *Other Semantic Approaches: Nicolae and Romero*

Nicolae (2013) and Romero (2015) propose two other semantic accounts of the *whether puzzle. For concreteness we focus here on Nicolae's account, but the problem we raise applies to Romero's as well.⁶ Nicolae (2013, p. 151) assumes that:

Predicates like *surprise*, when they embed a question, carry a presupposition of mutual compatibility. That is, they require that the set of propositions they embed be mutually consistent.

This assumption indeed leads to the prediction that *surprise* does not embed polar and alternative questions. However, it is problematic for cases like (29), which involves a *wh*-complement inducing mutually inconsistent alternatives, no matter whether it receives a weakly or strongly exhaustive interpretation.

(29) It is surprising who won the world cup this year.

The assumption is also problematic for cases like (30), under the assumption that *wh*-questions whose weakly and strongly exhaustive readings come apart, allow for a strongly exhaustive reading when embedded under *surprise*.

(30) It is surprising which students passed the exam.

It is a controversial matter whether *wh*-questions embedded under *surprise* and other emotive factives allow for a strongly exhaustive reading. Nicolae (2013) and Romero (2015) assume that they don't, following earlier claims by Berman (1991), Heim (1994) and Guerzoni & Sharvit (2007). However, these claims have been countered by Klinedinst & Rothschild (2011) and Theiler (2014), and recent experimental results of Cremers & Chemla (2016) show that *wh*-questions embedded under *surprise* indeed admit strongly exhaustive readings.

⁶ An additional problem for Romero's account, not shared by Nicolae's, is that it only applies to alternative questions. As noted by Romero herself, extending it to polar questions would require additional stipulations.

This finding, as well as the grammaticality of sentences like (29), show that a successful account of the *whether puzzle should not place a general ban on mutually consistent propositions in the complement of emotive factives.

3 Proposal

In order to get a handle on the puzzle, we first need to understand what the crucial difference is between *wh*-questions and *whether*-questions, and second, what the relevant difference is between emotive factives and other question embedding verbs. We will consider these two issues in turn.

3.1 *The Difference between Wh-questions and Whether-Questions*

A first important observation is that it is impossible to account for the contrast between *wh*-questions and *whether*-questions just in terms of their answerhood/resolution conditions. To see this, consider the following examples (see Romero, 2015, for a different example making the same fundamental point).

- (31) *Context: Ann and Chris have placed an order online. They are kept up to date about the status of the order, which is first 'in progress' and then at some point turns into 'sent'. Ann looks at her email and then tells Chris:*
- a. It is surprising what the status of the order is.
 - b. *It is surprising whether the order is still in progress.

The two embedded questions in these examples have exactly the same resolution conditions: if a certain piece of information resolves one of them, then it resolves the other as well. And yet, the *wh*-question in (31a) is licensed while the *whether*-questions in (31b) is not. So to account for the **whether* puzzle, we have to look beyond resolution conditions. What is it, then, that distinguishes *whether*-questions from *wh*-questions?

Our answer is based on a contrast that is parallel to the one in (31), though this time the two questions feature as *matrix* questions, rather than embedded under surprise, and the contrast between them concerns their ability to license yes/no responses.

- (32) *Context: Ann and Chris have placed an order online. They are kept up to date about the status of the order, which is first 'in progress' and then at some point turns into 'sent'. Ann hasn't looked at her email for a while so she asks Chris about the status of the order.*

- a. Ann: Is the order still in progress?
Chris: Yes, it is. / No, it isn't.
- b. Ann: What is the status of the order?
Chris: *Yes, it is. / *No, it isn't.

The two questions in (32) are the same as those in (31). This means in particular that they still have exactly the same resolution conditions. Thus, in order to explain the difference that exists between them when it comes to licensing yes/no responses, we again have to look beyond resolution conditions. In this case, however, it is quite clear in which direction we should look. Namely, it is natural to think of yes and no as anaphoric expressions, and we know that such expressions are only interpretable in the presence of a suitable antecedent. Plausibly, then, what explains the contrast between the whether-question in (32a) and the wh-question in (32b) is that the former provides a suitable antecedent for yes and no, while the latter doesn't. This is indeed in line with recent accounts of yes and no (e.g., Krifka, 2013; Roelofsen & Farkas, 2015).

The hypothesis that we will pursue is that the difference between whether-questions and wh-questions that is responsible for the contrast in (32) is also responsible for the contrast in (31). We assume that this difference, in general terms, concerns the semantic objects that the two types of questions bring into *salience* – or, in the terminology of Roelofsen & Farkas (2015), the semantic objects that they *highlight*. On the one hand, it is natural to assume that these objects are precisely the ones that become available as potential antecedents for subsequent anaphoric expressions, and that the contrast in (32) can thus be accounted for by assuming that the interpretation of yes and no is sensitive to the semantic objects highlighted by the preceding sentence. On the other hand, we will argue that the *whether puzzle can be accounted for by assuming that emotive factive verbs like surprise are sensitive to the semantic objects highlighted by their complement.

To make this concrete, let us consider the sentences in (33) and see which semantic objects they may plausibly be taken to highlight.

- (33) a. They serve breakfast.
b. Do they serve breakfast?
c. Do they serve eggs for breakfast, or cereals?
d. What do they serve for breakfast?

First, following Krifka (2013) and Roelofsen & Farkas (2015), we assume that both the declarative in (33a) and the polar question in (33b) highlight the

proposition ‘that they serve breakfast’. Indeed, this proposition can be referred to by yes and no:

- (34) They serve breakfast. / Do they serve breakfast?
 a. Yes. \rightsquigarrow they serve breakfast
 b. No. \rightsquigarrow they don’t serve breakfast

Similarly, we assume that the alternative question in (33c) highlights two propositions: ‘that they serve eggs for breakfast’ and ‘that they serve cereals for breakfast’. These propositions cannot be referred to by yes and no, presumably because these expressions require a *unique* most salient antecedent, just like anaphoric pronouns (Krifka, 2013; Roelofsen & Farkas, 2015); however, the two highlighted propositions *can* be referred to by means of anaphoric expressions that have slightly more descriptive content, like the former and the latter.

- (35) Do they serve eggs for breakfast, or cereals?
 a. The former. \rightsquigarrow eggs
 b. The latter. \rightsquigarrow cereals

Finally, we assume that the *wh*-question in (33d) does not make any proposition available for subsequent anaphoric reference, but rather a *property*, i.e., a function from individuals to propositions (see, e.g., Groenendijk & Stokhof, 1984; Krifka, 2001; Aloni et al., 2007; Roelofsen & Farkas, 2015). More specifically, we assume that the property highlighted by (33d) is the function that maps every individual x to the set of worlds where x is served for breakfast:

- (36) $\lambda x.\lambda w.$ they-serve-for-breakfast(x)(w)

It has been assumed in the literature on *wh*-questions that this property is anaphorically accessed in the interpretation of short answers to the given question, as in (37a), and even in the interpretation of full sentential answers, to compute their exhaustive interpretation, illustrated in (37b).⁷

7 It should be noted that this assumption is not uncontroversial. On the one hand, some authors have argued that short answers actually involve *ellipsis*, and their interpretation involves reconstructing the syntactic structure of the elided material rather than purely anaphoric access to the semantic property made available by the question (see, e.g., Merchant, 2005 for such a proposal, and Jacobson, 2012 for a critique of it). On the other hand, some authors have argued that the *exhaustive* interpretation of answers to questions comes about through pragmatic reasoning, rather than a semantic process that involves anaphoric access to the

- (37) What do they serve for breakfast?
 a. Eggs and cereals. \rightsquigarrow they only serve eggs and cereals
 b. They serve eggs and cereals. \rightsquigarrow they only serve eggs and cereals

To generalize over the various cases considered, it is useful to view propositions as \circ -place properties. All sentence types considered, then, highlight one or more n -place properties, where $n \geq \circ$ is the number of *wh*-elements in the sentence. The declarative in (33a) and the polar question in (33b) both highlight a single \circ -place property, i.e., a proposition, the alternative question in (33c) highlights two \circ -place properties, i.e., two propositions, and the *wh*-question in (33d) highlights a 1-place property.

So now we have a way of semantically distinguishing *whether*-questions from *wh*-questions, one that is motivated independently from the empirical phenomenon that we aim to account for. What about the other ingredient of the puzzle, emotive factive verbs? What distinguishes them from other verbs, and how does this distinguishing feature interact with the noted difference between *whether*-questions and *wh*-questions?

3.2 *The Difference between Emotive Factives and Other Verbs*

We start with an empirical observation due to d'Avis (2002): when surprise takes a *wh*-question as its complement, it triggers a strong existential presupposition. For instance, (38) below implies that something is served for breakfast, and this implication is preserved under negation.

- (38) It is surprising what they serve for breakfast.
 \rightsquigarrow they serve something for breakfast
- (39) It is not surprising what they serve for breakfast.
 \rightsquigarrow they serve something for breakfast

This presupposition seems to be characteristic for emotive factives in general. For instance, (40) also implies that something is served for breakfast, and this implication is again preserved under negation.

property made salient by the question (see, e.g., Westera, 2013). Be this as it may, it remains plausible to assume that *wh*-questions bring a certain property into salience which could in principle serve as the antecedent for subsequent anaphora, and which could play other roles in the interpretation process as well.

(40) It is disappointing what they serve for breakfast.
 ↷ they serve something for breakfast

(41) It is not disappointing what they serve for breakfast.
 ↷ they serve something for breakfast

Note moreover that it is odd to cancel the existential implication with if anything.⁸

(42) It is surprising what they serve for breakfast, *if anything.

(43) It is disappointing what they serve for breakfast, *if anything.

This contrasts with other verbs:

(44) Tell me what they serve for breakfast, if anything.

(45) Amy knows what they serve for breakfast, if anything.

Let us now characterize this existential presupposition more precisely. We say that an n -place property P is *satisfiable* in a world w just in case there is at least one tuple t of n individuals such that $P(t)$ is true in w . Note that if P is a 0-place property, i.e., a proposition, then it is satisfiable in w just in case it is *true* in w .

Now the existential presupposition of emotive factives can be formulated as follows.

(46) The existential presupposition of emotive factives

An emotive factive triggers the presupposition that every property highlighted by its complement clause is satisfiable in the world of evaluation.

To illustrate this, consider again the example in (38). The embedded *wh*-question in this sentence highlights a 1-place property:

⁸ Incidentally, the infelicity of (42) and (43) could also be accounted for in terms of *speaker factivity* (discussed in Section 2.1), without assuming an existential presupposition. Such an explanation, however, would not extend to somewhat more involved examples, like (i) and (ii):

- (i) I don't know anything about the Krasnapolsky hotel myself, but it surprises John what they serve for breakfast, *if anything.
- (ii) I don't know anything about the Krasnapolsky hotel myself, but it disappoints John what they serve for breakfast, *if anything.

(47) $\lambda x.\lambda w.\text{they-serve-for-breakfast}(x)(w)$

The presupposition triggered by surprise, then, is that this highlighted property is satisfiable in the world of evaluation, i.e., that something is served for breakfast. This is exactly the existential requirement observed by d'Avis (2002).

Now consider what the presupposition in (46) amounts to when surprise takes a declarative complement, as in (48):

(48) It is surprising that they serve breakfast.

In this case, the complement highlights a 0-place property, i.e., a proposition, namely the proposition 'that they serve breakfast':

(49) $\lambda w.\text{they-serve-breakfast}(w)$

The presupposition triggered by surprise, then, is that this proposition is satisfiable, i.e., that it is true. But this is the standard *factivity* presupposition, which is indeed characteristic for surprise and other factive verbs. So, when applied to a *wh*-complement the presupposition postulated in (46) yields the existential requirement observed by d'Avis, and when applied to a declarative complement it simply amounts to factivity.

Notice that the definition in (46) requires that *every* property that is highlighted by the complement clause (rather than, say, *at least one* of these properties) should be satisfiable in the world of evaluation. To justify this, we have to consider a somewhat more complex case.

(50) It is amazing what they serve for breakfast and what they serve for lunch.
 ↷ Presupposition: they serve sth for breakfast and they serve sth for lunch

Assuming that the conjunctive embedded clause in (50) highlights two 1-place properties, each contributed by one of the *wh*-clauses, the observed presupposition is predicted by (46). It is crucial in this case that *every* property highlighted by the complement clause is required to be satisfiable, rather than just one of these properties.⁹

9 One may be tempted to object to this argument that (50) may actually be seen as an elided version of (i) below, where conjunction does not apply to the interrogative complement clauses but rather to the declarative root clauses (the part that must be elided in order to obtain (50) is displayed in gray).

(i) It is amazing what they serve for breakfast and it is amazing what they serve for lunch. One may suspect that, under this analysis, it is possible to derive the conjunctive presupposi-

Let us now specify a concrete, semi-formal entry for surprise, incorporating the presupposition in (46).¹⁰

(51) **Surprise**

Presupposition. The truth value of a sentence of the form ϕ surprises x is only defined in a world w if:

1. Every property highlighted by ϕ is **satisfiable** in w ;
2. For every property P highlighted by ϕ and every tuple t such that $P(t)$ is true in w , x **believes** in w that $P(t)$ is true.

Assertion. A sentence of the form ϕ surprises x is true in w if and only if the above two conditions are fulfilled and, moreover, for every property P highlighted by ϕ there is a tuple t such that $P(t)$ is true in w and $P(t)$ is incompatible with x 's **prior expectations** in w .

Let us make three brief remarks about this entry. First, note that the entry does not assume that the complement ϕ is a question, it applies just as well if ϕ is declarative. Second, note that on this account, surprise is not directly sensitive to the truth conditions or resolution conditions of ϕ ; rather, it is only sensitive to what is highlighted by ϕ . And third, note that there is a close connection between the existential presupposition of the verb and its assertive component. Namely, its assertive component requires that for every property P highlighted by ϕ there is a tuple t such that $P(t)$ is true in w and that $P(t)$ is incompatible with x 's prior expectations in w . The existential presupposition ensures that for every property P highlighted by ϕ there is a tuple t such that $P(t)$ is true in w to begin with.

With our entry for surprise in place, we are now ready to return to the *whether puzzle.

tion of (9) even if the existential presupposition associated with verbs like *amaze* just requires that at least one of the properties (rather than every property) highlighted by the complement clause be satisfiable. We refer to the appendix for a counterargument to this potential objection.

- 10 While the entry given here is sufficient for our current purposes, we do by no means want to claim that it is completely realistic. It could be refined in various ways, based on discussions in the recent literature (George, 2011; Theiler, 2014; Spector & Egré, 2015; Uegaki, 2015; Cremers & Chemla, 2016, among others). In particular, while the present entry only yields mention-some/weakly exhaustive readings, it is easy to adapt it in such a way that it also generates strongly exhaustive readings (see the discussion in Section 2.3). We do not implement such refinements here, however, because (i) they address issues that are orthogonal to our main concern, (ii) they would, as far as we can see, not affect our account of the *whether puzzle, and (iii) we want to keep the presentation as transparent as possible.

3.3 *Back to the *whether Puzzle*

We have seen that when surprise takes a *wh*-complement, the presupposition that every property highlighted by the complement be satisfiable amounts to the existential requirement observed by d'Avis, and when surprise take a declarative complement, the presupposition amounts to the standard factivity requirement. Now, what if surprise takes a *whether*-complement?

3.3.1 Polar Questions

Let us first consider a case with a polar interrogative complement:

(52) *It surprises Bill whether Susan is drinking coffee.

Since surprise is assumed to be sensitive only to what is highlighted by its complement, and since a polar interrogative complement is assumed to highlight exactly the same proposition as the corresponding declarative complement, (52) is predicted to be fully equivalent with (53):

(53) It surprises Bill that Susan is drinking coffee.

This equivalence does not rely on any specific feature of our example; it occurs *systematically*, whenever a verb like surprise takes a polar interrogative complement. We propose that this systematic equivalence, together with the fact that declarative complements are less complex than polar interrogative complements in terms of processing, and therefore more likely to be interpreted as intended, explains why verbs like surprise do not license polar interrogative complements.¹¹

Our account is somewhat reminiscent of the pragmatic approach discussed above, in that it involves competition between declarative and polar interrogative complements. But there are two crucial differences. First, on our account the competition is not with one out of two declarative complements, depending on which one is true in the world of evaluation, but rather always with the same declarative complement, which is simply obtained by replacing *whether*

11 We take it that declarative complements are less complex in terms of processing than polar interrogative complements, because, as is quite widely assumed, computing the semantic value of a polar interrogative complement involves the same operations that are needed to compute the proposition expressed by the corresponding declarative complement, plus an additional operation (roughly, 'adding the complement proposition'). For a more explicit discussion of this issue, see, e.g., Roelofsen & Farkas (2015).

with that. As a consequence of this, we do not need to include speaker factivity as an additional assumption, something we identified as a weakness of the pragmatic approach.

Second, our semantics predicts that replacing a polar interrogative complement by the corresponding declarative complement does not yield a stronger meaning, but rather leaves the meaning of the given sentence intact. This renders a polar interrogative complement systematically dispreferred w.r.t. the corresponding declarative complement, whose semantic computation involves less effort and is therefore more likely to be interpreted as intended. Thus, while our account can in principle be thought of as having a pragmatic component, it is certainly not *quantity* based, like the approach of Guerzoni (2007) reviewed above (“the speaker should have been more informative”), but rather *manner* based (“the speaker could have expressed the same meaning in a way that would have been easier to process and would thus have been more likely to lead to successful communication”).¹²

3.3.2 Alternative Questions

Now let us consider a case where the complement is an alternative question.

(54) *It surprises Bill whether Susan is drinking coffee or tea.

Here, the complement highlights two \circ -place properties, i.e., two propositions, namely ‘that Susan is drinking coffee’ and ‘that Susan is drinking tea’. The verb presupposes that both of these properties are satisfiable in the world of evaluation. Since the properties are \circ -place, this again just means that they have to be true. So the verb contributes the presupposition that Susan is drinking both coffee and tea.

From here we can proceed in one of two ways. A first option is to adopt the rather commonplace assumption that alternative questions by themselves, i.e., independently of the embedding verb, contribute a presupposition that *exactly one* of the listed alternatives holds (see, e.g., Biezma & Rawlins, 2012). In our example, this is the presupposition that Susan is drinking either coffee or tea, but *not both*. This is incompatible with the presupposition generated by the verb. Thus, the sentence as a whole would have contradictory presuppositions, and this could explain its oddness.

12 Our account is compatible with the view that the infelicity of polar interrogatives under emotive factives is highly grammaticalized. It may be that the competition between polar interrogative complements and declarative complements has been the driving force behind this grammaticalization process diachronically, while no longer playing a role in the actual processing of these constructions synchronically.

However, if we do not want to rely on any specific assumption about the presuppositions of alternative questions, there is also another way to account for the oddness of (54). This explanation starts with the observation that (54) comes out equivalent to (55), with a conjunctive declarative complement:

(55) It surprises Bill that Susan is drinking coffee and tea.

Given this equivalence, we could argue, just as in the case of polar questions, that alternative questions are ruled out under verbs like *surprise* through competition with declarative complements, which are preferable because they are less complex and therefore also more likely to lead to successful communication.

Notice that it is crucial here, as anticipated, that the presupposition triggered by *surprise* requires *every* property highlighted by its complement to be satisfiable.

3.3.3 A Quantificational Case

Now let us consider a case with a quantificational subject, which we brought up in Section 2 as a problem for the pragmatic approaches of Guerzoni (2007) and Sæbø (2007).

(56) *Every guest was surprised whether he got breakfast.

Our explanation for the oddness of this sentence is essentially the same as that for (52). Namely, due to the existential presupposition of *surprise*, we predict that (56) is semantically equivalent with (57), which involves a declarative complement rather than a polar interrogative complement.

(57) Every guest was surprised that he got breakfast.

This equivalence, together with the lower complexity of the declarative complement, accounts for the infelicity of (56). Thus, quantified cases do not require any additional stipulations – unlike on the pragmatic approaches reviewed in Section 2.

3.3.4 Concealed Questions

Finally, there is one additional prediction that is worth mentioning before concluding the paper. Consider the following contrast, pointed out to us by Martin Stokhof:

- (58) a. *It is surprising whether they serve breakfast.
 b. The answer to the question whether they serve breakfast is surprising.

This example shows that, whereas surprise does not license a plain polar question as its complement, it does license a so-called 'concealed question' concerning the answer to that polar question. This contrast is expected on our view, under the assumption that concealed questions involve a type-shifting operation that turns the determiner phrase (here, the answer to the question whether they serve breakfast) into a *wh*-question concerning the identity of the referent of that phrase (What is the answer to the question whether they serve breakfast), an assumption that has been argued for in some detail in Aloni & Roelofsen (2011).¹³ Concealed questions are, under this assumption, expected to pattern with *wh*-questions rather than with *whether*-questions, and thus correctly predicted to be licensed under verbs like surprise.

4 Concluding Remarks

We have posited that emotive factive verbs such as surprise are sensitive to what is *highlighted* by their complement. More specifically, we have proposed that these verbs presuppose that every property highlighted by their complement is satisfiable in the world of evaluation. When the complement is declarative, this presupposition simply amounts to factivity. In the case of a *wh*-complement, it amounts to the requirement that there be at least one individual that has the property highlighted by the question, a requirement that had been observed empirically by d'Avis (2002). And finally, in the case of *whether*-complements, the proposed semantics predicts oddness, through systematic equivalence with the corresponding declarative complements.

One question that we have not addressed is *why* emotive factives would come with the proposed satisfiability presupposition. Is this connected to their 'emotive' nature? This question must be left for future work. Nevertheless, we hope that the proposed treatment of emotive factives as being sensitive to what is highlighted by their complement may contribute to a better understanding of question embedding more generally.

13 Several other approaches to concealed questions exist as well (see, e.g., Nathan, 2006; Schwager, 2007; Romero, 2010; Frana, 2013). We refer to Aloni & Roelofsen (2011) for comparison.

5 Appendix: Two Potential Objections, and Counterarguments

In this appendix we consider two potential objections against our assumption that the existential presupposition of emotive factives requires *every* property highlighted by the complement clause (rather than just one of them) to be satisfiable in the world of evaluation. We first consider the objection already alluded to in footnote 9. To recall, we justified our assumption by observing that (59), with two conjoined *wh*-questions embedded under surprise, presupposes both that they serve something for breakfast and that they serve something for lunch.

(59) It is surprising what they serve for breakfast and what they serve for lunch.

One may object to this argument by suggesting that (59) is actually an elided version of (60) below, where conjunction does not apply to the interrogative complement clauses directly but rather to the declarative root clauses (the part that must be elided in order to obtain (59) is displayed in gray).

(60) It is surprising what they serve for breakfast and *it is surprising what they serve for lunch.*

One may suspect that, under this analysis, it is possible to derive the conjunctive presupposition of (59) even if the existential presupposition associated with emotive factives just requires that at least one of the properties (rather than every property) highlighted by the complement clause be satisfiable. This is not exactly the case, but the presupposition that would be derived would, together with the at-issue informative content of the sentence, indeed imply the conjunctive presupposition of (59). Namely, under standard assumptions about the presupposition projection behavior of conjunction (see Beaver & Geurts, 2013, for a recent survey), the predicted presupposition of (60) would be (i) that they served something for breakfast, and (ii) that, if it was amazing what they served for breakfast, then they also served something for lunch. Together with the at-issue information provided by the first conjunct that, indeed, it was amazing what they served for breakfast, this implies the presumed conjunctive presupposition of (59).

However, it is easy to construct a variant of (59) which is immune to this objection. One such a variant is given in (61).

- (61) It is only surprising what they serve for breakfast and what they serve for lunch. (... It is not surprising what they serve for dinner)
 ↷ Presupposition: they serve sth for breakfast and they serve sth for lunch

The conjunctive presupposition is still present, and clearly this sentence cannot be analyzed as an elliptical version of (62) below, where conjunction again applies to the declarative root clauses instead of the interrogative complement clauses.

- (62) It is only surprising what they serve for breakfast and it is only surprising what they serve for lunch.

A related kind of objection to our argument may be attempted by suggesting that the two *wh*-complements in (50) first have to be *lifted* before being conjoined (just like a proper name has to be lifted into a generalized quantifier before it can be conjoined with a quantificational noun phrase). Szabolcsi (1997, 2015) calls this the *indirect* method for interpreting coordinated complement clauses, as opposed to the *direct* method which involves immediate coordination of the two clauses, without prior lifting.

- (63) a. Direct method:
 surprising($Q_1 \wedge Q_2$)
 b. Indirect method:
 surprising($\lambda P[P(Q_1) \wedge P(Q_2)]$) = *surprising*(Q_1) \wedge *surprising*(Q_2)

Using the indirect method for interpreting coordinated complement clauses, it is indeed possible to derive the conjunctive presupposition of (50) even if the existential presupposition associated with emotive factives just requires that at least one of the properties (rather than every property) highlighted by the complement clause be satisfiable.

However, this alternative derivation of the conjunctive presupposition of (50) crucially relies on the assumption that coordinated complement clauses are interpreted using the indirect method. Szabolcsi (1997, 2015) argues that in Hungarian one can tell very clearly whether a conjunction of two *wh*-complements is interpreted using the direct or the indirect method. Namely, when both conjuncts are headed by the subordinator *hogy*, as in (64) below, both clauses are first lifted and then conjoined (the indirect method), while if the conjunction as a whole is headed by *hogy*, rather than both conjuncts individually, as in (65), then the two clauses are immediately conjoined (the direct method); in this case the conjunction as a whole is lifted and then applied to the verb.

- (64) *János megtudta, hogy hova költöztél és hogy kit vettél feleségül.*
 Janos found.out subord where you.moved and subord whom you.took as.wife
 'Janos found out where you moved and who you married.'
 ↷ both clauses lifted before conjunction applies (indirect method)
- (65) *János megtudta, hogy hova költöztél és kit vettél feleségül.*
 Janos found-out subord where you.moved and whom you.took as.wife
 'Janos found out where you moved and who you married.'
 ↷ clauses are conjoined without prior lifting (direct method)

Szabolcsi argues, among other things, that while *conjoined* *wh*-complements can be interpreted using either the direct or the indirect method, *disjoined* *wh*-complements can only be interpreted using the indirect method.

- (66) *János megtudta, hogy hova költöztél vagy hogy kit vettél feleségül.*
 Janos found-out subord where you.moved or subord whom you.took as.wife
 'Janos found out where you moved and who you married.'
- (67) *#János megtudta, hogy hova költöztél vagy kit vettél feleségül.*
 Janos found-out subord where you.moved or whom you.took as.wife

Now, with this background, let us return to cases involving verbs like surprise. The conjoined *wh*-clauses in the following Hungarian example, where *hogy* does not precede each individual conjunct but just the conjunction as a whole, have to be interpreted using the direct method. However, a conjoined presupposition is still present.¹⁴

- (68) *János meglepődött azon, hogy hova költöztél és kit*
 Janos surprised at subord where you.moved and whom

14 We thank Donka Farkas and Anna Szabolcsi for discussion of this datapoint.

vettél feleségül.

you.took as.wife

'Janos was surprised by where you moved and who you married.'

↷ Presupposition: you moved somewhere and you married someone

Thus, if Szabolcsi's analysis of the subordinator *hogy* is correct, this example counters the potential objection to our argument considered here. That is, it provides evidence for our formulation of the existential presupposition associated with emotive factives: every property highlighted by the complement must be satisfiable.

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