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Why *Surprise*-Predicates do not Embed Polar Interrogatives[*]

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1 Background

Grimshaw (1979) and many subsequent authors have described the distribution of complements exemplified in (1)-(4) by assuming that lexical entries not only contain syntactic subcategorization frames (e.g. [__NP] or [__ {NP, CP}] etc.), but also semantic subcategorization frames. The semantic categories Grimshaw assumes include proposition (P), interrogative (Q) and exclamative (E) (e.g. [__Q], [__E], [__{P, E}]…).[1]

(1) a. ✓John believed [$_{CP/P}$ that Mary is tall].
b. *John believed [$_{CP/Q}$ whether Mary is tall].
c. *John believed [$_{CP/E}$ how very tall Mary is].

(2) a. *John asked/wondered [$_{CP/P}$ that Mary is tall].
b. ✓John asked/wondered [$_{CP/Q}$ whether Mary is tall].
c. *John wonders [$_{CP/E}$ how very tall Mary is].

(3) a. ✓John was amazed [$_{CP/P}$ that Mary is tall].
b. *John was amazed [$_{CP/Q}$ whether Mary is tall].
c. ✓John was amazed [$_{CP/E}$ how very tall Mary is].

(4) a. John {✓asked |✓wondered} [$_{CP/Q}$ what the time was].
b. John {✓asked |*wondered} [$_{NP/Q}$ the time].

A number of questions arise immediately. First, what is the relation of Grimshaw's features E, Q, and P to the semantic types used in formal semantics (e.g. <s, t>, <<s, t>, t> etc.). If the predicates in (1)-(4) are modeled as belonging to some higher functional type (e.g. $\lambda p_{<s, t>}\ \lambda x_{<e>}\ \lambda w_{<s>}$… for 'believe'), does the obligatory typing of the arguments also encode

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[1] For general discussion of exclamatives see Beijer 2002; Bennis, Corver and Dikken 1997; Campos 1992; d'Avis 2001, 2002; Elliot 1971, 1974; Espinal 1997; Grimshaw 1979; Gutierrez Rexach 2001; Huddelston 1993; Huddleston 1993; Makarova 2001a, b; McCawley 1973; Michaelis 2001; Michaelis and Lambrecht 1996; Oda 2003, in press; Ono 2003; Portner and Zanuttini 2000; Postma 1997; Toman 1982; Villalba 2001, 2003; Zanuttini and Portner 2000, 2003; Ziv 1995; Zybatow 1990 and references cited there.

semantic selection? Second, what is the justification for calling the embedded clauses in (1c), (2c), and (3c) exclamative? In other words, what if any properties do they share with matrix exclamative sentences? And what, if anything, distinguishes them from matrix exclamatives? Similarly for the relation between exclamatives and interrogatives: what do they have in common? What distinguishes them?

It is sometimes claimed that exclamation is a matrix phenomenon (though see Bolinger 1977; Hooper and Thompson 1974; Lakoff 1984) and that the complements in (1c), (2c), and (3c) therefore cannot be exclamatives. Be that as it may, we require a description and explanation of the distribution of various types of embedded clauses whether we call them exclamative or not, i.e., the facts shown in (1)-(4) need to be described and explained independently of terminological choices.

The justification for calling these clauses embedded exclamatives comes from two sources. First, when the embedded clauses in (1c), (2c), and (3c) are used as independent matrix clauses they must function as exclamatives (see (5))—matrix *wh*-exclamatives in English are syntactically distinguished by a lack of subject-auxiliary inversion. This of course distinguishes them from other interrogatives which either need not be used as exclamatives in matrix contexts or, in fact, cannot be so used (see (6)).

(5) a. ✓How very tall Mary is!
    b. *How very tall is Mary?
(6) a. *What he bought!
    b. ✓What did he buy?

Second, the predicates that show the distributional behavior of *amazed* in (3) (e.g. *surprised, baffled, shocked, bewildered,* etc.) express surprise. I will call such predicates *surprise*-predicates in the remainder of this paper. The fact that they express surprise makes them, at an intuitive level, similar to exclamatives, since exclamatives also typically express surprise.[2] All this needs to be explained independently of the decision to call the embedded clauses in (1c), (2c), and (3c) 'embedded exclamatives'. In the absence of a concrete proposal

[2] Grimshaw 1979 attributes to Elliot 1971, which I haven't seen, the idea that exclamatives are also factive. I hope to discuss this issue and how it relates to the examples under discussion in future work.

concerning exclamatives this is just a terminological move, anyway.[3] To the extent that Grimshaw's motivations capture true generalizations however, an explanation for them is needed.

This paper should be understood as a step in a research program which aims at describing facts such as those in (1)-(4) without recourse to Grimshaw's features P, I, and E. The program instead is to treat embedded exclamatives semantically as interrogatives (type <<s,t>, t>) and to deduce the restrictions observed in (1)-(3) from independently motivated assumptions. This paper concentrates exclusively on the question why examples like (3b) are ungrammatical, leaving the equally important question why (1c) and (2c) are ungrammatical for future work. Some implications of the present approach to the broader study of unembedded exclamatives will be discussed in the conclusion of the paper.

The paper is structured as follows. First I discuss some of the criticisms that have been leveled against Grimshaw's approach to embedded exclamatives in particular (section 2). Section 3 gives an informal sketch of the solution developed in the subsequent sections of the paper. Section 4 makes explicit the assumptions about interrogative semantics underlying the formal proof of section 6. Section 5 summarizes previous findings concerning the semantics of *surprise*-predicates (Heim 1994; d'Avis 2001, 2002). In section 6 the informal account of section 3 is rendered as a proof. Section 7 concludes the paper.

2 Why type E is insufficient

The most common criticism leveled at Grimshaw's account of the facts in (1)-(3) is that it is incomplete. A semantic explication of the feature E has never been given beyond some informal remarks Grimshaw makes about factivity (see fn. 2 above) and extremeness of degree. Lacking such an explication, however, the feature E is just a (formal, syntactic) diacritic. Moreover, there is no compositional analysis of sentences like (3c) for example which uses Grimshaw's E-feature (see d'Avis 2001, 2002; Lahiri 2000; Zanuttini and Portner 2000, 2003 among others).

There is a second point, related to the first. In sentences like (3c) it is unclear whether the characteristically exclamative aspects of meaning (e.g. extreme degree, surprise, factivity) are to be attributed to the matrix predicate. Attributing the exclamative like aspects of meaning to the matrix predicate allows for an easy account of examples like (3a) and (7a) and it would also explain why this moment of surprise is absent in examples such as (7c).

[3] The proposals in Zanuttini and Portner 2003 and in d'Avis 2001, 2002 are the best worked out semantic proposals concerning exclamatives to date. Zanuttini and Portner's founders on examples like (33) below. It is not clear that the account is meant to cover embedded exclamatives, however.

However, if we follow Grimshaw and designate the embedded clause in (3a) and (7c) as being of type [E], it is unclear why the moment of surprise is absent in (7c) (see in particular d'Avis 2001, 2002). Similarly, the notion of extreme degree is missing in (7b) and (7d). On Grimshaw's account it is unclear why this is so.

(7) a. ✓John is surprised that Mary is tall.
b. ✓John is surprised at who came to the party.
c. ✓John knows how very tall Mary is.
d. ✓John knows who came to the party.

Another area in which Grimshaw's account is clearly incomplete is the following. There are predicates that do not have the exclamative flavor of the *surprise*-predicates but which do share with them the property of not embedding polar interrogatives as examples (8)-(9) illustrate (see d'Avis 2001, 2002; Schwarz 1993).

(8) a. ✓John listed who came to the party.
b. *John listed whether Mary came to the party.

(9) a. ✓John is angry about who came to the party.
b. *John is angry (about) whether Mary came to the party.

Predicates like *list* are called predicates of incremental completion ("sequentielle Abarbeitung") by Schwarz. It is quite clear that they require, semantically, a multi-part answer to the embedded question—at the very least they require the possibility of a multi-part answer. But polar interrogatives do not and cannot have multi-part answers, which explains why (8b) is not acceptable.

Predicates like *be angry* in (9), like the *surprise*-predicates, express an emotional stance towards a proposition, i.e., the true answer of to the embedded question. Like the *surprise*-predicates they do not allow polar interrogatives as complements. An explanation of this fact can presumably be given along the lines of the explanation developed in this paper for *surprise*-predicates*,* but remains to be worked out in detail. Be that as it may, these predicates show differing behavior with respect to embedded exclamatives (10). Clearly, a description of these facts in terms of Grimshaw's features is impossible.[4]

(10) a. *John listed what a bad doctor Frank is.

b. ✓John is angry about what a terrible doctor Frank is.

I will not seriously consider the option of increasing the inventory of features used in the description of the embedded clauses, because it seems obvious that such an approach, even if more successful empirically, becomes even less explanatory. In any case, Schwarz'1993 treatment of the verbs of incremental completion suggests that the answer should be sought in the (interacting) semantics of the embedded clause and the embedding predicate. There is a pervasive and under Grimshaw's approach very puzzling cross-linguistic similarity (in fact near identity) between exclamatives and interrogatives (see Oda 2003, in press for a crosslinguistic survey including Brasilian Portuguese, Bulgarian, Mandarin Chinese, French, German, Japanese, Rumanian, Spanish, Russian, Thai, and Turkish and d'Avis 2001 for a broad comparison of the properties of exclamatives and interrogatives in German). In fact, Grimshaw treats exclamatives syntactically as questions, but this begs the question rather than answering it. The simplest hypothesis thus seems to be to treat exclamatives as interrogatives and, in particular, to attribute to them the semantics of interrogatives. From the vantage point of Grimshaw's theory we then have a reduced typology of clauses: propositions, which are semantically of type $<s, t>$, and questions, which are semantically of type $<<s, t>, t>$.

[4] The list of complaints against Grimshaw's theories can easily be extended. Thus, there are clauses that cannot act as independent exclamatives in English but that are embeddable under *surprise*-predicates (i). Of course the matrix interrogatives corresponding to (ia-b) exist and both are embeddable under *interrogative*-predicates like *wonder*. Such cases thus create a number of further problems for Grimshaw's approach (see d'Avis 2001, 2002 for review). I will not discuss them here, though, first of all since I do not present a theory of matrix exclamatives and second of all because I do not know how general these asymmetries are since exclamatives modeled on (ia-b) are more or less acceptable in German (see d'Avis 2001) and become impeccable if the quantifier *alles* –'all' is floated off the *wh*-word. It might be possible to treat the latter as rhetorical questions rather than exclamatives, though, the distinction being somewhat murky.

(i) a. *What John bought!
b. *Who bought what!
c. ✓I'm surprised what John bought.
d. ✓I'm surprised who bought what.

Notice though that an approach to (ib) like Ono's (2003), which makes the availability of single pair readings for multiple interrogatives a precondition for the availability of multiple matrix-exclamatives appears to be falsified by such languages as Romanian, which, according to Oda 2003, allows multiple exclamatives but does not, according to Bošković 2002, allow single pair readings for multiple *wh*-questions.

To show that such a program, which aims at eliminating clause type [E] can work, one would have to show that it follows on independent grounds (a) why polar interrogatives cannot appear embedded under *surprise*-predicates, (b) why some *wh*-clauses can never appear under interrogative predicates, (c) why some questions cannot be used as exclamatives (see fn. 4), and (d) why certain sentences that can be used as exclamatives cannot be embedded under *surprise*-predicates (11-12).

(11) a. ✓Was ist die Susi groß geworden!
What is the Susi tall become
'How tall Susi has grown!'

b. ✓Was die Susi groß geworden ist!
What the Susi tall become is
'How tall Susi has grown!'

c. *Ich bin erstaunt /frage mich /weiß, was die Susi groß geworden ist.
I am surprised /ask myself /know what the Susi tall become is
intended: 'I am surprise/wonder/know how tall Susi has grown.'

(12) a. ✓Wen hat der nicht alles eingeladen!
who has that not all invited
'Amazing, the people he has invited!'

b. ✓Wen der nicht alles eingeladen hat!
who that not all invited has
'Amazing, the people he has invited!'

c. *Ich bin erstaunt /frage mich /weiß, wen der nicht alles eingeladen hat.
I am surprised /ask myself /know who that not all invited has

This paper presents only a first step in this eliminative program and deals exclusively with the first of these questions, i.e. (a) above.

3 The idea in broad strokes

Surprise-predicates typically take declarative and interrogative complements as in (13) and (14).

(13) a. It's amazing that Mary invited Peter.

b. It's amazing who Mary invited.

(14) a. John is surprised that Mary invited Peter.

b. John is surprised at who Mary invited.

When the complement is a declarative, the proposition expressed by the complement causes surprise. It contradicts another unspoken proposition (*normp*) which, if true, would not have occasioned surprise.

When the complement is interrogative, the relation between the denotation of the complement and *normp* is a little more complex. Heim 1994 and d'Avis 2001, 2002 have shown convincingly that at least the following must hold. The person to whom surprise or amazement is attributed must know (at least partially – but this is a complication to which we will return only later) a particular kind of answer to the question (namely Heim's weakly exhaustive answer); basically, the subject must know who was invited, but he need not know who wasn't invited. The unspoken proposition *normp*, which, if true, would not have occasioned surprised must contradict this weakly exhaustive answer (i.e., there is no world that satisfies both). The complement must have a non-trivial weakly exhaustive answer (i.e., if John is surprised who Mary invited, Mary must have invited somebody). And finally, the person to whom surprise or amazement is attributed must have expected a non-trivial weakly exhaustive answer to be true (i.e., if John is surprised who Mary invited, John cannot have expected her to invite nobody). The last two points are logically independent. These ideas are motivated and formalized based on *wh*-complements of *surprise*-predicates.

On the crucial assumption that polar interrogatives are singleton sets of propositions, the formal definitions entail that there are only two possible weakly exhaustive answers to a polar interrogative: (i) the proposition p expressed in the interrogative itself and (ii) the tautology T (i.e., the set of all worlds, the trivial weakly exhaustive answer).

Suppose that p is true. In this case *normp* is a proposition contradicting p. It follows, again from the formal definitions, that all worlds where p is false are worlds where the weakly exhaustive answer to the complement question of the *surprise*-predicate is trivial because it is the tautology. This contradicts the assumption that the person to whom surprise or amazement is attributed must have expected a non-trivial weakly exhaustive answer to the polar interrogative.

Suppose then that p is false. In this case the weakly exhaustive answer to the interrogative is the tautology. This immediately runs afoul of several of the conditions mentioned above. First, the person to whom surprise or amazement is attributed must know the weakly exhaustive answer to the question and this knowledge must be non-trivial – which it isn't in this case, because the weakly exhaustive answer is the tautology. And second, the proposition *normp* must contradict the weakly exhaustive answer, but it can't without assuming that *normp* is the contradiction, certainly an anomalous assumption.

It thus follows that whether p is true or false, it is impossible to construct a proposition *normp* that would make the *surprise*-predicate embedding a polar interrogative true. What is more, the contradiction can be localized in the presuppositions of the *surprise*-predicate. This means that when a polar interrogative is embedded under a *surprise*-predicate, this leads systematically to a presupposition failure. This state of affairs is known from work on negative polarity items. Ladusaw 1980 argues that negative polarity items occur only in downward entailing contexts (see Heim 1984; von Fintel 1999 and references cited there for some refinements). Krifka 1994, 1995 and Lahiri 1998 have argued that Ladusaw's generalization follows on semantic grounds if we assume that sentences whose presuppositions are contradictory are unusable. This is so because presuppositions are felicity conditions and there is no context that would make the use of a sentence with contradictory presuppositions felicitous. The same reasoning can now be used to explain why *surprise*-predicates cannot appear with polar interrogatives: the sentences are not ungrammatical (i.e. no syntactic deviation), rather they have unsatisfiable felicity conditions and are thus unusable.

4 On the Meaning of Questions and Answers

Wh-interrogatives and polar interrogatives denote sets of propositions as in (15a)[5] (Hamblin 1973) and (15b).[6] I will call these sets of propositions Q_H, the question denotation according to Hamblin (see fn. 6 for a minor caveat concerning (15b)).

(15) a. $Q_H = [\![\text{What did Frank buy}]\!] = \{p \mid \exists x\ \text{thing'}(x)\ \&\ p = \{w' \mid \text{bought}(x)(f')(w')\}\}$

b. $Q_H = [\![\text{Did Frank buy milk}]\!] = \{p \mid p = \{w' \mid \text{bought}(m')(f')(w')\}\}$

[5] Properly speaking, we would of course have to treat questions not extensionally (as sets of propositions) but as functions from possible worlds to sets of propositions. Since nothing in this paper hinges on using question intensions, I will ignore this technical complication here, it would only unnecessarily complicate the exposition.

[6] In (15b) the polar interrogative is represented as a singleton set of propositions. In this regard, I deviate from Hamblin's view where (15b) would have had the representation (i).

(i) $Q_H = [\![\text{Did Frank buy milk}]\!] = \{p \mid p = \{w' \mid \text{bought}(m')(f')(w')\} \vee p = \{w' \mid \neg\, \text{bought}(m')(f')(w')\}\}$

(Roberts' (1998) account of discourse coherence in terms of her subquestion relation requires polar interrogatives to be singleton sets as in the main text. d'Avis (2001) shows that, given Heim's (1994) notions of answerhood to be discussed below in the text, no information is lost by treating polar interrogatives as singleton sets.

The approach advocated here is different from Karttunen's (1977) despite the fact that for Karttunen polar interrogatives also denote singleton sets: the set containing the true answer in the evaluation world. Relying on

To illustrate this, if we let the *wh*-word *what* range over objects, then the set in (15a) contains such propositions as *that Frank bought milk, that Frank bought cheese, that Frank bought sugar, that Frank bought bread, that Frank bought a Jaguar,* etc. And the set specified in (15b) simply contains the proposition *that Frank bought milk.*

Heim's (1994) 'weakly exhaustive answer' ($answ_1^w$) can easily be derived from Q_H.[7] The weakly exhaustive answer is the conjunction of all the answers in Q_H that are true in the evaluation world (16).

(16) $answ_1^w = \bigcap\{p \mid p \in Q_H \;\&\; p(w)\}$

Consider an example. Suppose that Frank has bought milk and cheese in the evaluation world, then for (15a) the propositions *that Frank bought milk* and *that Frank bought cheese* are true but not the propositions *that Frank bought sugar, that Frank bought bread, that Frank bought a Jaguar.* $Answ_1^w$ to (15a) is therefore the proposition *that Frank bought milk and cheese.* In the same scenario $answ_1^w$ for (15b) is the set containing the proposition *that Frank bought milk.*

Please note that if no member of Q_H is true in the evaluation world, then $answ_1^w = W$ (the set of possible worlds). This follows from the definition of intersection as shown in (17). We derive W, i.e., the tautology, as $answ_1^w$ to (15a) just in case Frank didn't buy anything and as $answ_1^w$ to (15b) just in case Frank didn't buy milk.

(17) $\bigcap S =_{def} \{x \in D \mid \forall M \in S \rightarrow x \in M\}$; thus, if $S=\varnothing$, then $\bigcap S=U$.

In a further step we can derive Heim's ‚strongly exhaustive answer' ($answ_2^w$) from $answ_1^w$. Contentwise, the strongly exhaustive answer is the conjunction of all true answers, i.e. $answ_1^w$, with the conjunction of the negation of all false answers. Heim offers a more elegant formulation based on $answ_1^w$ as shown in (18).

(18) $answ_2^w(Q_H) = \{w' \mid answ_1^{w'} = answ_1^w\}$

Karttunen's dentotation for polar interrogatives but not for *wh*-interrogatives would introduce an unwarranted asymmetry between polar and *wh*-interrogatives.

[7] There is a strong affinity between Heim's notion of weakly exhaustive answer and Karttunen's (1977) approach to question denotation. For Karttunen a question denotes the set of all true propositions in Q_H, Heim's weakly exhaustive answer is the intersection of this set.

The definition in (18) says that $answ_2$ in a particular world (w) is the set of worlds p such that $answ_1$ in all $w' \in p$ is the same as $answ_1$ in w. In our example if Frank has bought milk and cheese in w and nothing else, then $answ_1$ in the actual world (w) is the proposition p *that Frank bought milk and cheese (and possibly other things).* In all worlds w' where Frank also bought milk and cheese and nothing else, $answ_1^{w'}$ will be that same proposition p *that Frank bought milk and cheese (and possibly other things)*, i.e., $answ_1^{w'} = answ_1^{w}$. However, if Frank bought only cheese in w', $answ_1^{w'}$ will be the proposition p' *that Frank bought cheese (and possibly other things)*. Evidently p =/= p'. Likewise, if Frank had bought milk and cheese and bread in w', $answ_1^{w'}$ would be the proposition p' *that Frank bought cheese and milk and bread (and possibly other things).* Again p' is clearly different from p. In other words, p=p' in exactly those worlds where Frank bought milk and cheese and nothing else. Thus $answ_2^{w}$ is the proposition that Frank bought milk and cheese and nothing else. Notice that if Frank didn't buy anything, i.e. the case where $answ_1$ is the tautology, $answ_2$ comes out as the proposition *that Frank didn't buy anything.*

Similarly for the polar question. In all worlds where the answer to (15b) is 'yes', $answ_1^{w}$ is the same proposition p expressed by the question, thus $answ_2^{w} = answ_1^{w} = p$ in those worlds. On the other hand in all and only those worlds where the answer to (15b) is 'no', $answ_1$ is the tautology. The set of worlds where $answ_1$ is the tautology is just the complement of the worlds where the answer is p, thus if Frank didn't buy milk, $answ_2^{w}(⟦(15b)⟧) = \neg p$.

It is easy to show that $answ_2$ to a given question in a particular world is always a subset of $answ_1$ to that question in that world. I call this the Entailment Corollary and it is given in (19).[8]

(19) Entailment Corollary

$$answ_2^{w}(Q_H) \subseteq answ_1^{w}(Q_H) \Leftrightarrow \neg answ_1^{w}(Q_H) \subseteq \neg\, answ_2^{w}(Q_H).$$

As we will see, it will be expedient to also have the notion of positive partial answer at our disposal. Unlike the strongly and weakly exhaustive answers that are unique given a question and an evaluation world, questions will in general have sets of positive partial answers. The set of positive partial answers can be characterized by taking a subset of the true

[8] A simple proof can be given by reductio ad absurdum. Suppose $answ_2^{w}(Q_H) \subseteq answ_1^{w}(Q_H)$ is false. Then there exists a world w', such that $w' \in answ_2^{w}(Q_H)$ and $w' \notin answ_1^{w}(Q_H)$. By definition of $answ_2$, $answ_1^{w'} = answ_1^{w}$. $answ_1^{w'}$ is defined as the intersection of a number of sets. Every set that goes into the construction of $answ_1^{w'}$ contains w' (p(w')=1 in (16)); thus, $w' \in answ_1^{w'}$ contrary to the assumption.

propositions in Q_H and intersecting them (20). Clearly $answ_1^w$ is a member of the set of partial positive answers. In fact, from an informational viewpoint it is the strongest one in that it entails all the other.

(20) The set of positive partial answers to a question Q in evaluation world w is the set S_{pos} with

$$S_{pos} = \{p \mid p(w)=1 \wedge \exists w' \; p=answ_1^{w'}(Q_H)\}$$

In the example above, if Frank bought milk and cheese, then the tautology and the propositions *that Frank bought milk, that Frank bought cheese,* and *that Frank bought milk and cheese* are partial answers to the question. However, the proposition *that Frank didn't buy bread* is not.

This last proposition, *that Frank didn't buy bread,* could be called a negative partial answer - it is a proposition in Q_H which is false. We can define negative partial answers in the obvious way based on (20) as shown in (21). Clearly again the negative partial answers are partially ordered in terms of informativity by entailment relations.

(21) The set of negative partial answers to a question Q in evaluation world w is the set S_{neg} with

$$S_{neg} = \left\{p \mid p(w)=1 \wedge \exists S\, [S \in \wp Q_H \wedge p=\neg\bigcup S]\right\}$$

We are now equipped with the necessary concepts to tackle the question what *surprise*-predicates mean.

5 On the Meaning of Surprise-Predicates

In my exposition of the semantics of *surprise*-predicates, I will follow d'Avis 2001, 2002 in detail. D'Avis himself builds on Heim 1994. The main aim of this section is to formalize d'Avis' results to a slightly higher degree than he himself does this This is a necessary precondition without which I could not give the proof in section 5.

Consider again a simple example like (22a). The example carries a number of presuppositions.

(22) a. John is surprised at who Mary invited.

b. John is surprised at Q

An example like (22a) can only be uttered in a situation where John knows (at least partially) who Mary invited. If John didn't know this, he couldn't possibly be surprised at who she invited. In this case (22a) isn't simply false since its negation (*John isn't surprised at who Mary invited*) isn't true either. Thus something like (23a) is presupposed by (22a).

(23) a. John knows partially who Mary invited.

b. John knows some proposition p, which is a positive partial answer to Q.

John does not need to know the complete strongly exhaustive answer to Q in order to be surprised. In fact, he doesn't even need to know the complete weakly exhaustive answer. It is sufficient that he knows part of the answer to Q. However, the part that he knows must concern people that were invited – not people that were not invited. Thus, if John only knows that Mary didn't invite Frank and Peter but knows nothing else, sentence (22) is infelicitous. (23b) captures this intuition correctly.[9] This condition is a lexical presupposition of *surprise.*

A second condition that must be met by example (22), is that John must somehow be surprised by the invitees, i.e. there must be a proposition *normp* describing what John would have thought to be normal or what he might have expected. This expectation must conflict with what he knows to be the case (partial though that knowledge may be). In other words, normp must entail that the proposition p actually known by the subject of the *surprise*-predicate is false (normp $\rightarrow \neg$p or equivalently normp $\cap$ p = $\emptyset$). If the subject of the *surprise*-predicate is completely informed about all invitees and all non-invitees, then p = $answ_2^{@}(Q)$. Thus in the limiting case normp must entail that $answ_2^{@}(Q)$ is false.

However, this is a very weak requirement as a look at the Entailment Corrolary (19) reveals. Every proposition that contradicts $answ_1^{@}(Q)$ also contradicts $answ_2^{@}(Q)$ but not vice versa. Moreover, because $answ_1^{@}(Q)$ entails every positive partial answer to Q, every proposition that contradicts a given positive partial answer to Q will also contradict $answ_1^{@}(Q)$ and thus also $answ_2^{@}(Q)$. Since John cannot be surprised about something unless he knows it, we can demand that normp contradict the most informative positive partial

[9] The observant reader will have noted that the tautology is a positive partial answer, but if all John knows about a particular question is the tautology, we would not say that he actually knows anything. In fact, John must know a non-trivial positive partial answer to Q. I do not include this as a stipulation in (23b), because it follows independently once more components of the meaning of *surprise* have been considered. The issue is taken up below in the discussion of the limiting cases.

answer to Q that Frank knows in accordance with (23b), i.e. normp $\rightarrow \neg$p, where we identify p with the proposition mentioned in (23b).

An alternative might be to demand that normp simply contradict the aggregate of the information that Frank has about invitees, i.e. the aggregate information contained in the positive and negative partial answers that John knows. In the definitions given above this would amount to intersecting the most informative positive and negative partial answers John knows. However, Heim 1994 has argued for the limiting case, i.e., the strongly exhaustive answer, that knowledge about non-invitees is irrelevant. If John knows the strongly exhaustive answer to the question *who Mary invited*, the negative partial answer known by John plays no role in determining the truth of (22). The argument goes as follows: Suppose John expected Mary to invite Peter and Frank, i.e., normp is the proposition *that Mary invites Peter and Frank*. Suppose furthermore that Mary actually invited Peter and nobody else and that John is aware of this, i.e. Frank knows $answ_2^w$. In this situation, (22a) is not felicitous; instead, we must say (24).

(24) John is surprised who Mary didn't invite.

Note that in a world w the questions *who Mary invited* and *who Mary didn't invite* have the same strongly exhaustive answer, however they differ in their weakly exhaustive answers. We cannot possibly use the strongly exhaustive answer to differentiate between (22a) and (24) because the strongly exhaustive answer is the same in both cases. Moreover, since John by assumption knows $answ_2^w$, presupposition (23b) is also fulfilled in both cases. It is, apparently, not sufficient that normp contradict $answ_2^w$, rather, normp must contradict $answ_1^w$. Because $answ_2^w(Q)$ entails all negative partial answer to Q in w, it follows that all negative partial answers are similarly irrelevant.

We can arrive at the same conclusion via a different route. If initially John only knows that Peter and Frank were invited, (22a) might fail to be true. However, when John's knowledge increases and he finds out that Andrew was invited, too, (22a) may well become true all of a sudden. In other words, adding information to the positive partial answer that John knows has an effect on the truth of the proposition.

On the other hand, if John knows that Peter and Frank were invited and (22a) as before is not true, no amount of additional information concerning non-invitees will ever be able to change this.

Since one can only be surprised about things that one knows, we can now deduce that normp must contradict the maximal positive partial answer that John knows according to (23b).[10] This requirement is stated in (25).[11]

(25) John entertains a proposition *normp* that he considers normal. normp contradicts the maximal positive partial answer to Q that John knows.

Before going on, we need to consider a number of limiting cases. We consider the cases where normp=W, where normp=$\varnothing_w$, the case where Mary in fact invited nobody, and finally the case where John expected Mary to invite nobody.

It is plausible to demand that normp be a contingent proposition. If normp were not contingent it would have to be the tautology or the contradiction. Normp, as we just saw, has to contradict what is know by the subject of the *surprise*-predicate, but the tautology does not contradict any contingent proposition. Hence, normp cannot be the tautology. Normp also cannot be the contradiction. We demanded above that the subject of the *surprise*-predicate must consider normp more normal (or more likely) than the state of affairs that actually obtains. Certainly, the contradiction is a less likely proposition to hold than any other proposition known to hold in the evaluation world by the subject of the *surprise*-predicate; hence, normp cannot be the contradiction.

In fn. 9 I noted that what the subject of the *surprise*-predicate knows must be contingent. This now follows. If the proposition p known by the subject of the *surprise*-predicate were not contingent it would have to be either (i) the tautology or (ii) the contradiction. If p were the tautology, normp would have to be the contradiction otherwise (25) could not be fulfilled. But we just saw that normp cannot be the contradiction, hence, p is not the tautology. p cannot be the contradiction either. This follows from (23b) where we demanded that p be a positive partial answer. Positive partial answers are never contradictory.

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[10] d'Avis 2002 agrees with a referee comment that it might be possible to formulate this condition in terms of contradiction with $answ_2$ after all. I don't see a way of realizing this suggestion.

[11] There are some cases that at first blush appear to require us to take negative partial answers into account. Suppose Mary invited Andrew, Christopher, and Elmar and nobody else. Suppose that John know this, but he expects Andrew to always be invited together with his friend Bert and Christopher together with his friend Dave so that normp would be the proposition *that Mary invites Andrew and Bert or Christopher and Dave or all four of them together (or none of the four)*. In this situation it does seem to be possible to say that John is surprised who Mary invited despite the fact that normp is not incompatible with the weakly exhaustive answer *that Mary invited Andrew and Christopher and Elmar.* If we want to maintain the account given in the text, the most obvious solution to this problem is to assume that our characterization of normp was wrong. Given that John knows that Bert and Dave were not invited, normp becomes the proposition *that Andrew and Christopher were not invited* and this version of normp actually does contradict the weakly exhaustive answer as expected. Cases

This follows since all positive partial answers to a question in a given evaluation world are supersets of (i.e., entailed by) the weakly exhaustive answer. The weakly exhaustive answer to a question in an evaluation world w, always contains w as a member (see fn. 8). Hence all positive partial answers to a question in an evaluation world have at least one member: the evaluation world. They are therefore never the contradiction. This discussion shows that the proposition p known by the subject of the *surprise*-predicate must not be contingent.

We now turn to the case where Mary invited nobody in w. If Mary invited nobody, then the weakly exhaustive answer to the question who Mary invited is the tautology (i.e., $answ_1^w(Q)=W$). The tautology is then the maximally informative positive partial answer to the question. However, as we saw in the previous paragraph, the subject of the *surprise*-predicate must know a contingent partial positive answer, hence we correctly predict that (22a) cannot be uttered if Mary in fact invited nobody. Instead we must say (26).[12]

(26) John is surprised that Mary invited nobody.

Finally, we must consider the case where John expected Mary to invite nobody. In this case, normp is the proposition *that Mary invited nobody.* Example (22a) is not acceptable under these circumstances and neither is its negation (*John isn't surprised who Mary invited* – read with normal intonation). The situation can appropriately be described by (27) though.

(27) John is surprised that Mary invited anybody/people.

Of course, in (22) $answ_1^w$ is the set of all worlds W just in case Mary invited nobody. We can state this by putting a further condition on normp as in (28), which says that normp is incompatible with a world where $answ_1$ is the tautology, i.e., with worlds where Mary invited nobody.

(28) $\text{normp} \cap \{w' \mid answ_1^{w'} = W\} = \varnothing$

We can sum up the discussion so far as follows. *Surprise*-predicates contribute certain presuppositions (29) that make reference to normp, which additionally must answer a general condition (30).

like this then do not require changing the rather stringent condition concerning the relation between normp and the weak partial answer known by the subject of the *surprise*-predicate.

[12] d'Avis treats (26) by invoking an additional presupposition of *surprise*-predicates. However, the additional presuppostion that is needed is not logically independent from the assumptions already in place, but follows from them as shown in the text.

(29) a. normp $\cap$ p = $\emptyset$, where p is the maximally informative partial answer to the question embedded under the *surprise*-predicate known by the subject of that predicate

b. normp $\cap$ $\{w' \mid answ_1^{w'} = W\} = \emptyset$

(30) $\emptyset \subset p_{Erw} \subset W$

6 Why you can't be surprised whether this is true

I will now show that example (31) is excluded on the assumptions outlined and motivated independently in the previous sections. The idea is the following. Given a question whose denotation is a singleton set of propositions, there are only two partial positive answers to that question, the tautology and the proposition which is the single member of the question. Based on this, there is no construal of normp that does not violate one of the conditions stated in (29) and (30). This renders such sentences unusable.

Consider now example (31).

(31) John is surprised whether Mary invited Peter.

From the assumptions concerning the denotation of polar questions described in section 4 the embedded question in (31) denotes the proposition given in (32).

(32) $Q_H = \{p \mid p = \{w' \mid invited(m')(p')(w')\}\}$.

Notice that according to the reasoning given in the preceding section, John must know a non-trivial partial positive answer to Q in the evaluation world. There is only one such positive partial answer: p. Now there are two cases to consider: p(@)=0 and p(@)=1.

If p(@)=0, we derive an immediate contradiction since, by assumption, John knows p, which requires that p be true.

If p(@)=1, then normp must contradict what John knows, i.e., (i) normp $\cap$ p = $\emptyset$ ((29a)). Furthermore, (ii) normp $\cap$ $\{w' \mid answ_1^{w'} = W\} = \emptyset$ ((29b)). We saw above in section 4 that for a polar question Q={q} $answ_1^{w}(Q) = W$ iff q(w)=0. Therefore (ii) reduces to (iii) normp $\cap$ $\neg$p = $\emptyset$. From (i) and (iii) we deduce that normp= $\emptyset$, which violates the condition that expectations must be contingent ((30)).

In other words the presuppositions of (31) cannot be satisfied in a non-contradictory manner. This makes the example unusable (see for similar argumentation concerning the distribution of NPIs Krifka 1995; Lahiri 1998).

None of this hinged on the content of the proposition p. What we have shown is that questions that denote singleton sets cannot be embedded under *surprise*-predicates. Obviously this builds on the assumption that polar interrogatives are singleton sets of propositions.

It might be attempted to replicate this result on the assumption that polar interrogatives contain two propositions ($Q=\{p, \neg p\}$) after all. However, on this assumption the crucial step from (ii) to (iii) does not go through.[13] In fact if $Q=\{p, \neg p\}$, then (ii) above reduces to the trivial statement (v) normp $\cap \varnothing = \varnothing$ since there are no worlds w where $answ_1^w(Q)=W$. This leaves us then with (i) as the only relevant constraint on normp.

One could attempt to still maintain the idea that polar interrogatives are two membered set and blame the status of (31) on the fact that the two members of the question are logically dependent upon each other. Even if it were workable, this solution would be conceptually inferior to the one advocated in this paper, because it would require adding another difficult to motivate presupposition into the lexical entries for *surprise*-predicates. Apart from this conceptual flaw, the suggestion seems to be wrong empirically as a comparison of (33a33b) with (33b) shows. The embedded question in (33a) is a two membered set ($\{p, \neg p\}$) and the two members are logically dependent on each other. On the account where polar questions are two-membered sets, the embedded question in (33b) denotes the same object ($\{p, \neg p\}$) leaving the contrast between the two examples unexplained.

(33) 123,456,789 is either prime or not.
 a. ✓Frank is surprised which one of the two it is.
 b. *Frank is surprised whether it is prime.

I thus interpret the account of (31) given in this paper as an argument for treating polar interrogatives as singleton sets.

7 Conclusion

In this paper I have reported on work in progress aimed at accounting for the fact that polar interrogatives cannot be embedded under *surprise*-predicates. I claim that all *surprise*-

[13] Also the claim that there is only one non-trivial positive partial answer has to be (irrelevantly) relativized to in any given world there is only one non-trivial positive partial answer: p in the worlds where p is true and $\neg$p in the worlds where p is false.

predicates share the presuppositions in (29) and that the natural condition (30) holds. Together with a treatment of polar interrogatives as singleton sets, this explains the ungrammaticality of (31) and the initial example (3b). For this class of examples the need for Grimshaw's clause-type feature is therefore obviated and the hypothesis according to which exclamatives have the same denotation as questions is strengthened.

I have to leave the question of whether the restriction against embedding 'exclamatives' under *interrogative*-predicates, i.e. (2c), for future work. One idea discussed by d'Avis 2001, 2002 is to say that the embedded question in (2c) is degenerate, maybe because it presupposes its own unique answer. However, there are technical difficulties with this account, since the most straightforward implementations of it would treat the embedded question in (2c) as a singleton set leading to an immediate contradiction with the account of (3b) developed in the preceding sections.

The work reported here also has consequences for the study of unembedded exclamatives. If the thesis pursued here is correct that embedded exclamatives simply denote questions, then the differences between matrix questions and matrix exclamatives must basically be that between asking and exclaiming, i.e., it must be a pragmatic effect.

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