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## Coordinating questions: the scope puzzle\*

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**Abstract** This paper introduces a new puzzle concerning the interaction between questions on the one hand, and conjunction and disjunction on the other. It shows that a conjunction of two polar interrogative clauses is interpreted so that each conjunct involves a polar question operator and the conjunction takes scope over these, whereas a disjunction of two polar interrogative clauses can only be interpreted as involving a single polar question operator scoping over the disjunction. In other words, two full-fledged polar questions each including their own question operator can be conjoined, but cannot be disjoined. We argue that the source of this contrast is semantic (rather than syntactic, pragmatic, or other), and we formulate two general constraints on question meanings which can each account for it. The first, based on Fox (2018), requires that the resolutions of a question are related in a particular way to the cells of the partition that the question induces on the context set. The second requires that the exhaustive interpretation of a consistent resolution of the question is never inconsistent. We leave open which of these two constraints is to be preferred.

**Keywords:** questions, disjunction, conjunction, scope puzzle, exhaustification

### 1 Background: can questions be disjoined?

Szabolcsi (1997) and Krifka (2001) argue that questions can be conjoined but not disjoined, based on contrasts like that between (1) and (2):

- |  |               |
|--|---------------|
| (1) Who did you marry and where do you live? | ✓ conjunction |
| (2) #Who did you marry or where do you live? | # disjunction |

In recent work, however, seeming counterexamples to this empirical generalization have been put forward (Haida & Repp 2013; Ciardelli, Groenendijk & Roelofsen 2015, 2018; Szabolcsi 2016; Hirsch 2017). In particular, Ciardelli et al. (2015) argue that questions can in fact be disjoined on the basis of examples like (3), and Hirsch (2017) offers cases like (4).

- |   |               |
|---|---------------|
| (3) Where can we rent a car or who might have one that we could borrow? | ✓ disjunction |
| (4) What is your name or what is your social security number?           | ✓ disjunction |

These observations give rise to the following puzzles.

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(5) **Acceptability puzzles**

- a. Disjunction versus conjunction: Why is (2) not acceptable, while (1) is?
- b. Variation among disjunctions: Why is (2) not acceptable, while (3) and (4) are?

There are various possible approaches that one could take to address these puzzles. First, one might take a **syntactic approach** and assume that disjunction, unlike conjunction, simply cannot combine with interrogative clauses. Besides carrying little explanatory value, this would only account for the contrast between (1) and (2), but not that between (2) and (3)-(4).

Another option is the **semantic approach** proposed by Szabolcsi (1997). Under this approach, a question is taken to express a partition of the logical space, modelled as an equivalence relation over the set of all possible worlds (Groenendijk & Stokhof 1984). The unacceptability of (2) is then derived from the fact that the union of two equivalence relations (i.e., partitions) does not generally yield another equivalence relation. Since the intersection of two equivalence relations does always yield another equivalence relation, (1) is correctly predicted to be acceptable. However, the contrast between (2) and (3)-(4) is not accounted for.

A third option is the **speech acts approach** proposed by Krifka (2001). Under this approach, questions are viewed as speech acts. Krifka argues that speech acts can in general be conjoined (sequenced) but not disjoined.

“Why are there no natural cases of speech act disjunctions? If we see speech acts as operations that, when applied to a commitment state, deliver the commitments that characterize the resulting state, then we can give the following answer: speech act disjunction would lead to disjunctive sets of commitments, which are difficult to keep track of. [...] a disjunction of  $A$  and  $A'$  at the state  $s$  could only be captured by a set of commitment states which we would have to understand disjunctively,  $\{A(s), A(s')\}$ . This is of a higher type than a simple commitment state, and further disjunctive speech acts would lead to still higher types. Hence, we cannot have speech act disjunction and a uniform type of commitment states, namely sets of commitments, at the same time.”

Krifka (2001: p.16)

Like the semantic approach above, this captures the contrast between conjunction and disjunction, (1) vs. (2), but not the contrast between (2) and (3)-(4).

A fourth option is the **pragmatic approach** proposed in Ciardelli et al. (2015). Under this approach, nothing is wrong with a disjunction of two questions as far as semantics is concerned, but certain disjoined questions, such as (2), are odd for pragmatic reasons. More precisely, cases like (2) are odd because it is difficult to construe a context in which the resolutions of both disjuncts are relevant for the speaker's purposes. It is expected on this account that cases like (2) can actually become acceptable if a suitable context is provided. Hirsch (2017) shows that this is indeed the case with the following example:

- (6) [Context: You work as an archivist, and someone comes to you looking for help in locating records on their great-grandfather. Records are organized in two ways: based on spousal relations, and by place of residence. Either piece of information is equally

effective as the other to search the database. After explaining the database to your client, you say:]

So: Who did he marry or where did he live?

The pragmatic approach seems to strike a good balance: it explains the contrast seen in (1) and (2) between conjunction and disjunction, but also the variability in acceptability between the various cases involving disjunction, (2), (3), (4) and (6).

The present paper, however, draws attention to a new contrast between disjoined and conjoined questions, which, we argue, cannot be explained by pragmatic considerations alone, nor by syntactic constraints or restrictions on speech act coordination. Instead, the source of the puzzle seems to be semantic in nature. We will consider two semantic accounts which try to explain the puzzle in terms of the semantic properties of disjunction (Roelofsen & van Gool 2010; Szabolcsi 2016), but will identify problems for both. Then we will consider a semantic constraint on question meanings which has been independently motivated in Fox (2018). It requires that the resolutions of a question are related in a particular way to the partition that the question induces on the context set. We will show that, with a minor amendment, this constraint accounts for the observed contrast. Finally, we will also formulate another semantic constraint, which requires that the exhaustive interpretation of a consistent resolution of a question is never inconsistent. This constraint also captures the relevant data. We will leave open which of the two constraints is to be preferred.

## 2 The scope puzzle

The focus in the debate has so far been on *wh*-questions. We suggest, however, that data involving *polar* questions (PolQs) adds a non-trivial twist to the empirical picture, and can shed new light on the phenomenon. Consider (7) and (8), where  $\uparrow$  indicates rising intonation.

- (7) Does Mary speak French $\uparrow$  and does she speak German $\uparrow$  conjunction  
 (8) Does Mary speak French $\uparrow$  or does she speak German $\uparrow$  disjunction

In terms of surface structure and prosody, (7) and (8) are completely parallel. They both appear to involve a combination of two PolQs. The only difference is that (7) involves *conjunction* while (8) involves *disjunction*. We will see, however, that there are differences between them which cannot be directly derived from the semantics of conjunction and disjunction alone.

To bring out the puzzle, first consider the simple PolQ in (9).

- (9) Does Mary speak French $\uparrow$

This question can be resolved in two ways: by establishing the proposition that Mary speaks French,  $|F|$ , or the proposition that she doesn't,  $|\overline{F}|$ . How this is captured exactly differs from one theory to the next, but it is common to assume that the syntactic structure underlying this sentence involves an operator, let's call it  $?$ , which on the one hand is responsible for the interrogative syntax (auxiliary inversion) and prosody of the sentence, and on the other hand for delivering a semantic value which contains two alternative propositions,  $|F|$  and  $|\overline{F}|$ .

For concreteness, we will spell out the semantic contribution of  $?$ , as well as that of conjunction and disjunction, using the framework of inquisitive semantics (Ciardelli et al. 2018). Similar entries could be given in Hamblin/Karttunen semantics (Hamblin 1973, Karttunen 1977; see also Dayal 2016 for a recent overview), though the treatment of conjunction and disjunction in this framework raises a number of issues, which are avoided in inquisitive semantics.<sup>1</sup> We adopt a particular framework in order to make the exposition concrete and precise, but will at the same time keep the discussion as theory-neutral as possible, so as to make clear that the puzzle we draw attention to arises no matter which framework one adopts.

In inquisitive semantics, the semantic content of a question is a set of propositions, namely those propositions that resolve the issue that the question expresses. If a proposition  $p$  resolves the issues expressed by a given question, then any stronger proposition  $p' \subset p$  resolves the issue as well. Therefore, the set of propositions associated with a sentence  $\varphi$  in inquisitive semantics is always *downward closed*: if  $p \in \llbracket \varphi \rrbracket$  and  $p' \subset p$ , then  $p' \in \llbracket \varphi \rrbracket$  as well.

In this framework,  $\llbracket ?\varphi \rrbracket$  is simply defined as the union of  $\llbracket \varphi \rrbracket$  and  $\llbracket \neg\varphi \rrbracket$ , where  $\llbracket \neg\varphi \rrbracket$  is the set of propositions  $p'$  which are inconsistent with any  $p \in \llbracket \varphi \rrbracket$ .

$$(10) \quad \llbracket ?\varphi \rrbracket = \llbracket \varphi \rrbracket \cup \llbracket \neg\varphi \rrbracket$$

$$(11) \quad \llbracket \neg\varphi \rrbracket = \{p' \mid p' \cap p = \emptyset \text{ for all } p \in \llbracket \varphi \rrbracket\}$$

The semantic content assigned to the polar question in (9) by means of the  $?$  operator is depicted in Figure 1(a). As usual in inquisitive semantics, only the *maximal* elements of  $\llbracket (9) \rrbracket$  are depicted in the figure: the proposition that Mary speaks French and the proposition that she doesn't speak French. We will refer to these maximal propositions as the *alternatives* that (9) introduces. Alternatives correspond to 'elementary resolutions'. They resolve the issue expressed by (9) without providing any unnecessary further information. Stronger propositions, such as the proposition that Mary speaks both French and German, are also included in  $\llbracket (9) \rrbracket$  because they resolve the issue as well. However, they provide more information than is necessary to do so. We will use  $\text{Alt}(Q)$  to refer to the alternatives in  $Q$ .

Conjunction and disjunction are interpreted in inquisitive semantics as intersection and union, respectively. This treatment applies uniformly to conjunction/disjunction in declaratives and in interrogatives.

$$(12) \quad \llbracket \varphi \wedge \psi \rrbracket = \llbracket \varphi \rrbracket \cap \llbracket \psi \rrbracket$$

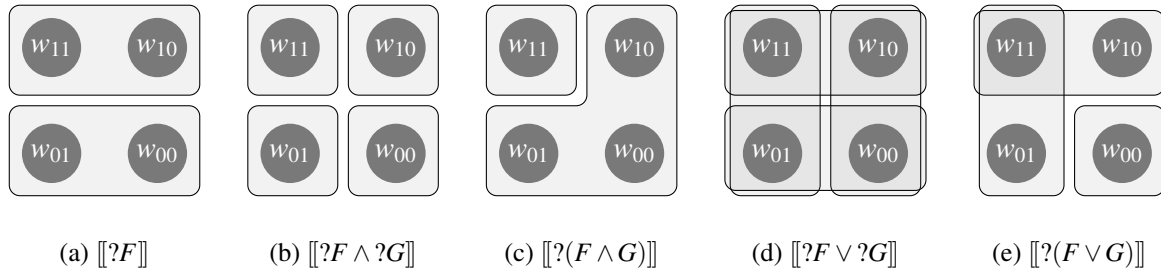
$$(13) \quad \llbracket \varphi \vee \psi \rrbracket = \llbracket \varphi \rrbracket \cup \llbracket \psi \rrbracket$$

Below we will also make use the so-called non-inquisitive projection operator, written as  $!$ , which merges the alternatives of its prejacent by taking their grand union:

$$(14) \quad \llbracket !\varphi \rrbracket = \{\cup \llbracket \varphi \rrbracket\}^\downarrow$$

With a treatment of these basic semantic operators in place, let us now return to the initial examples, which are repeated in (15) and (16), respectively.

<sup>1</sup> For discussion of these issues, see Roelofsen (2013); Ciardelli (2017); Ciardelli & Roelofsen (2017); Ciardelli, Roelofsen & Theiler (2017).



**Figure 1** Interactions between ? and conjunction/disjunction. In each diagram,  $w_{11}$  is a world in which Mary speaks both French and German,  $w_{10}$  a world in which she speaks French but not German, etc.

- (15) Does Mary speak French<sup>↑</sup> and does she speak German<sup>↑</sup>
- Wide scope conjunction:  $?F \wedge ?G$
  - Narrow scope conjunction:  $?(F \wedge G)$
- (16) Does Mary speak French<sup>↑</sup> or does she speak German<sup>↑</sup>
- Wide scope disjunction:  $?F \vee ?G$
  - Narrow scope disjunction:  $?(F \vee G)$

As noted above, the syntax and prosody of these examples suggests that (7) involves a conjunction of two polar questions,  $?F \wedge ?G$ , and (8) a disjunction of two polar questions,  $?F \vee ?G$ , as indicated in (15a) and (16a), respectively. The interpretations that are assigned to the two questions under this analysis are depicted in Figures 1(b) and 1(d).

For the conjunctive question in (15), the reading that this analysis predicts is indeed available. Under this reading, in order to resolve the issue expressed by (15) one needs to resolve the issue expressed by both polar questions. That is, if  $|F|$  is the proposition that Mary speaks French and  $|G|$  the proposition that she speaks German, then in order to resolve the issue expressed by (15) one needs to establish one of the following four propositions.

- (17)
- $|F| \cap |G|$  She speaks both French and German
  - $|F| \cap \overline{|G|}$  She speaks French but not German
  - $\overline{|F|} \cap |G|$  She speaks German but not French
  - $\overline{|F|} \cap \overline{|G|}$  She speaks neither French nor German

However, for the disjunctive question in (16), the reading that this simple analysis predicts is not available. Under this reading, establishing any of the following four propositions is sufficient to resolve the issue expressed by (16) (see Figure 1(d)).

- (18)
- |    |                  |                          |    |                  |                          |
|----|------------------|--------------------------|----|------------------|--------------------------|
| a. | $ F $            | She speaks French        | c. | $ G $            | She speaks German        |
| b. | $\overline{ F }$ | She doesn't speak French | d. | $\overline{ G }$ | She doesn't speak German |

Intuitively, establishing that Mary doesn't speak French is not sufficient to resolve the issue. And the same holds for establishing that Mary doesn't speak German. So the resolution conditions of (16) are not correctly captured if it is analyzed as a disjunction of two polar questions.

Before considering another possible analysis, let us first determine precisely what the resolution conditions of (16) are. To this end, it is helpful to consider a context in which it would be natural to ask this question.<sup>2</sup>

(19) Natural context for (16) (adapted from Ciardelli et al. 2018, p.91)

You keep a small collection of things that could be nice gifts when the occasion arises. At the moment you have two items in your collection, which you purchased on a recent trip through Europe. Both are science fiction novels, one in French and the other in German. You have been invited to Mary's birthday party, though you don't know her very well yet. You know she likes science fiction, but you don't know which foreign languages she speaks. Your friend Susan knows Mary much better. In this context it is natural for you to ask (16) to Susan in order to find out whether you can bring one of the items in your collection as a gift.

Intuitively, the question can be resolved by establishing one of the following propositions:

- (20) a.  $|F|$  She speaks French  
 b.  $|G|$  She speaks German  
 c.  $\overline{|F| \cup |G|}$  She speaks neither French nor German

Note in particular that it is not sufficient to just establish the proposition  $\overline{|F| \cup |G|}$ , because that would leave open the question *which* of the two languages Mary speaks.

We have seen that these resolution conditions are not derived if (16) is analyzed as a disjunction of two polar questions,  $?F \vee ?G$ . However, they *are* derived if we assume that disjunction takes scope *under* the question operator,  $?(F \vee G)$ , as in (16b). The semantic content assigned to the question under this analysis is depicted in Figure 1(e). The three alternatives in this figure are exactly the propositions in (20).

This is surprising. Even though each disjunct in (16) has the surface form and prosody of a polar question, semantically it appears that they are not complete PolQs in the sense that they do not introduce two alternatives each, but just one. The ? operator then applies to the disjunction as a whole, adding a third alternative,  $\overline{|F| \cup |G|}$ .

Now let us return to the conjunctive question in (15). What is predicted if we assume that

<sup>2</sup> Questions like (16) are called *open disjunctive questions* (Roelofsen & van Gool 2010; Roelofsen & Farkas 2015) or *open alternative questions* (Hoeks 2018). See these works for detailed discussion of how such questions differ from disjunctive polar questions like (i) and closed alternative questions like (ii) (with falling intonation on the second disjunct). See also Meertens (2019) for discussion of yet another type of disjunctive question.

- (i) Does Mary speak French or German<sup>↑</sup> disjunctive polar question  
 (ii) Does Mary speak French<sup>↑</sup> or does she speak German<sup>↓</sup> closed alternative question

conjunction takes scope below the question operator,  $?(F \wedge G)$ , as in (15b)? The interpretation that is assigned to the question under this analysis is depicted in Figure 1(c). The prediction is that the question can be resolved by establishing one of the following propositions:

- (21) a.  $|F| \cap |G|$  She speaks both French and German  
 b.  $\overline{|F| \cap |G|}$  She speaks at most one of the two languages

We believe that this is a possible reading of (15). It can be made salient by imagining, for instance, a context in which the speaker is looking for a French-German translator and is inquiring whether Mary might be suitable for the job.

These observations give rise to the following puzzle.

(22) **Scope puzzle**

Why do disjunctive questions like (16) admit a narrow scope disjunction reading,  $?(F \vee G)$ , but not a wide scope disjunction reading,  $?F \vee ?G$ , while conjunctive questions like (15) admit both narrow and wide scope readings?

Note that this puzzle is of a different nature than the acceptability puzzles in (5): it does not involve a contrast in *acceptability* between conjoined and disjoined questions, but rather a contrast in scope taking possibilities. Still, the puzzle directly pertains to the question we started out with: can questions be disjoined? We have seen that in conjunctive questions like (15), conjunction readily takes wide scope w.r.t.  $?$ , while in disjunctive questions like (16), disjunction must take narrow scope. Another way of putting this is that two clauses which are each interpreted as full polar questions (including the  $?$  operator) can be conjoined but not disjoined. So, the scope puzzle and the acceptability puzzles are closely connected and need to be addressed in tandem.

### 3 Generalizing the puzzle

We have introduced the scope puzzle by comparing one specific kind of disjunctive question, the one in (16), with its conjunctive counterpart. We now show that the puzzle is more general, in that (i) it does not only arise with questions like (16) but also with other types of disjunctive questions, and (ii) it does not only arise with matrix questions but also with embedded ones.

#### 3.1 Other types of disjunctive questions

First compare (16), repeated in (23), with the variant in (24).

- (23) Does Mary speak French<sup>↑</sup> or does she speak German<sup>↑</sup> open AltQ  
 (24) Does Mary speak French<sup>↑</sup> or does she speak German<sup>↓</sup> closed AltQ

The only difference in form between these two questions is their sentence final prosody: rising in (23), falling in (24). Following Hoeks (2018), we will refer to (23) as an *open alternative question* (open AltQ), and to (24) as a *closed alternative question* (closed AltQ). The main



difference in interpretation between these two questions is that (24) presents a choice between two alternatives, that Mary speaks French and that she speaks German, and presupposes that exactly one of these is true (Karttunen & Peters 1979, Biezma & Rawlins 2012, among others), while (23) presents a choice between three alternatives: that Mary speaks French, that she speaks German, and that she doesn't speak either of the two (Roelofsen & van Gool 2010, among others). Leaving the 'exactly one' presupposition out of consideration for a moment, (24) corresponds to  $F \vee G$ , while (23) corresponds to  $?(F \vee G)$ .<sup>3</sup> For our present purposes, the main point to be taken away from this is that closed AltQs, just like open AltQs, do *not* admit a reading corresponding to  $?F \vee ?G$ . That is, in this case, too, the two disjuncts, which look like full-fledged polar interrogative clauses, cannot be interpreted as involving the ? operator.

The same point can be made based on examples where a polar interrogative clause is disjoined with a *wh*-interrogative clause:

(25) Where can we rent a car or does Sue have one that we could borrow?

The fact that this question cannot be resolved by establishing that Sue does not have a car that we can borrow means that, semantically, the second disjunct is not a full PolQ.

Something similar holds for the example in (3), repeated here in (26) below.

(26) Where can we rent a car or who might have one that we could borrow?

This question cannot be resolved by establishing that we cannot rent a car, nor can it be resolved to by establishing that no one has a car that we can borrow. If either disjunct was uttered in isolation, these pieces of information would be resolving, however.

### 3.2 Embedding

Now consider (27) and (28), which both involve a disjunction of two *whether*-clauses, embedded under *wonder* and *know*, respectively.

(27) John wonders whether Mary speaks French or whether she speaks German.

(28) John knows whether Mary speaks French or whether she speaks German.

There are two observations to make about these cases. First, both (27) and (28) have a reading under which the disjunction scopes over the embedding predicate. For (27), this reading would be represented as  $!(wonder(John, ?F) \vee wonder(John, ?G))$ . This is not the reading that we are primarily interested in here, because it does not involve direct interaction between the two *whether*-clauses and disjunction. Rather, we are interested in readings that arise when disjunction scopes below the embedding predicate.

<sup>3</sup> It may be worth emphasizing that the disjunction operator in our logical representation language,  $\vee$ , is interpreted in inquisitive semantics as generating multiple alternatives. This makes  $F \vee G$  a suitable logical representation for the closed AltQ in (24). A disjunctive declarative sentence like *Mary speaks French or German* would be represented as  $!(F \vee G)$ . Similarly, a disjunctive polar question like *Does Mary speak either French or German?* would be represented as  $?!(F \vee G)$ . In both cases, the alternatives generated by the disjunction are merged by the ! operator.

The second observation is that there is only *one* such reading, namely the one in (29a).

- (29) a.  $!wonder(\text{John}, F \vee G)$  embedded closed AltQ reading  
 b.  $\# !wonder(\text{John}, ?(F \vee G))$  embedded open AltQ reading  
 c.  $\# !wonder(\text{John}, ?F \vee ?G)$  embedded disjunction of two PolQs reading

That is, the embedded question must be interpreted as a closed AltQ. The sentence conveys (i) that John is entertaining an issue which can be resolved in two ways, either by establishing that Mary speaks French,  $|F|$ , or by establishing that Mary speaks German,  $|G|$ , and (ii) that John believes that one of these alternatives is true. The embedded question cannot be interpreted as an open AltQ, under which the issue that John entertains could be resolved in three ways, including by establishing that Mary doesn't speak either French or German,  $|\neg F \wedge \neg G|$ .<sup>4</sup> Most importantly for our present purposes, the embedded question can certainly not be interpreted as a disjunction of two polar questions,  $?F \vee ?G$ , under which the issue entertained by John could be resolved in *four* ways, including by establishing that Mary does not speak French,  $|\neg F|$ , or by establishing that she does not speak German,  $|\neg G|$ .

Thus the impossibility of obtaining an interpretation corresponding to a disjunction of two full-fledged polar questions,  $?F \vee ?G$ , does not only manifest itself in open AltQs but also in closed AltQs, and not only in matrix questions but also in embedded ones.

#### 4 Arguments against syntactic, pragmatic, and speech act accounts

One way to approach the scope puzzle would be to assume that disjunction and conjunction simply have different syntactic properties. That is, we could assume that disjuncts can never be full interrogative clauses—let's call them ForcePs—while a conjunction of two questions, i.e., a conjunction of two ForcePs, is unproblematic. In this way we could rule out a reading of open AltQs as a disjunction of two PolQs, while we would allow for a reading of conjoined questions as a conjunction of two PolQs.

Of course, an account which just stipulates such a syntactic difference has little explanatory value. However, Krifka (2001) suggests that the assumed difference between conjunction and disjunction may be derived from a more general fact, namely the fact that *speech acts* can be conjoined but not disjoined. If ForcePs express speech acts rather than propositions, it would follow that they can be conjoined but not disjoined.

In Krifka's work, performing a speech act amounts to making a public social commitment, and in disjoined speech acts the addressee would lose track of what it is that the speaker is committing to. In his account, speech acts therefore differ from propositions ("sentence radicals" in Krifka's own terminology) in the sense that they have a dynamic effect on the discourse context: they update commitment states. To account for the difference in scope

<sup>4</sup> Interestingly, open AltQ interpretations *are* available in embedded contexts in cases of *pseudo-subordination*, as exemplified in (i). We must leave an analysis of such cases for another occasion. For present purposes, it suffices to note that here, too, the  $?F \vee ?G$  reading is impossible.

(i) John wondered, was Mary<sup>↑</sup> the right person for the job, or Bill<sup>↑</sup>.

taking ability of conjunction and disjunction, we could adopt Krifka's basic intuition that speech acts affect the context in which they are uttered and correspond to functions which map one discourse context to another. The idea is then that these functions can be sequenced (i.e. conjoined) but cannot be disjoined.

To make such an account work, we first need to assume that ForcePs are headed by a Force head which is responsible for providing the illocutionary force of an expression. For questions, this means that, syntactically, the Force head is responsible for the interrogative syntax (auxiliary inversion, *wh*-movement). Semantically, Force performs two functions: it contributes the ? operator, and it turns the propositional content of its prejacent into a speech act. Thus, at the ForceP level, a transition is made from propositional content to context change potentials, making sure that ForcePs always denote functions from contexts to contexts.

We can then follow Krifka and assume that conjunction expresses generalized intersection at the propositional level and below, while it corresponds to function composition at the speech act level. In practice, this means that a conjunction of ForcePs corresponds to consecutive update with each conjunct. Disjunction, on the other hand, can only express generalized union, because speech act disjunction is impossible. That is, taking the union of two update functions would not yield another update function. Moreover, since the output of a speech act is a discourse context, which is not a set-theoretic object, taking the union of the output contexts generated by the two disjuncts would not yield another output context either.

This would correctly predict that disjunction always has to scope below the illocutionary Force head. And since we assumed that this Force head contributes ? as well, this means that disjunction has to scope below ?.

However, both a purely syntactic account and a speech act account along the lines just sketched can be ruled out based on examples like (30) in which the complement alternatives are overtly mentioned instead of supplied by ?:

(30) #Is the baby awake<sup>↑</sup> or asleep<sup>↑</sup> or is it a boy<sup>↑</sup> or a girl<sup>↑/↓</sup>

Given the surface form of this question, it is most naturally taken to be of the form  $A \vee \neg A \vee B \vee \neg B$  (where *A* stands for 'awake' and *B* for 'boy').<sup>5</sup> This is equivalent to ?*A* ∨ ?*B*. The unacceptability of this sentence cannot be due to purely syntactic reasons since alternative questions with four clausal disjuncts are usually unobjectionable, as illustrated in (31).

(31) Is the door red<sup>↑</sup> or (is it) green<sup>↑</sup> or (is it) blue<sup>↑</sup> or (is it) yellow<sup>↑/↓</sup>

The speech act account cannot capture the infelicity of (30) either: it would rule out a structure in which full ForcePs are disjoined, but it cannot rule out a structure in which the illocutionary Force head scopes over the disjunction which itself consists of smaller disjuncts.

However, note that it would be reasonable to assume that (30) is bad for pragmatic reasons, just like Szabolcsi's initial example: it might be hard to construe a decision problem to which all disjuncts are considered relevant. This hypothesis would be supported by the observation that the AltQ in (32) is quite unnatural to begin with:

<sup>5</sup> In the case of a final rise, we may add a ? scoping over the four-way disjunction, but this would be semantically vacuous.

(32) #Is the baby awake<sup>↑</sup> or is it a girl<sup>↑/↓</sup>

The unacceptability of (30) may therefore have a pragmatic explanation. However, there are cases in which such a pragmatic account does not suffice. An example is given in (33):

(33) [Context: You posted an envelope a while ago, but it hasn't reached its destination yet. You go to the post office to ask about it. At the post office, post is sorted by weight and by date received. Knowing either of these would substantially help the post master in searching for your envelope. So he asks you:]

#Does the envelope weigh more<sup>↑</sup> than 120g or less<sup>↑</sup> or did you send it before<sup>↑</sup> May 1st or after<sup>↑/↓</sup>

This sentence is also unacceptable, even though there is a clear decision problem to which each of the disjuncts is relevant. Also note that the open AltQ version of (33) is fine:<sup>6</sup>

(34) Does the envelope weigh more than 120g<sup>↑</sup> or did you send it before May 1st<sup>↑</sup>

Again, the conjunctive version of (33) is also acceptable, as shown in (35):

(35) Does the envelope weigh more<sup>↑</sup> than 120g or less<sup>↑</sup> and did you send it before<sup>↑</sup> May 1st or after<sup>↓</sup>

Thus, the unacceptability of cases like (30) and (33) cannot be explained in terms of the syntactic properties of disjunction, the impossibility of disjoining speech acts, or pragmatic considerations. A combination of the three does not suffice either.

The problem arises in embedded cases as well. For instance, (36) cannot be interpreted as an embedded disjunction of two PolQs: it can only receive a wide scope reading in which the disjunction scopes over the embedding predicate.

(36) The post master is wondering whether the envelope weighs more<sup>↑</sup> than 120g or less<sup>↑</sup> or whether it was sent before<sup>↑</sup> May 1st or after<sup>↓</sup>

a.  $\rightsquigarrow !(wonder(postmaster, ?A) \vee wonder(postmaster, ?B))$   
 b.  $\not\rightsquigarrow !wonder(postmaster, ?A \vee ?B)$

For the reasons discussed above, the fact that the reading in (36b) is unavailable cannot be explained syntactically or pragmatically, and cannot be reduced to the impossibility of disjoining speech acts. In fact, for the speech act approach embedded questions present a more general problem. That is, if the reason that we do not find disjoined PolQs is that speech acts cannot be disjoined, we would have to say that embedded questions like those in (27) and (28) involve speech acts too. Even though it has been argued that some clause-embedding predicates (such as *ask* and *wonder*) permit speech act embedding, it seems less likely that this would be the case for predicates like *know* or *depend on* (see, e.g., McCloskey 2006).

We conclude that the scope puzzle must, at least in part, be accounted for semantically.

<sup>6</sup> This example is odd with falling intonation, but this can be explained straightforwardly: closed AltQs generally presuppose that exactly one of the disjuncts is true, and this presupposition is not warranted in the given context.

## 5 Existing semantic approaches and their limitations

There are three existing semantic proposals which partly account for the scope puzzle. Two of these (developed in Szabolcsi 2016 and Roelofsen & van Gool 2010, respectively) are based on a non-standard semantics for disjunction; the third on a general constraint on the semantic content of questions (Fox 2018). In this section, we will discuss these three proposals and their limitations. In Section 6, we will further develop Fox's proposal.

### 5.1 Making disjunctions of polar questions tautological

Szabolcsi (2016) suggests that it is possible to derive that two questions cannot be directly disjoined if we assume, following Roelofsen & Farkas (2015), that clausal disjunctions are analyzed as involving non-inquisitive closure of every clausal disjunct. That is, if  $CP_1$  and  $CP_2$  are two clauses translated into our logical language as  $\varphi_1$  and  $\varphi_2$ , respectively, then the disjunction [ $CP_1$  or  $CP_2$ ] is not simply translated as  $\varphi_1 \vee \varphi_2$  but rather as  $!\varphi_1 \vee !\varphi_2$ . The intuition behind this is that each clause is taken to contribute a single alternative to the semantic content of the sentence.

With this treatment of clausal disjunction, our crucial example (16), repeated in (37) below, has two possible translations, depending on whether disjunction takes wide or narrow scope:

- (37) Does Mary speak French<sup>↑</sup> or does she speak German<sup>↑</sup>
- a. *Wide scope disjunction:*  $!F \vee !G$
  - b. *Narrow scope disjunction:*  $?(!F \vee !G)$

The first,  $!F \vee !G$ , is tautological and therefore unlikely to represent the reading intended by the speaker. In the second translation,  $?(!F \vee !G)$ , the non-inquisitive closure operators in both disjuncts are vacuous because  $F$  and  $G$  are already non-inquisitive. So this can be simplified to  $?(F \vee G)$ , which, as we have seen, correctly captures the resolution conditions of the question.

The difficulty for this approach is to properly deal with cases in which at least one of the disjuncts is a *wh*-question rather than a polar question. For instance, it wrongly predicts that (4), repeated in (38) below, can be resolved by establishing the almost trivial fact that the addressee has a name, by establishing that she has a social security number, or by establishing that she doesn't have either a name or a social security number.

- (38) What is your name or what is your social security number?

Similarly, for (3), repeated in (39), it derives a reading on which the question can be resolved by establishing that we can rent a car somewhere (without identifying any specific rental place), by establishing that someone might have a car that we could borrow (without identifying any specific person), or by establishing that a car is nowhere to be rented or borrowed. These resolutions conditions are clearly much too weak.

- (39) Where can we rent a car or who might have one that we could borrow?

## 5.2 Making disjunction sensitive to positive and negative resolutions

Another semantic approach to the scope puzzle is suggested in Roelofsen & van Gool (2010) and Pruitt & Roelofsen (2011). The general idea is to make a distinction between the *positive* and the *negative* resolutions of a polar question. Positive resolutions are ones that confirm the alternative that the polar question overtly expresses or *highlights* in the terminology of Roelofsen & van Gool (2010), while negative resolutions are ones that reject this alternative. For instance, positive resolutions of the question in (40) are ones that confirm that Mary speaks French, and negative resolutions are ones that deny this.

(40) Does Mary speak French?

This distinction can be applied to wh-questions as well. For instance, for (41), positive resolutions are ones that identify someone who might have a car that we could borrow, while negative resolutions are ones that establish that there is no such person.

(41) Who might have a car that we could borrow?

Finally, for a declarative sentence like *Mary speaks French*, the natural assumption is that there are only positive resolutions, namely ones that establish that Mary indeed speaks French.

To obtain these results, ? is taken to introduce both positive and negative resolutions:

- (42) a.  $[[?\varphi]]^+ := [[\varphi]]^+$   
 b.  $[[?\varphi]]^- := [[\neg\varphi]]^+$

For disjunction, the proposal is that a proposition  $p$  is a positive resolution of  $\varphi \vee \psi$  just in case it is a positive resolution of either  $\varphi$  or  $\psi$ , and that it is a negative resolution of  $\varphi \vee \psi$  just in case it is a negative resolution of both  $\varphi$  and  $\psi$ .

- (43) a.  $[[\varphi \vee \psi]]^+ := [[\varphi]]^+ \cup [[\psi]]^+$   
 b.  $[[\varphi \vee \psi]]^- := [[\varphi]]^- \cap [[\psi]]^-$

This treatment of the ? operator and disjunction makes  $?F \vee ?G$  equivalent to  $?(F \vee G)$ . This means that the right resolution conditions are derived for questions like (37), (38), and (39), no matter whether disjunction takes wide or narrow scope.

A difficulty for this approach, however, is to deal with cases involving polar questions highlighting both alternatives that they introduce, and therefore presumably only involving positive resolutions. This is the case, for instance, in (44):

- (44) a. Did the package weigh more than 120 gram<sup>↑</sup> or did it weigh less<sup>↓</sup>?  
 b. Did you send the package before May 1st<sup>↑</sup> or did you send it after that date<sup>↓</sup>?

We have already seen above that disjoining these two questions leads to unacceptability. This is not predicted. Rather, such a construction would be treated as  $?(M \vee L) \vee ?(B \vee A)$ , whose positive resolutions confirm one of the disjuncts, and whose only negative resolution is the inconsistent proposition  $\emptyset$ . There does not seem to be any obvious reason why this should give

rise to semantic deficiency.

### 5.3 Placing a general constraint on question meanings

We now turn to the proposal of Fox (2018). While this proposal is not explicitly concerned with the scope puzzle, we will see that it does provide an account of it. Unlike the semantic approaches discussed above, it does not introduce a non-standard semantics for disjunction. Rather, it argues for a general constraint on question meanings. Roughly, the constraint is that every alternative in a question meaning  $Q$  must correspond to a particular cell in the partition that  $Q$  induces on the context set, and vice versa, every cell in the induced partition must correspond to some alternative in  $Q$ .

Let us make this more precise. First, the *partition* that a question  $Q$  induces on the context set  $A$  (the set of worlds that are compatible with the information that has been established in the conversation so far) has as its cells maximal subsets of  $A$  consisting of worlds which agree with each other on the truth or falsity of each alternative in  $Q$ .

$$(45) \quad \text{Partition}(Q, A) := \text{Alt}(\{C \subseteq A \mid \forall w, w' \in C. \forall q \in \text{Alt}(Q). (w \in q \Leftrightarrow w' \in q)\})$$

Second, the *exhaustification* of a proposition  $p$  w.r.t. a question  $Q$  is obtained by considering which alternatives in  $Q$  are *innocently excludable* given  $p$ . The notion of innocently excludable alternatives, introduced in Fox (2007), is defined as follows.

$$(46) \quad \text{IE}(Q, p) := \left\{ q \in Q \mid \begin{array}{l} \text{for all } R \subset Q : \\ \text{if } \{p\} \cup \{\bar{r} \mid r \in R\} \text{ is consistent,} \\ \text{then } \{p\} \cup \{\bar{r} \mid r \in R\} \cup \{\bar{q}\} \text{ is consistent as well} \end{array} \right\}$$

Intuitively, a proposition  $q \in Q$  is innocently excludable given  $p$  if, whenever it is possible to reject a set of propositions  $R \subset Q$  without contradicting  $p$  then it is also possible to reject  $q$  in addition to all propositions in  $R$  without contradicting  $p$ .

The exhaustification of a proposition  $p$  w.r.t. a question  $Q$  is then defined as the set of all worlds in the context set which make an alternative in  $Q$  true just in case this alternative is not innocently excludable given  $p$ .

$$(47) \quad \text{Exh}(p, Q, A) := \{w \in A \mid \forall q \in \text{Alt}(Q). (w \in q \Leftrightarrow q \notin \text{IE}(Q, p))\}$$

Given these notions, Fox's constraint on question meanings can be spelled out as follows.

#### (48) Question Partition Match (QPM)

Given a context set  $A$ , a question  $Q$  is licensed only if:

- a.  $\forall C \in \text{Partition}(Q, A). \exists p \in \text{Alt}(Q). (\text{Exh}(p, Q, A) = C)$  Cell Identification
- b.  $\forall p \in \text{Alt}(Q). \exists C \in \text{Partition}(Q, A). (\text{Exh}(p, Q, A) = C)$  Non-Vacuity

In words, Cell Identification requires that for every cell  $C$  in the partition induced by  $Q$  there is an alternative  $p$  in  $\text{Alt}(Q)$  such that the exhaustification of  $p$  w.r.t.  $Q$  amounts to  $C$ . In this case, we can think of the alternative  $p$  as 'identifying' the cell  $C$ . So, Cell Identification

requires that every cell be identified by some alternative. The second part of the constraint, Non-Vacuity, requires the opposite, namely that every alternative identifies some cell in the induced partition.

Fox provides empirical evidence for the QPM constraint which is independent from the scope puzzle under consideration here. This evidence concerns epistemic requirements that questions may place on the context set, as well as negative islands. We do not have space here to review these arguments, so we refer to Fox (2018) for details.

What is crucial for us is that the QPM constraint in fact prohibits question meanings like  $[[?F \vee ?G]]$ . To see this, let  $Q$  be  $[[?F \vee ?G]]$  and let  $A$  be the context set. Then:

$$(49) \quad \text{Alt}(Q) = \{|F|, |\neg F|, |G|, |\neg G|\}$$

$$(50) \quad \text{Partition}(Q, A) = \text{Alt}(\{A \cap |F \wedge G|, A \cap |F \wedge \neg G|, A \cap |\neg F \wedge G|, A \cap |\neg F \wedge \neg G|\})$$

Now consider the exhaustification of  $|F|$  w.r.t.  $Q$ . This is the set of worlds  $w$  such that for all  $q \in \text{Alt}(Q)$ ,  $w \in q \Leftrightarrow q \notin \text{IE}(Q, |F|)$ . Note that both  $|G|$  and  $|\neg G|$  are not in  $\text{IE}(Q, |F|)$ . But no world  $w$  can be both in  $|G|$  and in  $|\neg G|$ , since the two are mutually inconsistent. This means that  $\text{Exh}(|F|, Q, A) = \emptyset$ , and the same holds for  $\text{Exh}(|\neg F|, Q, A)$ ,  $\text{Exh}(|G|, Q, A)$ , and  $\text{Exh}(|\neg G|, Q, A)$ . Thus, the QPM constraint is only satisfied if  $A = \emptyset$ , that is, if the context set is inconsistent. This accounts for the fact that questions like (8), repeated in (51) below, are not interpreted as  $?F \vee ?G$ .

$$(51) \quad \text{Does Mary speak French}^\uparrow \text{ or does she speak German}^\uparrow?$$

However, the QPM constraint also makes a problematic predication concerning open AltQs like (51). Namely, it predicts that if such questions are interpreted as  $[[?(F \vee G)]]$ , then they are only licensed if it is already established in the context set that Mary does not speak *both* French and German. To see this, let  $Q$  be  $[[?(F \vee G)]]$  and let  $A$  be the context set. Then:

$$(52) \quad \text{Alt}(Q) = \{|F|, |G|, |\neg F \wedge \neg G|\}$$

$$(53) \quad \text{Partition}(Q, A) = \text{Alt}(\{A \cap |F \wedge G|, A \cap |F \wedge \neg G|, A \cap |\neg F \wedge G|, A \cap |\neg F \wedge \neg G|\})$$

$$(54) \quad \begin{array}{ll} \text{a. } \text{Exh}(|F|, Q, A) & = A \cap |F \wedge \neg G| \\ \text{b. } \text{Exh}(|G|, Q, A) & = A \cap |G \wedge \neg F| \\ \text{c. } \text{Exh}(|\neg F \wedge \neg G|, Q, A) & = A \cap |\neg F \wedge \neg G| \end{array}$$

This means that the QPM constraint is only satisfied if  $A \cap |F \wedge G| = \emptyset$ , which means that it is already established in  $A$  that  $|F \wedge G|$  does not hold. Thus, in its current form, Fox's QPM constraint is too strong to properly deal with open AltQs. In the next section we present an amended version which overcomes this problem.

## 6 Fox's account with an inquisitive twist

Fox's original proposal is formulated in Hamblin/Karttunen semantics. Both in HK semantics and in inquisitive semantics, the semantic content of a question is a set of propositions. However, while in HK semantics these propositions are intended to correspond to the most



basic *answers* to the question, in inquisitive semantics they are intended to correspond to pieces of information that *resolve* the question. This conceptual difference also has a formal repercussion: in inquisitive semantics the semantic content of a question is always downward closed (since if  $p$  resolves the question then any stronger proposition  $q \subset p$  does too), while in HK semantics this is not the case (since if  $p$  corresponds to a basic answer to the question, then this typically does not hold for stronger propositions  $q \subset p$ ).

One way to make precise what the ‘most basic answers’ to a question are is to say that they are answers that provide just enough information to resolve the question, not more than necessary. Under this explication of the notion of most basic answers, they are what we have called *elementary resolutions*. In inquisitive semantics, such resolutions correspond to the *alternatives* in the question denotation. In Section 5.3 we implicitly made use of this way of connecting denotations in HK semantics with ones in inquisitive semantics. As originally formulated by Fox (2018), the QPM requires a match between propositions in the HK denotation of a question and the cells of the induced partition. We stayed maximally close to this proposal by formulating the QPM as requiring a match between the *alternatives* in the question’s denotation in inquisitive semantics and the cells of the induced partition.

However, in inquisitive semantics it is equally natural to formulate the QPM as a constraint that applies to *all* consistent elements of a question’s denotation, rather than just the alternatives. We will show that adapting Fox’s proposal in this way will allow us to properly deal with open AltQs.

Below is a definition of the adapted QPM. The definitions of  $\text{Partition}(Q, A)$ ,  $\text{IE}(Q, p)$  and  $\text{Exh}(p, Q, A)$  can remain unchanged.

(55) **Inquisitive Question Partition Match (IQPM)**

Given a context set  $A$ , a question  $Q$  is licensed only if:

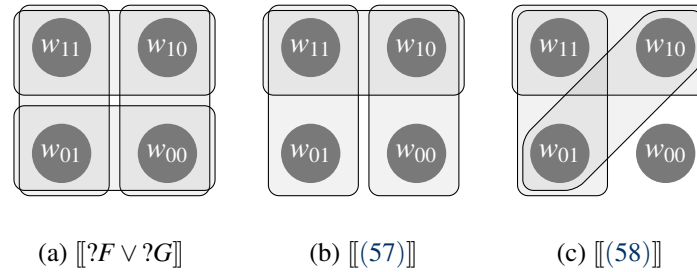
- a.  $\forall C \in \text{Partition}(Q, A). \exists p \in Q. (\text{Exh}(p, Q, A) = C)$  Cell Identification
- b.  $\forall p \in Q. p \neq \emptyset \Rightarrow \exists C \in \text{Partition}(Q, A). (\text{Exh}(p, Q, A) = C)$  Non-Vacuity

To see that the IQPM deals better with open AltQs, let  $Q$  again be  $\llbracket?(F \vee G)\rrbracket$ , and  $A$  the context set. The partition induced by  $Q$  on  $A$  is the same as above, that is:

$$(56) \quad \text{Partition}(Q, A) = \text{Alt}(\{A \cap |F \wedge G|, A \cap |F \wedge \neg G|, A \cap |\neg F \wedge G|, A \cap |\neg F \wedge \neg G|\})$$

However, because  $Q$  is downward closed, we not only have that  $|F| \in Q$  and  $|G| \in Q$ , but also that for any  $p \subset |F|$ ,  $p \in Q$ . In particular, this means that  $|F \wedge G| \in Q$ . And since  $\text{Exh}(|F \wedge G|, Q, A) = A \cap |F \wedge G|$ , the IQPM does not require that it is already established in the context set that Mary does not speak both French and German, as desired.

Moreover, the IQPM still rules out the semantic value  $\llbracket?F \vee ?G\rrbracket$ . To see this, let  $Q$  be  $\llbracket?F \vee ?G\rrbracket$ , and  $A$  the context set. Then the partition induced by  $Q$  on  $A$  is as in (56). We have that  $|F| \in Q$  and the exhaustification of  $|F|$ ,  $\text{Exh}(|F|, Q, A)$ , is  $\emptyset$ , because both  $|G|$  and  $|\neg G|$  are innocently excludable and mutually inconsistent. The same again holds for  $|\neg F|$ ,  $|G|$  and  $|\neg G|$ . This results in a violation of the IQPM because of Non-Vacuity. So the IQPM preserves the result that  $\llbracket?F \vee ?G\rrbracket$  is semantically illicit, while also correctly allowing for  $\llbracket?(F \vee G)\rrbracket$



**Figure 2** Question meanings ruled out by the (I)QPM.

without restrictions on the context set.<sup>7</sup>

Disjunctive questions which have one or more WhQs as their disjuncts, such as (25) and (26), can also be dealt with on this account. For reasons of space, we cannot give an explicit account of WhQs here, but in combination with a standard analysis of such questions in inquisitive semantics (Ciardelli et al. 2018), the IQPM correctly predicts that disjoint WhQs always have to be interpreted with ? scoping over the full disjunction.

Examples involving embedded questions, like (27) and (28), are also accounted for, completely parallel to matrix cases. This is because the semantic value  $[[?F \vee ?G]]$  is simply ruled out, whether it is expressed by a matrix question or an embedded question.<sup>8</sup>

In addition to accounting for the observations relevant for the scope puzzle, the IQPM also predicts the unacceptability of questions like (57) and (58) (cf., Pruitt & Roelofsen 2011).

(57) #Does Ann speak French, does she speak German, or does she not speak German?

(58) #Does Ann speak French, German, or exactly one of the two languages?

In general, the QPM predicts that a question  $Q$  is ruled out in context  $A$  whenever there is at least one alternative  $p \in \text{Alt}(Q)$  such that  $p$  is completely covered by two other alternatives which are each innocently excludable given  $p$ , but mutually inconsistent. In the case of (57), whose denotation is depicted in Figure 2(b), this holds for the alternative  $|F|$ , which is completely covered by the alternatives  $|G|$  and  $|\neg G|$ . In the case of (58), whose denotation is depicted in Figure 2(c), this holds for all alternatives.

<sup>7</sup> For *closed* AltQs, the IQPM does not predict that  $A$  should be inconsistent with  $|F \wedge G|$  either, whereas Fox's QPM does. In this case, the prediction of Fox's QPM is correct, because closed AltQs come with a *not both* presupposition. However, this presupposition may be derived in other ways as well, which are in principle compatible with the IQPM (see, e.g., Biezma & Rawlins 2012; Roelofsen 2015; Hoeks 2018).

<sup>8</sup> In order to account for the fact that open AltQ readings are not available for embedded disjunctive questions, as noted in (29b) above, we would have to make an additional assumption. For instance, we could assume that the ? operator in open AltQs is contributed by an element in the left periphery which is expressed by means of sentence-final rising intonation. Such intonation would be masked in embedded contexts by the intonational requirements of the matrix clause. See Hoeks (2018) for an account along these lines.

## 7 A simpler constraint

The results just obtained can also be achieved by a constraint that is simpler and weaker than the (I)QPM, namely one that requires that the exhaustive interpretation of a consistent resolution of a question is never inconsistent.

(59) **Exhaustification must Preserve Consistency (EPC)**

A question  $Q$  is licensed only if  $\forall p \in Q. (p \neq \emptyset \Rightarrow \text{Exh}(p, Q) \neq \emptyset)$

It is possible here to adopt the definition of  $\text{Exh}$  given in (47), though without making reference to the context set  $A$ . The same results, however, are obtained if we assume that  $\text{Exh}(p, Q)$  simply negates all alternatives in  $Q$  that are not entailed by  $p$ .

$$(60) \quad \text{Exh}(p, Q) = \{w \mid w \in p \text{ and } \forall q \in \text{Alt}(Q). (p \not\subseteq q \Rightarrow w \notin q)\}$$

The rationale behind the EPC constraint is that a question should always facilitate the exhaustive interpretation of resolving responses: it should always be possible to interpret resolutions of the question exhaustively without ending up with an inconsistency. The constraint is thus still tightly linked to exhaustivity, but does not make reference to the induced partition or the context set, in contrast with (I)QPM.

We should note, however, that while EPC has the same empirical coverage as IQPM with respect to the data discussed here, it does not account for the independent empirical facts that Fox (2018) originally used to motivate QPM.

## 8 Conclusion

In this paper, we introduced a new puzzle concerning the interaction between questions on the one hand, and conjunction and disjunction on the other. We showed that a conjunction of two polar interrogative clauses can be interpreted as a conjunction of two full-fledged polar questions, whereas a disjunction of two polar interrogative clauses can only be interpreted as involving a single polar question operator, scoping over the disjunction. Another way to put this is that two full-fledged polar questions, each including their own question operator, can be conjoined but cannot be disjoined.

We argued that the source of this puzzle is semantic, and we considered two types of semantic approaches. The first is to assume a particular semantics for disjunction. We discussed two particular versions of this approach, but we encountered problems for both of them. The second type of approach assumes a general constraint on question meanings. We first explored a version of this approach based on Fox (2018). On this account, the resolutions of a question must correspond, through exhaustification, with cells in the partition that the question induces on the context set. We also considered a simpler constraint, which says that the meaning of a question must be such that the exhaustive interpretation of a consistent resolution is never inconsistent. These constraints both account for the scope puzzle, and make correct additional predictions as well. Further work is needed to determine which of them is to be preferred.

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