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Preface

The purpose of this volume is to bring together a variety of work that has originated from Amsterdam, and a few places where work akin in spirit has been done (Berlin, Paris, Stanford). The reason is twofold. On the one hand the various authors have a very similar style (formal), spirit (making specific subjects fully explicit), and share an interest in closely related themes (which we dub 'questions and related topics'). On the other hand, all of this work has been distributed fragmentarily in the literature and over conferences and conference proceedings. As a consequence, researchers in the field often get to see only a glimpse of what we deem to be a rather coherent body of work, even though it also displays its own natural inconsistencies. With this volume we want to offer the reader the opportunity to get a better idea of the wealth and broad scope of what we immodestly call the Amsterdam style.

Deliberately we have chosen not to write a textbook or monograph. With this large number of authors and interrelated topics that would be by and large unfeasible. Moreover, the theme and style do not naturally lend themselves for a full course in classroom. Having the separate contributions as is, however, (and not a fully condensed canonical work), this offers a much better opportunity to see the Amsterdam style 'at work', and with this volume colleagues interested in specific subjects can easily access the relevant papers in a proper context now.

We did, of course, coordinate a few things. Very first versions of the contributions have been presented on a two-day workshop in Amsterdam (February 2004) where already first comments where exchanged. We have also asked the authors to look at related papers and refer to them, and fine tune their own contribution to the others wherever relevant. Finally we have written an extensive introduction which is meant to first give an overview of the field, to give an overview of the contributions to this volume and to put them in the context of the

wider area of the formal semantics and pragmatics of questions.

One of the starting points is the 1984 dissertation of Groenendijk and Stokhof which we first place among alternative approaches to the (formal) semantics and pragmatics of questions. This work was seminal and has been continued by many researchers (in- and outside of Amsterdam) over the years. A next milestone is Groenendijk's 1999 "Logic of Interrogation", which has given a new swing to the semantic and pragmatic study of questions in a so-called 'update'-style framework. Many contributions to this volume ex- or implicitly build on this paper and it is therefore included as the opening paper. This also motivates the title of the present volume. Jeroen Groenendijk has used it as a title of a talk delivered at Mundial (München, 1997) which predates his logic of interrogation. Although it is referred to at a couple of places, the written paper does not officially exist, so we thought it appropriate to kidnap this very title.

As intended readers we aim at (advanced) students (graduate and PhD), fellow researchers in linguistics, more in particular those with an interest in semantics and pragmatics and especially in the semantics/pragmatics interface. Potential readers include the visitors of, e.g., the Amsterdam Colloquia, SALT and Sinn und Bedeutung. Prerequisites for reading this volume are a working knowledge of first order predicate logic and set-theory, and affinity with issues on the semantics/pragmatics interface.

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The Semantics and Pragmatics of Questions

Paul Dekker, Maria Aloni and Alastair Butler

With this introduction we aim to give a sketch of the research area in which questions are studied from the perspective of a semanticist, a formal linguist interested in the notion of 'meaning'. We start with explaining some general notions and insights in this area, and then zoom in on one of the most influential theories about questions, the partition theory of Groenendijk and Stokhof (section 1.1). In section 1.2 we concisely discuss some alternatives to the partition semantics, and some current issues in the debate about the meanings of questions, which will also pop up every now and then in the contributions to this volume. Then, in section 1.3, we have a thematic discussion of the contributions to this volume themselves, considering them one by one and in relation to each other. We end (section 1.4) with a sketch of some issues which, we think, still abide or have arisen from this volume as a whole.

1.1 General Background

1.1.1 The Notion of a Question

This volume is concerned with the formal study of questions and related topics. Questions are studied from various perspectives. From the viewpoint of a syntactician, questions are linguistic entities, sentences of a certain kind with distinctive features. They can display changes in word order, as witnessed by "Is Peter a good mathematician?" ver-

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sus "Peter is a good mathematician."; *Wh*-expressions, like "Who", "What", "Where", "How", etc., but also "Which students", "Which Canadians" and the like; and in spoken language, a question normally, but not invariable, comes with rising intonation, and in written language with a question mark. The syntactic and cross-linguistic analysis of such 'interrogative' expressions is a matter of ongoing debate.

For a semanticist, questions are the objects which are denoted by the above described type of syntactic expressions. Here the situation is similar to the (formal) study of indicative sentences. In such a study the aim is to find a domain of denotations (propositions mostly), in the form of suitable algebras which generate logical constructions (like that of conjunction, disjunction, negation) and logical relations (like entailment, synonymy and (in-)consistency). Likewise, the study of interrogatives requires one to develop a denotational domain in terms of algebras which motivate suitable constructions like the conjunction and disjunction of questions, and logical relations like that of question entailment and answerhood. Here, too, various approaches are possible and the respective benefits and deficits of these approaches is subject to ongoing discussion.

From a pragmatic perspective, questions are basically acts in a discourse or dialogue. According to, for instance, speech act theorists, simple questions come with some propositional content (their semantics), and the question act is that of asking whether the proposition is true. As will appear from this volume, however, we can also think of questions as a type of act, without disqualifying the idea that there are questions in the semantic domain. The main question then is how the two relate, a typical question about the semantics/pragmatics interface, which is one of the main threads throughout this volume.[1]

From an epistemological, or if you want philosophical, perspective, questions are the things which agents can be concerned with, the questions which a person may have, also if these questions are never explicitly expressed. Judy may wonder whether or not she will be in Paris next year, and this without explicitly asking anybody. One may

[1] An approach which also can be called 'pragmatic' or, rather, 'practical', is the one adopted in the areas of Artificial Intelligence where one studies question answering systems. Here questions are really queries, and the aim is to find, define and study efficient procedures for making proper queries, and especially for answering them in an automated way. Although, clearly, the aims turn out be very similar, the type of work reported on in this volume is purely theoretical. It seeks underlying principles of language, its meaning and use, and is not (directly) concerned with computation and efficiency. We will therefore not go into further detail about this type of computational research. See Monz (2003a) for a recent overview of relevant work.

also wonder "Who am I?", "Does God exist?", "What is the meaning of life?", or "How will the stockmarket develop?", again without posing the questions, or putting them into words. This immediately raises the question whether the objects of wonder and doubt are the same as the objects which constitute the semantic denotations of interrogatives. Do they draw from the same domain?[2] Maybe there are questions which one can face, but cannot put into words.[3] We prefer not to settle this matter, though, but take a pragmatic (Wittgensteinian) stance on this issue, and we will henceforth talk only about questions which can be denoted by utterances, also if we talk about the objects of wonder and doubt (see Wittgenstein, 1953).

More generally, we can ask whether the four sketched perspectives on questions are concerned with different subjects, or whether they study different aspects of one and the same underlying phenomenon. Of course, the semantic study of questions most often takes the syntactic notion of an interrogative as given and as its point of departure, or, conversely, one can take interrogatives to be the syntactic means for expressing them. Furthermore, a semantic question can be taken to be raised in a discourse, and then a suitable pragmatic question is, under what circumstances is this appropriate, what are the effects of this, and what would be, under given circumstances, a (relatively) good reply. Also, it seems to be a reasonably fair assumption that questions raised in a discourse are the questions people themselves face, or wonder about. And there seems to be a case for assuming, as well, that the objects of wonder and doubt are the same as or at least very similar to the denotations of interrogative sentences. In sum, we witness at least close correspondences between the various notions of and perspectives on questions.

However, and this will become clear from various contributions to this volume, the correspondences are not always that close. It seems a 'contemplative' use of the indicative sentence "Peter is a good mathematician." can be used to raise a question, while a 'rhetorical' use of "Is Peter a good mathematician?" typically serves to make a statement. If this is right, then we may have to re-evaluate the semantic denotations of these expressions, thereby giving up very close correspondences between either the syntactic notion of a question and a semantic one or

[2]Indicative sentences raise a similar issue: are the objects of knowledge and belief the same as the denotations of indicative sentences, e.g., propositions?

[3]It seems to be very hard to argue for this position, though. It would require one to come up with a question one can face but not express, but in order to come up with such a question it seems the question has to be stated, thereby rendering the argument vacuous.

between a semantic and a pragmatic one. It can also happen that questions asked are not really the ones people actually face, even though it can be explained that the reply to the question asked may help in answering the question faced. I can ask "Is Judy in Paris now?", not because I am interested in her whereabouts, but because I am interested in those of John, who will always follow her. (And the reason may be that I don't want my interlocutor to know that I am interested in John.) The reason can also be that I want to upset my interlocutor pointing his nose on the fact that Judy could be there, while he could impossibly go. Finally, it is still not excluded that the questions people face are different from the semantic denotations of interrogative expressions.

The upshot of this discussion is not to take a stand on the issue whether there is one unifying or underlying concept of a question. We mainly want to point out that something which gets described under one label (that of a question), may turn out to be different things after all. A more important moral is that, when the term "question" is used, it can be quite important to realize from which perspective it is used: does it concern something syntactic (for which we prefer to use the term "interrogative" in what follows), or some associated abstract semantic object, or some linguistic act, or an object of an epistemic attitude? A phrase like "Albert's question" can refer to either of these, and to properly assess what is said about Albert's question one should make the proper choice.

This volume contains contributions on questions (and related topics) from all four perspectives, although most adopt a semantic or a pragmatic perspective, or the perspective of the semantics/pragmatics interface. The notion of a question we reserve for the semantic denotation of interrogative expressions (the syntactic notion). For the pragmatic and epistemic notions of a question we try to systematically use the terms "question posed" and "question faced", respectively.

In the remainder of this section we will proceed as follows. We start with discussing some of the classical insights in the formal study of questions and answers (subsection 1.2), and then zoom in on the partition semantics from Groenendijk and Stokhof (subsection 1.3). Next, in section 1.4, we show how the partition theory can be extended with a pragmatic component, and indeed can be motivated by it.

1.1.2 The Semantics of Questions

What is the meaning of an interrogative sentence? Maybe it is worthwhile to reconsider a similar question about indicative sentences, the answer to which is probably more widely known. While interrogative

sentences are normally used to pose questions, and imperative sentences to issue commands, indicative sentences are normally used to convey information about the world around us. What information? That the actual world or situation is like it is said to be by the indicative, in other words, that the indicative gives a true description of that world/situation. As we will see later there is more to be said about the meaning of indicatives, but if we focus on this (crucial) aspect of meaning, then we can say that a hearer understands an indicative sentence if he knows what a world or situation should be like for the sentence to be true. As Wittgenstein (Tractatus Logico-Philosophicus, Satz 4.024) has put it:

> Einen Satz verstehen, heißt, wissen was der Fall ist, wenn er wahr ist. (To understand a proposition means to know what is the case, if it is true.)

Insights like this, the roots of which can be traced back to the work of Frege, Russell and later Tarski, have invoked the slogan "Meaning equals truth conditions", and this slogan in turn has prompted the semanticist (who aims to describe and study the meanings of sentences) to specify for every sentence of a given language under what circumstances it is or would be true.

For instance, if Muriel says, in English, "It rains." to you, she has expressed the proposition that it rains, which is the proposition true in all and only the circumstances where it rains. By asserting it she claims that the actual world or situation is like one of those, so that if she is sincere and well-informed, and you are in the same situation, you may well conclude that it rains and take your umbrella when you go out. Of course Muriel may be wrong, she may be joking, but what counts in *understanding* the meaning of an indicative sentence equals understanding under which conditions it is true. These truth conditions thus can be taken to give the meaning of an indicative sentence.

A similar story can be told about interrogative sentences, be it not in terms of truth, but in terms of answerhood. Like we said, interrogative sentences are normally used to pose questions, and the purpose of posing a question normally is to get a true answer for it. So what is a true answer? Apparently this seems to be a proposition which (i) is true of the actual situation and which (ii) answers the question. Let us first focus on the second aspect. Clearly, "John came to the party yesterday.", even if true, cannot count as an answer to the question "Did Monica ever visit Prague?" (even though sometimes it can, in pragmatically deranged situations). Proper answers are like "Yes, Monica did." and "No, Monica never did.". Apparently, the question dictates what

propositions count as an answer. In case of polar questions like the one we are facing here (also known as *Yes/No* questions), there are always two possible answers, basically "Yes." and "No.". However, in cases of *Wh*-questions, those with a *Wh*-phrase inside, there always are many more possible answers. Consider the question: "Who wants to join us on a trip to the beach.". Again, "John came to the party yesterday." does not count as a proper answer, but "Marc, Michelle and Maria want to join." does count as an answer, as does "Nobody wants to.". As a matter of fact, if you take the sentence frame "... want to join." and if you fill in the dots with any list of names, you get a sentence expressing a proposition which is a possible answer. The meaning of a question can therefore be equated with a set of propositions: those that constitute an answer to the question as opposed to those that do not. And now we can come back to point (i) above. What a question solicits is not just any possible answer to the question, but *a* or *the* true answer to the question.

This time the conclusion ought to be that one knows the meaning of an interrogative sentence if one knows, given the circumstances, what counts as a true answer to that question. Since, however, this ought to be perfectly general, that is, since one should be supposed to know what would be a true answer in all possible circumstances, this means that the meaning of a question really resides in its answerhood *conditions*. Actually, this also expresses an age-old insight from Hamblin and Karttunen, and it has been taken up in one of the major semantic theories, like the partition semantics of Groenendijk and Stokhof discussed in the next subsection.

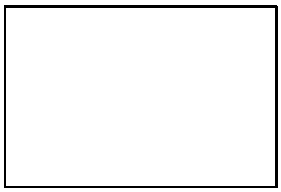
As an excursion, we want to point out that a similar strategy can be followed in the case of imperative sentences. The meanings of these sentences can be stated in terms of, not truth or answerhood conditions, but in terms of compliance conditions. One knows the meaning of an imperative, if one knows what has to be brought about in order to comply with the issued order. And like we can know the meaning (i.e. truth conditions) of an indicative sentence without knowing whether it is actually true or not, and like we can know the meaning (i.e. answerhood conditions) of an interrogative sentence without knowing what is actually the true answer, similarly we can know the meaning of an imperative (i.e. its compliance conditions) without knowing whether they will actually be satisfied. End of excursion.

So far the discussion has been fully general, apart from some illustrative examples drawn from natural language. A formal semanticist however wants more: proposals about the meanings of certain types of expressions should be such that one can in principle *prove* (or if you

want *disprove*) that certain desirable semantic consequences follow, and certain undesirable consequences don't. For this, taking a natural language, like English, as the direct object of study is undesirable because its syntactic analyses may be unclear, and it is full of ambiguities. A very general practice in formal semantics therefore consists in defining a formal language which mimics certain phenomena from natural language in an unambiguous way, make semantic proposals for this kind of language, and study the consequences of these proposals. This is not to say that such studies are no longer about natural language—ideally they are, be it indirectly. The way in which one can put the situation is that the expressions from the formal language represent the contents or meanings of expressions from natural language, be it in an unambiguous and perspicuous way. Besides, this allows one to study certain interesting aspects of meaning by themselves, without being bothered by other (interesting) aspects of meaning, which could only complicate things if studied in tandem. For instance, as one can see in this volume and in much of the literature, tense and temporal phenomena are totally abstracted away from and the focus of many papers is on a small language of predicate logic, extended with a question operator. Not because tense is irrelevant, but because the interpretation of questions (and their answers) is the prime subject of investigation here.[4]

1.1.3 The Partition Theory

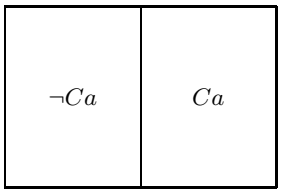
In the Groenendijk and Stokhof semantics for interrogatives (see, e.g., Groenendijk and Stokhof, 1984, 1997), questions "partition logical space". What this means can be best illustrated by means of some pictures. Logical space is a set of logical possibilities (possible worlds, possible situations or possible circumstances). We will keep on using the term 'possibilities' or 'worlds' from now on, without being committed to a particular interpretation of these terms. Logical space can be represented as follows:



[4] As, similarly, questions hardly play a role in any known semantics of the temporal system. Notice, though, that the interplay itself between questions and tense can be very interesting, but we do not know of any literature on this.

where all the points in the rectangle should be taken to constitute the possibilities. The sentences of some formal language can be evaluated on such a logical space by means of some given valuation function which tells us, for each possibility, whether the sentence is true there, or false, like in a standard (modal) predicate logical fashion. An indicative sentence like "Andrea is in Copenhague." (formally: Ca) is true in some possibilities and false in others. If it is asserted, the claim is that the actual world is among the Ca-worlds, the worlds in which Andrea is in Copenhague.

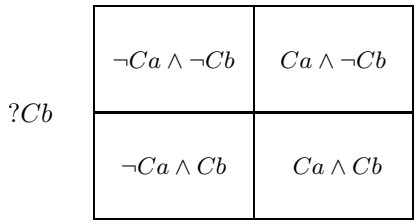
Now consider the question "Is Andrea in Copenhague?" (formally $?Ca$). This polar question has as possible answers a positive and a negative one. The possibilities in which the answer is positive can be grouped together, and the same can be done with the possibilities in which the answer is negative, and the two groups (propositional answers) have to be distinguished. This can be displayed as follows:



$?Ca$

This picture indicates an interest in knowing on which side of the vertical line the actual world resides: are we in a Ca-world, one in which Andrea is in Copenhague, on the right side of the line, or in a $\neg Ca$-world, where she is not there, on the left of the line. The differences between worlds on the same side of the line are immaterial to this question.

We can add the question whether Bernhard is in Copenhague, (formally: $?Cb$). This leads to a further subdivision, this time indicated by means of a horizontal line:



$?Ca$

If we now, for the purpose of exposition, make the simplifying assumption that Andrea and Bernhard are the only relevant individuals, then the last picture is the same as the next one representing the question "Who are in Copenhague?" (formally: $?x\ Cx$):

$?x\ Cx$

$\neg\exists xCx$	$Ca \wedge \neg Cb$
$\neg Ca \wedge Cb$	$\forall xCx$

The basic idea about exhaustiveness, and of the partition semantics, is that *Wh*-questions do not ask for some possible instantiation of the *Wh*-term, but they want a full specification of it. That is to say, as an answer to the question "Who are in Copenhague?" it is not sufficient to say that Andrea is, because that only tells us that the actual world is on the right of the vertical line, it does not tell us its location relative to the horizontal line, it does not tell us whether Bernhard is there or not. In that sense the mere proposition that Andrea is in Copenhague is only a partial answer to the *Wh*-question.

The pictures with their dividing lines (and in general many more lines can be added) indicate what, semantically speaking, questions are according to the partition semantics. The blocks in the partitions constitute sets of propositions (the possible answers), where propositions are taken to be sets of possibilities (those where the respective propositions are true). Moreover, they cut up logical space in non-overlapping parts, which together cover the whole space. In set-theoretical terms this means that a question $\mathcal{Q}$ is a set of sets of possibilities such that

1. $\bigcup \mathcal{Q} = \mathcal{L}$ (where $\mathcal{L}$ is logical space)
2. $\forall A, B \in \mathcal{Q}$: if $A \neq B$ then $(A \cap B) = \emptyset$

The first clause really says that the question has an answer in all possibilities: every possibility figures in some proposition, and the proposition in which it figures constitutes the full true answer to the question in that possibility. The second clause says that there is only one full and true answer in each possibility: if, with regard to the question, there may be a difference with another possibility, then that other possibility lives in another block, it is associated with a different answer. This is as we saw above. Even though Andrea is in Copenhague in two possibilities i and j, so that "Andrea is in Copenhague" is true in both i and j, if Bernhard is in Copenhague in i and not in j, then i and j

are in different blocks in the partition induced by the question "Who are in Copenhague?". So while "Andrea is there and nobody else.", "Bernhard is there but nobody else." and "Andrea and Bernhard are there." express three mutually exclusive propositions (three of the four possible answers to our question "Who is there?"), the answers "Andrea is there." and "Bernhard is there." are not mutually exclusive, and therefore not full answers to the question.

An exhaustive notion of a possible answer, as it can be modeled by partitions, turns out to be logically, empirically, and also pragmatically very well behaved. The last two benefits will be discussed in more detail in subsequent subsections. We want to end this subsection with a concise discussion of its logical benefits.

It is generally known that partitions are defined by equivalence relations. An equivalence relation on some set is reflexive, transitive and symmetric. It is easily seen that if a relation relates all elements which belong to the same block in a partition, and no element with any element residing in another block, then that relation is reflexive, transitive and symmetric, i.e., we have an equivalence relation. Conversely, if we have an equivalence relation over some set or space, then it induces a partition which puts related elements in one block, and no other ones. Since the relation is reflexive, transitive, and symmetric, all elements (possibilities) figure in at least one block, and no possibility figures in more than one, hence it is a partition.[5]

The formulation of a question in terms of an equivalence relation can be understood as follows: the question is insensitive to the difference between any two related possibilities, because for the 'purpose' of the question they are 'equivalent', in a rather literal sense. The question is, however, sensitive to the difference between two (or more) sets of mutually unrelated possibilities, because that is what the question boils down to: in which of the two (or more) sets does the actual world reside?

When questions are formulated as equivalence relations, we get a neat notion of question conjunction and question entailment in return. Conjunction is intersection and entailment comes down to the subset-relation in all possible models. Very standard Boolean relations thus apply to the logic of interrogatives as well. Let us expand a little bit on this before we proceed to the next subsection.

We sketched above that if we started with the question whether Andrea is in Copenhague (which induced a bi-partition, a division in

[5] Formally, if $\mathcal{Q}$ is a question, then the induced equivalence $R_{\mathcal{Q}} = \{\langle i, j\rangle \mid \exists A \in \mathcal{Q}: i \in A \,\&\, j \in A\}$; furthermore, if R is an equivalence relation, then the corresponding partition $\mathcal{Q}_R = \{\{j \mid \langle i, j\rangle \in R\} \mid i \in \mathcal{L}\} \setminus \emptyset$. Exercise: prove that $R_{\mathcal{Q}}$ is an equivalence relation, that $\mathcal{Q}_R$ is a partition, and that $\mathcal{Q}_{R_{\mathcal{Q}}} = \mathcal{Q}$.

two blocks), we could add the question whether Bernhard is there (another bi-partition). Multiplication of the two questions led to a four-way division as we have seen, and in general if we multiply any two independent questions, we get the product number of possible answers as a result. This is exactly what intersection of the corresponding equivalence relations gives us. (It is a very good exercise for the reader unfamiliar with this material to make this formally explicit and then prove this claim to be true.)

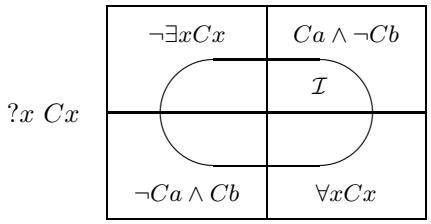
As for entailment, if we have two questions $\mathcal{Q}$ and $\mathcal{R}$, and if we look at the corresponding equivalence relations $R_{\mathcal{Q}}$ and $R_{\mathcal{R}}$, then $\mathcal{Q}$ entails $\mathcal{R}$ iff $R_{\mathcal{Q}} \subseteq R_{\mathcal{R}}$. In terms of partitions this boils down to the requirement that every block in $\mathcal{Q}$ is a subset of a block in $\mathcal{R}$, so every possible full answer to $\mathcal{Q}$ entails a possible full answer to $\mathcal{R}$. In terms of the examples we discussed, $?Ca \wedge ?Cb$ entails $?Ca$, because any full answer to the first entails a full answer to the second, and, likewise, $?x\ Cx$ entails $?Cz$, for any z, since if we have a full specification of the persons who are in Copenhague, we automatically know whether z is there, for any arbitrary z. In Groenendijk (1999) the very same entailment relation (specified in terms of the subset-relation) automatically generalizes to a few other cases, but before we can come to that, we have to address a couple of other issues in the theory of questions and answers.

1.1.4 The Pragmatics of Questions

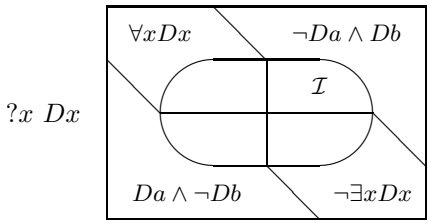
The partition semantics can be extended naturally when it comes to the use of questions, thereby making the whole framework much more sophisticated and of wider application. Besides, the pragmatics of questions can also be taken to motivate the partition semantics. In this subsection we will discuss some issues pertaining to the pragmatics of questions in discourse, as well as some subtle and instructive snags.

It is generally acknowledged that utterances (assertions, questions, etc.) are never or hardly ever evaluated against an empty background. Language is always used against a background of common knowledge or belief, private knowledge and belief, and information the interlocutors have about the information of others. Groenendijk and Stokhof already acknowledged this in their 1984 dissertation, and developed a notion of a 'pragmatic answer'.

Consider the following picture, the same as the one for $?x\ Cx$, but now with an additional oval (labeled $\mathcal{I}$) which represents the current state of information:



The oval $\mathcal{I}$ must be understood as indicating that the actual world is assumed to be inside of it, and that all possibilities outside the oval have been dismissed as being non-actual. (It may be important to realize that, maybe, they have been dismissed mistakenly, we will come back to this below.) The above picture indicates that, while the semantic question cuts up logical space into four big blocks, it is the division of the oval into four parts that is pragmatically relevant (since everything outside the oval is deemed non-actual, and therefore irrelevant). This means, however, that a question different from $?x\ Cx$ might do the very same job, pragmatically speaking. Consider the next picture with a possible alternative question $?x\ Dx$:

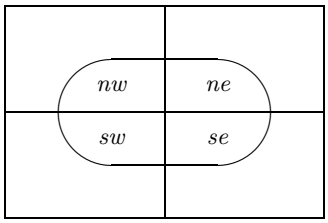


Notice first, that the two questions are logically independent. For instance, the answer $\neg\exists xCx$ to the first question does not entail (is not included in) any answer to the second question, and the answer $Da \wedge \neg Db$ to the second does not entail (is not included in) any answer to the first. So, semantically, there is no entailment relation between the two questions. However, inside the oval the two questions coincide, so pragmatically speaking, against the background $\mathcal{I}$, the questions are equivalent. It is important to note, though, that $\mathcal{I}$ after all might not include the actual world, and then the difference between the two questions becomes important. For the actual world might be one in which both $\neg\exists xCx$ and $Da \wedge \neg Db$; in that case the two propositions are (true) answers to the respective questions, but a person who believes to be in

$\mathcal{I}$ would feel licensed to draw two totally different conclusions.

With semantic and pragmatic notions of answerhood at hand, Groenendijk and Stokhof (1984) developed various notions of what is a better answer to a question relative to some background information $\mathcal{I}$. We will not discuss these here but refer the reader to the original dissertation and papers.

Let us now start from the pragmatic perspective and see how it can be seen to motivate a partition-style semantics. Robert van Rooij has shown that basic concepts from decision theory, in particular the concept of a decision problem, closely relate to such partitions (see, e.g. van Rooij, 2003). An agent who wants to eat in a Thai restaurant may face a decision problem, namely where to go? Let us assume she is at a junction, where she could take four directions: northwest (*nw*), northeast (*ne*), southwest (*sw*), and southeast (*se*). Let us assume as well that she has information that there is exactly one Thai restaurant, to be found in one of these directions, but that she has no information about in which direction it is. She could try all directions in some random order but that is quite troublesome. She could also ask some passer-by for the direction to the restaurant, something displayed by the following picture:



A full and hopefully true answer to her question would directly help to solve her decision problem: if the restaurant is to be found direction northeast, then that's the way to go. A partial answer, like "Northeast or southwest." however, would not help her out. Of course, she could skip considering northwest and southeast, but she still would not know where to go. This example shows that if one has to make a choice, where only one choice can or should be made among alternatives, then a very appropriate thing to do is to pose a question in which every possible answer corresponds to exactly one possible choice, that is, *given the background information*.[6] van Rooij (2003) has not only spotted this

[6]Nothing here excludes, of course, the posing of questions just for purposes like 'simply wanting to know', 'curiosity', or for 'keeping the conversation going', and

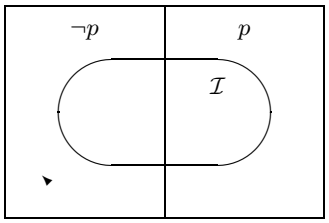
kind of formal correspondence between notions of decision theory and the partition semantics, but he has also worked out decision theoretic notions for comparing the relevance of questions and that of answers.[7]

In the previous paragraph we deliberately emphasized the clause *given the background information*, because this brings up two subtle points with which we want to end this section.

Let us go back to a simplified situation in which two interlocutors are facing two sets of apples: red ones and green ones. One of them wants to buy one group but doesn't know which, so she asks:

(1) Do the red ones taste better?
(Which apples taste better, the red ones or the green ones?)

The situation can be displayed as follows:



$?p$

Where p is short for "The red ones taste better.". Again, the question cuts up logical space in two parts, and also the information set $\mathcal{I}$. If the actual world happens to be a $\neg p$ world then one might choose to buy the green apples, the red apples otherwise. However, our agent has mistaken information, since the actual world, indicated by the little arrow, lies outside her information set, her information excludes the (possibility corresponding to the) actual world, which means that she has got some mistaken beliefs. One mistaken belief may be that the apples are real, whereas, actually, they are fake. Now the interlocutor may realize this, and come up with the full and true semantic answer $\neg p$, corresponding to the statement that the green (fake) apples taste better than the red (fake) ones. (For, the actual world here resides in the $\neg p$ block.) However, realizing our questioner's mistake, and realizing for what purpose she might want to buy the apples, he'd better explain the mistake and reply that all the apples are fake.

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the like. Probably the same semantic analysis, but probably a different pragmatic one can be applied to cover these cases.

[7] Actually, van Rooij treats plain questions and embedded questions alike in a so-called underspecified way, which allows various exhaustive, partial and scalar readings depending on the contextually given relevance ordering.

What this example teaches us is that we have to carefully distinguish the semantic and the pragmatic question posed, and that it makes sense, if we look at the pragmatics of questions, to consider the reason or relevance of asking a question, taking into account possibly mistaken information in the information set of the questioner. It moreover shows once more, that pragmatically speaking, questions are in a sense conditional on the assumption that the background information is correct. So here we witness another example where the question faced and the question posed, unbeknownst to the questioner, depart.

That questions can be conditional on background information can also be made explicit, and this can also be motivated from a choice- or decision-making perspective. Suppose I am in doubt whether or not to go to the party tonight. The presence of a certain constellation of guests might make it attractive for me, whereas other constellations might put me off. So, in order to make a good decision I may ask "Who comes to the party tonight?". But now the answerer may face a problem, because a full answer would have to include me or not, and since I have not yet decided, he cannot know. Besides, the decision of others to come to the party may as well depend on their expectation of me being there. So an appropriate answer could be: "Well, if you decide to go, then so-and-so will be there." A most probably inappropriate answer would be "Well, if you don't go, then so-and-so will be there."

My question thus is understood in a conditional way, and I might as well have asked directly: "If I go the party, then who will be there as well?" This question asks for a specification of those present and absent in the case where I go, and asks nothing about the cases in which I don't go. It turns out that the interpretation of such conditional questions can be elegantly modeled, but at the cost of giving up true partitions in favour of so-called 'pseudo-partitions': zooming in on the set of possibilities in which I go, we find a true partition, but none of these is distinguished from any of the possibilities in which I don't go.[8]

1.2 Current Issues

There are a couple of issues which plague the literature on the semantics of questions, and in this section we take a brief look at four of them.

[8] Velissaratou (2000) has elaborated such an analysis for conditional questions. Questions like "If Felix goes to Paris, then who will do the household?" partition the set of possibilities with Felix in Paris, but don't distinguish them from those in which Felix is not, since the very conditional antecedent makes these possibilities irrelevant. We refer to Velissaratou (2000) and Dekker (2004) for a more detailed investigation.

Three of them—the topics of exhaustification, structured meanings and dynamic interpretation—play a notable role in the contributions to this volume, and while the fourth on "knowing who" does not, it is certainly worth addressing here, because it will definitely play a role in future extensions of the proposals made in this volume.

1.2.1 Exhaustification

The first issue concerns the idea that the meanings of questions are exhaustive. Before we can make this precise, it is expedient to make the question language precise. Like we said, the language is that of predicate logic, extended with a question operator. The formulas of predicate logic will also be referred to as indicatives, and if ϕ is an indicative, and $\vec{x}$ a (possibly empty) sequence of variables $x_1, \ldots x_n$, then $?\vec{x}\ \phi$ is an interrogative.

The question operator $?\vec{x}$ queries the possible values of the variables $\vec{x}$ under which the embedded formula ϕ is true. In case $\vec{x}$ is empty, $?\vec{x}\phi$ is a polar question, (a *yes/no* question). If $\vec{x}$ consists of one variable x only, as in $?xCx$ ("Who comes?"), it asks for the extension of C; if $\vec{x} = xy$ consists of two variables, as in $?xy(Bx \wedge (Gy \wedge Sxy))$ ("Which boys saw which girls?"), it asks for the set of pairs consisting of a boy and a girl the boy saw.

Groenendijk and Stokhof's semantics of questions, which is quite similar to that of Higginbotham and May (1981), Higginbotham (1996), can be specified as follows, relative to a model of modal predicate logic $M = \langle W, D, I\rangle$, where W is a set of possibilities, D a domain of individuals, and I an interpretation function for the individual and relational constants in each possibility. For the interpretation of free variables we use the usual assignments g of values from D to variables as a parameter. By $g'[\vec{x}]g$ we mean that assignment g' which is like g except (possibly) for the values it assigns to the variables $\vec{x}$:

- $[\![?\vec{x}\ \phi]\!]_{M,g} = \{\{w' \mid \forall g'[\vec{x}]g\colon [\![\phi]\!]_{M,w',g'} = [\![\phi]\!]_{M,w,g'}\} \mid w \in W\}$

Relative to some world w, a question denotes the full and true answer to the question. It is a proposition true in exactly those possibilities where exactly the same valuations of the variables $\vec{x}$ render ϕ true, respectively false. If $\vec{x}$ is the empty sequence, then relative to some world w this boils down to the set of possibilities $\{w' \mid [\![\phi]\!]_{M,w',g} = [\![\phi]\!]_{M,w,g}\}$, which is the set of worlds w' where ϕ has the same truth values as in w. So this is the proposition that ϕ if ϕ is true in w, and the proposition that not ϕ, if ϕ is false in w. If $\vec{x}$ is non-empty, things get more interesting. Consider $?x\ Cx$ ("Who comes?") relative to w. Some calculations show that this denotes the proposition true in exactly those worlds w' where

the denotation of C is the same as in w. If $n_1, \ldots, n_j$ is an enumeration of all and only the people who come in w, then the full and true answer is the proposition that $n_1, \ldots, n_j$ come and nobody else. Here we see what is exhaustive about this semantics: it requires a full specification of the possible values of the queried variables, and a closure statement stating that this is indeed the full set of possible values. In general we see that indeed the meaning of a question is a set of propositions. Each world is associated with one full possible answer, and as it so happens it partitions logical space: in each world there is only one full and true answer, and worlds in which this answer is the same are grouped together and they are distinguished from worlds where the answer is different.

Earlier treatments of questions by Hamblin (1973) and Karttunen (1977) are also based on the idea that the meaning of an interrogative resides in its answerhood conditions. They differ, however, in the way they spell this out, namely in a non-exhaustive way. For completeness, let us consider Hamblin's semantics for interrogatives, slightly adapted to the present format (by $g[\vec{x}/\vec{e}]$ we mean the assignment which is like g except that it assigns $\vec{e}$ to $\vec{x}$:

- $[\![?\vec{x}\ \phi]\!]_{M,g} = \{\{w' \mid [\![\phi]\!]_{M,w',g[\vec{x}/\vec{e}]} = 1\} \mid \vec{e} \in D^*\}$

In this definition $\vec{e}$ is assumed to be any sequence of individuals with the same length as that of the sequence $\vec{x}$ of variables queried. Again the meaning of an interrogative is specified as a set of propositions (possible answers), but its relation to the question is quite different from that of Groenendijk and Stokhof (and Higginbotham). The main difference is that the possible answers are not (meant to be) exhaustive.

Consider $?x\ Cx$ ("Who comes?"). Some calculations show that the possible answers according to the last definition are the propositions that d comes, for any individual in the domain, i.e., the proposition that Marc comes, the proposition that Muriel comes, etc., this for any entity in the domain. Or consider $?xy(Bx \wedge (Gy \wedge Sxy))$ ("Which boys saw which girls?"). This time the answering propositions are taken to be that Marc saw Muriel, that Menno saw Mathilde, etc., for any pair $\langle d, d' \rangle$ where d is a boy and d' a girl. In case $\vec{x}$ is the empty sequence as in $?p$ ("Does it rain?") there is only one possible answer: p ("That it rains.").

The latter definition can be modified somewhat, in that, relative to some possibility, we only select the possible answers true in that possibility, and we can take the conjunction of all true answers in a possibility, thereby generating something like an exhaustive specification. The underlying ideas are different, though.

One advantage of the exhaustive approach to question meanings is that it automatically comes with a straightforward logic of interrogatives and that it also neatly fits in with pragmatic and decision-theoretic approaches to natural language (as seen in the previous section). It is not so obvious whether the same points can be made in favour of the non-exhaustive approaches.

Besides, as Groenendijk and Stokhof rightly argue, their (exhaustive) semantics of unembedded interrogatives directly applies to embedded interrogatives. Consider:

(2) Marc knows who come.
(3) Muriel wonders who come.

Example (2) can be taken to express that there is a true answer to the question "Who comes?" and even though the speaker may fail to know the answer, she expresses that Marc knows it. Intuitively, this is not just a singular proposition of the form "Menno comes." which Marc is said to know; rather it says that, relative to a domain of relevant individuals, Marc knows of each of them whether he or she comes or not — indeed the exhaustive interpretation. And in example (3), Muriel is not said to be concerned with the truth or falsity of a singular proposition of the form "Judy will come.", but with a set of exhaustive propositions possibly answering the question "Who comes?", and trying to figure out which of these is the actually true answer. In both cases, the exhaustive interpretation of the embedded interrogative seems to be the right object of knowledge and wonder (see Heim, 1994).

So far, the odds seem to favour the exhaustive interpretation of interrogatives. However, one type of example may speak in favour of non-exhaustive interpretations, questions with so-called 'mention some' readings. Typical examples include:

(4) Who's got a light?
(5) How can I get to the station?
(6) Where can I buy an Italian newspaper?

These type of questions are normally (not invariably!) used to ask for one verifying instance only. If I have found someone who has a light, I don't care about who else has got one. If one asks the road to the station, one is not assumed to be interested in the infinite number of ways one could get there. And if I want to buy an Italian newspaper, one close enough place suffices, and a specification of all places around town where you can buy one seems pedanticly superfluous.

There is a lot of literature on this subject. Do interrogatives have two types of meanings? Are they ambiguous? Or can we derive one of them from the other? We will not go into a discussion of these matters

here, since the subject will return in more empirical detail in the next section and in the contributions to this volume themselves.

1.2.2 Structured Meanings

An approach to the semantics of interrogatives which seems to be more radically different from the ones above, is the so-called 'categorial' or 'structured meanings' approach (von Stechow, 1991, Krifka, 2001, e.g.,). This type of approach also seeks the key to the meaning of interrogatives in terms of their possible answers, but it does not take propositional answers (answerhood conditions) as the fundamental notion, but constituent answers.

The main idea is that questions basically are functions, and that their possible answers supply the arguments to these functions in order to yield a proposition. Consider the examples from above again, this time as they are formulated in the structured meanings framework:

(7) Who comes? $(\lambda x\ Cx)$[9]
Marc. $((\lambda x\ Cx)(m) \Leftrightarrow Cm)$

(8) Which boys saw which girls? $(\lambda\langle x, y\rangle\ Sxy)$
Marc Judy. $((\lambda\langle x, y\rangle\ Sxy)(\langle m, j\rangle) \Leftrightarrow Smj)$

(9) Does it rain? $(\lambda f\ f(r))$
No. $((\lambda f\ f(r))(\lambda p\ \neg p) \Leftrightarrow (\lambda p\ \neg p)(r) \Leftrightarrow \neg r)$

If we take sentences to denote propositions, then every interrogative denotes a function from answer-type denotations to propositions. If the interrogative hosts *Wh*-elements, as in the examples (7) and (8), then the required answer types are those of the (tuples of) *Wh*-elements. In case of a polar question (9), the argument type is a function on the domain of propositions, basically "Yes." $(\lambda p\ p)$ and "No." $(\lambda p\ \neg p)$.

It is relatively easily seen that the structured meanings interpretation of interrogatives is strictly richer than its propositional counterpart. For we can *derive* the latter from the former (but not the other way around):

- Let $\mathcal{S}$ be the structured meanings interpretation of an interrogative; then the corresponding propositional interpretation $\mathcal{Q}_{\mathcal{S}} = \{\{w' \mid \forall \vec{e} \in D^*\colon w' \in \mathcal{S}(\vec{e}) \text{ iff } w \in \mathcal{S}(\vec{e})\} \mid w \in W\}$

[9] Just for completeness, if x is a variable of type a, and β an expression of type b, then $\lambda x\ \beta$ is an expression of type $\langle a, b\rangle$ with interpretation: $[\![\lambda x\ \beta]\!]_{M,g} =$ that function h from a-type things to b-type things such that $\forall d \in D_a\colon h(d) = [\![\beta]\!]_{M,g[x/d]}$. As we can see in the next example, we can also abstract over tuples of variables, and apply these abstracts to tuples of arguments. As is well-known $(\lambda x\ \beta)(\alpha) \Leftrightarrow [\alpha/x]\beta$, provided that no free variables in α get bound by the substitution for x in β (λ-conversion).

This fact indicates that anything that can be done on the propositional approach can be done on the structured meanings approach as well, in an indirect way. This comes at a price, though. In the first place a structured meanings account must assume that questions and their characteristic answers live in many categories: in principle they can be functions of any type of arguments to propositions. Furthermore, question-embedding verbs like "wonder" and "know" (as in "know who", "know whether" etc.) cannot directly apply to the meanings of their embedded arguments, because their structured meanings interpretation first has to be recast into their propositional interpretation.

It must be said, however, that this price is not paid for nothing. As we can see from the examples (7–9), a structured meanings interpretation of interrogatives gives us a direct means to interpret (non-propositional) constituent answers: the function associated with the interrogative simply applies to the interpretation of the argument and the result is the propositional answer (which can be true or false by the way). Things are not that easy on a propositional approach. First notice that on a propositional (partition) approach, the following questions are pairwise equivalent:

(10) Is it raining?
Is it not raining?

(11) Who wants an icecream?
Who does not want an ice cream?[10]

Every full answer to the first question of these pairs also fully answers the second, intuitively, and formally. However, an affirmative reply ("Yes.") to the first question of (10) implies that it is raining whereas as a reply to the second question of (10) it implies that it is not raining.[11] The examples in (11) are probably clearer. A constituent answer like "Judy." to the first of these questions means that Judy wants an icecream, while if it answers the second question it means that Judy does not want one.

These observations imply that partition interpretations of interrogatives are not rich enough to (directly) interpret corresponding constituent answers, so that other means have to be looked for. One way to go is to assume that constituent answers are elliptic, and that a reply like "Judy." is really short for, for instance, "Judy [does not want an ice cream].", where the material in brackets has been elided and

[10] This pair of examples is from Zeevat, p.c.

[11] One has to be cautious here, though, because it seems we could answer the second question with "Yes, it *is* raining.", "Yes, it is not raining.", "No it is raining." and "No, it is not raining." Whatever the rules are, it is certain that languages differ with respect to the ways in which negative questions get answered.

must be reconstructed on a syntactic level. Groenendijk and Stokhof argue for a semantic approach. They resort to a previous or deeper level of the interpretation of interrogatives, where questions are associated with relational abstracts, which are very much like the functions from the structured meanings approach. These relational abstracts lie at the basis of the derived partitions, but they can be re-used when it comes to the interpretation of constituent answers, very much in the same way as these are interpreted on the structured meanings approach. But if these relational abstracts are indeed semantically relevant, then the propositional and the structured meanings account of questions and answers are not that wide apart after all.

Quite a reverse story, of course, has to be told about full propositional answers. A reply "Marc and Judy want an ice-cream (and nobody else)." to the first question of example (11) can be directly interpreted on the partition approach as it selects one block from the partition associated with the question. In order for the structured meanings approach to deal with such a reply it seems it must first turn the question *function* into the corresponding partition (as defined above) before it can interpret the reply in a similar way.

We leave this discussion here, since the issues involved will show up again in some of the contributions to this volume, and in our discussion of them in section 3.

1.2.3 Knowing Who and Which

There are two more or less technical issues which any theory of questions has to face, but which are best explained in terms of the most rigorously formulated partition theory, the solutions of which seem to carry over to the other frameworks.

In the models $M = \langle W, D, I\rangle$ for the partition semantics, names or individual constants are assumed to be 'rigid designators', i.e., they denote the same individual in every possibility.[12] This is enforced for a good reason. In this way, a reply like "Judy comes (and nobody else)." counts as a good full possible answer to the question "Who comes?". Let us see this by computing the possible answers to this question relative to an arbitrary variable assignment g:

- $\{\{w' \mid \forall g'[x]g\colon [\![Cx]\!]_{M,w',g'} = [\![Cx]\!]_{M,w,g'}\} \mid w \in W\} =$
  $\{\{w' \mid \forall d \in D\colon [\![Cx]\!]_{M,w',g[x/d]} = [\![Cx]\!]_{M,w,g[x/d]}\} \mid w \in W\} =$
  $\{\{w' \mid I_{w'}(C) = I_w(C)\} \mid w \in W\}$

The above mentioned reply denotes the following proposition:

[12] Formally, $\forall w, w'\colon I_w(c) = I_{w'}(c)$, for any individual constant c.

- $\{w' \mid \forall d \in D\colon d \in I_{w'}(C) \text{ iff } d = I_{w'}(j)\} =$
  $\{w' \mid I_{w'}(C) = \{I_{w'}(j)\}\}$

Clearly, if "Judy" is rigid, say $I_w(j) = d$ for any possibility w, this is one of the full possible answers, namely the proposition true in those w' such that $I_{w'}(C) = \{d\}$. If, however, "Judy" were not rigid, the reply would not correspond to any of the possible answers to our question.

The above example shows that there are good reasons for a rigid interpretation of names, or individual constants. However, it has a pretty nasty by-effect. Consider the question "Who is Judy?" ($?x\ x = j$), on the assumption that "Judy" is rigid, say $I_w(j) = d$ for any possibility w:

- $\{\{w' \mid \forall g'[x]g\colon [\![x = j]\!]_{M,w',g'} = [\![x = j]\!]_{M,w,g'}\} \mid w \in W\} =$
  $\{\{w' \mid \forall d' \in D\colon [\![x = j]\!]_{M,w',g[x/d']} = [\![x = j]\!]_{M,w,g[x/d']}\} \mid w \in W\} =$
  $\{\{w' \mid \forall d' \in D\colon d' = d \text{ iff } d' = d\} \mid w \in W\} =$
  $\{W\}$

The question turns out to be trivial. It has only one possible answer, which is the trivial proposition, true in all possible worlds. This means that any answer to any question whatsoever entails (is included in) the one and only answer to this question. Obviously, this is not what we want, because we can ask such questions like "Who is Judy?" in a non-trivial way, and we can make contingent assertions like "Marc knows who Judy is." and "Bernhard does not know who Judy is.". If "Judy" is interpreted rigidly this has to remain inexplicable. Indeed, we face a dilemma, as Aloni (2001) has it: either we make "Judy." a proper answer to a *Wh*-question, but then asking who Judy is becomes trivial. Or we try and make sense of questions like "Who is Judy?" but then we cannot properly use the name in a reply to a constituent question. We cannot have it both ways, it seems.

Aloni (2001) has shown a way out of this dilemma, with a technique she has also shown to be very useful for the analysis of attitude reports and epistemic operators in dynamic semantics. It would go too far to give the details of her analysis here, so we will only sketch the outlines. The basic idea is that even though quantification and reference are concerned with the domain of individuals, this concern is modeled from the perspective of a conceptual cover, a way of 'seeing' the domain.

We can assume names to be non-rigid, i.e., they are individual concepts, functions which assign a, possibly different, individual to each possibility as the referent of the name. (This can be taken as the default interpretation of names in an epistemically oriented semantics.) Under ideal circumstances, the set of (interpretations of) names constitutes

a conceptual cover, in the sense that each individual is named once in each possibility. Another conceptual cover is the domain itself, as, for instance, when we are in direct perceptual contact with the whole domain. Many other ways of 'seeing' the domain are possible, though.

The main technical contribution is that quantifiers (and variable-binding question operators) are also interpreted relative to specific conceptual covers. The net effect is that if the question operator in $?x\ x = j$ is interpreted from a 'naming' cover, then indeed the question is trivial: it is as if it asks "Who among Marc, Judy, ..., and Muriel is Judy?", which is quite silly indeed. However, if the question operator is interpreted from another perspective the question is not at all trivial any longer. For instance, if you have a list of the names of the soccer players, about whom you know quite a bit from the newspapers, and if you see all of the players on the field, it is quite legitimate to ask which of the persons you see there on the field is this player so-and-so on your list. This is neatly accounted for in Aloni's semantics.

Moreover, if the perspective associated with a question $?x\ Cx$ is that of a 'naming' cover, then any list of names will constitute a proper answer, as we would like to have it in the first place. Interestingly, this approach also explains why the very same answer to the very same question can be appropriate or inappropriate depending on the circumstances, more in particular, on the assumed perspective. Thus, to adapt an example from Aloni, a teacher can ask in the classroom:

(12) Do you know who Sandra Roelofs is?

A proper answer in this situation seems to be something like "The Dutch wife of the Georgian president Mikhail Saakashvili.". However, if you are at a party where Sandra Roelofs is known to be present, and if you want to ask her to open the next Tbilisi symposium, then the very same reply to the very same question does not make much sense. Rather, you would expect or hope your interlocutor to point out one of the visibly present individuals. (And conversely, indeed, your teacher in classroom would not be very happy if, in response to her question, you would go out, kidnap Sandra Roelofs, bring her to the classroom and say, "This is Sandra Roelofs.".) With Aloni's conceptual covers, these data can be neatly accounted for, independent of the general framework used to deal with the interpretation of questions.

Another issue has to do with *which*-questions. A relatively 'flat' rendering of "Which boys saw which girls?" (slightly different from the one we implicitly assumed above) looks as follows: $?xy\ (Bx \wedge (Gy \wedge Sxy))$. This is slightly non-compositional, since, for instance, we cannot really isolate a part corresponding to the phrase "which girls", but

with some ingenuity the analysis can be amended at this point. Somewhat more worrying is the fact that the contents of the *which*-phrases and what is predicated of or questioned about their interpretations is treated on equal par. The following pairs of examples may show that we need to be more distinctive:

(13) Which males are bachelor?
Which bachelors are male?

(14) Judy knows which males are bachelor.
Judy knows which bachelors are male.

According to the 'flat' analysis, the questions in examples (13) are analysed as $?x\ (Mx \wedge Bx)$ and $?x\ (Bx \wedge Mx)$, which are obviously equivalent. They both ask for a full specification of the male bachelors, i.e., of the bachelors, according to the lexical meaning of that term in English ('bachelor' = 'unmarried male'). By the same token, the embedded questions in examples (14) would be the same, so both sentences ought to be equivalent as well. Intuitively, however, these equivalences do not hold: the first question of (13) makes (contingent) sense, whereas the second does not seem to. An obvious reply is, for instance: "Well, all of course!". For the same reason the first statement of (14) can be of interest, while the second need not be.

There is a principled way out of this problem, corresponding to the analysis of *which*-phrases on Krifka's structured meanings approach. According to Krifka (2001), the first question of (13) is a function from individuals to propositions to the effect that the individuals are bachelor. It is a partial function, though, restricted to the set of males. This function is non-trivial because some of the males may be bachelor, and others may not be. A similar analysis of the second question of (13) shows it to be trivial. It is a function from individuals to propositions to the effect that the individuals are male. Since this time the partial function is restricted to the set of bachelors, the question is trivial: all of them are male, of course. Quite the same idea can be used to explain the contrast between the two sentences in (14).

Krifka's 2001 analysis can be generalized, and exported to other frameworks for the analysis of questions, because it appears to be an instance of a much wider phenomenon in natural language. It has been argued every now and then in the literature that quantified noun phrases in a sense presuppose their domain of quantification. (This idea is as old as Aristotle, and in the linguistics literature it has been argued for convincingly by Milsark (1974) and Diesing (1992), and recently Moltmann (to appear).) If we apply the same idea to *which*-noun phrases the facts seem to fall right into place.

Consider again "Which males are bachelor?". According to the previous suggestions this implies that the domain of males is given, or under discussion, and that it asks for a distinction in that domain between the ones that are and those that are not bachelor. This makes intuitive sense, of course. Conversely, "Which bachelors are male?" implies that we are talking about the domain of bachelors, and questions which of them are male and which are not. Given the assumptions about bachelors previously stated, this question is indeed trivial, since all the bachelors are, by definition, known to be male.

We will not go into further detail on this issue here, because the proper treatment of presuppositions, and especially that of domain presuppositions, is a matter of current debate. The discussion here was mainly meant to show that a quite puzzling question around the interpretation of *which*-questions can, and probably should be, resolved by means of an independently needed treatment of the presuppositions of noun phrases more generally, which, at present, is outstanding.

1.2.4 Dynamic Semantics

One can, but need not, agree that the meaning of a sentence resides in its so-called 'update potential', contrary to the view exposed above that it resides in its 'truth conditions'. Even if one does not, it has proven worthwhile to study how assertions change or are intended to change the context: 'common grounds', representations of the contents of discourses, the information of the interlocutors, or what have you Stalnaker (1978), Kamp (1981), Heim (1983a), Seuren (1985), Groenendijk and Stokhof (1991a), Veltman (1996). As will appear from the contributions to this volume, and as has earlier been shown in different types of frameworks (like those of Roberts (1996), Hulstijn (1997), Asher and Lascarides (1998), Cooper (1998), Ginzburg and Sag (2000)), basically the same holds for questions in discourse.

Whether or not one accepts the view that meanings are context change potentials, it is beyond doubt that the semantics/pragmatics interface cannot ignore the question how utterances depend on, and can be taken to modify, the 'common ground'. In this respect interrogatives, like imperatives and permission utterances, are much more convincing examples than simple assertions are. Discourses or dialogues which are aimed at the exchange of information can be seen as games of stacking and answering 'questions under discussion' (Ginzburg, 1995) or as processes of 'raising and resolving issues' (Hulstijn, 1997). Such processes are not un-structured: they are governed by structural rules which can be deemed linguistic (in a broad sense), and by very pragmatic principles of reasonable or rational coordination. Especially by adopting a

dynamic view of interpretation, one is able to lay bare such systematic properties and effects of questions and assertions in practice.

From the very start, there have been two closely related approaches to the dynamics of discourse, a representational and a non-representational one. Hans Kamp's discourse representation theory (Kamp 1981, as well as its successors like, e.g., UDRT, Reyle 1993, SDRT, Asher and Lascarides 2003) is of the first type, which, as its name indicates, aims to represent the cumulative contents of discourses. Amsterdam formulations of the dynamics of discourse are, arguably, of a non-representational nature (Jeroen Groenendijk and Martin Stokhof's dynamic predicate logic and Frank Veltman's update semantics). Irene Heim's file change semantics is a perfect blend: it employs a representational metaphor (that of updating 'files') while it also comes with a non-representational semantics for these updates. It is, of course, obvious, that a representational semantics is a much more powerful tool than a non-representational one, since many more operations are conceivable on highly structured representations, than on the less structured semantic objects. Nevertheless, it seems to be worthwhile to see how far the scope of a non-representational semantics can be stretched. For the latter does not commit itself to the reality or form of the representations people actually use when computing meanings and interpretations. Any cognitive theory of interpretation ought to be in principle compatible with its findings. Such a point can hardly be upheld for a representational semantics, since if it turns out that the representations used would not be realistic in a psychological or cognitive sense, in a way this would refute the theory.

All contributions to this volume adopt this non-representational stance. Information (of the interlocutors or in the common ground) is generally modeled in terms of sets of possibilities, viz., those which are compatible with that information. Update of information consists of the elimination of possibilities. If we know or learn more, less possibilities turn out to be compatible with the information we have, and in the extreme case we could be left with only one possibility, totally specifying what (we think) exactly are the ways things are Roberts (1996). Of course, hardly anybody would like to achieve this goal. (Except, if he exists, God, who would know this by definition.) Since we are agents with practical needs and finite capabilities, we are confronted with only very limited subsets of the infinite sets of questions we could raise, and therefore updates in discourse should be guided by the questions we have, we actually pose, or which others may think we might be interested in.

Here is where Hulstijn's 1997 'raising and resolving issues' kicks

in, and, likewise, the 'questions under discussion' from Ginzburg (1995), Roberts (1996). At any point in a discourse or dialogue several questions may be 'alive' because they are ex- or implicitly raised, or assumed to be relevant. In order to account for such a state in discourse, we therefore cannot simply do with the set of possibilities compatible with the information assumed and exchanged so far. It should also indicate the relevant differences which the interlocutors wish to distinguish between. Information states or common grounds therefore ought to be (at least) sets of ordered possibilities, for instance partitions of parts of logical space. As in Groenendijk and Jäger's papers, these states can be updated in basically two ways. Assertions can be used to reduce the relevant part of logical space by the elimination of possibilities, as no longer being potentially actual. Questions can be used to fine-tune the structure, and increase the number of distinctions one is interested in. From this very sketchy description we can already deduce two general and reasonable constraints (which are not inviolable, though, as we will see later). For instance, it should make no sense to assert something which is already entailed by the common ground at a certain point in a discourse; and it ought not to make sense to ask a question which is entailed by previous questions in the discourse. Much more detail will be provided in the various contributions to this volume.

There is one problem for a non-representational update semantics which we have to mention and which we cannot solve here. How to deal with conflicting information, corrections, and withdrawal of information? In a representational semantics it is fairly easy to correct the assertion that Judy is in Paris with the statement "No, Judy is in Prague." One could simply wipe out the record for "Judy is in Paris" and replace it by one recording that she is in Prague. (In general, this is not without pitfalls, though.) However, if we have reached a state modeled by possibilities in which Judy is in Paris, it is not clear how we could or should extend this set of possibilities to one in which Judy may not be in Paris, and leave other independent information intact. (Anyway, it is unclear on both a representational and non-representational account what should count as 'independent information'.) For such corrections current systems of dynamic semantics offer only a blind 'die or survive'-scenario. If new information contradicts currently established information, we can accept it, and reach the absurd state, the empty set of possibilities which excludes all possibilities from being actual. Or we can refuse the update, and say "Ho, stop, this is not what we have agreed upon.". Of course, none of these options is very practical or reasonable, and in actual practice corrections and the presentation of conflicting information normally leads to a negotiation of what has

to be accepted after all. It may be clear, though, that this type of discussion goes beyond the confines of straightforward systems of update semantics, and it must be submitted that, so far, no solution to this issue has been offered in the literature.

1.3 This Volume

Before we engage in a thematic discussion of the contributions to this volume, it may be useful to explain the order in which they appear. The twelve contributions are grouped in four sections of three papers each, which display their thematic coherence. As will become clear from the subsequent discussion, there are also many cross-connections though. The first three sections start with what may be labeled a 'classical' contribution. The first section (on update semantics) starts with Jeroen Groenendijk's "The Logic of Interrogation" which can be taken to be the starting point of the whole volume, and which has appeared as such in the Proceedings of SALT IX, 1999. The second section (on topic and focus) starts with Gerhard Jäger's "Only Updates", which has appeared in the Proceedings of the Tenth Amsterdam Colloquium, 1996. The other papers in this section are true elaborations of this paper. The third section (on implicatures and exhaustiveness) starts with Henk Zeevat's "Exhaustivity, Questions and Plurals in Update Semantics". This is a substantially revised version of his "Questions and Exhaustivity in Update Semantics", which has appeared in the Proceedings of the International Workshop on Computational Semantics, 1994. These 'classical' papers appear as the first in each of the three sections, the further order of papers is alphabetical. The last section (on intonation and syntax) provides a truly new angle on the subjects discussed, so it does not contain any classical paper—or not yet, for that matter.

1.3.1 Update Semantics

Jeroen Groenendijk's paper "The Logic of Interrogation" carries its pun right in the title. Interrogations are normally carried out to gain new information. Logic, as traditionally conceived, is only concerned with conclusions based on pre-given premises which already entail these conclusions. They ought not bring us something new. Adopting a broader view, however, 'logic' is concerned with valid reasoning, be it from the structure of our minds, language, practices, or reality (which is where logic or $\lambda o\gamma o\varsigma$[13] etymologically stems from). In accordance with the Gricean program, Groenendijk sets out to make logic and pragmatics

[13]The classical Greek word was used for a wide variety of concepts such as language, understanding, reason, doctrine, structure, and principle.

meet, and to account for particular aspects of games of information exchange. The core notion here is not that of a logically valid conclusion, but that of a 'pertinent' move in a dialogue game.

In order to lay bare the very characteristics of them, Groenendijk focuses on a very specific type of dialogue game, with two players, the interrogator and the witness, each of which has its own obvious role to play. The interrogator raises issues, and the witness is supposed to answer them. Good deal. This allows for a very straightforward definition of a 'pertinent' move, which is, basically, non-redundant: a question from the interrogator is pertinent if it raises a new issue; a statement from the witness is pertinent if it contributes new information. Interestingly, but not unexpectedly, this goes right across the notions of entailment proposed in logical systems for games of argumentation. Entailed questions and assertions are superfluous and therefore, pragmatically, deviant. Interesting contributions are those that are not superfluous.

On the basis of these quite basic insights Groenendijk succeeds in showing why some elementary discourses are or are not felicitous (or 'pertinent' as he calls it), and why they get their most likely interpretation. As a response to "Who rescued Bea?" the reply that Alf rescued Bea and no-one else implies that Alf was the sole Bea-rescuer; in response to the question "Whom did Alf rescue?", however, the very same answer gets the quite different interpretation that Bea was the only one rescued by Alf. In Groenendijk's formal language, and in keeping with his notion of pertinence, these facts fall right into place. This is a neat example of how, concentrating on a special design toy language, one can account for some apparently fundamental data. The results, it must be observed, are similar to the observations from Jäger on *only*, and it must be emphasized, as Groenendijk himself notices, that 'real discourse' can be much more flexible and creative than artificial models are. In this respect the empirical data on intonation reported by Šafářová are rather telling.

Balder Ten Cate and Chung-chieh Shan provide an axiomatization of Groenendijk's logic of interrogation which is both logically and linguistically most interesting. Groenendijk's notion of entailment can be captured by means of the logical notion of interpolation, and more in particular in terms of Evert Beth's definability theorem. Established logical findings, thus, do not only contribute to our understanding of the logic of interrogation, but suitable variants of it also suggest interesting modifications of this logic. One of these is a suitable modification of the logic to allow variable domains, and the linguistic and computational consequences of this move are discussed.

Paul Dekker advocates a broader perspective on games of infor-

mation exchange. Without committing anyone to the very special role of interrogator or witness, his idea is that all interlocutors come with their own information and questions, and that the ideal is that the very questions get answered on the basis of the information distributively present. There are many ways in which this goal can be achieved, if it is achievable at all. An interesting result is that the aim of the participants in a conversation is to seek to achieve these goals, sometimes by making queries and statements that might not directly contribute to the envisaged goals. The devise of efficient strategies, therefore, does not seem to be totally obvious, and is left to pragmatic or decision theoretic types of reasoning about the discourse, its possible goals, the interlocutors, and the information they have about that.

The three perspectives on games of information exchange, Groenendijk's arguably more linguistic one, ten Cate and Shan's more logical one, and Dekker's more pragmatic one, raise a number of principled issues. Some data are neatly accounted for in Groenendijk's approach, i.e., the interpretation of focused answers to specific questions. The merits of, e.g., counterquestions, it seems, can hardly be explained without resort to the pragmatics of discourse. In either case we need to have access to a reasoning component, dealing with entailments between questions and answers. Obviously ten Cate and Shan's system provides a very first and promising start, but in the end we would need a richer epistemic logic to reason about the facts of discourse and the information exchanged.

All three contributions raise the issue where, if at all, the borderline should be drawn between logic and pragmatics. Logic, narrowly conceived, is engaged with valid entailment relations between sets of indicative sentences. It must be clear from these contributions, though, that logic naturally expands its scope to interrogative sentences as well. Moreover, in order to establish the relevance of utterances in a discourse, it is required to *reason* about the point they can be taken to make. Lots of work for an epistemic logic. It is not clear, though, how much of this can be put on the logician's agenda. Many, or even most, day-to-day inferences draw from practical or pragmatical assumptions about the people who are engaged in games of information exchange. Logic can be used to model these assumptions, but it certainly should not be taken to motivate them. The main, and moderate, moral seems to be, then, that no principled distinction can be drawn as yet, and that we would like existing (logical and pragmatical) formalisms to interact, in the most productive ways.

1.3.2 Topic and Focus

Rooth (1985) has effectively drawn attention to the ambiguity, and intonation sensitivity, of the following pair of examples:

(15) In Saint Petersburg, [officers]$_F$ always escorted ballerinas.
In Saint Petersburg, officers always escorted [ballerinas]$_F$.

The first appears to be a (universal or generic) claim about ballerinas, the second one is about officers. Another telling pair of examples is from Pieter A.M. Seuren (p.c.):

(16) Frederick always/only [sleeps]$_F$ at work.
Frederick always/only sleeps at [work]$_F$.

If the emphasis is on *sleeps*, it seems to indicate that Frederick is a hangabout. If the emphasis is on *work*, Frederick appears to be an incorrigible workaholic. Gerhard Jäger can be credited for observing another kind of context-sensitivity:

(17) Who is wise?
Only Socrates is wise.

(18) Which Athenian is wise?
Only Socrates is wise.

In the first example, Socrates is claimed to be the only wise person in the world. In the second, it seems, Socrates is claimed to be the only wise Athenian. All three pairs of examples can be taken to show that information structure is relevant to interpretation, and the three contributions to this section can be taken to capitalize on that.

Jäger's paper was the first to extend the coverage of the dynamic paradigm to topic and focus sensitive phenomena associated with the use of the term "only". It defines a neat system **ULQA** which accommodates the updates with both questions and assertions in a Groenendijk-style manner. An intriguing, innovation is the treatment of *Wh*-questions as questions embedded under a (possibly restricted) universal quantifier. Thus:

(19) Who is wise?

is interpreted as asking for each individual in a relevant domain whether he or she is wise or not. Similarly:

(20) Which Athenian is wise?

asks for each Athenian whether he or she is wise or not. Jäger accounts for these data by rendering the interpretation of in particular atomic formulas context dependent in the following sense: any such formula At only provides a proper update of an information state if it addresses a current question under discussion. While the information state is

modeled as the set of possible answers to current questions, an update with At does not simply preserve the possibilities where At is true, but only those which figure in an answer that strictly implies the truth of At.[14] As a consequence, quantified sentences get restricted to individuals which are known to satisfy certain properties, or whose possession of that property is under discussion. Consider again:

(21) Only Socrates is wise.

The contents of this sentence are rendered by the formula: $\forall x(Wx \rightarrow x = s)$. In the system of *ULQA* the universal quantifier is restricted to the people who are known or questioned to be wise. So in case this sentence serves as a reply to question (20), it is taken to assert that Socrates is the only wise Athenian. In response to the question "Who is wise?", however, it is generally taken to assert that Socrates is the only wise person in the world. (In response to no question, the reply is trivial.)

The other two contributions to this section can be seen to render the effects of domain restriction in a more sophisticated manner, linguistically and empirically speaking. Jäger models contextual restriction by means of an implicit modal operation in the interpretation of atomic formulas (universal quantification over possibilities in possible answers), and relative to information states which are partitions. Maria Aloni, David Beaver, Brady Clark and Robert van Rooij and Paul Dekker employ more fine-grained question meanings, the so-called abstracts underlying these partitions: sets of (sequences of) individuals satisfying the property under discussion. Subsequent quantifiers can thus be explicitly restricted to these sets of (sequences of) individuals. Besides this, both Aloni et al. and Dekker make Jäger's type of modality explicit: in Aloni et al. it appears as an operator ∂ which presupposes that certain questions are under discussion; Dekker employs an abstract operator *ELSE* which can be used to identify a set of individuals currently known to possess properties under discussion.

Elaborating on Gawron, Aloni et al. combine an update semantics of questions with an explicit analysis of (free) focus and its pragmatic and semantic role. On this account, questions introduce topics, formalized as dynamic information states. An introduced topic structures the context as in Groenendijk (1999), but it can also be presupposed by subsequent focused structures and it has the potential to restrict subsequent quantification. In this proposal, then, the dynamics of questions

[14] This is not totally unproblematic, for the interpretation of an (embedded) conditional such as $p \rightarrow q$ is trivial if $?p$ is not a question in the input information state. Exercise: show triviality of $p \rightarrow q$ in the empty information state $W \times W$.

does not only involve their potential to raise issues which structure the factual information shared in conversations, but also concerns their impact on the felicity (or congruence) and meaning of their focused answers. The paper also models the distinction, put forward in Beaver and Clark (2003), between focus sensitive operators like *only* and topic sensitive operators like *always*. The focus sensitivity of the former derives from a grammatical mechanism, whereas the interpretation of the latter is a purely pragmatic matter, and determined by discourse topic.

Paul Dekker's elegant analysis minimally defines topical domain restriction and uses it for a compositional analysis of (quantified) constituent answers, like "Who gave what to whom? Mary a picture to a boy". Constructions like these are known in the linguistic literature as 'stripping' or 'bare argument ellipsis' or 'gapping' (Ross, 1970), and are problematic for syntactic approaches to ellipsis because, for example, they do not respect constituency. Dekker's theory shows that a semantic/pragmatic analysis of gapping can be given where the reconstruction of the missing material follows as a case of dynamic topical domain restriction. It is minimal in the sense that it does not need to resort to keeping track of information about variables. Discourse information (indicative as well as interrogative) is modeled directly, and anaphoric take up and domain restriction is not mediated by the (arbitrary) choice of variables. All relevant information is modeled as a pure set-theoretic construct out of objects in the domain. The paper also provides an analysis of the particle *ELSE* which can be used in a proper and compositional interpretation of locutions like "Nobody else" and "Somebody else", as a matter of fact, the result of a decomposition of Zeevat's epistemic exhaustivity operator (see Zeevat, 1994b, a predecessor of Zeevat, this volume).

An important issue arising from these contributions concerns the relation between the logical notions of entailment, answerhood and pertinence defined purely in terms of propositional content versus the more discourse oriented notions of anaphora, topical domain restriction and congruence depending more on discourse information than on factual information. Jäger's implicit account of topical domain restrictions purely in terms of partitions had some empirical drawbacks, showing that a proper account of discourse phenomena require more fine-grained structures, e.g. dynamic information states as in Aloni et al, or equivalently, sequences of witnesses as in Dekker's contribution.

1.3.3 Implicatures and Exhaustiveness

As we already have seen, exhaustification is a crucial issue in the theory of questions and answers, but its impact is certainly not confined to

that. Exhaustification in a sense refers to limits, and it gives you a/the bit of information that allows you to know all the other information you needed to know. Thus, as we have seen, (23) in reply to (22) can be taken to mean (24):

(22) Who has sneakily eaten from the pie?
(23) Amanda, Ben, and Curt and Donny.
(24) Amanda, Ben, Curt and Donny are the ones who have sneakily eaten from the pie.

But with scalar predications other exhaustification effects show up:

(25) How fast may I drive here in an urban area?
(26) You may drive 50 kilometers an hour.
(27) How slow may I drive on the highway?

In reply to question (25), answer (26) can be taken to mean "50 and no more", while in reply to (27) the very same answer can be taken to mean "50 and no less". Also:

(28) Prof. Vamp can prove this theorem in five minutes.
(29) Prof. Champ can lecture for five hours.

Typically, example (28) can be used to refer to an upper limit, indicating that Vamp can do it in five minutes *or less*; example (29) typically indicates a lower bound, Champ can lecture for five hours *or more*. Exhaustification thus is a highly context dependent and flexible notion, and not just a question of the relevant domain but also of the relations that elements of that domain have entered into with one another. One of the main issues in the literature pertains to the question how much of the exhaustification effects should be assigned to the semantics (logical form, (lexical) meaning) of the various constructions, and how much to pragmatics (i.e., implicatures, world knowledge). The three contributions to this section approach the phenomena of exhaustification from various perspectives.

Approaches to exhaustification prior to Groenendijk and Stokhof and Zeevat were purely stipulative, e.g., they derived effects of exhaustification with a universal operator Szabolcsi (1981), with definiteness Moltmann (1992), and with maximality Rullmann (1995). But such operators fail to capture exhaustification in general: it is a smarter notion. Henk Zeevat provides an attempt to use semantic tools to get a proper grip on what underlies the concept of exhaustification. Exhausted interpretations basically are the strongest interpretations of free variables (discourse markers), given a set of (primitive) meaning postulates. It is extraordinarily successful, as it applies uniformly to questions, answers, focus, plurals and scalar implicatures, but it still faces problems:

the set-up assumptions are costly/stipulative, there still are the cross-world identity problems (and the problematic notion of an 'ontological alternative'), and it relies on meaning postulates to an extreme extent.

Robert van Rooij and Katrin Schulz's contribution deals with the particle 'only' and its relation with exhaustification. The analysis systematically distinguishes between a semantic and a pragmatic contribution of 'only'. The sentence "Only Mary smokes" means that nobody except Mary smokes and has the pragmatic implication that Mary smokes. The account of the semantic contribution of 'only' is based on Groenendijk and Stokhof's rule of exhaustive interpretation in contrast with alternative approaches (e.g., Rooth, 1985, 1992) where 'only' is taken to quantify over focus alternatives, rather than over 'background' alternatives (as in von Stechow, 1991). The pragmatic contribution of 'only' is characterized as a conversational implicature formally derived by Gricean maxims formalized in terms of operations mapping sentences to their minimal interpretations. These same operations are shown to derive the exhaustive interpretation of answers without 'only'. In the latter case, exhaustification ceases to be a semantic operation and is understood as a pragmatic interpretation function that strengthens the semantic meaning of a sentence.

Benjamin Spector's contribution also deals with a pragmatic notion of exhaustification. Defending a globalist account of implicatures against recent attacks (e.g., Chierchia, 2002) the article offers a precise formalization of the Gricean reasoning underling scalar implicatures and shows that exhaustification of answers can be obtained by the same pragmatic mechanisms. Gricean implicature derivations typically rely on the assumption of a set of alternatives against which the used sentence is compared to. Spector gives a perspicuous characterization of the alternatives involved in the derivation of exhaustive meanings, identifying them with the positive answers to the question under discussion, thus raising the interesting empirical question of why exhaustive answers are never among these alternatives. Given this choice of alternatives the analysis is shown to imply an asymmetry between positive and negative answers, while only the former are predicted to be interpreted as exhaustive. These predictions seem to be correct when tested on interesting data involving answers with (combination of increasing and) decreasing quantifiers.

Many issues on the semantic-pragmatic interface arise from these contributions. The contributions from Van Rooij and Schulz and Spector offer a purely pragmatic explanation of exhaustification of answers as derived by Gricean reasoning. Applications for exhaustification in natural language however gives a long list: e.g., questions, answers, fo-

cus, quantifiers, scalar implicatures, Evans effects, plurals, clefts, comparatives, free relatives and degree relatives (see Butler, 2001), and it is not clear how a purely pragmatic analysis can be extended to cover these genuinely semantic phenomena. Zeevat's dynamic analysis seems to blur the distinction between semantics and pragmatics, and its operator explains exhaustification of answers as well as a large number of semantic data. Nevertheless, as it is clear from all three contributions, exhaustification and scalar implicatures have a common core that should be explained and a Gricean analysis of the latter phenomenon, although not totally without stipulation—in the choice of the relevant alternatives, is less costly than an explanation in terms of Zeevat's operator.

1.3.4 Intonation and Syntax

The papers that we've seen thus far have concentrated almost exclusively on matters of meaning and use. But this has only been achieved with the (muted) accompaniment of basic assumptions about the forms taken by interrogatives and related constructions (e.g., focus constructions). The papers of this section are more explicit about the consequences for the form-meaning mapping of the theories they explore. To put it another way, they show exacting concern for (i), what semantics and pragmatics require from other areas of linguistic theorising, (ii), what semantics and pragmatics can offer to relieve other areas from internal problems, and (iii), what semantics and pragmatics can get by without (that is, how explicit does the linguistic code need to be?). In particular, the focus is on connections with intonation and syntactic forms.

Maria Aloni, Alastair Butler and Darrin Hindsill start the section off with an analysis in the framework of Bidirectional Optimality Theory (BiOT) that predicts the placement of nuclear accent within a focus. From the start they harness the advantages of a default framework by making a syntactic constraint, the Nuclear Stress Rule, a weak constraint. This salvages an otherwise problematic constraint with clear counterexamples, yet a strong intuitive appeal. This is also an interesting move from the perspective of constraint origins, since constraints that follow from syntactic form are frequently hard; and indeed the hardest constraint is the Focus Set Rule, which is essentially another constraint on form, requiring the accent to fall within the syntactic scope of the focus. Their setup also has interesting consequences for views on optimisation, as well as language acquisition, suggesting that the production task needs only unidirectional optimisation, while the interpretation task crucially relies on bidirectional optimisation, that

is, optimising with respect to the hearer and speaker perspectives. This paper also raises a very interesting theoretical question. In linguistics it is generally assumed that syntactic rules are forbiddingly hard (specific structures are either right or wrong) while pragmatic constraints can be overruled. Aloni et al.'s paper shows that a neat account of focus and stress can be obtained by ranking pragmatic constraints harder than syntactic ones. Besides thus motivating an optimality theoretic account of the phenomena, this raises the question whether focus and stress should be assigned a special place in an overall syntactic theory, or whether we have to rethink the impact of structural and pragmatic rules more in general (and if so, how). Of course the issue is much more general than we can handle in a volume like this, so it is left for further study.

Alastair Butler offers a novel take on a range of so-called intervention effects that can arise in interrogatives with WH-phrases. Existing syntactic accounts of such phenomena have become extremely involved, and largely internally inconsistent, assuming ad-hoc constraints on logical forms (e.g., Beck, 1996a) or stipulation (e.g., Rizzi, 1990, Pesetsky, 2000) (see Butler and Mathieu, 2004 for a recent overview). Here the syntax is extremely simple, while the burden for an account is shifted to the semantics, following a trend initiated by Honcoop (1998). Of course, assumptions about form are required for the account to go through. But the demands placed on syntax are very slight and lead to the least controversial of positions, with requirements that are consistent with all major theories of syntax. And here we see another of this volume's recurring themes: the methodology of the approach is to concentrate on a specially designed toy language with an explicit semantics that derives apparently fundamental data without any additional stipulation. This time the data captures the diversity in coding strategies for WH-interrogatives cross-linguistically. It is striking indeed to see how such minimal tools can be used to uniformly account for a vast set of cross-linguistic data which may have seemed to be so heterogeneous at first glance.

Using a framework that combines Veltman's update semantics with a simple semantics for questions, Marie Šafářová shows how it is possible to pinpoint a consistent interpretative role for intonation patterns, again with a toy language especially designed for the (intonation) data to be accounted for. Specifically, she argues that the properties of rising declaratives can be captured uniformly by taking the final rise to be a kind of "intonational adverb", comparable with *it might be that*. This is in sharp contrast with previous accounts, which have typically attributed a meaning of 'questionhood' to the rising declarative, owing

to the questioning effect that results from its use. Such a position is tenable because the questioning effect is shown to fall out from the semantics/pragmatics set up as a derived pragmatic effect, following from the uncertainty that is actually signalled. We therefore have a significant instance where semantics/pragmatics is able to do without a triggering interrogative form, allowing for declaratives to be consistently coded as statements. Not only is this a very welcome extension of the empirical scope of linguistic theory. It also serves to correct a widespread theoretical assumption that final rises (on both declaratives and interrogatives) are associated (one-to-one) with questionhood. Empirical data do not at all support this assumption, and Šafářová shows how to correct it from a theoretical (semantic / pragmatic) perspective. Innovative as the findings (empirically and theoretically speaking) may be, it leaves the interested linguist with the burning question: why should we have thought so in the first place? One of the morals may be that, however transparent they are, intuitions need not be decisive, neither in logic, nor in language.

To sum up, the contributions of this section give a taster as to how the tools assembled from findings in semantics and pragmatics can be used to tackle problems that have originated from other areas of study (here, intonation and syntax). These are interesting developments, as they promise to breathe new awareness into areas that have been widely researched, but have lacked conclusive outcomes. Of course, what gets opened up here is a two-way street: semantics and pragmatics, as practised in this volume, have much to learn from the other areas of linguistic theorising.

1.4 Remaining Issues

So far we've stressed the relevance of the work which this volume reports upon for semantic and pragmatic theory. But are there implications for other areas of linguistic theorising (e.g., syntax, morphology, intonation, language acquisition, language evolution)? How will these findings fit in with the findings of other areas? Can they be used to strengthen existing viewpoints in other areas, perhaps resolving internal inconsistencies, or will they lead to an importing of radically new ideas, or a syphoning off of the burden of explanation? That such questions can now be addressed is testimony to the maturity of the ideas this volume presents. A couple of open questions have become manifest throughout this volume, and we will briefly comment upon them, without suggesting particular answers.

In the first place, the whole notion of a question is as open as

it was at the start of this introduction. We can take the moral from Šafářová and keep to a uniform syntactic distinction between declaratives and interrogatives but then it remains unclear how to assess the results of the other proposals which build on a semantic/pragmatic distinction, at least on the level of logical form. Another open issue pertains to the interpretation of questions which can also be identified syntactically: *where*-, *how*- and *why*-questions. These have not been addressed explicitly in this volume and it remains to be seen whether the same semantic / pragmatic tools like the ones advocated can be used to deal with these types of questions.

In the second place, various contributions (in particular those of Aloni et al., Butler, Dekker, and Zeevat) have pointed at the close correspondence, logically, and cross-linguistically, between *Wh*-questions and indefinites. At present it is not clear how to evaluate such correspondences. Should we assume a universal category, or should or could we deem these correspondences to be accidental by-products of interpretational mechanisms? (For, as observed by Butler, the use of an indefinite may license a *namely*-continuation, or a *who-then*-question, but it is not clear whether this should be accounted for structurally or by means of pragmatic mechanisms.)

In the third place, various proposals incorporate notions of presupposition, contradiction, and correction in discourse. None of these provide or build upon an elaborate theory of accommodation and revision. This is fortunate to the extent that the proposals, with their specific targets, probably ought to be independent of that. Nevertheless, the proposals remain incomplete as long as there is no consensus on the appropriate form of a theory of accommodation, and current literature does not seem to supply that.

An actual theme, in the fourth place, is whether questions can be outscoped, or to what extent. This volume does not directly deal with embedded questions, like we find in *wonder who*-, and *know whether*-constructions, where questions arguably figure in the scope of structural operators. Nevertheless, their interpretation is highly relevant for judging the interaction between semantics (meaning) and pragmatics (interpretation). On the face of it, questions can also be embedded in other questions, that is, if we take a run of the mill syntactic analysis of multiple *wh*-questions. In more classical proposals, like that of, e.g., Groenendijk and Stokhof (1984), multiple *wh*-phrases are treated as unary, but polyadic operators; some proposals in this volume suggest that more compositional approaches are possible, which for instance allow one to combine an interrogative noun phrase like “Which professors” with an interrogative verb phrase like “failed which students”.

Finally, questions can be embedded under generalized quantifiers so as to yield, e.g., pair list readings. The phenomenon has already been discussed in Groenendijk and Stokhof, among others, and recently Krifka (2003) has given this discussion a new twist. There is no room here for an elaborate discussion of this phenomenon of embedding questions, but a little reflection will show that an unlimited possibility of embedding is not linguistically realistic. Only a few type of quantifiers and operators allow questions in their semantic scope, and it is not clear beforehand which ones do, and why.

In the fifth and final place, hardly anything has been said about the computation of questions, the generation of answers, and (automated) information retrieval. Arguably, the contribution from ten Cate and Shan comes closest to that, but not yet as close to be interesting for the computational community. This is a pity in as far as the focus on the semantics and pragmatics of questions answers should in principle allow the prospect of bridging theoretical and practical endeavours. The, modest, moral here can only be that the gap between these two types of approaches is still felt to be too large to be bridged in the single step we can take in one volume. The Chunnel was not built in one day either. We hope this volume shows, not only, that much of the ground-preparing work on the theoretical level still remains to be done; at the same time, as well, that the theoretical work is shifting its focus towards more practical matters, as indeed can be expected from research on the semantics / pragmatics interface.

Part I

Update Semantics

2

The Logic of Interrogation

Jeroen Groenendijk

2.1 Logic and Conversation

On the standard view, logic is concerned with reasoning, more in particular with fixing criteria for the soundness and validity of arguments. If we apply standard logic in natural language semantics, we inherit this basic trait, and can only expect our logical semantics to have descriptive and explanatory value for the kind of linguistic phenomena that are related closely enough to what the logic is about.

Reasoning is just one particular language game. And if we think of our daily conversations, it does not have the same central position it has in logic. Cooperative information exchange seems a more prevailing linguistic activity. It is reasonable to assume that such a predominant function has a distinctive influence on the structure of natural language, which forms the subject matter of linguistics. For example, it is a widespread (and age-old) idea, that the organization of discourse is largely determined by a mostly implicit process of raising and resolving issues, and that even sentential structure, including the intonational contour of utterances, can only be properly understood, if we take that to heart. If there is some truth in this, then linguistic semanticists should be worried by the fact that by and large they base themselves on a logical paradigm that is biased to such an extent towards reasoning rather than exchange of information.

As a response to this fear, one might point out that Gricean pragmatics is as much part of an overall theory of meaning, as logical semantics is. And the Cooperation Principle, which is at the heart

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of it, precisely is a principle of rationality which governs information exchange. Grice proposed to use it in the explanation of linguistic phenomena that lie beyond the reach of logical semantics as such. Among other things, he employed the principle in a defense of standard logic —in particular the truth functional analysis of the logical connectives— against the allegation that it leaves important aspects of meaning unaccounted for. He argued that standard logic together with the general assumption that we follow the Cooperation Principle does provide us with the means to account for such additional features of meaning. Hence, we are in no need to *replace* the standard logical analysis by some other type of interpretation, we only have to *combine* logical semantics with general pragmatic strategies to cover the relevant facts.

One way to look at the logical investigations carried out in the present paper, is to view them as an attempt to turn the Cooperation Principle as such into the key notion of logical semantics. Instead of centering the logic around the explication of what makes a piece of reasoning into a sound and valid argumentation, we intend the logic to judge whether a conversation proceeds in accordance with the principles of cooperative information exchange.

2.2 The Game of Logic

In logic we use a simple picture of an argument. An argument is conceived of as a sequence of sentences, of which all but the last one are called the premises, and the last sentence is called the conclusion of the argument. One can look upon an argument as the proceedings of a language game. If the game is played according to the rules, then the truth of the premises guarantees the truth of the conclusion. If such is the game of logic, then the logical notion of validity arbitrates whether the game was played according to the rules.

Argumentation is just one particular language game. For one thing, although there may be spectators, it is a solitary game, whence we can leave the player out of the logical picture. The more typical case, at least from a linguistic perspective, are dialogue games, which involve exchange of information among two or more participants. If we generalize the picture of the game of argumentation sketched above, then we arrive at the following.

A discourse is a sequence of utterances, the proceedings of a particular language game. The task of a logical analysis consists in providing us with logical notions which enable us to arbitrate the game, to characterize an utterance as a pertinent or impertinent move in the game.

In this paper, we study a simple dialogue game from this perspective:

Definition 2.1 (The Game of Interrogation) Interrogation is a game for two players: the *interrogator* and the *witness*. The rules of the game are as follows:

A. The interrogator may only raise issues by asking the witness non-superfluous questions.

B. The witness may only make credible non-redundant statements which exclusively address the issues raised by the interrogator.

The game of interrogation is a logical idealization of the process of cooperative information exchange, which makes stiff demands on the witness. The elements of the rules can be linked to elements of the Gricean Cooperation Principle: The requirement that the witness makes credible statements is related to the Maxim of Quality; that the statements of the witness should be non-redundant, and the questions of the interrogator non-superfluous, relates to the Maxim of Quantity; and that the witness should exclusively address the issues raised by the interrogator is a formulation of the Maxim of Relation.

From a linguistic perspective, our interest does not lie in the game as such. The empirical success of the logic of interrogation depends on whether it can be used in the explication of structural linguistic facts. We will give an illustration of that in Section 11 of the paper.

2.3 The Tools of Interrogation

Relative to a suitable language, and a semantic interpretation for that language, the logic of interrogation has to provide us with logical notions by means of which we can arbitrate the game. As a language for the game of interrogation, we use a simple query-language, a language of first order predicate logic enriched with simplex interrogatives:[1]

Definition 2.2 (Query-Language) Let PL be a language of predicate logic.
The *Query Language* QL is the smallest set such that:

i. If $\phi \in PL$, then $\phi \in QL$;

ii. If $\phi \in PL$, $\vec{x}$ a sequence of n variables $(0 \leq n)$, then $?\vec{x}\,\phi \in QL$.

[1] For more discussion about the language and its interpretation, see Groenendijk and Stokhof (1997), in particular Section 4.

In case the query-operator binds no variables, prefixing it to an indicative results in a *yes/no*-question. E.g., $?\exists xPx$ asks whether there is an object which has the property P. If the query-operator binds a single variable, a single *who*-question results. E.g., $?xPx$ asks which objects have the property P. When two variables are bound, as in $?xyRxy$, we get a question asking for the denotation of a two-place relation, it asks for a specification of which pairs of objects stand in the relation R. So, in general, we interpret an interrogative $?x_1 \ldots x_n\, \phi$ as asking for a specification of the actual denotation of an n-place relation.

We call the formulae of PL the *indicatives*, and the other formulae in QL the *interrogatives* of the language. We use ϕ, ψ, etc., as meta-variables which range over all sentences. Adding an exclamation point, as in $\phi!$, restricts the range to the indicatives, and adding an interrogation point, as in $\phi?$, to the interrogatives of the language. We refer to a sequence of sentences $\phi_1; \ldots; \phi_n$ as (the proceedings of) an *interrogation*, and use τ to range over such (possibly empty) sequences.

It is a convenient feature of the game of interrogation, that given the strict casting, we do not have to indicate who said what: interrogatives are uttered by the interrogator, indicatives by the witness. If the players were allowed to change roles, the proceedings of the game should include an indication of the source of each utterance.

2.4 Partitioning Logical Space

We state the semantics of the language in two steps. As our point of departure, we take a standard denotational semantics, and on top of that we define a notion of interpretation in terms of context change potentials.

As for the indicative part of the language, we assume a standard truth definition: $\|\phi!\|_{w,g} \in \{0, 1\}$, where w is an element of the set of possible worlds W (first order models), and g an assignment of an element of the domain D to the individual variables. We assume a single domain for all worlds. Furthermore, we assume that the individual constants (names) of the language are interpreted as rigid designators.[2]

For the interrogatives in the language, we employ a *partition-semantics*. We take the denotation of an interrogative in a world to be the set of worlds where the answers to the question are the same:[3]

[2] These are not very natural assumptions to make in an epistemic setting. See Aloni (2001) for a discussion of the issue, and an analysis which makes it possible to lift these assumptions.

[3] See Groenendijk and Stokhof (1984, 1997) for extensive discussion of the partition semantics for interrogatives.

Definition 2.3 (Semantics of Questions)
$\|?\vec{x}\,\phi\|_{w,g} = \{v \in W \mid \forall \vec{e} \in D^n\colon \|\phi\|_{v,g[\vec{x}/\vec{e}]} = \|\phi\|_{w,g[\vec{x}/\vec{e}]}\}$.

Whereas an indicative $\phi!$ *selects* a subset of the set of worlds: the worlds where $\phi!$ is true, an interrogative $\phi?$ *divides* the set of worlds into a number of (mutually exclusive) *alternatives*. For example, the question $?\exists x Px$ divides the set of worlds into two alternatives: the alternative consisting of the worlds where some object has the property P, and the alternative consisting of the worlds where there is no such object in the domain. The question $?x\,Px$ divides the set of worlds in as many alternatives as there are possible denotations of the property P. And the question $?xy\,Rxy$ divides the set of worlds in as many alternatives as there are possible denotations of the relation R.

The meaning of an interrogative corresponds to a *partition* of the set of possible worlds W. Hence, it also corresponds to an *equivalence relation* on W. It is the latter way of modeling a question that we will employ in formulating the context change potential of interrogatives.

2.5 Structuring the Context

In general, a semantics for a language in terms of context change potentials states the interpretation of a sentence as an operation on contexts. Hence, in order to formulate such a semantics for a particular language, we have to decide on a suitable notion of context.

Our query-language consists of two different types of sentences, with different functions, and different effects on the context. The function of indicatives is to provide *data*, the function of interrogatives is to raise *issues*. So, we could look upon a context as consisting of two elements: data and issues.[4]

We can model contextual data as a set of worlds, those worlds which are compatible with the data provided by the preceding discourse. Then, in general, the context change potential of an indicative will be to *eliminate possible worlds*.

We can model contextual issues as an equivalence relation on the set of possible worlds. If two worlds are non-related, i.e., if they belong to different contextual alternatives, then it is a contextual issue whether the actual world is like the one or like the other. The differences between related worlds, i.e., worlds which belong to the same alternative, is not a contextual issue.

Since interrogatives raise issues, their context change potential

[4] The terminology is taken from Hulstijn (1997), who defines an update semantics for questions in a similar way.

is to *disconnect* certain worlds, creating new or more fine-grained contextual alternatives. The context change potential of an interrogative consists in *eliminating pairs of worlds*—without eliminating the worlds themselves from the data: interrogatives do not provide data, they only raise issues.

Instead of splitting the context into two separate elements, a subset of the set of worlds representing the data, and an equivalence relation on the set of worlds representing the issues, we combine the two in modeling a context as an equivalence relation on a subset of the set of possible worlds. Or, equivalently:[5]

Definition 2.4 (Structured Contexts)
A *context* C is a symmetric and transitive relation on the set of possible worlds W.

Two worlds are contextually related iff they both belong to the divided subset and to the same alternative. A world w belongs to the divided subset iff $\langle w, w\rangle \in C$, which by abuse of notation, we write as $w \in C$. The set of contexts is partially ordered by $\subseteq$. The minimal context is W^2, the *initial context* of ignorance and indifference, where no data have been provided, and no issue has been raised. The *absurd context*, $\emptyset$, results if the contextual data are inconsistent. An *indifferent context* is a context such that $\forall w, v \in C\colon \langle w, v\rangle \in C$, a context where all worlds in the data are related, i.e., a context where there are no (unresolved) issues.

2.6 Changing the Context

In defining the context change potentials of the formulae of our query-language, we restrict ourselves to the sentences, the closed formulae of QL. The definition uniformly interprets indicatives and interrogatives as functions from contexts to contexts, but they have a different kind of effect on the context:

Definition 2.5 (Context Change Potentials)

i. $C[\phi!] = \{\langle w, v\rangle \in C \mid \|\phi!\|_w = \|\phi!\|_v = 1\}$;

[5] What is used here as the notion of context, a symmetric and transitive relation on the set of possible worlds, could also be taken as a notion of semantic content, replacing the usual notion of a proposition as a set (property) of possible worlds. The content of any sentence can then be taken to consist of a (possibly empty) assertive part, and a (possibly empty) interrogative part. The content of a sentence can be a mix of asserting/presupposing data and raising/supposing issues.

ii. $C[\phi?] = \{\langle w, v\rangle \in C \mid \|\phi?\|_w = \|\phi?\|_v\}$;
iii. For $\tau = \phi_1; \ldots; \phi_n$, $C[\tau] = C[\phi_1] \ldots [\phi_n]$.

An indicative $\phi!$ eliminates a pair of worlds from the context as soon as $\phi!$ is false in one of the worlds of the pair. In effect, this means eliminating worlds from the contextual data. An interrogative $\phi?$ eliminates a pair of worlds (disconnects two worlds) if they belong to different alternatives, i.e., if the two worlds differ in such a way that the question would receive a different answer in them. Interpreting an interrogation, a sequence of a mix of interrogatives and indicatives, is just interpreting the sentences in the sequence one by one.

It can easily be checked that all context change potentials in the language have the *classical update property*: $\forall C, \phi : C[\phi] \subseteq C$.[6] Further we note:

Fact 2.1 (Indicatives and Interrogatives)

a. $\forall C, w, v\colon \langle w, v\rangle \in C \;\&\; w, v \in C[\phi!] \Rightarrow \langle w, v\rangle \in C[\phi!]$.
b. $\forall C, w\colon w \in C \Rightarrow w \in C[\phi?]$.

Fact 1b says that interrogatives cannot eliminate worlds from the data, they can only eliminate pairs of worlds, i.e. disconnect worlds, leaving both of them in the data as such. Fact 1a says that indicatives cannot disconnect worlds: if two worlds are connected in the data, then if both remain in the data, they remain connected.[7]

Now that we have specified the logical language and its semantics, we turn to a specification of the logical notions by means of which we can arbitrate whether an interrogation is played according to the rules of the game.

2.7 Consistency and Entailment

One of the elements of the rules of the game of interrogation, the *Maxim of Quality*, is that the witness may only make *credible* statements. From a minimal, purely logical perspective, giving the witness every benefit

[6] This is why in the title of the paper it says: *Classical Version*. Originally, the logic of interrogations presented here was designed in a non-classical, dynamic setting, which lacks the classical update property. The richer system, also allowing for anaphoric relations across utterances, will be discussed in another paper. See also Groenendijk (1998).

[7] This fact about the complete division of labor between indicatives and interrogatives is specific for the language at hand, and not a necessary feature. Mixed cases of sentences which both provide/presuppose data and issues can be accommodated without difficulty.

of the doubt, her statements can be judged credible as long as she does not contradict herself. This requirement is covered by the logical notion of contextual consistency:

Definition 2.6 (Consistency)
ϕ is *consistent with* τ iff $\exists C\colon C[\tau][\phi] \neq \emptyset$.

A sentence ϕ is consistent with a preceding sequence τ, if there is at least some context C such that after an update of C with τ, a further update with ϕ does not lead to absurdity.

Since interrogatives do not eliminate worlds from the data, but can at most disconnect worlds in the data (Fact 1b), as long as the context is not absurd, an interrogative will always be consistent with it. Hence, the Quality Maxim cannot fail to be obeyed by the interrogator, only the witness may fail to do so.

Two other elements of the rules, both instances of the *Maxim of Quantity*, are that the witness may only make *non-redundant statements*, and that the interrogator may only ask *non-superfluous questions*. From a minimal, purely logical perspective, a statement is redundant, and a question superfluous, in case it is already entailed by the preceding context:

Definition 2.7 (Entailment) $\tau \models \phi$ iff $\forall C\colon C[\tau] = C[\tau][\phi]$.

A sentence ϕ is entailed by a preceding sequence τ, if after an update of a context C with τ, a further update with ϕ will never make a difference.

Contrary to what is the case in the game of reasoning, entailment is a vice rather than a virtue in the game of interrogation. Although defined in a uniform way, non-entailment means something different for indicatives and interrogatives:

Fact 2.2 (Informativeness and Inquisitiveness)

a. $\tau \not\models \phi!$ iff $\exists C, w\colon w \in C[\tau]$ & $w \notin C[\tau][\phi!]$.

b. $\tau \not\models \phi?$ iff $\exists C, w, v\colon \langle w, v\rangle \in C[\tau]$ & $\langle w, v\rangle \notin C[\tau][\phi?]$.

Indicatives, and only indicatives, can be *informative*, which means that at least in some context, some world is eliminated. Interrogatives, and only interrogatives, can be *inquisitive*, which means that at least in some context, some pair of worlds is disconnected.

The notions of consistency and entailment are standard logical notions. New is at most that they indiscriminately apply to statements and questions, and that we focus on the use of these notions in the formulation of Quality and Quantity requirements for the cooperative exchange of information, instead of as criteria for the soundness and validity of reasoning.

In fact, the latter would only make sense for the indicative part of the language. Which is not to say that, e.g., $\phi?\models \psi?$, or $\phi!\models \psi?$, makes no sense. The latter means that $\psi?$ is a superfluous question to ask after having been told that $\phi!$, i.e., that $\phi!$ has already completely resolved the issue raised by $\psi?$. It is not unusual to read this as: $\phi!$ *gives a complete answer to* $\psi?$, which is only a bit unnatural given that in $\phi!\models \psi?$, the answer precedes the question. However, when read in the other direction, $\psi?\models \phi!$, the entailment only holds in case $\models \phi!$, which is only logical, given that questions provide no data. What $\phi?\models \psi?$ means is that the question $\psi?$ is superfluous after $\phi?$ has already been asked, which is the case if whenever the issue raised by $\phi?$ is resolved, the issue raised by $\psi?$ cannot fail to have been resolved as well.

Although the familiar notions of contextual consistency and entailment have a minor role to play in the logic of interrogation as minimal requirements on the sensibility of utterances as moves in a game of information exchange, we have not yet touched upon the more central aspect, which is that information provided by the witness should be relevant to the issues that have been raised by the interrogator. We turn to that heart of the matter now.

2.8 Licensing and Pertinence

The last element of the rules, the *Maxim of Relation*, is that the statements of the witness should *exclusively address the issues* raised by the interrogator. This requirement is covered by the new logical notion of licensing:

Definition 2.8 (Licensing)
τ *licenses* ϕ iff $\forall C, w, v\colon \langle w, v\rangle \in C[\tau]\ \&\ w \notin C[\tau][\phi] \Rightarrow v \notin C[\tau][\phi]$.

A sentence is contextually licensed if whenever a world is eliminated from the data, all worlds related to it are eliminated as well, i.e., the whole alternative to which the world belongs is eliminated. Licensing forbids the elimination of some world in some alternative, leaving some other world from the same alternative in the data. In eliminating some world, a sentence would be informative, but if it does not eliminate a

whole alternative at the same time, the information provided does not exclusively address the contextual issues. The sentence would provide irrelevant information, information not directly related to the contextual issues.[8]

Note that since interrogatives never eliminate any world from the data, they are trivially licensed. As was the case with consistency, licensing only puts constraints on the statements of the witness, but reckons any question from the interrogator to be relevant.[9] Note also that if an indicative $\phi!$ is inconsistent with τ or is entailed by τ, then $\phi!$ is trivially licensed by τ.

Consistency and non-entailment are added to the requirement of licensing in the over-all notion of pertinence, the logical notion which arbitrates whether an interrogation is played according to the rules:

Definition 2.9 (Pertinence) ϕ is *pertinent after* τ iff

i. ϕ is consistent with τ (*Quality*)
ii. ϕ is not entailed by τ (*Quantity*)
iii. ϕ is licensed after τ (*Relation*)

As indicated, the three elements of logical pertinence can be related to the Gricean Conversational Maxims (leaving *Manner* out of consideration) which constitute the Cooperation Principle. But whereas the Gricean notions are usually thought of as belonging to a level of pragmatics which comes on top of logical semantics, here they make up the logic as such. In the logic of interrogation the notion of pertinence plays the same methodological role as the notion of entailment normally does. Whereas the latter arbitrates the game of argumentation, the former arbitrates the game of interrogation.

2.9 Putting Licensing to the Test

Intuitively, a good criterion for logical relatedness of a sentence ϕ to the contextual issues is the following: If ϕ gives any information in the context at all, then ϕ at least partially resolves the contextual issues. The latter is the case if at least one of the contextual alternatives is eliminated.[10] The notion of licensing meets this criterion:

[8] In Jäger (this volume), a similar relevance notion can be found, but baked right into the semantics as such, and not as a logical notion which comes on top of the semantics to arbitrate appropriateness.

[9] This is a feature particular to the present set-up. One could add requirements of relatedness for the questions of the interrogator as well.

[10] The notion of resolution, defined as eliminating at least one alternative, is the usual notion of a giving a partial answer in a partition semantics for questions, next

Fact 2.3 (Adequacy Test) τ licenses ϕ iff for all contexts C:

if $\exists w\colon w \in C[\tau]$ & $w \notin C[\tau][\phi]$
(*if* ϕ *is informative in* $C[\tau]$),
then $\exists w \in C[\tau]\colon \forall v\colon \langle w, v\rangle \in C[\tau] \Rightarrow v \notin C[\tau][\phi]$
(*then* ϕ *is resolvent in* $C[\tau]$).

This says that τ licenses ϕ is materially the same as: for any context C, if ϕ is informative in C after τ, then ϕ is resolvent in C after τ. I.e., as soon as ϕ eliminates a world from the data, ϕ cannot fail to eliminate a contextual alternative.

At first sight, this property may seem weaker than licensing. Relative to a particular context, a sentence ϕ can be informative and resolvent, in case next to eliminating some whole alternative, ϕ also eliminates some world in some other alternative without eliminating that alternative as a whole. However, if that were the case, then there would also be some other context where ϕ is informative, but not resolvent. It is by quantifying over *all* contexts, that being resolvent when informative, amounts to the same as licensing.[11]

That logical relatedness requires addressing contextual issues, is most clearly indicated by the fact that an indicative ϕ is licensed iff the corresponding *yes/no*-question $?\phi$ is contextually non-inquisitive:

Fact 2.4 (Relatedness Test)
Let ϕ be an indicative. τ licenses ϕ iff $\tau \models ?\phi$.

We refer to this fact as the Relatedness Test, because it gives a way of judging whether an indicative utterance is related to the contextual issues. If when ϕ is uttered, the corresponding question whether $?\phi$ is inquisitive, this means that the question is new, and not already present. Hence, the utterance is not licensed by the issues that have

to the notion of giving a complete answer, defined as $\phi \models \psi?$. Unlike the notion of an answer defined in the next section, both notions have in common that they allow for over-informative answers. The main feature of the present approach is that it starts out from precisely forbidding that.

[11] There is no space to go into this here, but there is also an important difference between the notion of licensing and the notion of being resolvent when informative. Unlike the latter notion, licensing is *grounded*. By this we mean that being licensed is the same as being licensed in the initial context of ignorance and indifference, updated with whatever went on in the discourse. The notions of consistency and non-entailment are grounded as well, which means that pertinence is also a grounded notion. So, in calculating pertinence one only has to reckon with one single minimal context. Whatever counts as appropriate there, is appropriate *per se*.

already been raised (and are not yet resolved) in the context.

Pertinence is a notion of contextual appropriateness, where the latter is usually taken to relate to presuppositions. Pertinence is a presuppositional notion:

Fact 2.5 (Presupposition Test)
$\neg\phi$ is pertinent after τ iff ϕ is pertinent after τ.

Putting the last two facts together, we can say that under the notion of pertinence, an indicative sentence presupposes the corresponding *yes/no*-question, in the sense that it should be non-inquisitive in the context, i.e., it should be a contextual issue.

In Section 11 we shall see, that taking the intonation contour of sentences into account, indicative sentences may also presuppose stronger *who*-questions.

2.10 Pertinent Answers

The new notion of licensing also gives rise to a new logical notion of an answer. An answer can be characterized as the special case of an indicative being licensed in the context of a single interrogative:

Definition 2.10 (Answers)
$\phi!$ is an *answer* to $\psi?$ iff $\phi!$ is licensed by $\psi?$

In Section 7, we noted that inconsistency and entailment imply relatedness. Hence, tautologies and contradictions are borderline cases of trivial and absurd answers. Apart from absurd and trivial answers, which answer any question, there are two (non-equivalent) answers to *yes/no*-questions:

Fact 2.6 (Yes/No)
ϕ is an answer to $?\psi$ iff $\models \phi$ or $\models \neg\phi$ or $\phi \Leftrightarrow \psi$ or $\phi \Leftrightarrow \neg\psi$.

Adding Quality and Quantity to the requirement of Relation, we arrive at the more informed notion of pertinent answers:

Definition 2.11 (Pertinent Answers)
$\phi!$ is a *pertinent answer* to $\psi?$ iff $\phi!$ is pertinent after $\psi?$.

Being a pertinent answer just excludes absurd and trivial answers:

Fact 2.7 (Pertinency and Contingency)
ϕ is a pertinent answer to $\psi?$ iff ϕ is an answer to $\psi?$ & $\not\models \phi$ & $\not\models \neg\phi$.

Only non-trivial questions ($\not\models \psi?$) have pertinent answers, and only equivalents of *yes* and *no*, are pertinent answers to non-trivial *yes/no*-questions. As for single *who*-questions, such as $?x\,Px$, an atomic sentence like Pa is a (pertinent) answer:[12]

Fact 2.8 (Literal Answers) $[\vec{c}/\vec{x}]\phi$ is an answer to $?\vec{x}\,\phi$.

Given the presuppositional nature of licensing and pertinence, answerhood is preserved under negation:

Fact 2.9 (Negative Answers)
ϕ is a (pertinent) answer to $\psi?$ iff $\neg\phi$ is a (pertinent) answer to $\psi?$.

Sentences which only state something about the cardinality of the set of objects that have the property P, are also answers to the question $?x\,Px$. For example, $\exists xPx$ and $\forall xPx$ are (pertinent) answers to $?x\,Px$.

The notion of an answer defined in terms of licensing differs from the standard notion of an answer in a partition theory of questions, which, as we mentioned in Section 7, is formulated as $\phi!\models \psi?$. The standard notion is both less and more demanding than the one defined here in terms of licensing.

The standard notion of an answer is less demanding in that it allows for *over-informative answers*, whereas the notion of an answer in terms of licensing typically does not. Under the standard notion, if ϕ counts as an answer to $\psi?$, then for arbitrary χ, also $\phi \wedge \chi$ counts as an answer to $\psi?$. Under the present notion, it does so only if χ as such, is also an answer to $\psi?$:

Fact 2.10 (Conjoined Answers) If ϕ is an answer to $\psi?$, and χ is an answer to $\psi?$, then $\phi \wedge \chi$ is an answer to $\psi?$.

[12] This feature makes it possible to link the logically elegant partition view of questions with a notion of answers that meets linguistic intuitions. In Groenendijk and Stokhof (1984) and elsewhere, we argued at length on logical grounds against Hamblin's and Karttunen's semantic analyses of questions. Nevertheless, almost without exception, linguistic semanticists fall back on these analyses, because they dislike the notion of exhaustive answers that seems to be baked into the partition view. Under the present notion of an answer, linguists can have their cake and eat it.

Given that answerhood is also preserved under negation, other logical operations which can be defined in terms of negation and conjunction, like disjunction, also preserve answerhood.

The standard notion of an answer is more demanding in that it is a notion of *exhaustive* answering. E.g., whereas under the present notion $Pa \wedge Pb$ counts as a (pertinent) answer to $?x\,Px$, under the standard notion it does not. Only an explicitly exhaustive answer, like $Pa \wedge Pb \wedge \neg\exists x(Px \wedge x \neq a \wedge x \neq b)$, is an answer under the standard notion. Under the notion defined here, the explicitly exhaustive answer can be characterized as a better, a more informative answer:[13]

Definition 2.12 (Comparing Answers)
Let ϕ, χ be pertinent answers to $\psi?$.
ϕ is a more informative answer to $\psi?$ than χ iff $\phi \models \chi$ & $\chi \not\models \phi$.

In fact, the explicitly exhaustive answer counts as an *optimal answer* to the question, in the sense that there are no pertinent answers to $?x\,Px$ which are more informative. Note that: If ϕ is an optimal answer to $\psi?$, then $\phi \models \psi?$.

The focus of the present paper is not so much on the relation of answering as such, but rather on the more general issue of the role of the logical notions of licensing and pertinence in arbitrating the appropriateness of utterances from the perspective of cooperative information exchange. The following section is devoted to the discussion of some examples.

2.11 An Illustration. And Nothing Else

The examples given below are only intended as an illustration of, and partly as further motivation for, the logical notions introduced above, in particular the new notion of licensing. We make no claims to the effect that we present linguistic analyses, or provide alternative explanations as compared to other approaches.

2.11.1 Resolving an Ambiguity with an Issue

Consider the following example. Out of context, and without intonational information, (1a) is ambiguous between (1b) and (1c):[14]

[13] Precisely because the notion of licensing forbids over-informativeness, we obtain this easy way of comparing answers in terms of informativeness. Compare this with the much more intricate notions of comparing answers in Groenendijk and Stokhof (1984, 1997).

[14] English is not the perfect language for this type of example, because of the easy availability of *do*-support. Lacking *do*-support, Dutch would be better.

(1) a. Alf rescued Bea. And no-one else.
b. $Rab;\ \neg\exists x(Rxb \wedge x \neq a)$
c. $Rab;\ \neg\exists x(Rax \wedge x \neq b)$

However, after the interrogative in (2a), or with the intonational information indicated by underlining in (2a), the ambiguity in (1a) is resolved:

(2) a. (Who rescued Bea?) Alf rescued Bea. And no-one else.
b. $?x\,Rxb;\ Rab;\ \neg\exists x(Rxb \wedge x \neq a)$
c. $?x\,Rxb;\ Rab;\ \neg\exists x(Rax \wedge x \neq b)$

Only (2b) is a plausible interpretation for (2a), and not (2c). Alternatively, after the interrogative in (3a), or with the intonational information indicated by underlining in (3a), (3a) can only be interpreted as (3c), and not as (3b):

(3) a. (Whom did Alf rescue?) Alf rescued Bea. And no-one else.
b. $?x\,Rax;\ Rab;\ \neg\exists x(Rxb \wedge x \neq a)$
c. $?x\,Rax;\ Rab;\ \neg\exists x(Rax \wedge x \neq b)$

Our logic of interrogation accords with the difference between (2a) and (3a). Both the interrogations (2b) and (3c) are pertinent. The interrogatives $?x\,Rax$ and $?x\,Rxb$ are both inquisitive. And both the sequence of indicatives in (3b) and in (3c) are contingent. More importantly, Rab is licensed by (is an answer to) both $?x\,Rxb$ and $?x\,Rax$. And $\neg\exists x(Rxb \wedge x \neq a)$ is licensed by $?x\,Rxb;\ Rab$, just as $\neg\exists x(Rax \wedge x \neq b)$ is licensed by $?x\,Rax;\ Rab$.

Given that $?x\,Rxb$ asks for the specification of the (whole) denotation of the property $\lambda xRxb$, the answer that a has that property may leave the interrogator with the question whether anyone else does. And this is precisely the issue that $\neg\exists x(Rxb \wedge x \neq a)$ addresses. We can also inspect this by performing the Relatedness Test: the *yes/no*-question $?\exists x(Rxb \wedge x \neq a)$ is non-inquisitive after $?x\,Rxb;\ Rab$. Hence, $\neg\exists x(Rxb \wedge x \neq a)$ is contextually licensed, it is an issue the witness is entitled to address.

But *not* the other way around: the sequences in (2c) and (3b) are impertinent. The sentence $\neg\exists x(Rax \wedge x \neq b)$ is not licensed by $?x\,Rxb;\ Rab$. And the sentence $\neg\exists x(Rxb \wedge x \neq a)$ is not licensed by $?x\,Rax;\ Rab$. That Alf rescued no-one else but Bea, can be informative in a state in which the question has been raised who rescued Bea, without being resolvent after the answer has been given that Alf rescued Bea, and hence, is not licensed by the context.

A simple counterexample against licensing, is the situation where the interrogator already knows that one and only one person rescued Bea. She wants to know who it was. After her question to that effect,

and having been told by the witness that it was Alf, the state of the interrogator is a state of indifference. Still, that Alf rescued no-one else, can very well be informative in her state. Only she did not ask for that. That Alf rescued no-one else does not resolve a contextual issue. Such a counterexample shows that the last sentence of (2c) is not licensed by the context, which makes it impertinent.

Again, we can also put the Relatedness Test to work: the *yes/no*-question $?\exists x(Rax \wedge x \neq b)$ is inquisitive after $?x\,Rxb;\ Rab$. This means that $\neg\exists x(Rax \wedge x \neq b)$ is not licensed by the context. In the context of $?x\,Rxb;\ Rab$, it addresses an issue which was not raised by that context.

What the discussion of these examples suggests is the following. One way of accounting for the resolution of the ambiguity in (1a), in the contexts (2a) and (3a), is that we cooperatively interpret (2a) and (3a) in such a way that our interpretation gives rise to a pertinent discourse, where each sentence is licensed by the preceding context. That is how we arrive at (2b) and (3c), and not at (2c) and (3b), as appropriate interpretations for (2a) and (3a).

2.11.2 Presupposing an Issue

If we swap the interrogatives in (2a) and (3a), leaving the intonational contour of the utterances the same, the resulting interrogations are not appropriate, e.g., compare (2a) with (4a):

(4) a. *Whom did Alf rescue? Alf rescued Bea. And no-one else.
b. $?x\,Rax;\ \ll ?x\,Rxb \gg Rab;\ \neg\exists x(Rxb \wedge x \neq a)$

The intuition is that with the intonation contour as indicated in (4a), the first indicative simply does not fit the interrogative. It fits the interrogative we originally had in (2a), not this one in (4a). A natural conclusion to draw is that the intonation contour as such has some semantic impact, because otherwise, we are (semantically) out of business in explaining what is wrong with (4a).

Along not unusual lines, we might account for the unacceptability of (4a), in a presuppositional setting, by assuming that the intonation contour of the first indicatives in (2a) and (3a), presuppose the issue raised by the interrogatives in (2a) and (3a). We can look upon the sequences in (2b-c) and (3b-c) as the result of presupposition accommodation. In (4b), I indicated that by fronting the first utterance of the witness, with the corresponding presupposed question between double angled brackets.[15]

[15] This is only a bit of suggestive notation. The semantics presented in Section 6 does not take presuppositions into account. It would declare $C[\ll \phi \gg \psi] = C[\psi]$,

Now we are back in business. If anything may be assumed, then it is that, leaving accommodation aside, if a question is presupposed, it is to be non-inquisitive in the context. Just as, leaving accommodation aside, a presupposed indicative should be non-informative in the context. Then we are quickly ready with explaining what is wrong with (4a): $?x\,Rxb$ is inquisitive after $?x\,Rax$, the unacceptability of (4a) is due to presupposition failure.

A general feature of presuppositions is that they are preserved under negation. As we noted above, contextual relatedness is of a presuppositional nature. An utterance of an indicative ϕ always presupposes the corresponding *yes/no*-question. Returning to the type of examples we are discussing here, where we take intonational contour into consideration, if we think along these presuppositional lines, then we can represent (3a) out of context, but with the intonation contour as indicated in (5a), as (5b):

(5) a. Alf rescued Bea. And no-one else.
b. $\ll ?x\,Rxb \gg Rab;\ \neg\exists x(Rxb \wedge x \neq a)$

Just concentrating on the first sentence, we see that as compared to the general presupposition of indicatives we just noted, that ϕ presupposes the *yes/no*-question $?\phi$, the effect of the intonation contour in the first sentence of (5a), according to the representation in (5b), leads to a *stronger* presupposed *who*-question. The stronger presupposition is also preserved under negation:

(6) a. Alf did not rescue Bea. And, also, no-one else.
b. $\ll ?x\,Rxb \gg \neg Rab;\ \neg\exists x(Rxb \wedge x \neq a)$

Observe that if we consider the first sentence in (6a) with a neutral intonation contour, we get back the same kind of ambiguity we found in (1a), where the second reading is the only one which (7a) has:

(7) a. Alf did not rescue Bea. And, also, no-one else.
b. $\ll ?x\,Rax \gg \neg Rab;\ \neg\exists x(Rax \wedge x \neq b)$

Next to preservation under negation, the possibility to be cancelled is another characteristic feature of presuppositional phenomena. Compare (2a) with (8a):

(8) a. (Who rescued Bea?) Alf rescued Bea. And, actually, no-one else.
b. ??(Who rescued Bea?) Alf rescued Bea. And he rescued no-one else.

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if $C[\phi] = C$, else undefined. Note that indicative and interrogative presuppositions are uniformly dealt with in this way.

Unlike in (2a), in (8a) the ambiguity of (1a) turns up again. Actually, I tend to believe that for (8a) the reading in (2c), which was excluded for (2a), is more salient than the reading in (2b), the only acceptable reading of (2a). The word *actually* crucially seems to give rise to the availability of both readings. Apparently, the conversational effect of *actually*, is an indication of the fact that the issue at hand is being overruled.

Unlike in the artificial language game of interrogation, in real discourse we may invent the issues we want to address ourselves. As (8a) shows, although we are not asked for that, we may provide the additional piece of information that rescuing Bea was Alf's only heroic act. Does this get in the way of the role of our strict notion of relatedness in steering discourse, and determining its appropriateness? I don't think so. The relevant observation is, that if one overrules relatedness to a contextually given issue, and addresses a new issue, as happens in (8a), then one explicitly marks one's utterance for having this effect. If relatedness did not operate, there would be no need for that. So, my hypothesis is, that (8b) is not an appropriate sequence, that is, unless one way or the other, for example, by adding special intonation contour to the utterance (AAANNNDDD!...), the utterance is marked for providing extra unsolicited information.

2.11.3 How Accommodating Can One Get?

The two sentence sequence in (9a) is just as alright as the three sentence sequence in (2a); and from the unavailability of the reading (2c) for (2a), we may expect that (10a) is hardly acceptable:

(9) a. Who rescued Bea? Only Alf rescued Bea.
b. $?xRxb;\ Rab \wedge \neg\exists x(Rxb \wedge x \neq a)$

(10) a. ??Who rescued Bea? Alf rescued only Bea.
b. $?xRxb;\ Rab \wedge \neg\exists x(Rax \wedge x \neq b)$

The following examples also give an illustration of that:

(11) Did Alf rescue Bea? Yes he did. And, in fact, he rescued only Bea.

(12) ??Did Alf rescue Bea? Alf rescued only Bea.

The last two sentences of (11), and the last sentence in (12), provide the same information. Still, the discourse in (11), where we first just resolve the issue raised by the interrogative, and then go on to provide some extra information that is not asked for as such, is alright. But if we make the answer as such over-informative, as in (12), by putting the extra information already in it, the acceptability of the resulting discourse is questionable.

Although the examples discussed above support the idea that the strict notion of contextual relatedness embodied in the notion of licensing is operative in a structural way, it is hard to believe that just being a bit over-informative is always punished so harshly. The following example is a case in point:

(13) a. Did someone rescue Bea? Alf rescued Bea.
b. $?\exists xRxb;\ Rab$

The indicative in (13), is impertinent after the *yes/no*-question. Only $\exists xRxb$ and $\neg\exists xRxb$ are pertinent in the context of the question $?\exists xRxb$. The sentence Rab properly entails $\exists xRxb$, and hence counts as over-informative. However, intuitively, the information that Rab is such a natural elaboration of $\exists xRxb$, anticipating the further question: *Who?*, that it seems wrong to deem it impertinent in the context. Rather than blaming her for being uncooperative, the witness deserves praise for her accommodating attitude.

Note, first of all, that the indicative in (13a) really needs the intonation contour indicated in (14a):

(14) a. Did someone rescue Bea? <u>Alf</u> rescued Bea.
b. $?\exists xRxb;\ \ll ?x\ Rxb \gg Rab$

In line with the observations made above, this means that the indicative presupposes the issue who rescued Bea, and should be represented as in (14b), and not as in (13b). However, this does not yet explain why the sequence feels alright. The issue $?x\,Rxb$ is not implied by $?\exists xRxb$, but rather the other way around: $?x\,Rxb \models ?\exists xRxb$. The issue presupposed by the indicative in (14), is stronger than the issue posed by the question, and hence is inquisitive in the context.

Note, secondly, that although it is perhaps a more standard way to react to the question, it seems not really obligatory to first say: *Yes*, as in (15a):

(15) a. Did someone rescue Bea? Yes, <u>Alf</u> rescued Bea.
b. $?\exists xRxb;\ \exists xRxb;\ \ll ?x\,Rxb \gg Rab$

If this were the case, we would arrive at (15b), and the present examples would fit in with the observation made above, that providing extra information is allowed only after the contextual issue has been resolved.

However, if, as I assume, (14a) as such is fully appropriate, then, as it stands, the logic of interrogation does not give us the means to account for this. One way to approach the matter might be to add a notion of contextual relatedness for questions, which explains why the issue presupposed by the last utterance in (14a) is so closely related to the opening *yes/no*-question, that its accommodation takes no effort.

Another way to address this issue might be to interpret the effect of focussing in the indicative utterance in (14a) in such a way, that it involves existential quantification, and amounts to the same thing as we find in (15b). But further investigations along these lines have to be left to another occasion.

2.12 Summary and Conclusion

In this paper, we investigated the prospects of basing logic on cooperative information exchange instead of valid reasoning. To this end, we introduced a simple dialogue game of interrogation. Relative to a minimal logical query-language suitable for the game, and a semantic interpretation for that language in terms of context change potentials, we defined a logical notion of pertinence, which enables us to arbitrate whether the game is played according to the rules. The elements of pertinence —contextual consistency, non-entailment, and licensing— were seen to correspond to elements of the Gricean Cooperation Principle. The main novelty is the notion of licensing, by which we can judge whether an utterance is logically related to the context. We illustrated the use of the logic of interrogation in natural language semantics by considering some linguistic examples, which exhibit phenomena which are inherently related to the communicative function of language.

We hope to have shown that a reorientation of logic towards raising and resolving issues is a feasible enterprise, which is interesting both from a logical and from a linguistic perspective. It leads to a new notion of meaning as cognitive content, which treats data and issues as equal citizens. In doing so, logical semantics invades the territory of pragmatics. Instead of viewing semantics and pragmatics as constituting two separate components within a theory of meaning, we make a move towards an integrated theory by shifting the logical perspective from valid argumentation to cooperative communication.