77. Questions

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Abstract

Questioning is a basic type of speech act essential for human communication, and questions form a distinct sentence type in every language. The article first gives a survey of different uses of questions, as speech acts and as embedded clauses. It then lists the various types of questions and characterizes the notion of congruent answer. It gives an introduction into the principal semantic approaches to questions, like the functional approach, the proposition set approach and the partitional approach, and discusses how question meanings can be constructed from given syntactic structures. The last section takes up a number of supplementary topics, like the relation between indefinite NPs and interrogative pronouns, the nature of question-embedding predicates, biased questions and focus within questions, and the role of questions in structuring discourse.

There are four ways of answering questions. Which four? There are questions that should be answered categorically. There are questions that should be answered with an analytical answer, defining or redefining the terms. There are questions that should be answered with a counter-question. There are questions that should be put aside.

(Pañha Sutta, translated from the Pali by Thanissaro Bhikkhu)

Questions as speech acts and as semantic objects

We will be concerned with the most pedestrian type of questions here that the Enlightened One mentioned, the questions that should be answered categorically by *yes* or *no, this* or *that.* Yet even then questions are a highly interesting linguistic phenomenon that continues to inspire developments in syntax, semantics, and pragmatics.

In the classification of speech acts by Searle (1975), questions form a subtype of directives, one of the major five classes, together with commands and requests. This is because questions try to make the addressee do something, namely, provide a particular piece of information. While this is certainly the prototypical function of questions, one should be aware that not every request for information is expressed by a ques-

tion — consider, e.g., commands like *Tell me the time!* Also, an assertion like *You want coffee* whose truth value is only known by the addressee may be used to express a question; if not true, the addressee can be expected to reject it. It has been claimed that Yélî Dnye, a Papuan language, does not distinguish between assertions and polar (yes-no) questions at all (cf. *Annual Report* 2006).

On the other hand, not every sentence with question form expresses a request for information. There are exam questions like *Rome was founded when?* in which the questioner knows the answer but wants to check the ability of the addressee to supply it. There are rhetorical questions like *Did you ever lift a finger to help me?*, which amounts to a strong assertion that you never lifted a finger to help me. There are reflective questions that do not oblige the addressee to answer but express the speaker's interest in an issue, such as German *Ob es wohl regnen wird?*, lit. 'whether it will rain?' There are deliberative questions that do not ask for facts but inquire what should be done, as in *What should I do?*, and whose answers, consequently, are directives, e.g. *Read this article!* There are questions that express conditions, as in *Are you easily tired? XZZ will help you.* Questions are also used to seek confir-

mation in cases in which the speaker is not sure, as in question tags, cf. *He will come, won't he?*, or to utter commands, as in *Could you open the window?* And there are embedded questions (sometimes called "indirect questions") like *Bill knows who will come*, which do not express information requests either.

Nevertheless, the various uses of unembedded or root questions can be reduced to one basic pragmatic function, namely, expressing lack of information of a specified type. We will see how the wide variety of question uses can be derived from this core meaning. Embedded questions, on the other hand, do not imply lack of information. Yet there are properties that questions as speech acts and questions as constituents of clauses have in common.

Stenius (1967) has argued that utterances used to perform speech acts like assertions, commands, and questions can be partitioned into a sentence radical denoting a semantic object, like a proposition, and a sentence mood indicator or illocutionary operator that turns this semantic object into a communicative act. While Stenius considered only simple yes/no-questions, which may have the same sentence radical as assertions, we can assume that the sentence radical of question in general is a proposition that lacks certain parts. Such open propositions can be used to perform speech

act that expresses that the speaker lacks information, as specified by the gaps in the sentence radical. For example, the question *Who will come?* contains a sentence radical COME(X), where "x" identifies the information lacking, which is changed by an illocutionary operator QUEST into a request to the addressee to specify the lacking pieces of information in such a way that the resulting closed proposition is true. Embedded questions, as in *Bill knows who will come*, presumably contain the sentence radical only, as in KNOW(COME(X))(BILL), which says that Bill knows for which entities the sentence radical COME(X) will lead to a true proposition. That is, root questions and embedded questions are both built on interrogative sentence radicals:

1. *Who will come?*
   QUEST(COME(X))
2. *Bill knows who will come*.
   ASSERT(KNOW(COME(X))(BILL)).

The semantics of questions deals with the interrogative sentence radicals that occur in root questions or as dependent clauses; the pragmatics of questions is concerned with the various roles that questions serve in communication. While the main focus of this article is on semantics, the meaning of interrogative sentence radicals, we also have to consider different uses of questions, as the proposed semantics should ultimately

lead to an explanation of how questions function in communication. As questions often request answers, the linguistic form of answers will also constrain possible theories of questions, and hence, interrogative sentence radicals. The semantics of interrogative sentence radicals should furthermore provide for an explanation of the distribution of embedded questions — which predicates allow for indirect questions, and why.

Types of questions

We can distinguish three types of interrogative sentence radicals, and correspondingly, of questions, according to the type of the lacking information: constituent questions, polarity questions and alternative questions.

Constituent questions

Constituent questions create an open proposition by leaving parts of the description of the proposition unspecified. Languages apply interrogative pro-forms for this purpose. In English, these pro-forms have an initial *wh-* (going back to Indo-European $^{+}k^{w}$); hence terms like "*wh*-questions" or "*wh*-pronoun". A better term might be "completion question", reflecting the German term *Ergänzungsfrage.*

In English, constituents that can be questioned include all arguments and ad-

juncts that are part of the description of a proposition:

3. a. *What did John read?*
   b. *Who read this book?*
   c. *When did John read this book?*
   d. *Where did John read this book?*
   e. *Why did John read this book?*

Questioning a constituent that includes the finite verb requires a higher-order verb, as in *What did John do?*. But there are languages that have interrogative pro-verbs; e.g. Kiribati (Austronesian) has seven pro-verbs expressing meanings like 'to do what', 'to be where', or 'to do how':

4. *Kam na aera?*
   you.PL FUT do.what
   'What will you do?'

It is also possible to question sub-constituents, as e.g. [*Whose book*] *did John read?* Again there are differences between languages. English lacks a way to question ordinals, which German has:

5. *Den wie-viel-t-en Geburtstag feiert Maria?*
   lit. 'The how-many-th birthday does Maria celebrate?'

It has been suggested (Gil 2001) that only open-class items can be questioned; this excludes pro-forms for prepositions or determiners (other than number words). There are languages with a very small inventory of question constituents, like Asheninca Campa (Arawakan) with possibly a single such constituent that is further specified by various

light verbs (cf. Cysouw, to appear). It should be mentioned that constituent questions can also be expressed without any interrogative pro-form (cf. Gretsch 2000) (rising intonation is crucial).

6. *Sie sind geboren am _ ?*
   you are born at _
   'When are you born?'

Constituents that are not part of the descriptive sentence radical cannot be questioned. This holds, in particular, for constructions that specify the nature of the speech act, but also for constituents expressing speaker attitudes, as the underlined constituents in the following examples:

7. a. *Frankly, I don't like you.*
   b. *Luckily, the train was late.*

Languages differ not only in the types of interrogative pro-forms, but also in where they are realized within a sentence. While many place them sentence-initally, as in English, many others leave them *in situ* (cf. Dryer 2005). Some languages move interrogative pro-forms into a dedicated focus position, such as the preverbal position in Hungarian (cf. Szabolcsi 1981), or to a postverbal position in Western Bade (Chadic; cf. Tuller 1992), which corresponds to the preferred focus position in these languages. Many exhibit both strategies: English allows for in situ in echo questions, which request the repetition of linguistic material that

was not understood properly or that is incredulous, and in exam questions. In general, in situ interrogative pro-forms appear to be marked intonationally (indicated by accent):

8. a. *You are leaving whén?*
   b. *Napoleon died whích year?*

It is possible to use more than one interrogative pro-form per clause, resulting in so-called “multiple questions”. In English, only one pro-form undergoes movement, the others remain in situ and are accented. In Slavic languages and in Romanian, all interrogative pro-forms can move (cf. Comorovski 1996). In the following examples, movement is indicated by coindexed traces.

9. *Who will* t_1 *read what?*
10. *Cine*$_1$ *ce*$_2$ [t_1 *ti-a spus* t_2]
    who what you-AUX told
    ‘Who has told you what?’

We will see that there are at least two subtypes of multiple questions, “matching” questions that are supposed to be answered by more than one answer, and non-matching questions for which there is no such restriction.

Movement of interrogative pro-forms is restricted by syntactic island constraints, (cf. 11). Ungrammaticality can be avoided by the in situ strategy (cf. 12) or by moving the whole syntactic island (so-called pied piping, cf. 13).

11. *[Which author]$_1$ did Bill read [a book by t_1]?

12. *Bill read* [*a book by whích author*]*?*
13. [*A book by whích author*] *did John read?*

Answers to such questions do not consist just of the *which*-phrase, but must correspond to the syntactic island. For example, (12) and (13) cannot be answered by *Jane Austen*, but need more complex phrases like *a book by Jane Austen.* Such data have led to the idea that even in situ structures like (12) involve syntactic movement, on the level of logical form (cf. Nishigauchi 1990, von Stechow 1996).

Constituent questions also occur in embedded structures:

14. *John knows what Bill will read.*
15. *John knows who will read what.*

The syntactic structure of embedded questions often differs from root questions. In English root questions, there must be a verbal head preceding the subject (cf. 16), which must be an auxiliary – different from German (cf. 17). When questioning the subject itself, this requirement does not obtain, arguably because the subject itself has already undergone movement, and the verbal head precedes the subject trace (cf. 18):

16. *What will / does Bill read?*
17. **What reads Bill? / Was liest Bill?*
18. *Who*$_i$ *read* t_i *'War and Peace'?*

In questions embedded by verbs like *know,* the requirement that the verbal

head precedes the subject does not obtain:

19. *John knows what Bill will read.*
*/ *what will Bill read.*

20. *John weiß, was Bill liest. / *was liest Bill.*

This suggests that the filling of a pre-subject position by a verbal head is a feature of root clauses, hence a property of the illocutionary force QUEST that changes an interrogative sentence radical into a question. Embedded questions do not contain QUEST, and hence do not have a pre-subject verbal head requirement.

As we have seen, there are two strategies of forming questions. The in situ strategy does not require, and in fact does not allow, a pre-subject verbal head:

21. **Does / *Will Bill read whát?*

22. **Liest Bill wás?*

In situ questions express the illocutionary force by non-syntactic, purely prosodic means that are expressed by rising tone on the interrogative proforms. In this case, it seems that no interrogative sentence radical is formed, as these questions do not occur as embedded questions:

23. a. *John knows what Bill read.*
b. **John knows (that) Bill read whát.*

However, languages that only have the in situ strategy, like Japanese, use such questions also in embedded structures, as in the following example:

24. Naoya-wa [Mari-ga nani-o nomiya-de nonda ka]
Noya-TOP Mari-NOM what-ACC bar-LOC drank Q
imademo oboeteru
even.now remember
'Naya still remembers what Mary drank at the bar.'

Ishihara (2004) has shown that the embedded wh-word is prosodically prominent and leads to deaccenting of the rest of the embedded sentence up to the interrogative marker *ka* that it is associated with.

Polarity Questions

The second type of questions, which are also called "Yes/No-Questions" (German *Entscheidungsfrage,* 'decision question'), request an answer that specifies whether the proposition expressed by their sentence radical holds or does not hold, rather than closing a proposition with an open parameter.

25. *Will Bill read 'War and Peace'?*
26. *Does Bill understand the task?*

In these realizations of polarity questions we find pre-subject verbal heads, just as in constituent questions, but there is no additional *wh*-movement, as there is no interrogative pro-form. Just as with constituent questions, this requirement is absent in embedded questions, where a special complementizer, in English *whether* or *if*, must be present:

27. *John knows whether/if Bill read 'War and Peace'.*

28. **John knows (whether/if) did Bill read 'War and Peace'.*

Just as with constituent questions, there is a way to form questions without a pre-subject verbal head, by modulating a sentence with indicative word order by a strong final rise (cf. Gunlogson 2003). Again similar to constituent questions, polarity questions marked in this way cannot be embedded by verbs like *know*.

29. *Bill read 'War and Peace'?*

30. **John knows Bill read 'War and Peace'?*

The strategy of marking polarity questions by interrogative word order is typologically rare but happens to be widespread in European languages, in particular in Germanic languages (cf. Siemund 2001, Dryer 2005). The second strategy, rising intonation, is very frequent, but not universal; for example, it is reported to be non-existent in Quechua, Greenlandic and Yelí Dnye.

Another way of marking polarity questions is by question particles. They often occur at the periphery of the sentence, e.g. sentence-finally as in Japanese (31), or sentence-initially in Swahili (32).

31. *kono hon wa omoshiroi desu ka*
this book TOP interesting COP Q
'Is this book interesting?'

32. *je, a-li-kwenda shule-ni?*
Q 3SG-PST-go school-LOC
'Did (s)he go to school?'

Peripheral realization is to be expected for illocutionary operators, which take the whole sentence radical in their scope. But we find question particles also in other positions, e.g. preverbally in Georgian and cliticized to the first constituent in Latin:

33. *čai xom ginda?*
    tea Q you.want
    'Do you want tea?

34. *Puer-ne bonus est?*
    boy-Q good is
    'Is the boy good?'

Many languages have question-specific modal particles, which are not obligatory and often express additional meaning components, like a bias towards a positive or negative answer. For example, in German the particle *denn* suggests expectation of a negative answer.

Another type of marking is by verbal morphology, as in Greenlandic:

35. *Iga-va.*
    cook-INTER.3SG,
    'Do you cook?'

The last marking strategy is particularly important for understanding their semantics; it consists of disjunctive constructions as in Chinese:

36. *nǐ hē pijiǔ bu hē pijiǔ*
    2SG drink beer NEG drink beer
    'Do you drink beer?'

Alternative Questions

The third type of questions is semantically related to constituent questions, as they request information to close an open proposition.

37. *Did Bill read 'War and Peáce' or 'Anna Karénina'?*
38. *John knows whether Bill read 'War and Peáce' or 'Anna Karénina'.*

It is crucial that the initial alternative receives a strong rising accent, and the final a strong falling accent. Without this, the sentence would be interpreted as a yes/no question with a disjunctive term in its descriptive part ('Is it true that Bill read W&P or AK?').

Alternative questions differ from constituent questions as they mention the possible completions explicitly. But this can also be done with constituent questions:

39. *What did Bill read, 'War and Peáce' or 'Anna Karénina'?*
40. *John knows what Bill read, 'War and Peáce' or 'Anna Karénina'.*

In contrast to constituent questions, finite verbs, prepositions and quantifiers can be questioned:

41. *Did Bill búy or bórrow this book?*
42. *Did the plane fly abóve or belów the clouds?*
43. *Did you drink móst or áll of the whiskey?*

Alternative questions also differ from constituent questions as they do not show *wh*-movement, which seems to be

triggered by a specific feature expressed by the *wh*-property.

44. **'War and Peace' or 'Anna Karenina' did Bill read?*

We find the same island restrictions in interpretation as in *wh*-in situ cases:

45. A: *Did Bill read a book by Jane Austen or by Charlotte Brontë?*

46. **Jane Austen. / A book by Jane Austen.*

As standard examples show (cf. 37), alternative questions have pre-subject verbal heads, which indicate question mood. As there is no overt movement of a question constituent, they appear syntactically as a subtype of polarity questions, yet semantically they are similar to constituent questions.

Answers to questions

The question/answer relation and the semantics of questions

In their prototypical use, questions are requests for answers. Consequently, any theory of questions will have to take into account the discourse relation between question and answer. As we have seen, the Pañha Sutta used this relation to classify questions. In more recent times, this research strategy was attractive because answers are assertions, and there are well-developed semantic theories of assertions.

Now, naturalistic reactions to questions come in a wide variety, including *I don't know* or *Go and ask someone else*,

or by various strategies of telling more, less, or something different than what a speaker has asked for. Such reactions might be important for the pragmatics of the questions/answer-relation. The answers that are of particular interest for the semantics of questions are so-called “congruent” answers (cf. von Stechow 1990).

47. Q: *Who will go where tomorrow?*
    A1: *Fritz will drive to Potsdam tomorrow.*
    A2: *Fritz will go to Potsdam tomorrow.*
    A3: *Fritz will go somewhere tomorrow.*

Among the three reaction to Q’s question, the congruent answer is A2; it satisfies the informational need expressed by the question without giving more information than required (like A1) or less information than required (like A3). As stated, the semantics of questions is formulated in terms of possible congruent answers like the following:

48. *Fritz will go to Potsdam tomorrow.*
    Fritz will go to Berlin tomorrow.
    Franz will go to Potsdam tomorrow.
    Franz will go to Berlin tomorrow.
    ...

But is it justified to give assertions this privileged role in semantics? Perhaps we can give a semantics for assertions in terms of a semantics for questions, instead of the other way round? In fact, in the current setup, which distinguishes between the meaning of sentence radicals and speech acts, we do

neither. Rather, both questions and assertions are based on sentence radicals, where the sentence radical of an assertion that is a congruent answer specifies the open parameters of the sentence radical of the question:

49. QUEST [x WILL GO TO y TOMORROW]
    ASSERT [FRITZ WILL GO TO POTSDAM TOMORROW]

The relation between QUEST and ASSERT belongs to pragmatics; an utterance based on QUEST expresses an informational need, a request to specify information of a particular type, and a congruent answer based on ASSERT satisfies this information need. The systematic relation between the sentence radical [x WILL GO TO y TOMORROW] and the sentence radical [FRITZ WILL GO TO POTSDAM TOMORROW] belongs to semantics, and in the section on modeling question meanings we will discuss various ways how this relation can be captured.

Marking answer congruence

Often, a fully specified sentence radical can answer more than just one question. For example, the assertion *Fritz will go to Potsdam tomorrow* is a congruent answer to at least the following questions:

50. a. *What happened?*
    b. *What will happen tomorrow?*
    c. *What will Fritz do tomorrow?*
    d. *Where will Fritz go tomorrow?*
    e. *When will Fritz go to Potsdam?*

f. *Who will go to Potsdam tomorrow?*

g. *Who will go where tomorrow?*

h. *Who will go where when?*

But notice that the answer indicates the type of question by focus, as expressed by sentence accent (cf. Paul 1880). In the following, focus is indicated by an F subscript, and sentence accent by accented letters. Notice that the realization of (51.a) to (d) is the same, an instance of focus ambiguity.

51. a. [*Fritz will go to Pótsdam tomorrow*]$_F$

b. [*Fritz will go to Pótsdam*]$_F$ *tomorrow.*

c. *Fritz will* [*go to Pótsdam*]$_F$ *tomorrow.*

d. *Fritz will go* [*to Pótsdam*]$_F$ *tomorrow.*

e. *Fritz will go to Potsdam* [*tomórrow*]$_F$.

f. [*Frítz*]$_F$ *will go to Potsdam tomorrow.*

g. [*Frítz*]$_F$ *will go to* [*Pótsdam*]$_F$ *tomorrow.*

h. [*Frítz*]$_F$ *will go to* [*Pótsdam*]$_F$ [*tomórrow*]$_F$.

While the truth conditions of all the answers in (51) are the same, they differ in signaling which question they answer. Focus is thought to indicate alternative meanings; focus in answers indicate that the alternatives are all grammatically possible answers to the question. It should be added that languages do not generally mark question/answer coherence by focus. For example, Zerbian (2006) points out that Northern Sotho (Bantu) lacks focus marking except for subjects.

Most of the answers in (51) have a pedantic ring to them as they rephrase much of the material of the question. In

real life, speakers tend to omit parts that are present in the question and give elliptical answers, also called "term answers":

52. b. *Fritz will go to Pótsdam.*
    c. *Go to Pótsdam.*
    d. *To Pótsdam.*
    e. *Tomórrow.*
    f. *Frítz.*
    g. *Frítz, to Pótsdam.*

Parts belonging to the focus obviously cannot be elided. Hence elliptical answers provide us with a test to determine the focus of non-elliptical answers: If an elliptical paraphrase of a focused sentence necessarily contains some constituent α then α must be part of the focus.

Modeling question meanings

Preliminaries

In this section we will turn to the ways how the meaning of interrogative sentence radicals, the sentences that embed them, and the questions that are formed with them, can be represented in model-theoretic, truth-conditional semantics. There are three established approaches, which will be called the functional representation, the proposition set representation, and the partition representation. We will also discuss a new approach, Inquisitive Semantics.

In the development of these representation frameworks, embedded questions have played an important role, as they are constituents of indicative sentences, and the semantics of indicatives allows for a familiar truth-conditional theories. In particular, semantic theories of questions tried to reconstruct logical inference patterns like the following:

53. *John knows what Bill read.*
Bill read 'War and Peace'.
Hence: *John knows that Bill read 'War and Peace'.*

But notice that this inference holds only under a total (exhaustive) understanding of the embedded question, which is not always the most natural one. For example, from *John knows where one can buy a Chinese newspaper in Berlin* and *One can buy a Chinese newspaper in the Asia Shop at Potsdamer Straße* it does not follow that *John knows that one can buy a Chinese newspaper in the Asia Shop at Potsdamer Straße*, as the first sentence may be considered true already if John knows some place or other where one can buy a Chinese newspaper.

For root questions, it is crucial to consider congruent answers to questions (see above). We find elliptical or term answers and non-elliptical answers, where the focus of the answer corresponds to the interrogative pro-form of the question.

54. A: *Who read 'War and Peace'?*
B: [$_F$ *Bíll*].
B: [$_F$ *Bíll*] *read 'War and Peace'.*

As with embedded interrogatives, we find that answers can be understood exhaustively or non-exhaustively, in which case they specify one or a few instances, but not necessarily all of them.

For each of the three ways to reconstruct the meaning of questions, we will consider how they treat embedded questions, and what they have to say about pairs of questions and congruent answers, in particular, about the focus of non-elliptical answers.

The functional (or categorial) approach

The idea that interrogative sentence radicals denote open propositions suggests that they are should be reconstructed as functions that map the missing piece of the proposition to the whole proposition. We call this the functional representation; it is the same as what Groenendijk & Stokhof (1997) call "categorial" representation. For a simple interrogative like *which novel Bill read*, we initially have the following options:

55. *which novel Bill read*
a. $\lambda x[\text{NOVEL}(x) \wedge \text{READ}(x)(\text{BILL})]$
b. $\lambda x \in \text{NOVEL}[\text{READ}(x)(\text{BILL})]$

(55.a) is a total function; it maps every entity x to truth iff x is a novel

and Bill read x. This representation treats the descriptive content of the interrogative constituent *which novel* and the remainder of the sentence the same. Yet there is an important difference: Answering (55) by naming a non-novel that Bill actually did read (e.g., *the New York Times*) should be just inappropriate, not false. The analysis in (55.a) does not capture this. In contrast, (55.b) is a partial function that is only defined for novels. In this case, the answer *the New York Times* is inappropriate because the question meaning cannot even be applied to this entity, as it is not in the domain of this function. Hence we will follow the representation (55.b).

Both question representations in (55) are extensional, but can be turned into an intensional representations. Assuming a framework with explicit quantification over possible worlds i, in which the proposition 'Bill read 'War and Peace'' is rendered by $\lambda i[\text{READ}_i(\text{W\&P})(\text{BILL})]$, we have the choice between two formats:

56. a. $\lambda x \in \text{NOVEL} \lambda i[\text{READ}_i(x)(\text{BILL})]$

    b. $\lambda i \lambda x \in \text{NOVEL}_i[\text{READ}_i(x)(\text{BILL})]$

(56.a) appears to be most straightforward, as it proposes a function from novels (to propositions). However, in this representation we cannot make the predicate NOVEL dependent on the index i, which we should, as the question asks

for entities read by Bill in i that are novels at this index i. Hence (56.b) seems more appropriate, a function from indices i to a function from novels at i to truth values, in particular to Truth iff Bill read x in i. Hence we will follow this representation. Consider the following examples:

57. *which novel Bill read*
    $\lambda i \lambda x \in \text{NOVEL}_i [\text{READ}_i(x)(\text{BILL})]$

58. *who read 'War and Peace'*
    $\lambda i \lambda x \in \text{PERSON}_i [\text{READ}_i(\text{W\&P})(x)]$

59. *when Bill read 'War and Peace'*
    $\lambda i \lambda R \in \text{TEMPORAL\_SPECIFICATION}_i [R(\lambda i [\text{READ}_i(\text{W\&P})(\text{BILL}))])(i)]$

60. *who read which novel?*
    $\lambda i \lambda x \in \text{PERSON}_i \lambda y \in \text{NOVEL}_i [\text{READ}_i(y)(x)]$

For (59), the function ranges over the meanings of temporal specifications that apply to propositions, like *in 1998*. If indices i have a world and time component, i = $\langle w,t \rangle$, then this meaning could be rendered by $\lambda \langle w,t \rangle \, \lambda p[p(\langle w,1998 \rangle)]$. The multiple question (60) denotes a function from pairs x,y of persons and things to the proposition that x read y.

Alternative questions are treated in a similar way, where the alternatives specify the domain of the function:

61. *whether Bill read 'War and Peace' or 'Anna Karenina'*
    $\lambda x \in \{\text{W\&P}, \text{AK}\} \lambda i [\text{READ}_i(x)(\text{BILL})]$

For polarity questions, we can assume a function that has two functions in its domain, the identity function for propo-

sitions and the negation of propositions, cf. (62). The operators λp.p and λp.λi[¬p(i)] correspond to the possible answers *yes* and *no*.

62. *whether Bill read 'War and Peace'*
λiλf∈{λp.p,λp.¬p}[f(λi[(READ_i(W&P)(BILL)])]

Interrogative sentence radicals can be used to form questions, which then express an interest of the speaker in finding out the "Werteverlauf", or value-range, of the indicated function, i.e. for which arguments the value is Truth. Take the following example:

63. *Which novels by Tolstoy did Bill read?*
QUEST(λiλx∈NOVELS BY TOLSTOY_i[READ_i(x)(BILL)])
'Speaker tries to get Addressee to specify for which arguments the function
λx∈NOVELS BY TOLSTOY_{i0}[READ_{i0}(x)(BILL)]
yields Truth for the world of evaluation i_0.'

The domain restriction of the function and the description of the argument serve quite different purposes. As for the first, it restricts the function to novels by Tolstoy; an answer like *Crime and Punishment* is sorted out as inappropriate. As for the argument description, it describes the conditions under which an argument counts as a true answer; if the answer is *Anna Karenina and War and Peace*, denoting the sum individual AK+W&P, the addressee effectively asserts the proposition READ(AK+W&P)(BILL). The partition of the information inherent in a question into a description of

the domain and a description of the values is important, as the answer presupposes (and does not assert) that *Anna Karenina* and *War and Peace* are novels by Tolstoy; it asserts -- given that the presupposition is satisfied — that Bill read these novels.

In many cases the description of the value of a question function can be seen as suggesting that there is an argument to which the function can truthfully be applied. A question like *What did you just steal from my pocket?* could very well lead to a law suit, as an innocent addressee can rightly feel to be accused of theft. Besides existence, questions also suggest uniqueness of the argument to which they can be truthfully applied. A question like *Which novel by Tolstoy did Bill read?* suggests that Bill read exactly one novel by Tolstoy, whereas the original question (63) suggests that Bill read more than one. We can express such presuppositions by the iota operator that identifies the unique or maximal individual for which the descriptive part is true:

64. *Which novel by Tolstoy did Bill read?*

$\mathrm{QUEST}(\lambda i \lambda x \in \mathrm{NOVEL\ BY\ TOLSTOY}_i[\mathrm{READ}_i(x)(\mathrm{BILL})])$

'Speaker asks Addressee to identify the unique/maximal object $\iota x \in \mathrm{NOVEL\ BY\ TOLSTOY}_{i0}[\mathrm{READ}_{i0}(x)(\mathrm{BILL})]$ for the world of evaluation i_0.'

However, on closer inspection existence, uniqueness and maximality occur

too inconsistently to be captured by a presuppositional analysis. In the literature, there is a debate between analyses that take such meaning effects seriously, e.g. Higginbotham & May (1981), and others that downplay these effects, such as Groenendijk & Stokhof (1997). In any case, there are questions that do not come with existential import (e.g. *Who can solve this problem?*). Also, maximality often does not hold, as we have seen with the non-exhaustive answer to questions like *Where can I buy a Chinese newspaper?* So these meaning components rather appear to have the status of implicatures, in particular, as they can be cancelled:

65. *Which novel by Tolstoy did Bill read, if any?*
66. *I need a Chinese newspaper. Where can I buy one?*

We now turn to the issue of how the answerhood relation can be treated under the functional analysis of questions. This is straightforward for elliptical or term answers. A question and its term answer determine a proposition when we apply the question meaning (or rather, the function that corresponds to the *wh*-term) to the meaning of the term answer:

67. A: *Which book did Bill read?*
    $\mathrm{QUEST}(\lambda i \lambda x \in \mathrm{BOOK}_i\ [\mathrm{READ}_i(x)(\mathrm{BILL})])$
    B: *'War and Peace'.*
    $\mathrm{ANSW}(\mathrm{W\&P})$

Question radical applied to answer radical:

$\lambda i[\lambda x \in \text{BOOK}_{i0}[\text{READ}_{i0}(x)(\text{BILL})](\text{W\&P})]$

$= \lambda i[\text{READ}_i(\text{W\&P})(\text{BILL})]$.

Non-elliptical answers like *Bill read War and Peace* show a more indirect relation to the question under the functional theory. But notice that the answer $\lambda i[\text{READ}_i(\text{W\&P})(\text{BILL})]$ specifies the argument(s) for which the question meaning $\lambda i \lambda x \in \text{BOOK}_i[\text{READ}_i(x)(\text{BILL})]$ is mapped to a true proposition, namely W&P. This is facilitated by the focus feature of the answer, which naturally can be taken to indicate a partition between a focus part and a background part, where the background part corresponds to the question meaning. (This is the so-called structured meaning account of focus developed by Szabolcsi 1981, von Stechow 1981, 1990 and Jacobs 1983).

68. *Bill read* $[_F$*'War & Peace'*].

ASSERT$(\lambda i \lambda x[\text{READ}_i(x)(\text{BILL})], \text{W\&P})$

The pre-theoretical notion of congruent answers can be explicated in the functional theory as follows: If F is the focus and B is the background of the answer, and Q is the question radical, then the answer is congruent iff $Q(i) \subseteq B(i)$, and $Q(i)(F)$ is defined. This is satisfied in our example (67-68), as $\lambda x \in \text{BOOK}_i[\text{READ}_i(x)(\text{BILL})]$ is a subset of $\lambda x[\text{READ}_i(x)(\text{BILL})]$, and W&P is an element of BOOK_i. In this way, we can also cap-

ture answers to polarity questions like *yes* and *no*, which are interpreted as functions from truth values to truth values:

69. A: *Did Bill read 'War and Peace'?*

QUEST($\lambda i \lambda f \in \{\lambda t.t, \lambda t \neg t\}[\text{READ}_i(\text{W\&P})(\text{BILL})]$)

B: *No.*

ANSW($\lambda t \neg t$)

Question radical applied to answer radical:

$\lambda i[\lambda f \in \{\lambda p.p, \lambda p \lambda i \neg p(i)\}[f([\text{READ}_i(\text{W\&P})(\text{BILL})])](\lambda t \neg t)]$

$= \lambda i \neg [\text{READ}_i(\text{W\&P})(\text{BILL})$

Turning to embedded questions, the functional theory offers analyses like the following:

70. *John knows which book Bill read.*

$\text{KNOW}(\lambda i \lambda x \in \text{BOOK}_i[\text{READ}_i(x)(\text{BILL})])(\text{JOHN})$

This can be understood in such a way that John knows the value-range of the embedded function for the index of evaluation i. That is, John knows for each x in the domain of the function whether its value is Truth or Falsity. This explains why the inference (53) holds, for the exhaustive interpretation of KNOW. We can capture the question-embedding reading of *know* as follows, by reducing it to the proposition-embedding *know*:

71. $\text{KNOW}_{i0}(Q)(x)$ iff

a. $\forall y[Q(i_0)(y) \rightarrow \text{KNOW}_{i0}(\lambda i[[Q(i)(y)](x)]]$

b. $\exists y[Q(i_0)(y) \wedge \text{KNOW}_{i0}(\lambda i[[Q(i)(y)](x)]]$

Here, (a) represents the exhaustive interpretation, and (b) the non-exhaustive interpretation for which the inference

(53) does not hold.

While the basic idea of the functional analysis appears quite natural, it has been criticized as it entails that questions have different logical types (cf. Groenendijk & Stokhof 1982). This is problematic considering the fact that embedded interrogatives of different types can easily be conjoined. For example, (72) combines a question of type ⟨e, st⟩ and a question of type ⟨⟨st,st⟩, st⟩.

72. *Mary knows what Bill read and whether he fell asleep.*

However, notice that (72) is truth-conditionally equivalent to (73), which suggests that the conjunction of the two embedded questions in (72) can be interpreted as in (74), which is based on a natural operation in a semantics with lifted Boolean operators (cf. Keenan & Faltz 1985).

73. *Mary knows what Bill read and knows whether he fell asleep.*

74. *what Bill read and whether he fell asleep.*

$$\lambda F[F(\lambda x \in \text{THING}[\text{READ}(x)(\text{BILL})] \wedge F(\lambda f \in \{\lambda t.t, \lambda t.\neg t\}[f(\text{FELLASLEEP}(\text{BILL}))])])$$

We conclude this presentation of the functional approach to questions with a few words about its history. It was proposed in various forms by a variety of authors. Cohen (1929) can be seen as an early example; he suggested that interrogative pronouns have the role of vari-

ables in mathematical equations. Jespersen (1940) coined the term “x-question” that expresses a similar idea. Other versions were proposed by Hull (1975) and, using the lambda calculus, by Egli & Schleichert (1976), Tichy (1978), Hausser & Zaefferer (1979) and Hausser (1983). The way how functional questions were treated here did not follow any particular framework but tried to work out the essence of this approach. Put simply and in the most general terms, it assumes that interrogatives are “incomplete” propositions where the positions at which they are incomplete and the type of meanings that would make them complete are specified by the *wh*-constituents.

The proposition set approach

The proposition set approach models the meaning of questions by the set of propositions that are answers to the question. In contrast to the functional approach, it takes full, propositional answers as basic, not term answers.

75. *who read ‘War and Peace’*
$\{\lambda i[\mathrm{READ}_i(\mathrm{W\&P})(x)] \mid x \in \mathrm{PERSON}\}$,

76. *when Bill read ‘War and Peace’*
$\{\lambda i[\mathrm{AT}_i(t)(\lambda i[\mathrm{READ}_i(\mathrm{W\&P})(\mathrm{BILL})]] \mid t \in \mathrm{TIME}\}$,

77. *who read which novel*
$\{\lambda i[\mathrm{READ}_i(y)(x)] \mid y \in \mathrm{NOVEL},\ x \in \mathrm{PERSON}\}$

For example, (75) is the set of propositions $\lambda i[\text{READ}_i(\text{W\&P})(x)]$, where x varies over persons,

$\{\lambda i[\text{READ}_i(\text{W\&P})(\text{BILL}), \lambda i[\text{READ}_i(\text{W\&P})(\text{MARY})], \ldots\}$.

This is the set of propositions that would be expressed by congruent answers, *Bill read War and Peace, Mary read War and Peace* etc. In the formulation given in (75) the predicate PERSON is not in a position to be evaluated at the index i of the proposition; this can, however, be achieved as follows:

78. $\lambda p \exists x[p=\lambda i[\text{PERSON}_i(x) \wedge \text{READ}_i(\text{W\&P})(x)]]$

Alternative questions can be expressed as propositions restricted by the alternative phrase:

79. *whether Bill or Mary read 'War and Peace'*

$\{\lambda i[\text{READ}_i(\text{W\&P})(x) \mid x=\text{BILL} \vee x=\text{MARY}\}$

$= \{\lambda i[\text{READ}_i(\text{W\&P})(\text{BILL})], \lambda i[\text{READ}_i(\text{W\&P})(\text{MARY})]\}$

The simplest way of dealing with polarity questions is to assume that they combine a proposition and its negation:

80. *whether Bill read 'War and Peace'*

$\{\lambda i[\text{READ}_i(\text{W\&P})(\text{BILL})], \lambda i \neg[\text{READ}_i(\text{W\&P})(\text{BILL})]\}$

The treatment of non-elliptical, full answers is straightforward:

81. A: *Which novel by Tolstoy did Bill read?*

QUEST($\{\lambda i[\text{READ}_i(x)(\text{BILL})] \mid x \in \text{NOVEL BY TOLSTOY}\}$)

B: *Bill read 'War and Peace'*

ASSERT($\lambda i[\text{READ}_i(\text{W\&P})(\text{BILL})]$)

This answer is congruent, as the answer proposition is an element of the set of propositions specified by the question.

Elliptical answers like '*War and Peace*' could be modeled as the remnants of full answers, where parts that were mentioned in the question are suppressed: ~~*Bill read*~~ *'War and Peace'*. As far as polarity questions are concerned, the simple answers *yes* and *no* cannot be captured in a straightforward way either. What we can derive are full answers like *Bill read 'War and Peace'*, meaning $\lambda i[\text{READ}_i(\text{W\&P})(\text{BILL})]$, which is an element of the polarity question meaning (80).

How can we express the relation between the question and the focus in the answer? Notice that any solution to this problem will also account for elliptical answers, as they can be understood as specifying the focus only. The most natural way is to employ Alternative Semantics for the representation of focus (Rooth 1992), which assumes that expressions have two semantic representations, a standard meaning and a set of alternatives induced by the item in focus:

82. *Bill read* [*'War and Peace'*]$_F$.
    Meaning: $\lambda i[\text{READ}_i(\text{W\&P})(\text{BILL})]$
    Alternatives: $\{\lambda i[\text{READ}_i(i)(\text{BILL})] \mid i \in \text{ALT}(\text{W\&P})\}$

A declarative sentence containing focus is assumed to be a congruent answer to a question iff its set of alternatives A corresponds to the question meaning Q, a condition that is interpreted by Rooth (1992) in the sense that

$Q \subseteq A$. This condition obtains for questions like (81.A) and answers like (82).

Focus also helps to explain a certain distinction between infelicitous answers. The assertion *Bill read 'Crime and Punishment'* is infelicitous as an answer to (81), as 'Crime and Punishment' is not a novel by Tolstoy. The answer *It is raining* is also infelicitous, but more severely so. The original theory does not account for this difference. The refined theory, which factors in the focus in answers, can: The first infelicitous answer is bad because it is not an element of Q, but at least it holds that Q is a subset of the set of alternatives of the answers (provided that focus is on *Crime and Punishment*).

83. a. $\{\lambda i[\text{READ}_i(x)(\text{BILL})] \mid x \in \text{NOVEL BY TOLSTOY}\} \subseteq$
$\{\lambda i[\text{READ}_i(x)(\text{BILL})] \mid x \in \text{ALT}(\text{C\&P})\}$

b. $\lambda i[\text{READ}_i(x)(\text{C\&P})] \in$
$\{\lambda i[\text{READ}_i(x)(\text{BILL})] \mid x \in \text{NOVEL BY TOLSTOY}\}$

For the second infelicitous answer, *it is raining*, it does not even hold that the answer alternatives contain the question meaning. Hence it violates the criterion for congruent questions more severely.

Embedded interrogatives consist in applying a question-embedding verb to a set of propositions (84). As before, question-embedding *know* can be reduced to proposition-embedding *know* (85), which says that for all propositions in

the question meaning p, Mary knows that p.

84. *Mary knows which novel by Tolstoy Bill read.*

$\text{KNOW}_{i0}(\{\lambda i[\text{READ}_i(x)(\text{BILL})] \mid x \in \text{NOVEL BY TOLSTOY}\})$

85. $\forall p \in \{\lambda i[\text{READ}_i(x)(\text{BILL})] \mid x \in \text{NOVEL BY TOLSTOY}\}$

$[p(i_0) \rightarrow \text{KNOW}_i(p)(\text{MARY})]$

The proposition set theory proposes the same semantic type of questions – sets of propositions – no matter how they are formed. This allows for the conjunction of different types of questions, which can be represented in a straightforward way by set union.

86. *Mary knows what Bill read and whether he fell asleep.*

$\text{KNOW}_{i0}(\{\lambda i[\text{READ}_i(x)(\text{BILL})] \mid x \in \text{THING}\} \cap$

$\{\lambda i[\text{FELL\_ASLEEP}_i(\text{BILL})], \lambda i \neg[\text{FELL ASLEEP}_i(\text{BILL})]\})(\text{MARY})$

Interpreted exhaustively, this means that Mary knows every true proposition in this set, which gives us the right result. However, it is questionable that the conjunction is interpreted by set union, as normally it is understood as intersection.

The proposition set theory of questions goes back to Hamblin (1973). In the version of Karttunen (1977) the meaning of a question is the set of true answers. This makes it slightly simpler to express the relation between question-embedding *know* and declarative-embedding *know*:

87. *which novel by Tolstoy Bill read* (in world i_0):

$\{p \mid \exists x \in \text{NOVEL BY TOLSTOY}[p = \lambda i[\text{READ}_i(x)(\text{BILL})] \wedge p(i_0)]\}$

88. *Mary knows which novel by Tolstoy Bill read.*

$\forall p \in \{p \mid \exists x \in \text{NOVEL BY TOLSTOY}[p = \lambda i[\text{READ}_i(x)(\text{BILL})] \wedge p(i_0)]\}$

$[\text{KNOWS}_{i0}(p)(\text{MARY})]$

It should be pointed out that the functional analysis of questions is more explicit than the proposition set analysis. That is, it is possible to turn a functional representation into a propositional one, following the recipe (89), but not the other way round.

89. If F is a functional representation of a question, then $\{F(X) \mid X \in \text{DOMAIN}(F)\}$ is its proposition set representation.

Following a general methodology rule that strives for the weakest representation of a phenomenon possible, propositional representations of questions are to be preferred if they capture all the linguistic phenomena. But do they? Krifka (2001b) points out several shortcomings. There is the problem that straightforward answers to polarity questions like *yes* and *no* cannot be captured directly; we can only model full answers. Another problem is that the proposition set theory cannot distinguish between polarity questions and a certain type of alternative question. Both the questions of (90) and (91) will be represented by (92), even though the answer patterns are different, as the alternative question excludes the answer *He did.*

90. A: *Did Bill leave?*
B: *Yes. / Yes, he did (leave). / He did (leave).*

91. A: *Did Bill leave, or not?*
B: **Yes. / *Yes, he did (leave). / He did (leave).*

92. {λi[LEFT_i(BILL)], λi[LEFT_i(BILL)]}

In the functional theory we can express the meanings of the two questions in distinct ways that invite the distinct answer patterns:

93. λf∈{λp[p], λpλi[¬p(i)]}[f(λi[LEFT_i(BILL)])]

94. λp∈{λi[LEFT_i(BILL)], λi¬[LEFT_i(BILL)]}[p]

While (93) asks for the proposition modifier that yields a true proposition when applied to the proposition 'Bill left', (94) asks which of the two propositions 'Bill left', 'Bill didn't leave' is true. Answers like *yes* and *no* that specify preposition modifiers are impossible in (94), whereas full answers are possible for (93), just as full answers are possible as a more complex answering strategy in the functional analysis in general.

Another problem appears when we look at the focus pattern of answers (cf. Krifka 2001b, 2004). Recall that the focus of answers was explained by the requirement that the question meaning is a subset of focus-induced alternatives of the answers, Q ⊆ A. This does not exclude over-focused answers such as the following:

95. A: *What did Bill read?*

{λi[READ_i(x)(BILL)]|x∈NOVEL}

B: [*Bíll*]$_F$ *read* [*'War and Peáce'*]$_F$

Meaning: λi[READ_i(W&P)(BILL)]

Alternatives:

{λi[READ_i(x)(y)]|x∈ALT(W&P), y∈ALT(BILL)}

The focus pattern of B's answer is not the one of a congruent answer, yet the meaning of the question is a subset of its alternatives. One can exclude such cases by a pragmatic rule for alternatives, a rule that Schwarzschild (1999) introduced for contrastive focus, which prefers the minimal focus pattern that satisfies the context requirements. In (95), focus on *'War and Peace'* would be sufficient. But the preference for minimal focus marking does not exclude focus marking that is too broad, as in the following answer to A's question in (95):

96. B: *Bill* [*read 'War and PEACE'*]$_F$.

Meaning: λi[READ_i(W&P)(BILL)]

Alternatives: {λi[P_i(BILL)] | P∈ALT(λiλx[READ_i(W&P)(x)])}

In (96) we have incorrect focus assignment, yet the requirement Q ⊆ A is satisfied. We would have to supplement Schwarzschild's rule that selects for the least specific focusation to exclude unwarranted multiple focus by one that selects for the most specific focus to exclude unwarranted broad focus.

The partitional approach

We now turn to the third type of question representation, which was proposed by Higginbotham & May (1981) and in greater detail by Groenendijk & Stokhof (1982, 1984). In a sense, it incorporates features of both the functional approach and the proposition set approach. In G&S's theory, question meanings are constructed in two steps. First, a functional representation is built, as in (97.a). In a second step, a relation between indices is constructed using the rule in (b).

97. *which novel Bill read*

a. $\lambda i \lambda x[\text{NOVEL}_i(x) \wedge \text{READ}_i(x)(\text{BILL})]$, = FR

b. $\lambda j \lambda i[\text{FR}(i) = \text{FR}(j)]$

$= \lambda j \lambda i[\lambda x[\text{NOVEL}_i(x) \wedge \text{READ}_i(x)(\text{BILL})]$

$= \lambda x[\text{NOVEL}_j(x) \wedge \text{READ}_j(x)(\text{BILL})]]$

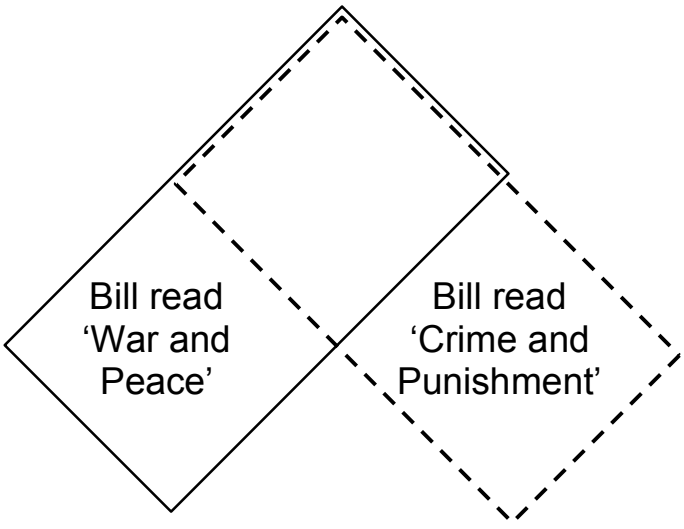
This results in an equivalence relation between indices that holds between index j and i iff the novels that Bill read in j and the novels that Bill read at i are the same. The indices i, j are indistinguishable as far as the interrogative *which novel Bill read* is concerned. As equivalence relations generally do, this creates a partition of the set of indices (hence the term for this type of question theory used here). Let ER be the representation of a question meaning by an equivalence relation, as in (97.b), then the corresponding partition is defined as follows:

98. {p | ∀i∀j[i,j∈p iff ER(j)(i)]}

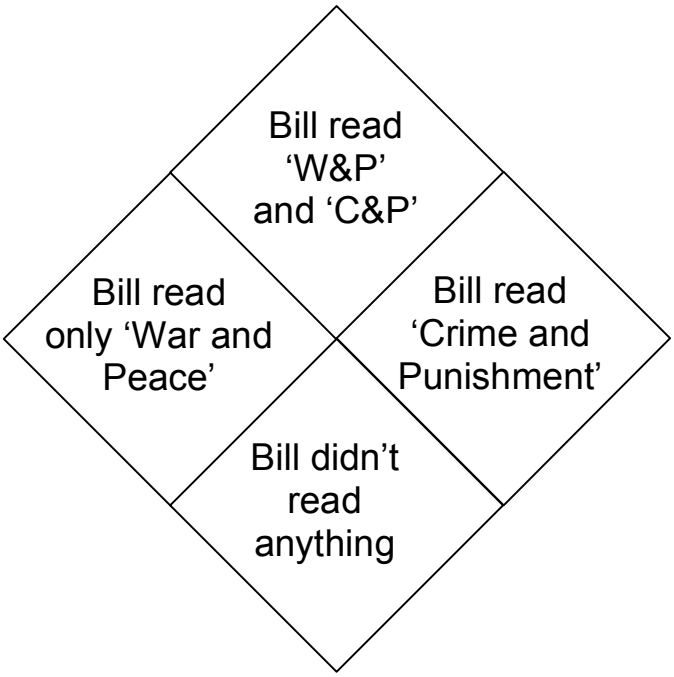
A partition of the set of indices is a set of propositions – hence the similarity to the proposition set theory – but the propositions are non-overlapping and exhaust the set of all indices.

It is perhaps best to compare the proposition set theory and the partitional theory with the help of an example. Assume that there are two readable things, 'War and Peace' and 'Crime and Punishment'. In this model, the question *What did Bill read?* is interpreted in the proposition set theory as involving two propositions (99), and in the partitional theory as involving four propositions (100):

99. Proposition set representation of *what Bill read*



100. Partitional representation of *what Bill read*



While the proposition set representation contains overlapping propositions and does not cover every index, the partition representation consists of mutually non-overlapping propositions that together cover all indices. Consequently, the partition approach takes the exhaustive interpretation of questions as basic. An answer like *Bill read 'War and Peace'* is to be interpreted as *Bill read only 'War and Peace'*, if it is to be understood as a congruent answer. Groenendijk & Stokhof assume an operator with the semantics of *only* that creates exhaustive interpretations (see below). Furthermore, negative answers like *Bill didn't read anything* are answers just like other answers. In the propositional theory such answers are peculiar as they

do not correspond to any proposition in the question set.

The formation rule for equivalence relations illustrated in (97) is flexible enough to capture different types of questions. This is illustrated with a VP question and with a multiple question:

101. *what Bill did*

$$\lambda j \lambda i [\lambda P [\text{ACTION}_i(P) \wedge P_i(\text{BILL})] = \lambda P [\text{ACTION}_j(P) \wedge P_j(\text{BILL})]]$$

102. *who read which novel*

$$\lambda j \lambda i [\lambda x \lambda y [\text{PERSON}_i(x) \wedge \text{NOVEL}_i(y) \wedge \text{READ}_i(y)(x)] = \lambda x \lambda y [\text{PERSON}_j(x) \wedge \text{NOVEL}_j(y) \wedge \text{READ}_j(y)(x)]]$$

For example, (102) describes the equivalence relation that holds between two indices iff the same persons read the same novels in them.

When comparing the functional approach and the proposition set approach we observed that the question constituent and the other parts of the question play distinct roles in answers, as the question constituent contributes presupposed information (cf. 63). This is not captured in the usual representations of the partitional theory. As a consequence, representations like (97) do not indicate that the question presupposes that Bill read only one novel, in contrast to questions like *Which novels did Bill read?*, or questions based on number-indifferent question words like *who* and *what*. We can introduce this presuppositional component and at the same time regain the insight of the func-

tional theory that negative answers like *nobody* are special by a variant of the partitional theory in which the construction of partitions is based on the following rule instead of (97.b), where ι maps sets to the maximal element in the set, if defined.

103. $\lambda j \lambda i[\iota(FR(i)) = \iota(FR(j))]$

We could easily generalize ι to various types. In the simple case that FR is of type ⟨s,⟨e,t⟩⟩ we get the following interpretation, given by way of example (97.a):

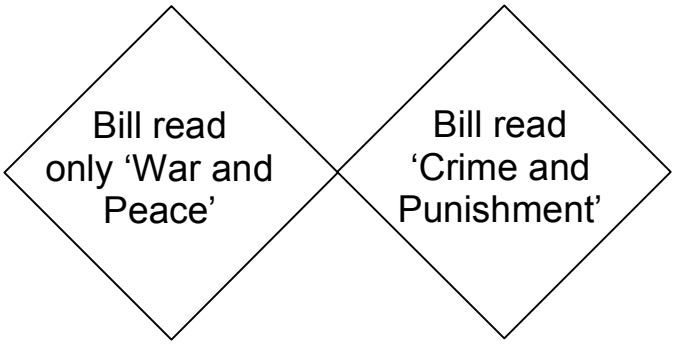
104. *which novel Bill read*

a. $\lambda i \lambda x[\text{NOVEL}_i(x) \wedge \text{READ}_i(x)(\text{BILL})]$, = FR

b. $\lambda j \lambda i[\iota x[\text{NOVEL}_i(x) \wedge \text{READ}_i(x)(\text{BILL})]$
$\iota x[\text{NOVEL}_j(x) \wedge \text{READ}_j(x)(\text{BILL})]]$

This presupposes that Bill read exactly one novel. If presuppositions are taken to select admissible common grounds, then the set of indices to be partitioned is reduced, as it cannot include indices in which Bill read more than one novel, or no novel at all. Returning to our example where there are just two novels, the partition can be depicted as follows:

105. *which novel Bill read*



Let us return to the standard representations of questions in the partitional account. For alternative questions we can assume that the restriction is expressed by a disjunction:

106. *whether Bill read 'War and Peace' or 'Crime and Punishment'*

$$\lambda j \lambda i[\lambda x[[x=W\&P \vee x=C\&P] \wedge READ_i(x)(BILL)] = \lambda x[[x=W\&P \vee x=C\&P] \wedge READ_j(x)(BILL)]]$$

This creates the partition illustrated in (100). While this gives us essentially the right result, the problem remains that alternative questions presuppose that two of the mentioned alternatives do not hold at the same time, a meaning component not expressed by (106).

For polarity questions the suggested representation is one in which no constituent is identified by a lambda-abstraction:

107. *whether Bill read 'War and Peace'*

$$\lambda j \lambda i[READ_i(W\&P)(BILL)] = READ_j(W\&P)(BILL)]$$

This yields an equivalence relation that sorts indices into two sets, one in which Bill read 'War and Peace', and an-

other one in which he didn't. Note that this is the same representation that the proposition set analysis would assign to this question. We also find the same problem as with that analysis, namely that it appears impossible to give a separate interpretation to the alternative propositions *whether Bill read 'War and Peace' or not* (cf. discussion of 91 and 92).

One very attractive feature of the partitional theory of questions is that it can explain properties of embedded questions in an elegant way. Question-embedding predicates like *know* apply to the extension of a question meaning (that is, the question meaning applied to the index of evaluation, i_0). As a result, the inference from knowing-who to knowing-that follows straightforwardly:

108. *Mary knows who came.*

$$\text{KNOW}_{i0}(\lambda j\lambda i[\lambda x[\text{CAME}_i(x)] = \lambda x[\text{CAME}_j(x)]](i_0))(\text{MARY})$$

$$= \text{KNOW}_{i0}(\lambda i[\lambda x[\text{CAME}_i(x)] = \lambda x[\text{CAME}_{i0}(x)])(\text{MARY})$$

$$= \text{KNOW}_{i0}(\lambda i[\text{CAME}_i(\text{BILL}) \wedge \text{CAME}_i(\text{JOHN})])(\text{MARY})$$

iff Bill and John are the only ones who came at i_0

This means that *Mary knows who came* has the same truth conditions as *Mary knows that Bill came and John came* in case Bill and John are the only ones who came. Similarly, if no one came, (108) means the same as *Mary knows that no one came.* This is because the equation in the extensional question meaning states

that the entities that come in i are the same as the entities that came in the real world. In addition to extensional question predicates like *know*, there are predicates like *wonder* for which such inferences do not hold – notice that *wonder* does not even embed *that*-clauses. Groenendijk & Stokhof take *wonder* to be a predicate that takes question intensions, which have a type different from the meanings of *that*-clauses:

109. *Mary wonders who came.*

$$\text{WONDER}_{i_0}(\lambda j \lambda i[\lambda x[\text{CAME}_i(x)] = \lambda x[\text{CAME}_j(x)]])(\text{MARY})$$

We can capture the meaning roughly by saying that Mary would like to know in which cell of the partition defined by the embedded questions the real world i_0 is.

Like the proposition set analysis, the partitional analysis assigns the same semantic type to all questions – functions from indices to functions from indices to truth values (i.e. relations between indices) for intensional questions, and functions from indices to truth values for extensional questions. This predicts that questions can be combined by the Boolean operator *and.* In contrast to the proposition set analysis, we can now apply the usual intersective semantics of *and:* If the two questions Q_1 and Q_2 induce the partitions $P(Q_1)$ and $P(Q_2)$, the question Q_1 *and* Q_2 will induce the partition $P(Q_1) \cap$

$P(Q_2)$. This is illustrated in the following example:

110. *who came and who left*

$= \lambda j \lambda i[\lambda x[\text{CAME}_i(x)] = \lambda x[\text{CAME}_j(x)]] \cap$

$\lambda j \lambda i[\lambda x[\text{LEFT}_i(x)] = \lambda x[\text{LEFT}_j(x)]]$

$= \lambda j \lambda i[\lambda x[\text{CAME}_i(x)] = \lambda x[\text{CAME}_j(x)] \wedge$

$\lambda x[\text{LEFT}_i(x)] = \lambda x[\text{LEFT}_j(x)]]$

If there are two persons, Bill and Mary, then this intersection can be graphically represented as follows. Observe that the result is a partition, hence a proper question meaning.

111.

B & M came.
B came.
M came.
Nobody came.

$\cap$

B & M left.	B left.	M left.	Nobody left.

=

B& M came. B & M left.	B & M came. B left.	B & M came. M left.	B & M came. Nobody left.
B came. B & M left.	B came. B left.	B came. M left.	B came. Nobody left.
M came. B & M left.	M came. B left.	M came. M left.	M came. Nobody left.
Nobody came. B & M left.	Nobody came. B left.	Nobody came. M left.	Nobody came. Nobody left.

We have already mentioned that the partitional theory takes the exhaustive interpretation of questions as basic. The role of focus in answers is to indicate where exhaustification has to be applied. In the partitional approach no

specific theory of focus has been developed, but as long as we assume that focus indicates alternatives, any focus theory should do. Groenendijk & Stokhof (1984) consider the structured meaning approach of Szabolcsi (1981). Consider the following interchange:

112. *Who read 'War and Peace'?*
Bíll$_F$ *read 'War and Peace'.*
$\langle \lambda i \lambda x[\text{READ}_i(\text{W\&P})(x)], \text{BILL}\rangle$

Focus on *Bill* introduces a structured meaning, as indicated. This can be used to form an exhaustive interpretation, based on an operator that has the meaning of *only* (Groenendijk & Stokhof actually present a more refined version of the exhaustivity operator).

113. $\lambda\langle B,F\rangle\lambda i[B(i)(F)$
$\wedge \forall X[B(i)(X) \rightarrow [B(i)(X) \rightarrow B(i)(F)]]]$

Applied to (112) this operator derives the following meaning:

114. $\lambda i[\text{READ}_i\text{W\&P})(\text{BILL})$
$\wedge \forall x[\text{READ}_i(\text{W\&P})(x) \rightarrow \text{READ}_i(\text{W\&P})(\text{BILL})]]$

The universally quantified formula states that for every x that read W&P, it follows from 'x read W&P' that Bill read W&P. This yields the proper exhaustification for (112), and it also captures cases like [*Bíll and Máry*]$_F$ *read 'War and Peace'*, which does allow for entailed alternatives like *Bill read 'War and Peace'.*

Inquisitive Semantics

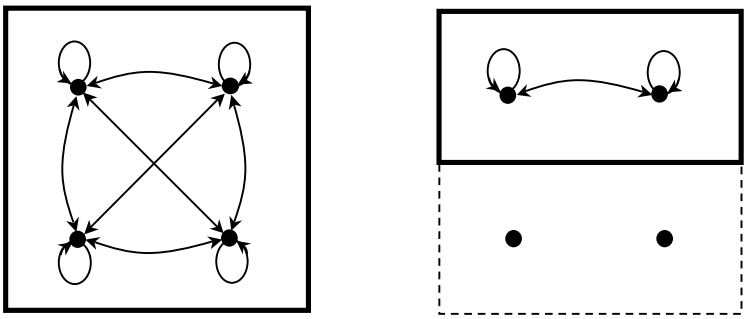
The last framework we will consider here is currently being developed by Groenendijk (2008a, b). Its point of origin is the partitional representation, but it leads to a representation that is closely related to the proposition set representation. It provides a framework in which coordinations of interrogative and indicative sentences can be treated, and which is also well suited to capture the role of questions in conversation, a point to which we will return below.

Inquisitive semantics assumes relations between indices that are reflexive and symmetric, but not necessarily transitive, and hence to not form partitions of indices; such relations are called "states" (of conversation). If two indices stand in such a relation, their difference in factual content is not at issue at the current point in conversation.

The point of departure is the total relation s_0 that distinguishes between none of the indices: $s_0 = I \times I$, the so-called "ignorant" state. An assertion like *It is raining* reduces the input state to a state s_1 so that it applies only to those index pairs $\langle i,j \rangle$ such that it is raining in i and raining in j. We write s[p] for the "update" of a state s by a proposition p. States s for which it holds that if $\langle i,i \rangle \in s$ and $\langle j,j \rangle \in s$ then $\langle i,j \rangle \in s$ are called "indifferent"; notice

that s_1 is indifferent. As the sentence *it is raining* results in a reduction of the initial state s_0, it is called "informative". In the following graphical representations, states are represented by sets of sets of indices, with representative indices indicated by dots and the relation between them; if s is a state, then s is represented by the set of all the largest sets of indices S such that for all $i,j \in S$: $\langle i,j \rangle \in S$. For indifferent states this is a singleton set:

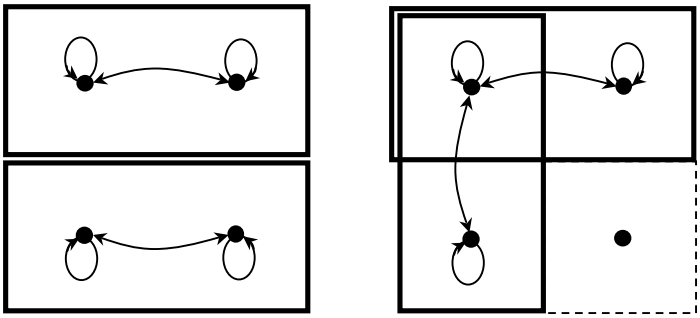
115. s_0: ignorance $s_1 = s_0[p]$.



Disjunction plays a crucial role in Inquisitive Semantics; it is treated as the source of inquisitiveness, as it introduces alternatives. A question like *Is it raining?* is interpreted as a disjunction of the form $[p \vee \neg p]$, and an alternative question like *Is it raining or snowing?* leads to a disjunction of the form $p \vee q$. Disjunction is not interpreted as a Boolean operation, but leads to the formation of a set of "possibilities". More specifically, we have that $s[p \vee q] = s[p] \cup s[q]$, as illus-

trated in (116). Notice that s_2 is not indifferent, and that s_3 is neither indifferent nor transitive. We say that states like s_2 and s_3 have two "possibilites".

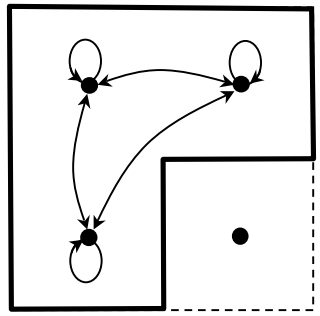
116. $s_2 = s_0[?p] = s_0[p \vee \neg p]$ $\quad s_3 = s_0[p \vee q]$



This representation is reminiscent of Hamblin's but actually it is weaker: While in Hamblin's theory questions like *Did John come, or did John and Bill come?* would lead to a set of two propositions, one a subset of the other, this is not a possible configuration in Inquisitive Semantics, where $[p \vee [p \wedge q]]$ would have the same meaning as p.

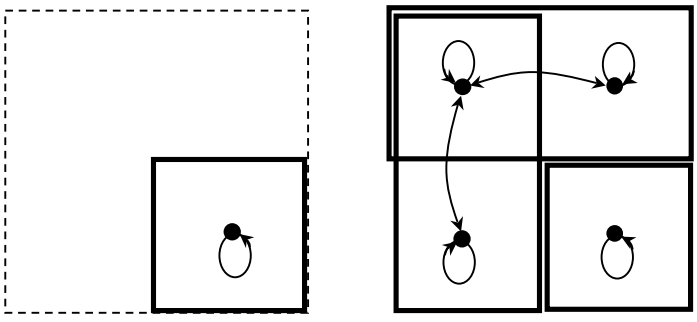
Disjunctions can also occur in assertions, of course, as in *it is raining or it is snowing*. For this Groenendijk proposes an operation of "indifferentiation" that amounts to Euclidian closure, or the union formation over possiblities. In the language of inquisitive logic, this is handled by the operation of "assertive closure", !. In the following example, s_5 is again a state of indifference.

117. $s_5 = s_0[![p \vee q]]$



Negation is defined in such a way that $s[\neg\varphi]$ applies to all index pairs $\langle i,j\rangle \in s$ such that $\langle i,i\rangle \notin s[\varphi]$ and $\langle j,j\rangle \notin s[\varphi]$. It is applicable to indifferent states and to inquisitive states, and leads to indifferent states. Assertive closure can be defined by double negation: $!p := \neg\neg p$. The left-hand side of (118) illustrates that the negation of the inquisitive state after $[p \vee q]$ and of the indifferent state after $![p \vee q]$ has the same result.

118. $s_6 = s_0[\neg![p \vee q]] = s_0[\neg[p \vee q]]$ $s_7 = s_0[?[p \vee q]]$

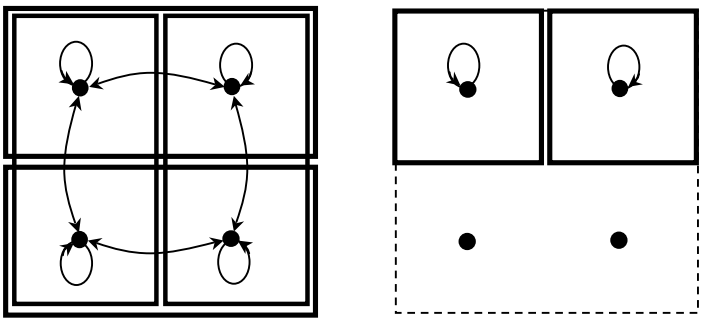


The right-hand side of (118) illustrates the meaning of the question $?[p \vee q]$, short for $[p \vee q] \vee \neg[p \vee q]$. Notice that this is distinct from the

question [p ∨ q], as it includes the possibility that neither p nor q are hold. This captures the fact that question alike *Did John come or did Bill come, or did neither of them come?* do not presuppose that anyone came, in contrast to the alternative question *Did Jóhn come or did Bíll come?*

Inquisitive Logic allows for the coordination of questions, as in (*John knows) whether it is raining and whether the newspaper will be delivered*, and for the coordination of questions and assertions like (*John knows*) *that it is raining and whether the newspaper will be delivered.* Coordination is dynamic, incremental update: s[p & q] = s[p][q], which leads to interpretations like the following:

119. $s_5 = s_0$+[?p & ?q] $s_6 = s_0$+[p & ?q]



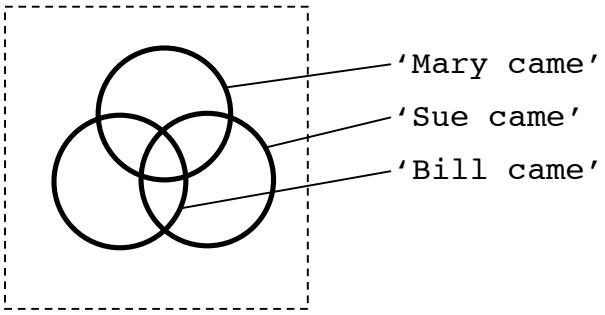
While inquisitive semantics has not been extended beyond polarity and alternative questions in published work so far, this can be done in natural ways (cf. Kratzer & Shimoyama 2002 for a related proposal within the proposition set account). Constituent questions can

be seen as generalized disjunctions. A question like *Who came?*, where Mary, Sue and Bill are the alternatives, amounts to the coordinated question *Did Mary come or did Sue come or did Bill come?* More generally, we can render the meaning of constituent questions as follows:

120. *Who came?* $\bigvee_{x \in \text{PERSON}} \text{CAME}(x)$

This also illustrates how a functional representation like $\lambda x \in \text{PERSON}[\text{CAME}(x)]$ can be turned into a representation in Inquisitive Semantics. We get representations like the following one, with three possibilities:

121. *Who came (John, Mary or Bill?)*



We will return to Inquisitive Semantics below. Here we will turn to the issue how question meanings are constructed.

The construction of question meanings

Question meanings should be derived compositionally, and we should ask how the three theories of question interpretation can work with what syntactic theories offer for the syntactic structure of questions. We have seen that

there are two syntactic strategies for question constituents: they either move to a dedicated position ("*wh*-movement"), or they remain in situ, in which case they typically carry some sort of intonational marker. There are also mixed strategies, like movement languages that leave question constituents of certain questions like echo questions in place, or that move only one question constituent in multiple questions. Then there is the phenomenon of partial wh-movement in which one *wh*-element marks the scope of the question, and another one stays in a more local position, as in the following German example:

122. *Was*$_1$ *denkst du,* [*wen*$_1$ *ich* t$_1$ *gesehen habe*].
what thinks you who I seen have
'Who do you think I saw?'

See Sabel (2006) for an overview of wh-movement types. In alternative questions, the alternative construction never moves, but is always marked intonationally.

Marking questions by movement or an equivalent syntactic operation (see Ginzburg & Sag 2001 for an HPSG account) is suggestive of the functional representation of question meanings. Movement can be seen as a syntactic operation that identifies positions in the description of a proposition, which provides the blueprint for the construction of a functional meaning. The *wh*-feature in the question constituent triggers

movement, the content of the question constituent defines the domain of the function, and the trace identifies the position abstracted over:

123. a. [[*which novel*]$_1$ [*Bill* [*read* t$_1$]]]

b. $\lambda x_1 \in$ NOVEL [READ(x_1)(BILL)]

Marking questions by in situ question constituents is suggestive of the proposition set theory. Hamblin (1973) has proposed that question words are interpreted as sets of meanings, leading to sets of meanings when combined with other meanings:

124. *which novel*: {x|x is a novel}

read: λyλx[x read y]

read which novel: {λx[x read y]|x is a novel}

Bill: BILL

Bill read which novel: {λx[Bill read y]|x is a novel}

No movement is required. The intonational marking of question constituents *in situ* can be seen as focus marking, where focus indicates the presence of alternatives.

The partitional theory makes crucial use of lambda abstraction, which suggests that questions are constructed by movement. Also, Inquisitive Semantics, even though it leads to representations that are somewhat similar to the proposition set theory, requires a type of *wh*-movement, as the representation (123) suggests.

In spite of these natural affinities between syntactic realizations of ques-

tions and approaches to their semantics, it should be stressed that different ways of question marking do not presuppose one or the other semantic representation. We have seen in (89) that propositional representations can be derived from functional representations (which can be constructed from syntactic structures containing *wh*-movement). And we can derive functional representations from structures without overt *wh*-marking if we assume *wh*-movement (or some equivalent process) on logical form. Considering the fact that many languages show mixed strategies (e.g., the movement strategy of one question constituent only, or the in situ strategy for certain types of questions only) one could also envision mixed semantic representations. Furthermore, there are syntactic considerations that argue for one or the other type of question constructions. For example, the island restrictions discussed above square well with a movement (or coindexation) account, and so do the so-called "intervention effects" (Beck 2006) that prohibit certain operators like negation between the interpretation site of a wh-element and its trace, as in the following German example where *niemandem* 'to nobody' intervenes between was_2 and its trace t_2 at LF.

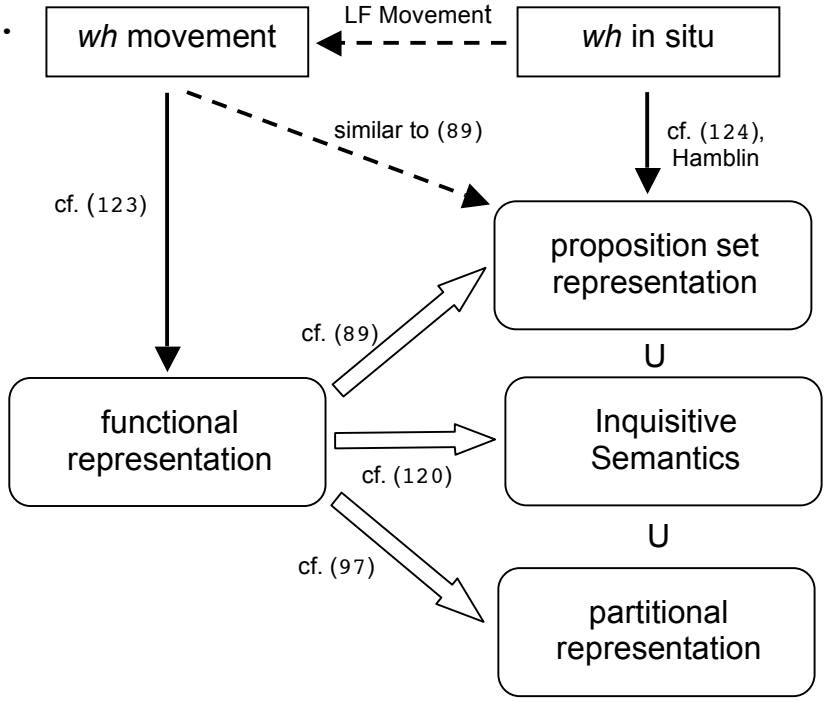
125. *Wer_1 *hat* t_1 *niemandem was gegeben?*
LF: *Wer_1 was_2* [*hat* t_1 *niemandem* t_2 *gegeben?*]
'Who didn't give what to nobody?'

A comparison of question theories

After having discussed three distinct approaches to question meanings, a comparison is in order.

First, we should consider the complexity of the question representations. The functional representation takes a privileged role here, as we can derive the propositional representation from it (cf. 89), but not vice versa. Functional representations also form the basis of the partitional theory, as it uses functional abstracts to construct the equivalence relation that then defines the partition (cf. 97, 98). This is how Groenendijk & Stokhof derive partitional representations. Furthermore, example (120) illustrates how a functional representation can be turned into a representation of Inquisitive Semantics. None of these construction rules are reversible. With this, we can draw the following map for the syntactic marking of questions and the logical expressiveness of semantic question representations.

126.



The functional representation is the most articulate one from which all the others can be derived. Within the non-functional representations, the representations of Inquisitive Semantics are a proper subset of the general proposition set representations (it disallows two propositions where one is the subset of the other). And partitional representations form a proper subset of the representations of Inquisitive Semantics (the propositions do not overlap, and are exhaustive).

Further topics

Indefinites and Interrogatives

Interrogative pronouns like *when* and *where* can be seen as consisting of two parts: one expressing interrogativity

(*wh-*), the other expressing the type or sort of entities that are asked (e.g. *-en* for time, which also occurs in *th-en*; *-ere* for place, which also occurs in *th-ere*). In most languages, this combination appears to be at least partially transparent, and we find completely transparent systems in Pidgin and Creole languages (cf. Muysken & Smith 1990).

In many languages, interrogative proforms are related to indefinite proforms, as in English *how* and *somehow*, or German *wer* and *irgendwer* (cf. Haspelmath 1997). In languages that have segmentally identical forms, the two readings differ either in prosody or in syntax. In German, the interrogative form receives special accent or is moved to a dedicated position, as examples (128.a,b) show:

127. *Bill hat was gelesen.*
'Bill has read something.'

128. a. *Bill hat wás gelesen?*
b. *Was/Wás hat Bill gelesen?*
'What did Bill read?'

In Lhakota, the presence of an interrogative particle turns an indefinite into a *wh*-term; again, the indefinite has to be focused (cf. Van Valin & LaPolla 1997).

129. *šúka ki táku yaxtáka he*
dog DEF something bite QU
'What did the dog bite?'

130. *šúka ki táku yaxtáka*
dog DEF something bite
'The dog bit something.'

The similarity between indefinite and interrogative pronouns is well motivated at an intuitive level: these two forms have in common that semantic information is left unspecified. How can it be captured by the different frameworks of question representations? As for the proposition set representation, notice that it can be rendered in a format in which the *wh*-constituent is represented by an existential indefinite:

131. *who read 'War and Peace'*
$\lambda p\underline{\exists x[\text{PERSON}(x)}\ \wedge\ p=\lambda i[\text{READ}_i(\text{W\&P})(x)]]$

For the partitional account, Haida (2008) has proposed a variety that works with dynamic existential quantifiers, underlined in (132) that are natural meanings of indefinites. The biconditional expresses that the context-change potential of the two formulas is exactly the same, which amounts the same truth conditions as in the original approach by G&S.

132. *who read 'War and Peace'*
$\lambda j[\underline{\exists x}[\text{PERSON}_j(x)\ \wedge\ \text{READ}_j(\text{W\&P})(x)]\ \leftrightarrow$
$\exists x[\text{PERSON}_i(x)\ \wedge\ \text{READ}_i(\text{W\&P})(x)]]$

No proposal exists so far for the functional account that would explain the relationship between indefinites and *wh*-words. However, it can be implemented in a number of ways; one just has to

make sure that the semantic contribution of the indefinite is used to restrict the question function. If we assume a standard analysis of indefinites as Generalized Quantifiers Q that undergo LF-movement, then this can be done by reference to the witness set W(Q):

133. *Who did Mary meet?*

QUEST [*someone*$_1$ [*Mary met* t_1]]

QUEST($\lambda P \exists x$[PERSON(x) $\wedge$ P(x)])

(λx_1[MET(x_1)(MARY)])

= $\lambda x \in W(\lambda P \exists x$[PERSON(x) $\wedge$ P(x)])

[λx_1[MET(x_1)(MARY)]]

The indefinite character of *wh*-words also explains why they can be antecedents to anaphora, as in *Who wrote 'War and Peace' (hint: his name starts with 'T')*, a fact that can be captured in dynamic theories like the one of Haida.

One surprising fact is that the indefinite interpretation almost always appears to be derived from the interrogative interpretation, if there is any morphological relation at all (cf. English *where — somewhere*. Bhat (2000) has called this the "Interrogative-Indefinite Puzzle". It can be explained by pointing out that the basic form *where* itself is not an interrogative yet, but just a variable; it becomes one only by association with an interrogative operator by movement or focus. Forms like *somewhere*, or German *irgend-*

wann, consist of an indefinite quantifier *some* that binds this variable.

A particularly natural explanation of Bhat's observation can be obtained in Inquisitive Semantics. In (120) we have analyzed constituent questions as generalized disjunctions. Now, indefinites, as existentials, are generalized disjunctions. In Inquisitive Semantics, the basic meaning of the disjunction is inquisitive; only by assertive closure do we get a non-inquisitive, indifferent meaning. We can interpret the additional marking of indefinites as the assertive closure operator. This is illustrated with German *wer* and *irgendwer*.

134. *wer*: $\lambda P \bigvee_{x \in \text{PERSON}} P(x)$ *irgendwer*: $\lambda P\ !\bigvee_{x \in \text{PERSON}} P(x)$

Question-embedding predicates

Right from the beginning we have treated questions in their double role, as speech acts and as part of other sentences. In this section we will turn to some of the semantic properties of the predicates that embed questions.

We have assumed that root questions and embedded questions have in common that they both involve a sentence radical:

135. *Which novel did Bill read?*
$\text{QUEST}(\lambda i \lambda x \in \text{THING}_i[\text{READ}_i(x)(\text{BILL})]$

136. *Mary told Jane which novel Bill read.*
$\lambda i[\text{TELL}_i(\lambda i \lambda x \in \text{THING}_i[\text{READ}_i(x)(\text{BILL})])(\text{JANE})(\text{MARY})$

As we have observed, root questions have an additional feature insofar as they require an auxiliary verb in second position. Now, notice that certain verbs allow for embedded "root" questions:

137. *Which novel did she have to read,*
Mary wondered / asked / is curious about.

Embedded root questions are limited in Standard English but readily occur in varieties such as Irish English (cf. McCloskey 2005, a quote from Joyce's *Dubliners*):

138. *The baritone was asked what did he think of Mr. Kearsey's conduct*

Embedded root questions only occur under predicates like *ask, wonder,* or *want to know* that express an inquisitive interest – all predicates that do not embed *that*-clauses. Hence, in the framework of Groenendijk & Stokhof they require question intensions as their complements (cf. 109 above). However, in this account it is not motivated why we find root clause features in precisely those embedded questions. Krifka (2001a) proposed a theory in which this is explained by the assumption that these verbs actually embed question speech acts, not sentence radicals.

139. *Mary wondered which novel did Bill read*
$\lambda i[\text{WONDER}_i(\text{QUEST}(\lambda i \lambda x \in \text{NOVEL}_i[\text{READ}_i(x)(\text{BILL})])(\text{MARY})]$

This says: Mary has an interest in the information that would be satisfied by answers to the indicated question.

Beyond the class of inquisitive verbs, there are further subclasses of question-embedding verbs, and different classifications have been proposed (cf. Baker 1968, Wunderlich 1976, Karttunen 1977, Dipper 1997). Several of the nine classes that Karttunen lists have to do with acquiring, retaining, or communicating knowledge (e.g. *discover, remember, disclose*). They all allow for expressing this knowledge by a *that*-clause, but also by an interrogative clause that generally stands for the true answer of this question. We have seen how the various approaches to question semantics explain this meaning (e.g., 71, 85, 108). In all theories, the *that*-clauses that specify the answer are necessarily understood as factive, that is, they are presupposed to be true. Indeed, question-embedding predicates receive a factive interpretation even if their non-interrogative variant is not factive (cf. Karttunen 1977):

140. a. *Mary told John that Bill is coming.*
b. *Mary told John whether Bill is coming.*

In (140.a) it is left open whether or not Bill is in fact coming, but (b) presupposes that Mary told John the truth. This factivity effect of embedded questions is the reason why verbs that differ from others only because they lack factivity do not embed questions, such as *believe*:

141. *Mary knows whether Bill is coming.*
**Mary believes whether Bill is coming.*

In addition to verbs expressing relations to knowledge, Karttunen lists verbs that express matters of relevance or of dependency, such as *be important* or *care*, and *depend on* and *be related to*. Again, these cases are to be interpreted with respect to the instances that truly satisfy the sentence radical. Consider the case of *depend on*:

142. *What you get depends on what you ask for.*

$$\text{DEPEND ON}_{i0}(\lambda i\lambda x[\text{GET}_i(x)(\text{YOU})])(\lambda i\lambda x[\text{ASK FOR}_i(x)(\text{YOU})])$$

$$\text{iff } \forall i,j \in R_{i0}[\iota x[\text{ASK FOR}_i(x)(\text{YOU})] \neq \iota x[\text{ASK FOR}_j(x)(\text{YOU})] \rightarrow \iota x[\text{GET}_i(x)(\text{YOU}) \neq \text{GET}_j(x)(\text{YOU})]]$$

This is a modal statement; it says that for all accessible worlds i, j, iff they differ in what you ask for, then they differ in what you get. Notice that *depend on* is an intensional predicate in terms of Groenendijk & Stokhof, yet it is different from *wonder* as it does not allow for root clause syntax of the embedded question.

We conclude this section by mentioning two additional types of embedded question-like constructions. One concerns so-called “concealed questions”, which are of a different syntactic type, the type of determiner phrases, but are interpreted like questions:

143. *Bill asked / knew the time.*

This means the same as *Bill asked / knew what the time was*, whose embedded questions would be interpreted as:

144. $\lambda i \lambda x[x = \text{TIME}_i]$

The concealed questions in (143) can be seen as a different way of constructing the meaning (144), by invoking the standard operation of type lifting of a meaning of type e to a meaning of type $\langle e,t \rangle$ (cf. Partee 1987). In the case at hand, the standard meaning of *the time*, $\lambda i[\text{TIME}_i]$ of type $\langle s,e \rangle$, which yields the time of the index i, is lifted to $\lambda i \lambda x[x = \text{TIME}_i]$, which is a regular question meaning that maps for each index i a variable x to Truth iff it is the time of i.

The second type of question-like meanings that should be mentioned here are embedded exclamatives, as in the following examples:

145. *Bill was amazed about how (very) tall she was*

146. *Bill was amazed about who (all) came to the party.*

Exclamatives of this type show the familiar question syntax. Like questions, they denote a set of alternatives (however specified, e.g. by a function or by a proposition set). But in addition, these alternatives are ordered, e.g. in (145) along the degree scale. In the proposition set analysis this relation can be expressed as follows:

$\{\langle \lambda i[\text{TALL}_i(\text{SHE})(d)], \lambda i[\text{TALL}_i(\text{SHE})(d')] \rangle \mid d < d'\}$

Exclamative clauses then come with a presupposition that the actual index i_a is contained in a proposition that is ordered higher than expected. In the following, P is the set of propositions typical for questions, and < is the order relation characteristic for exclamatives.

147. $\text{EXCL}(\langle P, < \rangle)$

presupp: $\exists p \in P[i_0 \in p \wedge \exists p' < p[\text{EXPECT}(s, i_0 \in p')]$

From this it follows that exclamative clauses are formed over a variable that ranges over degrees, like tallness in (145) or cardinality and noteworthiness in (146). In German, there is a specialized *wh*-determiner *welch* which is restricted to degrees denoted by adjectives or certain nouns, and consequently only occurs in exclamatives:

148. *Welch kluger Schachzug dies ist!*
'What a clever move this is!'

149. *Welch ein Idiot ich bin!*
'What an idiot I am!'

Multiple questions

All semantic representations of questions mentioned above can deal with multiple constituent questions, in the sense that the way they deal with questions with one constituent can be generalized to questions with two or more constituents. But multiple questions show interesting properties that do not follow in a straightforward way from the basic treatment.

First, multiple questions come in at least two distinct types. One comprises multiple echo questions and quiz questions:

150. A: *Esmeralda needs a bandoneon.*
B: *Whó needs whát?*

151. *Which Turkish singer won the Eurovision Song contest in which year?*

In the examples above we expect one answer due to special properties of context in which the question is uttered. In contrast, the second type, also called “matching questions”, presupposes that there is more than one group of satisfying instances:

152. *I don’t have proper records about the assignments in the literature class. Which student is supposed to present which novel?*

153. *When did Bill spend his vacation where?*

One difference between the two types of multiple constituent questions is that in the case of quiz questions the *wh*-elements can be conjoined in case they are adverbials, cf. 154. (In languages with multiple *wh*-movement such as Romanian, this even holds for arguments, cf. Comorovski 1996).

154. *When and where did Bill spend his vacation?*

The first type of multiple constituent questions, quiz questions, can be captured easily, as we have seen. In the functional representation, for example, it can be rendered as follows:

155. *Which student presented which novel?*

QUEST($\lambda i \lambda x \in \text{STUDENT}_i \lambda y \in \text{NOVEL}_i [\text{PRESENTED}_i(y)(x)]$)

The uniqueness assumption can be enforced in a similar way as with singular constituent questions (cf. 64), i.e. QUEST is understood to ask to identify, relative to the actual index i_0, the unique x that is a student at i_0 and the unique y that is a novel at i_0 such that x presented y at i_0. But why do matching questions lack this uniqueness requirement? The answer given by Higginbotham & May (1981) is that such questions lead to a construction of a function, which in turn satisfies the uniqueness requirement. The idea is that the logical form of (155), given in (156.a) or alternatively its semantic representation, repeated in (156.b), is turned into a question radical over a function that maps elements of the set STUDENT_i to elements of the set NOVEL_i, as given in (156.c). This rule, which combines two (or more) question constituents is called “absorption”; it is a rule that violates compositionality in the strict sense.

156. a. [*which* student]$_1$ [*which novel*]$_2$ [t_1 *presented* t_2]

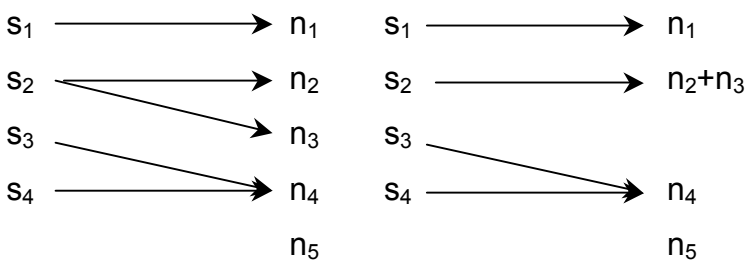
b. $\lambda i \lambda x \in \text{STUDENT}_i \lambda y \in \text{NOVEL}_i [\text{PRESENTED}_i(y)(x)]$

c. $\lambda i \lambda f [\text{STUDENT}_i \rightarrow \text{NOVEL}_i]\ \forall x [\text{PRESENTED}_i(y)(x)]$

If (156.c) serves as sentence radical of a question, then the question, as usual, asks for the unique function that satisfies the description. In our case,

it asks for the unique function f from the set of students to the set of novels such that for each student x, f(x) is a novel that x read. Notice that this enforces that each student read a unique novel, otherwise there would be more than one such function. This is the case in situation (157.a), where there are two functions from students to novels, $\{\langle s_1,n_1\rangle, \langle s_2,n_2\rangle, \langle s_3,n_4\rangle, \langle s_4,n_4\rangle\}$ and $\{\langle s_1,n_1\rangle, \langle s_2,n_3\rangle, \langle s_3,n_4\rangle, \langle s_4,n_4\rangle\}$.

157. a. b.



In situations of this type, it is more appropriate to use plurals, as in *which student presented which novels*. Plurals can apply to sum individuals as well as to single individuals, and this allows for the construction of a unique function $\{\langle s_1,n_1\rangle, \langle s_2,n_2+n_3\rangle, \langle s_3,n_4\rangle, \langle s_4,n_4\rangle\}$, as illustrated in (157.b).

The idea that multiple questions of the type of matching questions ask for a function implies an asymmetry between the domain and the range. This is illustrated in (157.b), which contains a case in which two students present the same novel, and one novel is not presented by any student. Such situations are com-

patible with questions like *Which student presented which novel(s)?* Also, the domain of the function is typically specified in the sense that it is given in discourse (a phenomenon called D-linking, cf. Comorovski 1985, 1996 and Pesetsky 1987). The domain is specified by the question constituent that is first in surface order. Often, this question constituent c-commands the others in the underlying order as well, which is the basis of the so-called "superiority" effect (cf. Chomsky 1973), according to which sentences like *what did who see?* are ungrammatical.

Quantifying into Questions

Matching questions sometimes have a similar communicative effect as questions containing a quantifier:

158. *Which novel did every student present?*

In addition to a reading which asks for the unique novel x for which it holds that every student presented x, there is a reading equivalent to (155), which becomes prominent when *every student* is deaccented. For this reading, the universal quantifier has to scope out of the question. In the partition approach we get the following representation:

159. $\lambda j \lambda i [\forall x \in \text{STUDENT}_j \rightarrow$
$[\lambda y [\text{NOVEL}_i(y) \wedge \text{PRESENTED}_i(y)] =$
$\lambda y [\text{NOVEL}_j(y) \wedge \text{PRESENTED}_j(y)]]$

It turns out that this is a well-behaved question meaning, as it is an equivalence relation. It holds between indices j,i iff for every student x in j, the novels that x read in j and the novels that x read in i are indistinguishable. Interestingly, with quantifiers other than universal quantifiers, the result fails to be an equivalence relation, which is as predicted, as such cases do not allow for a reading of the type of matching questions easily (cf. e.g. *which novel did several students present?*)

Cases like (158), and their restriction to universal quantifiers, have been taken by Krifka (2001a) as evidence that semantic operators can scope out of speech acts:

160. $\forall x[\text{STUDENT}_{i0}(x) \rightarrow \text{QUEST}(\lambda i \lambda y \in \text{NOVEL}_i[\text{PRESENTED}_i(y)(x)])]$

More specifically, the universal quantifier is understood as a generalization of conjunction of question speech acts. That is, the question asks *which novel did Bill present, which novel did Mary present,* etc.

We can identify a different type of quantification over questions with embedded questions, as in the following example:

161. *Bill knows, for the most part, who cheated on the exam.*

This type of quantification is not possible for questions embedded under verbs like *wonder*. One explanation is that the

quantifier modifies the quantifier that we have assumed for the reduction of question-embedding *know* to declarative-embedding *know*.

162. $\text{MOST}(\lambda x[\text{CHEATED}_{i0}(x)])$
$(\lambda i \lambda x[\text{KNOW}_{i0}(\lambda i[\text{CHEATED}_{i}(x)])(\text{BILL})])$

This says that for most x such that x cheated, Bill knows that x cheated. See Berman (1989) and Lahiri (1991) for studies of quantifications over embedded questions.

Biased questions

The various semantic representation formats for questions all have the property that they do not distinguish between the expected answer. However, speakers can impose a certain bias within the answers. This is most evident with polarity questions. A question with declarative syntax as in (163) suggests that the speaker considers it likely that the underlying proposition, here 'You are born in Texas', is true. This bias can be strengthened with a question tag.

163. *You are born in Texas (aren't you?)*

Similarly, an embedded question with the complementizer *if* suggests a bias towards the underlying proposition, whereas *whether* indicates neutrality. For this reason, (164.b) is strange in contrast to (a), as it suggests that Bill does not favor the proposition that

Jill would marry him over the other (cf. Bolinger 1978).

164. a. *Bill asked Jill if she would marry him.*
b. *Bill asked Jill whether she would marry him.*

Gunlogson (2003) proposed that sentences like (163) are declaratives without the characteristic falling intonation, which indicates the lack of speaker commitment that is normally required for assertions. But such sentences can also be understood as questions if we capture their bias by representing them by only one proposition (in the proposition set theory), or by a function that only allows for a positive answer (in the functional theory):

165. $\{\lambda i[\text{MARRY}_i(\text{BILL})(\text{JILL})]\}$

166. $\lambda f \in \{\lambda p.p\}[f(\lambda i[\text{MARRY}_i(\text{BILL})(\text{JILL})])]$

As before, questions ask the addressee to provide the information in which property the real world is, or which sentence operator provides for a true proposition. But as there is no choice in the case at hand, the speaker strongly suggests that the real world is indeed in the selected proposition. Still this is not an assertion; the addressee is required to do something, and saying *no* will result in rejecting the proposition.

We have to distinguish from examples like (163) cases in which a strong rising intonation expresses incredulity (here expressed by two question marks). Under this contour, example (167.a) ex-

presses that the speaker did not believe that you were born in Texas. The same holds for the positive question (b), whereas the negative question (c) expresses that the speaker believed that you were born in Texas.

167. a. *You are born in Texas??*
b. *Are you born in Texas??*
b. *Aren't you born in Texas??*

Romero & Han (2002) analyze such questions as involving a VERUM element that expresses that a proposition is true against contrary evidence. Examples (167.a,b) then have the representation (168.a), whereas example (167.c) has the representation (168.b).

168. a. $\{\lambda i \mathrm{CERTAIN}(\mathrm{BORN\_IN\_TEXAS}_i(\mathrm{YOU})), \lambda i \neg \mathrm{CERTAIN}(\mathrm{BORN\_IN\_TEXAS}_i(\mathrm{YOU}))]\}$
b. $\{\lambda i \mathrm{CERTAIN}(\neg \mathrm{BORN\_IN\_TEXAS}_i(\mathrm{YOU})), \lambda i \neg \mathrm{CERTAIN}(\neg \mathrm{BORN\_IN\_TEXAS}_i(\mathrm{YOU}))\}$

A point in favor of this analysis is that we can form questions like *Are you INDEED born in Texas?* which contain a VERUM element. However, there is nothing in the questions in (167) that seem to identify VERUM. Rather, the special intonation contour can be associated with a subtype of the question force operator expressing incredulity in a positive answer. This seems to suggest that we would have to assume that the alternatives that questions raised are, in addition, endowed with a preference relation among them.

Fine-grainedness of alternatives

Imagine you are a tourist in Zanzibar City and got lost in the maze of streets of the Old Town. You might ask a local: *Where am I?* The answer, *In Zanzibar*, might be true, but it is not very helpful. Why? Obviously, the question was not understood as fine-grained enough. In the situation just described, alternatives like *Zanzibar* and *Daressalaam* don't help; it is given that the speaker is in Zanzibar, and more fine-grained alternatives are required.

Imagine now you give a lecture in an institute that you don't know well. You ask the director, *Who will be in the audience?*, and you get a list of names. This is less helpful if you don't know the people than an answer like *several anthropologists, a neuro-scientist, and a historical linguist*.

Such differences have been addressed by Ginzburg (1995) under the notion of "resolvedness", which specifies that the addressee of an answer has particular goals, and that the choice of one of the alternatives in the answer is supposed to assist the addressee in making a selection between alternatives in achieving this goal.

Focus and NPIs in questions

We have seen that questions induce alternatives that are taken up by the fo-

cus of the answer. But questions can also be focused themselves, as in the following examples:

169. a. *Did $BILL_F$ go to the party?*
     b. *What did $BILL_F$ bring?*

As usual, focus indicates the presence of alternatives, here of alternative questions. For example, (169) suggests that in addition to the question expressed, alternative questions that can be expressed by *Did x go to the party?* are relevant at the current point of discourse. That is, we have a set of speech acts as alternatives:

170. $\{QUEST(\{\lambda i[CAME_i(x)], \lambda i\neg[CAME_i(x)]\}) | x \in ALT(BILL)\}$

Indicating alternative possible speech acts means that the speaker, at the current point in discourse, has reasons to select, out of this set, the one speech act that is actually made. This is quite similar to the role of contrastive topics, which also occur in questions:

171. *As for Bill, did he go to the party?*

Another way of introducing alternatives is by the use of negative polarity items (NPIs, see article #), which also occur in questions (cf. Fauconnier 1980). We find both grammaticalized NPIs like *ever* and idiomatic NPIs like *lift a finger*:

172. a. *Did you ever smoke marihuana?*
     b. *Did you ever lift a finger to help me?*

While (172.a) can be understood as a regular question seeking information, (b) clearly is a rhetori-

cal question, implying that you never lifted a finger to help me.

How can we explain the specific effects of NPIs in questions? The distribution of NPIs in assertions has been explained in various ways, e.g. by downward-entailingness and by non-veridicality, which initially do not seem to be particularly helpful. However, Krifka (1995) and van Rooij (2003) have suggested that the idea that NPIs indicate the presence of alternatives that are ordered along a scale makes sense for questions. For example, *ever* denotes the most general time under consideration, indicating more specific times as its alternatives. Forming a question on a most general proposition indicates an attempt of the speaker to achieve a more similar likelihood for all possible answers. For example, *ever* in (172.b) indicates that the speaker is so sure that the answer will be negative that he or she tries to increase the likelihood for a positive answer by letting the time index range over all possible times. Thus, (b) is a question with a very strong negative bias, practically equivalent to a strong assertion. In the information-seeking question (a), the speaker suggests a common ground in which the immediate informational need would be best satisfied by the answers 'Bill smoked (at some time or other)' and 'Bill didn't smoke (at any time)',

which is the case in a common ground lacks any knowledge concerning Bill's smoking at specific times.

Questions and text structure

Since antiquity questions were seen as structuring devices of texts, and even today journalists learn that newspaper articles should answer six questions: *What? Who? Where? When? How? Why?* Several theories have been developed in recent years that investigate this function of questions in discourse and dialogue. For example, Question Theory (Klein & von Stutterheim 1987) assumes that text genres are structured by typical questions (imagine a description of your last vacation). Kuppevelt (1995) and Roberts (1996) have developed discourse theories that work with notions like questions-under-discussion and of question stacks that are answered systematically by the sentences of a text. Büring (2003) has shown how such notions can be used to capture the notion of contrastive topics (CT) that are indicated by a rising intonation pattern, as indicating strategies that break down a complex question that may be implicit.

173. *I visited my parents last week.*
(Implicit question: How are they?)
[*My father*]$_{CT}$ *is doing fine,*
but [*my mother*]$_{CT}$ *is in a hospital.*

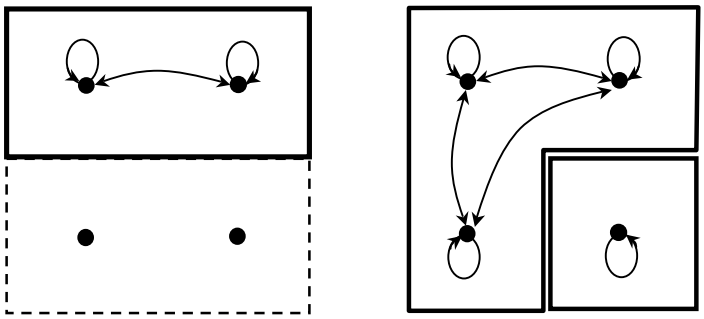
Inquisitive Semantics (Groenendijk 2008b) considers this role of questions

in the information flow in conversation as crucial, and has developed a theory of “Inquisitive Dialogue Management”. Recall that information states are considered to be reflexive and symmetric relations between situations. Asking an initial question amounts to changing an indifferent state to an inquisitive state, as in (116.a,b). Such conversational moves are modeled by stacks of states; here we add to the existing stack of states the new inquisitive state. Dialogue participants follow certain pragmatic rules, e.g. they should maintain a common ground, and they should be compliant, a formal notion that captures various possible continuations of inquisitive states: One of the possiblities offered by inquisitive states can be asserted, or the possibilities can be refined. One can see how splitting up a question into subquestions can be captured within this framework: If we take (116.a) to be the state after the question *Are your parents doing fine?*, then one continuation would be (a) *Yes, my parents are doing fine*, yielding an indifferent state. Another one would be (b) *Is you mother doing fine?*, yielding another inquisitive state, with the suggestion that (116.a) cannot be answered directly. If (b) is continued by *My mother is not doing fine*, then we get the small square in (b) as a result, which entails the lower

rectangle in the original question, (116.a);

174. Possible continuations of (116.a)

a. b.



Groenendijk shows how the notion of alternative changes of states can lead to quantity implicatures that may lead to exhaustive interpretations of answers.

Conclusion

It has been said that questions are more interesting than answers. Certainly, the point can be made that the semantics of questions is far richer than the semantics of assertions, and as a field of study it is as lively as ever.

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