A Note on Uniqueness with Questions*

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Contents

Introduction

In this paper, I am discussing some aspects of uniqueness presuppositions associated with wh-interrogative sentences containing "`which`" (henceforth "*which-interrogatives*"). Section 1 presents pertinent data, in particular, it contains a discussion of multiple which-interrogatives. Section 2 looks at some previous attempts to deal with the phenomenon. Finally, in section 3, I present my own approach. It is a conservative extension of Karttunen's (1977) theory and owes much to the work of Lahiri (1991) and Heim (1993).

1 Some phenomena

1.1 A taxonomy

Certain interrogative sentences have been argued to carry presuppositions. For example, intuitively, (1-a) presupposes (1-b) and (2-a) presupposes (2-b).

(1) a. Has anybody invited the king of France?

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b. France has a king.

(2) a. Who fell asleep?

b. Somebody fell asleep.

(1-a) and (2-a) both have an existential presupposition. However, the respective sources of the presupposition are different in nature. In (1-a), the presupposition is clearly due to the definite description "`the king of France`" and as such not particular to interrogatives. For, the same presupposition arises with Russel's example (3).

(3) The king of France is bald.

(2-a), on the other hand, carries the presupposition (2-b) solely by virtue of being a wh-interrogative sentence. This kind of presupposition specific to interrogatives, I will henceforth call "*i-specific*". Alternative–question also give rise to i-specific presuppositions. For example, (4-a) has a reading in which it presupposes (4-b).

(4) a. Did it rain or did the sun shine?

b. Either it rained or the sun shined, but not both.

i-specific and non-i-specific presuppositions may combine. (5-a), for example, presupposes (5-b).

(5) a. Who invited the king of France?

b. France has a king and somebody invited the king of France.

A more complex case is (6-a). Here, two sources of presupposition interact, in that the wh–phrase "`who`" binds a variable within the definite description "`his BMW`". I am not sure what (6-a) presupposes, (6-b) and (6-c) seem possible candidates.

(6) a. Who loves his BMW?

b. Everybody has a BMW and somebody loves his BMW.

c. Somebody has a BMW and loves his BMW.

In this paper, I will exclusively consider i–specific presuppositions. In fact, attention will be restricted even more, namely to uniqueness presuppositions associated with singular "`which`". (7-a) below presupposes (7-c). Its plural counterpart (7-b), on the other hand, doesn't.

(7) a. Which Scandinavian got the Nobel price?

b. Which Scandinavians got the Nobel price?

c. Exactly one Scandinavian got the Nobel price.

Intuitively, (7-b) rather presupposes that at least two Scandinavians won the Nobel price. The aim of this paper is to explore how i–specific uniqueness presuppositions like (7-c) can be derived from a suitable semantic analysis of wh-interrogatives.

1.2 Theoretical status

Before discussing how i–specific uniqueness presuppositions can be encoded in the semantics of interrogatives it is advisable to first establish that they should be encoded there. For, this view has been challenged by Groenendijk & Stokhof (1984) (henceforth G&S). They present the following data (p.35):

(8) a. Which member of the cabinet voted against the proposal?

b. Which members of the cabinet voted against the proposal?

(9) a. Which member of the cabinet leaked the information to the press?

b. Which members of the cabinet leaked the information to the press?

G&S note:

> "It seems that, whereas of (8), the plural form (8-b) is the neutral one, in that it carries no suggestion as to the actual number of people involved, the reverse holds for (9). Of the

latter two, the singular form (9-a) seems to be neutral, and the plural form (9-b) to be marked."

From this observation G&S proceed to the conclusion that "there is no clear grammatical relation between singular and plural forms of wh-phrases on the one hand and existential and uniqueness presuppositions on the other" and moreover that "presuppositions in this area are, by and large, a non-grammatical matter". (p.36f)

If G&S were right the present enterprise would be pointless. However, their observation is not incompatible with the assumption that grammar invariably provides uniqueness presuppositions for sentences like (9-a). After all, pragmatic factors could keep a presupposition, though given by grammar, from giving rise to the corresponding inference. The case in (10) below illustrates the point.

(10) a. The owner of this car likes teddy bears.
b. This car is not shared property of two or more people.

Suppose, I am walking down the street with my friend Mary when she utters (10-a), pointing at a car full with teddy bears. Her utterance will not make me infer (10-b). One is not forced to conclude from this that grammar does not provide (10-b) as a presupposition. Rather, the inference that (10-b) is true, might be waived by way of the following considerations:

Mary had to choose between the singular noun phrase "`the owner`" and its plural counterpart "`the owners`". While the use of the latter does not presuppose (10-b) it presupposes the negation of (10-b). Mary is very unlikely to know whether the car is the property of exactly one person or a group of persons. Yet, (10-b) is likely to be true, given the way our society is. I expect Mary to know this and thus assume that she has used the singular definite description on the grounds of a best guess rather than on the grounds of safe knowledge. Therefore, I will not infer that (10-b) holds.

Now turn to G&S's case (9-a). Notice that in a typical situation, a speaker uttering (9-a) will not know whether or not (11) holds.

(11) At most one member of the cabinet passed the information to the press.

At the same time, (11) is likely to be true. Therefore, by reasoning as above, I conclude that in a typical situation, (9-a) will not give rise to the inference that (11) is true.

G&S do not specify the kind of situation with respect to which they evaluate (9-a). It is likely that they have a typical situation in mind. But then, their observation can be reinterpreted in the way just sketched and thus does not prove uniqueness presuppositions coming with singular "`which`" to be a "non–grammatical matter".

1.3 An empirical criterion

In this paper, I will assume the following test for presuppositions of interrogatives: Suppose there is a discourse involving two or more participants. Suppose A utters the interrogative S. The other discourse participants believe that p is false. If A's uttering S is deviant in this context I will say that S presupposes p. By A's utterance being deviant I mean that it is perceived by the others as neglecting an assumption they took to be established in the discourse. One could say that S is deviant if the question it expresses cannot receive a genuine answer. But, given that the notion of a "*genuine answer*" is controversial, I leave it at the intuitive notion of deviance.

The reader can verify that this test assigns the presupposition (11) to G&S's controversial case (9-a). The test will be of further use when discussing complex presuppositions coming with multiple which-interrogatives. Before, however, I will look at a phenomenon that can be argued to be closely related to i–specific uniqueness presuppositions.

1.4 A related phenomenon

G&S argue that, on empirical grounds, grammar should not be required to encode a connection between morphological number of which–phrases and uniqueness presuppositions. Suppose they were right. Would this mean that singular and plural which–phrases could be considered semantically equivalent? Certainly not. (12) shows that collective predicates within which-interrogatives distinguish between singular and plural which–phrases.

(12) a. # Which soccer player gathered in the yard?
b. Which soccer players gathered in the yard?

Thus, morphological number of which–phrases is semantically significant. One may nevertheless hold that no problem arises that is specific to wh-interrogative sentences. It is to be expected that any account of the contrast in (13) easily carries over to (12).

(13) a. # The/some soccer player gathered in the yard.
b. The/some soccer players gathered in the yard.

One may conclude that morphological number of which–phrases is not an interesting part of the semantics of wh-interrogatives. However, even without directly considering presuppositions, this conclusion can be shown invalid. For, the grammar of wh-interrogative sentences should allow to derive the grammaticality contrast in (14).

(14) a. # Mary rattled off which soccer player she adores.
b. Mary rattled off which soccer players she adores.

This time, the burden cannot be shifted onto the grammar of declarative sentences. The task is to characterize the class of interrogatives that can be embedded by "`rattle off`". And this characterization evidently must make reference to morphological number of which–phrases[1]. Notice that the ungrammaticality of (14-a) cannot simply be reduced to the fact that (15-a) is associated with the presupposition (15-b).

(15) a. # Which soccer player does Mary adore?
b. Mary adores at most one soccer player.

For, the embedded interrogative in (16) presupposes (15-b) as much as (15-a) does and yet, (16) is impeccable.

(16) John rattled off who detests the soccer player that Mary adores.

Nevertheless, it can be argued that the oddness of (14-a) and the fact that (15-a) presupposes (15-b) should be derived from a common source. In particular the analogous data in (17) make this desirable.

(17) a. # Mary rattled off her date.
b. Mary rattled off her dates.

Here again, an expression carrying a uniqueness presupposition cannot be embedded by "`rattle off`". This makes it unlikely that the ungrammaticality of (14-a) is to be explained in terms unrelated to the uniqueness presupposition of the embedded interrogative. Also, an adequate theory should take the analogy between definte noun phrases and which-interrogatives into account.

Finally, (18) presents a case that goes beyond this analogy: "`rattle off`" also accepts multiple wh-interrogatives with singular which–phrases.

(18) a. # Mary rattled off in which year she adored Litti.
b. Mary rattled off in which year she adored which soccer player.

Multiple which-interrogatives deserve special attention. In the following section, it is discussed to what kinds of presuppositions they give rise[2].

[1]A related point can be made with respect to data on "*Quantificational Variability*" due to Berman (1991). Berman (p.250) observes a contrast between (i) and (ii):
(i) The maitre d' seldom knows which patrons of Maxim's are rich.
(ii) The maitre d' seldom knows which patron of Maxim's is rich.
According to Berman, (i) has a reading in which it can be paraphrased as follows: Few rich patrons of Maxim's are such that the maitre d' knows that they are rich. On the other hand, Berman observes that (ii) does not have such a reading and moreover is grammatically marked. Thus, here again, morphological number of which–phrases excerts an influence on the distribution of interrogatives sentences.

[2]Like "`rattle off`", the verb "`compare`" also is a selective embedder of wh–interrogative sentences. In certain contexts, it can embed multiple wh–interrogatives. For example, suppose Mary wants to find out which type of interrogative

1.5 Multiple which-interrogatives

Multiple which-interrogatives pose special problems for the mere reason that pertinent judgements vary between linguists. For example, what i–specific presupposition can be argued to be associated with (19)?

(19) Which square overlaps which circle?

In the literature, intuitions have been expressed with respect to analogous examples. Transferred to the present case, they amount to the following proposals.

(20) a. **absolute uniqueness**
(19) presupposes that
at most one square overlaps some circle and at most one circle is overlapped by some square[3].

b. **scopal uniqueness**
(19) presupposes that
at most one square overlaps exactly one circle[4].

c. **bijective uniqueness**
(19) presupposes that
each square overlaps at most one circle and each circle is overlapped by at most one square[5].

d. **no uniqueness**
(19) does not carry any kind of uniqueness presupposition[6].

The aim of this section is to evaluate the judgements in (20), thereby taking into account the empirical criterion introduced in section 1.3.

Suppose A and B are practicing a kind of fraudulent card trick. As cards, they use six pieces of cardboard, three circles and three squares. On the back, the cards are are all white, whereas the faces are colored. There is a red, a green and a blue circle and there is a red, a green and a blue square. A trial of the game goes like this: A places the cards face up on the table. Then she turns them face down and moves them around on the tabletop. At some point she stops and asks B some question about the resulting configuration.

Here, only the question expressed by (19) above will be of interest. According to the test in section 1.3, the class of configurations with respect to which (19) can felicitously be asked, characterizes the presupposition carried by (19). The follwing list presents a sample of representative configurations. Next to each configuration, it is indicated to what degree uttering (19) is deviant w.r.t. this configuration. ($\surd$ = non-deviant, ? = uncertain, # = deviant. For typographic reasons, (21) only shows a symbolic representation of the actual card configurations. S represents squares, C represents circles. A lower case c immediately adjacent to a square S represents a circle (partially) overlapped by this square.)

(21) a. $\surd$ S S Sc C C
b. $\surd$ S Sc Sc C

sentence enters children's language at what age. Suppose she has just been doing an experiment involving ten children. Now (i) could be used to describe a step in Mary's evaluating the experimental results.
(i) Mary is comparing which child used which construction.
However, (ii) and (iii) are deviant.
(ii) # Mary is comparing which child used echo questions.
(iii) # Mary is comparing which children used echo questions.
In German, similar patterns arise with "`verwechseln`" ("`mix up`") and "`auseinanderhalten`" ("`to distinguish`"), see Schwarz (1994).

[3]See Higginbotham & May (1981), Belnap (1982). To be precise, these authors propose that (19) has an absloute uniqueness presupposition in one of its readings. Higginbotham & May propose that (19) has another reading in which it has a bijective uniqueness presupposition, see below.
An equivalent formulation of (20-a) is: (19) presupposes that there is at most one pair of a square and a circle such that the former overlaps the latter.

[4]See Bennett (1977, 1979).

[5]See Higginbotham & May (1981), Srivastav (1992). See footnote 3.

[6]See Groenedijk & Stokhof (1984), Engdahl (1986).

c. √ Sc Sc Sc
d. # ScS S C C
e. # cSc C S S
f. ? ScS Sc C
g. ? cSc Sc S
h. # C C C S S S

(21) reveals that none of the proposals in (19) can be maintained as it stands[7]. To correctly describe the data in (21), first some terminology: Let $R(c)$ be the set of square-circle pairs in a configuration c such that the square overlaps the circle. Let the domain [range] of $R(c)$ be the set of squares [circles] that are the first [second] component of some pair contained in $R(c)$. Finally, let (n):(c) refer to sentence (n) interpreted with respect to configuration c.

Now, the following picture emerges from (21):(19):(c) is only felicitous if the following holds. (i) $R(c)$ is non-empty. (ii) The domain of $R(c)$ is a singleton set if and only if the range of $R(c)$ is a singleton set[8].

(i) accounts for #(19):(20h), since R(21-h) is empty. (ii) captures that e.g. (19):(21-a) and (19):(21-f) are better than (19):(21-d). For, the domain of R(21-d) contains two squares, but the range contains only one circle. What is unclear, is the status of (19):(21-f) and (19):(21-g). I cannot do more than express an intuition on why (19) with respect to these configurations is so hard to judge.

Suppose A utters (22-a) or (22-b) to B with respect to configuration (21-f), repeated below.

(21-f) ScS Sc C

(22) a. √ As you see, each square overlaps some circle. But which square overlaps which circle?
b. # As you see, two of the circles are overlapped by some square. But which square overlapps which circle?
c. # As you see, two of the circles are overlapped by some square. But which circle is overlapped by which square?

As indicated, I perceive a difference in felicity between (22-a) and (22-b). Here is a suggestion as to what may be behind this: The first sentences in (22-a) and (22-b) set up a discourse topic with respect to which the second sentences are interpreted. In (22-a), the discourse topic are the three squares, in (22-b) the two leftmost circles. A possible generalization is therefore that (19):(c) is only felicitous if (iii) each of the objects given by the discourse topic occurs in at most one pair in $R(c)$. This rules out (22-b):(21-f). The leftmost circle in (21-f) is part of the discourse topic but occurs twice in R(21-f). The judgement ?(19):(21-f) can now be made plausible as follows: Suppose that the card configurations as such do not specify discourse topics in the relevant sense and that therefore, a hearer/reader must reconstruct one. For certain configurations ((21-a)–(21-c)), the choice of discourse topic (squares or circles) does not matter. But for (21-f), the choice matters. The judgement ?(19):(21-f) could therefore be due to the hearer/reader's vacillating between two possible choices of discourse topic, and, consequently, between √ and #.

This explanation suggests that there are configurations c such that (iii) is violated with respect to any choice of discourse topic. In fact, (23) is such a case.

(23) # cSc ScS

Yet, one might argue that (22-b) is odd only for independent reasons. It could well be that the syntax of (19) is not compatible with the circles being the discourse topic. After all, it is known that discourse topics are preferably taken up by expressions in subject position, whereas "`which circle`" is the grammatical object in (22-b). However, (22-c) is designed to dispel these doubts. There, (19) is passivized so that its information structure fits well with the preceding sentence. But the result is still deviant.

[7]Statistically, (20-c) does best. The problematic cases are (21-f) and (21-g). (20-c) predicts (19) to be deviant with respect to them, a prediction that I consider too strong, as indicated by the question marks in (21-f) and (21-g).

[8]I do not want to claim that #(19):(21-h) shows that (19) carries an existential presupposition. Notice that, in the given scenario, the speaker and the hearer are fully informed about R(21-h). This may be enough to make an utterance of (19) inappropriate.

For completeness, here some data about (21-g). They seem to fit well with those in (22)[9].

(21-g) cSc Sc S

(24) a. # As you see, two of the squares overlap some circle, but which square overlaps which circle?

b. ? As you see, each circle is overlapped by some square. But which square overlaps which circle?

c. As you see, each circle is overlapped by some square. But which circle is overlapped by which square?

Before concluding this section, I want to address the question of whether multiple which-interrogatives should be assigned several readings. In particular, one may ask whether there is one reading in which they carry absolute uniqueness conditions and another one in which they carry a weaker uniqueness presupposition. There are in fact data that make absolute uniqueness appear special. Consider again (21-a) and (21-b).

(21-a) S S Sc C C

(21-b) S Sc Sc C

Let me modify (19) slightly and ask (25).

(25) Which of the three squares overlaps which of the three circles?

Both which–phrases in (25) are to be read as morphologically singular. It seems to me that (25):(21-a) is fully felicitous while (25):(21-b) is deviant. This suggests that in (19):(21-b), the which–phrases are implicitely restricted to objects occurring in R(21-b). Intuitively, it seems that the partitive construction in (25) blocks this implicit restriction and that therefore, (25):(21-b) is deviant. On the other hand, the felicity of (25):(21-a) suggests that no implicit restriction is required to interpret (19):(21-a).

This concludes the discussion of multiple which-interrogatives and, for the time being, also the discussion of data as a whole. I now turn to the question of how i–specific uniqueness presuppositions can be derived in a formal semantics of wh-interrogatives.

2 Some analyses

2.1 Semantics of interrogatives

In this paper, I will focus on the semantics of interrogatives developped by Karttunen (1977). The reason is, that the proposals on i–specific uniqueness presuppositions considered here, including my own, are extensions or modifications of Karttunen's theory. In the terminology of Groenendijk & Stokhof (1984), Karttunen's theory is a "propositional" theory of interrogative semantics. This terminology highlights the fact that Karttunen establishes a rather direct link between an interrogative sentence S and certain propositional answers to the question that S expresses. For concreteness, let's look at some types of interrogatives and see what kind of denotation Karttunen assigns to them.

(26) Are lemons yellow?

In Karttunen's theory, the yes/no–interrogative (26) denotes (27-a) in the actual world, due to the fact that there, lemons are yellow. In a world where lemons are not yellow, (26) denotes (27-b)[10].

(27) a. {Lemons are yellow}

b. {Lemons are not yellow}

Thus, in any world, a yes/no–interrogative sentence S denotes a singleton set containing the true answer to the question expressed by S. Other types of interrogatives may denote sets of other cardinalities:

(28) Are lemons yellow or are oranges yellow?

[9] Again, I suggest that syntactic restrictions on topichood intervene. This would be why (24-b) is not that good.

[10] For convenience, I let English sentences represent the propositions they express.

(29) a. $\emptyset$
b. {Oranges are yellow}
c. {Lemons are yellow}
d. {Oranges are yellow, Lemons are yellow}

(28) is an alternative-question (in one reading). In any world, it denotes one of the sets in (29). In the actual world, it denotes (29-c), in a world where oranges and lemons are yellow it denotes (29-d), and so on. Thus, the denotation of an alternative-question S is the set of true propositions expressed by some conjunct of S.

Next, consider the wh-interrogative (30).

(30) Which kind of fruit is yellow?

The sets in (29) are all possible denotations of (30). One more is given in (31).

(31) {Lemons are yellow, Egg yolks are yellow}

In a world w, (30) denotes that set of propositions that contains the proposition $[\![\text{x are yellow}]\!]^{g[x/b]}$, just in case b is a yellow kind of fruit in w. For example, suppose the world w is just like the actual word except that lemons and oranges are the only kinds of fruit. Then (30) denotes (29-c) in w. In a world w' that is just like w except that egg yolks are a kind of fruit in w', (30) denotes (31), and so on.

A possible denotation for the multiple wh–interrogative (32-a) is (32-b).

(32) a. Which man likes which kind of fruit?
b. {John likes apples, John likes lemons, Bill likes lemons, Bill likes pears}

In general, in a world w, (32-a) denotes a set that contains $[\![\text{x likes y}]\!]^{g[x/c][y/b]}$ just in case c is a man in w and b is a kind of fruit in w and c likes b in w.

What is the intuitive content of an interrogative denotation in Karttunen's theory? Karttunen proposes that the propositions in an interrogative denotation in a world w "jointly constitute a complete and true answer" in w to the question expressed by the interrogative. I will refer to the conjunction of the propositions in Karttunen's denotation of an interrogative as "Karttunen–answer". But Karttunen does not set out to treat direct questions and their answers. His primery concern is the semantics of interrogatives in embedded contexts. He argues that his way of setting up interrogative denotations allows to express the semantics of a variety of interrogative embedding verbs.

I now turn to Karttunen's syntax/semantics interface for wh-interrogatives.

He constructs his analysis as an extension of Montague (1974) (PTQ). Instead of explicitely stating rules, I will introduce the essentials by way of example[11].

(33) Mary knows which fish walks.

[11]Comments on the derivation in (34): The colon stands for the translation relation. PQ, WHP, WHQ, QE are abbreviations used by Karttunen. PQ = Proto–Question Rule. WHP = Wh–Phrase Rule. WHQ = Wh–Quantification Rule. QE = Question Embedding Rule.
p is a variable of type <s,t>. Q in know'$_{\mathrm{IV/Q}}$ is the category of indirect questions and is defined as t//t.
Diverging from PTQ, I do not use individual concepts. Also, extensional transitive verbs, I will assume to be of type <e,<e,t>>.

(34) (1) he_1 walks: walk'(x_1) ($\approx$ PTQ)

(2) ? he_1 walks: $\lambda p[{}^{\vee}p \wedge p = {}^{\wedge}walk'(x_1)]$ (PQ)

(3) fish: fish'

(4) which fish: $\lambda P[\exists x[fish'(x) \wedge {}^{\vee}P(x)]]$ (WHP)

(5) which fish walks: $\lambda p[\exists x[fish'(x) \wedge {}^{\vee}p \wedge p = {}^{\wedge}walk'(x)]][:= \text{q}]$ (WHQ,1)

(6) know: $\text{know'}_{\text{IV/Q}}$

(7) knows which fish walks: $\text{know'}_{\text{IV/Q}}(\hat{}\text{q})$ (QE)

(8) Mary: m

(9) $\text{know'}_{\text{IV/Q}}({}^{\wedge}\text{q})(\text{m})$ ($\approx$ PTQ)

The most important features of the derivation in (34) are the following ones: From (1) to (2), an open proposition p is lifted into a set Q, the Proto-Question. Q is empty or just contains p, depending on whether p is true. The wh-phrase "`which fish`" is translated just like "`some fish`" in PTQ. Formula (5) is arrived at by cross–categorially quantifying–in of the wh–phrase into the Proto-Question. Finally, English "`know`" is assumed to have two translations into IL, know'_{t} to embed declaratives and $\text{know'}_{\text{IV/Q}}$ to embed interrogatives.

Proto–Questions do not have counterparts in actual English. They are nevertheless needed to derive the translation of multiple wh–interrogatives.

(35) Which man eats which fish.

(36) ...

(1) he_1 eats he_2: eat'(x_1,x_2)

(2) ? he_1 eats he_2: $\lambda p[{}^{\vee}p \wedge p = {}^{\wedge}eat'(x_1, x_2)]$ (PQ)

...

(5) which man eats which fish
$\lambda p[\exists x[man'(x) \wedge \exists y[fish'(y) \wedge {}^{\vee}p \wedge p = {}^{\wedge}eat'(x, y)]]]$

To derive (36,5), WHQ can be applied twice to successively quantify–in the two wh–phrases. If there were no Proto-Question, the first and the second wh–phrase would have to be introduced by different rules, or one would have to introduce them simultaneously.

Karttunen also establishes a relation between $\text{know'}_{\text{IV/Q}}$ and know'_{t} by way of a meaning postulate. Slightly simplifying, its effect can be captured by taking $\text{know'}_{\text{IV/Q}}$ to abbreviate $\lambda Q \lambda x[\forall p[{}^{\vee}Q(p) \longrightarrow know'_t(x, p)]]$. Then, (33) is true in w if Mary knows in w every proposition in the denotation of (34,5) in w.

Notice that Karttunen does not treat plural wh-phrases like "`which fishes`", probably because PTQ does not treat plural either. Neither does he account for possible presuppositions. I now turn to the presentation of attempts to extend or modify Karttunen's theory in a way that allows to compute i–specific uniqueness presuppositions.

2.2 Uniqueness presuppositions

2.2.1 Some previous attempts

In this section, I will go through some previous attempts to account for i–specific uniqueness presuppositions. I will confine myself to proposals that modify or extend the analysis of Karttunen (1977). The proposals instantiate two general approaches to presuppositions of interrogatives. One approach takes the interrogative sentence S to presuppose p just in case p follows from every possible answer to the question Q that S expresses (Bennett 1977,1997; Belnap 1982; also Higginbotham & May 1981, Keenan & Hull 1973). Another approach takes S to presuppose p just in case p must be true in order for Q to have a true answer (Srivastav 1991, also Katz 1972). The two proposals will be referred to as "entailment approach" and "answerability approach", respectively.

As it stands, Karttunen's theory does not qualify for any of these two approaches. First, no Karttunen–answer to (37-a) will imply (37-b).

(37) a. Which man walks?
  b. At most one man walks.

Second, if two men walk in w then the denotation of (37-a) in w will contain two propositions instead of being empty.

Bennett (1977,1979) and Belnap (1982) follow Karttunen (1977) in important respects. There are at least two main differences: First, unlike Karttunen's theory, their theories are meant to apply to embedded and unembedded interrogatives alike. Second, they want to account for i–specific uniqueness within an entailment approach. Thus, in their analyses, (38-b), but not the Karttunen-answer (38-a), is a possible answer to (37-a).

(38) a. John walks.
  b. John is a man who walks and no other man walks.

For multiple which–interrogatives, the two authors' intuitions diverge. While Bennett thinks that (39-a) presupposes (39-b), Belnap proposes (39-c) as presupposition of (39-a) in its main reading.

(39) a. Which woman loves which man?
  b. Exactly one woman is such that exactly one man is loved by her.
  c. Exactly one woman–man pair is such that the woman loves the man.

Given the discussion in section 1.5, I follow Belnap in considering Bennett's judgements on this point too idiosyncratic. On the other hand, it seems reasonable, though not sufficient, to assume that (39-a) in some reading presupposes (39-c), cf. section 1.5. Thus, under an entailment approach, (40-b), but not the Karttunen-answer (40-a) , is a possible answer to (39-a) in this reading.

(40) a. Mary loves John.
  b. Mary is a woman and John is a man and she loves him and only him and no other woman loves any man.

(41) and (42) below show slightly simplified versions of derivations that Belnap would assign to (37-a) and (39-a), respectively.

(41) he$_1$ walks: walk'(x_1)

  man: man'

  which man walks:
  $\lambda p[{}^{\vee}p \wedge \exists x[p = {}^{\wedge}\forall x_1[[man'(x_1) \wedge walk'(x_1)] \Longleftrightarrow x_1 = x]]]$

(42) he$_1$ loves he$_2$: love'(x_1, x_2)

woman: woman'; man: man'

which woman loves which man:
$\lambda p[{}^{\vee}p \wedge \exists x_{1'} \exists x_{2'}[p = {}^{\wedge}\forall x_1 \forall x_2[[woman'(x_1) \wedge man'(x_2) \wedge love'(x_1, x_2)]$
$\Longleftrightarrow x_1 = x_{1'} \wedge x_2 = x_{2'}]]$

The main features of these derivations are the following ones: In order to derive answers like (38-b) and (40-b), Belnap must refer to the predicate "`man who walks`" in the course of the derivation. For this reason, the wh–determiner "`which`" is made semantically vacuous. There is also nothing like Karttunen's Proto-Question. The reason is that it would complicate reference to the predicate "`man who walks`". Also, Belnap can do without Proto-Questions, because, unlike Karttunen, he allows himself to introduce several wh-phrases simultaneously. This is shown in (42). In fact, simultaneous introduction is needed in order to derive answers like (40-b), at least as long as the introduction of wh-phrases goes hand in hand with set formation[12].

Bennett (1977, 1979) also has a view on plural which–phrases. For him, (43-c), but not the Karttunen–answer (43-b), is a possible answer to (43-a).

(43) a. Which men walk?
b. John and Bill walk.
c. John and Bill are men who walk and no other man walks.

This is not the place to go into the intricate translation of (43-a) that Bennett (1979) proposes. It is enough to note that Bennett's analysis correctly captures that plural which–phrases do not give rise to uniqueness presuppositions.

Srivastav (1991) takes an answerability approach to i–specific uniqueness presuppositions. She modifies Karttunen's theory which she reinterprets as applying to embedded and unembedded interrogatives alike. In her theory, (44) will denote the empty set in any world where two or more men walk.

(44) Which man walks? (=37a)

The result is derived as follows[13]:

(45) he$_1$ walks: walk'(x_1)

man: man'

which man walks:
$\lambda p[\exists x_1[x_1 = iota(\lambda x_1[man'(x_1) \wedge walk'(x_1)]) \wedge {}^{\vee}p \wedge {}^{\wedge}walk'(x_1)]]$

Here, it is assumed that iota(P) denotes the single member of the denotation of P if P denotes a singleton. If P does not denote a singleton, iota(P) is assumed to denote a dummy individual O that no predicate truthfully applies to. This way, in a world where two men walk, the denotation of (44) will in fact be empty. The derivation (45) shares some characteristics with Belnap's derivation: Reference to the predicate "`man who walks`" requires "`which`" to be semantically vacuous and also bars the level of Proto-Questions as an intermediate step. Like Belnap, Srivastav does not need Proto-Questions, since she allows several which–phrases to enter the derivation simultaneously[14].

[12]Bennett (1979) introduces a category of "*Basic Questions*" that serves a similar purpose as Karttunen's Proto-Questions. In order to derive presuppositions like (39-b), Bennett must introduce wh–phrases one at a time. As a consequence, considerable technical problems arise because Bennett must recover predicates burried in Basic Questions. In order to make Basic Questions independent of variable assignments, Bennett introduces abstraction over assignments into intensional logic.

[13]Srivastav's proposal is expressed in the format of Logical Form. For the sake of comparison, I have translated it into the PTQ format. I hope that nothing is lost or distorted by that

[14]Following Higginbotham & May (1981), Srivastav argues that multiple wh-interrogatives with singular which–phrases carry bijective uniqueness presuppositions (cf. section 1.5). Therefore, in a world where Mary and Sue are women and John and Bill are men and Mary loves John and Bill and Sue loves only John, (46) should denote the empty

(46) Which woman loves which man? (=39a)

(47) he$_1$ loves he$_2$: love'(x_1, x_2)

woman: woman'; man: man'

which woman loves which man:
$$\lambda p[\exists x_1 \exists x_2[x_1 = iota(\lambda x_1[woman'(x_1) \wedge love'(x_1, x_2)]) \wedge$$
$$x_2 = iota(\lambda x_2[man'(x_2) \wedge love'(x_1, x_2)]) \wedge$$
$$^{\vee}p \wedge p = {}^{\wedge}love'(x_1, x_2)]]$$

Srivastav also treats plural which–phrases. (48-a) is translated as (48-b).

(48) a. Which men walk? (=43a)

b. $\lambda p[\exists x_1[x_1 = iota(\lambda x_1[{}^{\star}man'(x_1) \wedge$
${}^{\star}walk'(x_1)]) \wedge {}^{\vee}p \wedge p = {}^{\wedge\star}walk'(x_1)]]$

Here, $\star$ is the plural operator introduced by Link (1983). Its semantics presupposes that the domain D_e includes plural individuals. $[\![{}^{\star}P]\!]^w$ contains an individual x just in case x is a sum of (atomic) individuals in $[\![P]\!]^w$. This way, $[\![{}^{\star}P]\!]^w$ always has a maximal member, viz. the sum of all individuals in $[\![P]\!]^w$. Again essentially following Link, Srivastav generalizes the semantics of the iota operator: For any predicate P and world w, iota(P) denotes the maximal member of $[\![P]\!]^w$ if there is one, and O otherwise. Now, if x and y are the men who walk in w, then (48-a) denotes in w a singleton set containing the proposition that x and y both walk. On the other hand, (44) above will still denote the empty set in w, since $[\![\lambda x[man'(x) \wedge walk'(x)]]\!]^w$ does not have a maximal member. This way, Srivastav correctly distinguishes between (48-a) and (44).

2.2.2 Evaluation

I will not discuss here the question of whether the theories presented above reconstruct presuppositions of questions as the right kind of linguistic relation. This would involve a discussion of presuppositions of declaratives as well, something beyond the scope of this paper. Instead, I will focus on the syntax/semantics interface and on certain empirical issues.

As for the interface, Belnap and Srivastav commit themselves to the view that it must be possible to introduce any number of wh-phrases simultaneously. Translated to the terminology of generative syntax, this means that, at the level of logical form (LF), a flat structure of the form (49) is assumed, where the wh-phrases and the open sentence all c-command each other.

(49) [[which N_1] ... [which N_n] [$_S$ ... t_1 ... t_n ...]]

I will not discuss here the syntactic implications of such an analysis, but it is clear that Belnap and Srivastav impose a severe restriction on the syntax of multiple wh–interrogatives that they fail to justify by way of independent syntactic considerations. On the other hand, the semantic operations they assume to interpret which–interrogatives only serve this single purpose and do not have a place in semantics on independent grounds. This is a step away from Karttunen's elegant interface. There, wh–phrases are introduced by (cross–categorial) quantifying–in. The only rule peculiar to interrogatives is the Proto-Question rule. Yet, von Stechow (1993) suggests that, in the syntactic framework of Chomsky (1986), it is plausible to assume a so–called "*interrogativator*" in complementizer position (C^0) at LF, which takes an open proposition and returns a Proto–Questions. This operator can reasonably be identified with the [+wh] feature proposed in much work on the syntax of wh–interrogatives.

The two proposals correctly assign uniqueness presuppositions to simple unembedded wh-interrogatives containig singular "`which`". Bennett and Srivastav also take a stand on why plural "`which`" does not create uniqueness presuppositions. However, there is a problem with their proposals because of the data in section 1.4 above.

(50) a. # Mary rattles off which man walks.

b. Mary rattles off which men walk.

set. But given Srivastav's translation, the denotation of (46) will contain the proposition that Sue loves John.

c. Which man walks? (=37a)
d. At most one man walks.
e. Which men walk? (=43a)

(50-c) presupposes (50-d). I have pointed out in section 1.4 that this fact as such cannot be used to explain the oddness of (50-a). Rather, there must be something about the denotations of (50-c) and (50-e) that makes (50-a) ungrammatical, but not (50-b). Yet, in Bennett's and Srivastav's analyses, simple which–interrogatives always denote singleton sets of propositions, whether "`which`" is singular or plural. The single propositions in these sets do not show whether they encode an interrogative with singular or plural "`which`". Number information thus gets lost at the level of interrogative denotations. Therefore, in the systems of Bennett and Srivastav, it is not clear how (50-a) can be ruled out on semantic grounds, without ruling out (50-b) as well.

For Bennett's semantics, a similar point can be made with respect to multiple which–interrogatives.

(51) a. # Mary rattles off which man walks.
b. Mary rattles off which man walks in which direction.

In Bennett's system, the embedded interrogatives in (51) denote singleton sets of propositions in any world, so there is again no way to account for the contrast. It is also clear that none of the two proposals accounts for the empirical subtleties of multiple which-questions presented in section 1.5.

3 A more conservative approach

3.1 Simple which–interrogatives

There is a simple way to derive i–specific uniqueness presuppositions of simple which–interrogatives embedded under "`know`". Notice that, intuitively, (52-b) carries the same presupposition as (52-a).

(52) a. Which man walks? (=37a)
b. Mary knows which man walks.

A well known, though problematic, view on presuppositions of declaratives is that sentence S presupposes the proposition p if and only if p must be true in order for S to have a truth value at all. Adopting this approach, (52-b) is to be interpreted as a partial function f from worlds to truth values, such that f(w) is only defined if exactly one man walks in w.

I propose that the required partiality comes in with the semantics of interrogative embedding "`know`". No longer take $\text{know'}_{\text{IV/Q}}$ to abbreviate $\lambda Q \lambda x[\forall p[{}^{\vee}Q(p) \longrightarrow know'_t(x,p)]]$ but instead $\lambda Q \lambda x[know'_t(x, THE({}^{\vee}Q))]$. Here, THE will be interpreted as a partial function on interrogative denotations. If S denotes a singleton set of propositions containing p, then THE(S) denotes p. If S does not denote a singleton set, THE(S) will be undefined. This way, it is made sure that (53-b) has a truth value only in those worlds where (53-a) denotes a singleton[15].

(53) a. $\lambda p[\exists x[man'(x) \wedge {}^{\vee}p \wedge p = {}^{\wedge}walk'(x)]]$ (=:q)
b. $\text{know'}_{\text{t}}(\text{m,THE(q)})$

Now, in any "reasonable" model, any world where (53-b) denotes a singleton is a world where exactly one man walks, and vice versa. One direction of this claim is obvious: If exactly one man walks in w then (53-a) denotes a singleton in w. On the other hand, suppose (53-a) denotes a singleton in w and that at the same time two men, say b and c, walk in w. Then $[\![\text{walk'(x)}]\!]^{g[x/b]}$ and $[\![\text{walk'(x)}]\!]^{g[x/c]}$ are both in the denotation of (53-a) in w. This leads to a contradiction unless $[\![\text{walk'(x)}]\!]^{g[x/c]}$ equals $[\![\text{walk'(x)}]\!]^{g[x/b]}$. However, in any reasonable model, these two propositions should come out logically independent. b will walk in some world without c doing so and vice versa. Thus, the above claim in fact holds. But then, under the present conception, (53-b) presupposes that exactly one man walks[16].

[15] Thus, the semantics of THE is modelled after a Fregean analysis of the definite article.

[16] A very similar argument is presented in Heim (1993). There, Heim shows how Karttunen's semantics can be used to mimic G&S's semantics for cases of interrogatives embedded under "`know`". Heim points out that the validity of her proof hinges on the semantics of the predicate, here "`walk`". There seem to be ill–behaved predicates in English for which her argument does not go through. The same kind of predicate will pose problems for my analysis. See Heim's

Notice that the result is achieved without building up the predicate "`man who walks`" in the translation of (52-a), as Belnap and Srivastav do. Karttunen's elegant syntax/semantics interface can be maintained without any changes.

Before going on, let me note that the approach is motivated by data on alternative–questions as well. (54-a) presupposes (54-b).

(54) a. Mary knows whether it rained or the sun shined.
b. Either it rained or the sun shined, but not both.

Karttunen suggests that ((56-a)–(56-d)) are the possible denotations of (55).

(55) Did it rain or did the sun shine?

(56) a. $\emptyset$
b. {It rained}
c. {The sun shined}
d. {It rained, The sun shined}

But $[\![\text{THE}]\!]$ is only defined for (56-b) and (56-c). Thus (54-a) is predicted to presuppose (54-b).

Something must be said about plural which–phrases. I will follow a suggestion by Irene Heim (Class lectures 1989, quoted in Lahiri 1991), and translate (57-b) as (57-c).

(57) a. Mary knows which men walk.
b. Which men walk?
c. $\lambda p[\exists x[{}^{\star}man'(x) \wedge {}^{\vee}p \wedge p = {}^{\wedge\star}walk'(x)]]$

This is an application of Link's (1983) theory to wh–phrases. The denotation of "`which men`" does not only quantify over atomic individuals but over plural ones as well. As a result, the propositions in the denotation of (57-c) will not be logically independent. For example, suppose b and c are the walking men in world w. Then, in w, (57-c) denotes the following set (where + does sum formation).

(58) $\{[\![{}^{\star}walk'(x)]\!]^{g[x/b]}, [\![{}^{\star}walk'(x)]\!]^{g[x/c]}, [\![{}^{\star}walk'(x)]\!]^{g[x/b+c]}\}$

In (58), the third proposition implies the other two, since $[\![{}^{\star}walk'(x)]\!]^{g[x/b+c]}$ is equivalent to $[\![{}^{\star}walk'(x) \wedge {}^{\star}walk'(y)]\!]^{g[x/b][y/c]}$.

The task is to derive that (57-b) does not carry a uniqueness presupposition. A solution that suggests itself uses Link's (1983) method of replacing uniqueness by maximality: Suppose q denotes a set M of propositions that contains a most informative member, i.e. a member p that implies all the other members of M. Then THE(q) denotes p. If the denotation of q does not contain a most informative member, THE(q) will be undefined[17].

Now, even if the denotation of (57-c) has more than one member in a world, the truth of (59) will be defined, due to the generalized interpretation of THE.

(59) $\text{know'}_{t}(\text{m},\text{THE(57-c)})$

At the same time, (53-b) above will still not have a truth value in such a world in any reasonable model, since there, (53-a) will denote a set of logically independent propositions, none of which is most informative[18].

paper for details.

[17]Like Heim, Lahiri (1991) establishes a part–whole structure on interrogative denotations in order to give a parallel treatment of mass quantification and Berman's (1991) Quantificational Variability. He proves that his denotations form Boolean Algebras. He also introduces a supremum operator to pick out the most informative member of an interrogative denotation. However, for reasons having to do with multiple wh–interrogatives, he does not follow Heim in compositionally distinguishing singular and plural which–phrases. Neither does he treat presuppositions.
Chierchia (1992), modifying Lahiri (1991), proposes a treatment of interrogative embedding "`know`" very similar to the one presented here.

[18]It is not necessary to localize the presupposition trigger within the semantics of "`know`". For, $[\![\text{THE}]\!]$ could be looked at as a general type–shifting device in the sense of Partee (1987). In fact, Partee suggests that type–shifting principles may be responsible for uniqueness presuppositions associated with singular definite noun phrases occurring in extensional argument positions. Under this perspective, semantically, there is only one "`know`", viz. a relation between individuals and propositions. When "`know`" syntactically combines with an interrogative S, type–shifting applies and picks out the most informative member of S's denotation. Such a treatment is hinted at in Chierchia (1992:fn.13).

Notice that the present proposal can cope with the data in section 1.4.

(60) a. # Mary rattles off which man walks.
b. Mary rattles off which men walk.
c. Which man walks? (=37a)
d. Which men walk? (=43a)

Suppose "to rattle off + S" roughly means "`to quickly verbalize all the many parts of the most informative true answer to S`". Suppose that an answer p is a part of an answer p' if p and p' are in the denotation of S and p' entails p. The oddness of (60-a) can now be derived from the fact that in no world, a most informative proposition in the denotation of (60-c) ever has a proper part. On the other hand, the most informative answer in the denotation of (60-d) may have proper parts.

Thus, a desirable feature of this analysis is that the semantics of number associated with which–phrases is visible at the propositional level. This is necessary for a compositional treatment of the contrast in (60). Also, the analogous contrast in (61), observed in section 1.4, is not surprising under this perspective.

(61) a. # Mary rattles off her date.
b. Mary rattles off her dates.

What happens with unembedded interrogatives like (62-a)?

(62) a. Which man walks? (=37a)
b. Exactly one man walks.

My proposal assigns matrix predicates the role of triggering i–specific presuppositions. In (62-a), there is no matrix predicate, still (62-a) is felt to presuppose (62-b). In similar situations, Karttunen (1977) and Karttunen & Peters (1976) choose to analyze interrogatives as embedded by a suitable kind of performative verb at some semantically relevant level. They would consider (62-a) equivalent to (63).

(63) I ask you (to tell me) which man walks.

It is conceivable that this equivalence can be used to derive the presupposition (62-b) of (62-a). I am not convinced that this is a satisfactory account. However, for the time being, I will leave it at that[19].

3.2 Multiple which–interrogatives

The present proposal predicts that (64-a) presupposes (64-b).

(64) a. Which woman loves which man?
b. There is exactly one woman-man pair such that the woman loves the man.

This is so because in Karttunen's theory, in any world w, the propositions in the denotation q of (64-a) in w are logically independent of each other. Therefore, the requirement that q contain a most informative member amounts to the requirement that it be a singleton. But in any reasonable model, the latter is the case in a world w if and only if (64-b) holds in w, see above.

In section 1.5, I have presented evidence that (64-a) may in fact be argued to have a distinct reading in which it presupposes (64-b). On the other hand, this cannot be the only reading. I will not be able to do justice to the more subtle observations on uniqueness presented in section 1.5. Instead, the focus will be on the grammaticality pattern in (65).

[19]Here is a vague outline of a possible alternative: G&S observe that in the context of (62-a), (i) does not mean the same as in isolation.
(i) Meier walks.
According to G&S, (i) as an answer to (62-a) is to be understood as (ii):
(ii) Meier is the only man who walks.
A possible way to account for this is to look at the meaning of a wh–interrogative sentence S as a device to map (i) into (ii). Suppose Q is Karttunen's sense of (62-a). Then let p be a proposition that is true in w if and only if the most informative proposition in Q(w) is (i). A slight extension of an argument presented in Heim (1993) shows that p will imply (ii). This fact may be used to derive uniqueness presuppositions as a by-product of the role interrogatives play in discourse.

(65) a. # Mary rattles off which man walks.
b. Mary rattles off which men walk.
c. Mary rattles off which man walks in which direction.

(66) a. Which man walks? (=37a)
b. Which men walk? (=43a)
c. Which man walks in which direction?

In the previous section, I have suggested to derive the contrast between (65-a) and (65-b) from the fact that, in any world, the most informative proposition in the denotation q of (66-a) will not have proper parts in q, while the most informative proposition in the denotation q' of (66-b) may have proper parts in q'. The grammaticality of (65-c) therefore suggest that denotations of multiple wh-interrogatives with singular which–phrases may as well have a part-whole structure. This could be implemented by the IL translation (67) of (66-c) (see below for explanation).

(67) $\lambda p[\exists r[^{**}\lambda x\lambda y[man'(x) \wedge direction'(y)](r) \wedge$
$^{\vee}p \wedge p = {^\wedge}[^{**}walk-in'(r)]]]$

Here **is to be interpreted as an operator on two-place relations. Its semantics presupposes that the set $D_e x D_e$ of pairs of individuals is structured in the same way as D_e: Besides atomic pairs of individuals there are also plural "*pair sums*" which have atomic pairs as their parts. Then **R denotes the set M of (atomic or plural) pairs of individuals such that a pair r is in M if and only if all the atomic parts of r are in the denotation of R. Accordingly, r in (67) is a variable ranging over atomic and plural pairs of individuals[20].

The translation (67) assimilates the semantics of (66-c) to the semantics of (66-b) in that in either case, plural operators account for missing strong uniqueness presuppositions. Yet, morphological clues being absent, it is surely misterious how and why the semantics of plural enters the translation of (67). Moreover, (67) has the syntactic consequence that, in terms of generative grammar, the two which–phrases in (66-c) must form a constituent at the level of logical form. Under the label "*Absorption*", such a structure has indeed be proposed be Higginbotham & May (1981). But their analysis is not syntactically motivated either. Finally, the translation (67) presupposes that "`which`" is semantically vacuous, so Karttunen's analysis of wh–phrases as indefinites cannot be maintained.
Besides, the translation (67) does not encode the right presupposition of (66-c), for it predicts that (66-c) doesn't carry any uniqueness presupposition whatsoever. Section 1.5 has shown that this is too weak. As I said, I cannot account for the subtleties. But, for example, Higginbotham & May's bijective reading can be accommodated in my account. (66-c) could be translated as (68).

(68) $\lambda p[\exists r[C(^{**}\lambda x\lambda y[man'(x) \wedge direction'(y)])(r) \wedge$
$^{\vee}p \wedge p = {^\wedge}[^{**}walk-in'(r)]]]$

Here, let C denote a function that applies to a set of M (atomic or plural) pairs of individuals and returns the set of all r in M that correspond to a one–to–one relation. Although I do not consider this a serious analysis, neither empirically nor theoretically, note that it makes a prediction about wh–interrogatives containing a singular and a plural which–phrase.

(69) a. Which man read which books?
b. $\lambda p[\exists r[C(^{**}\lambda x\lambda y[man'(x) \wedge {^*}book'(y)])(r) \wedge$
$^{\vee}p \wedge p = {^\wedge}[^{**}\lambda x[^{*}\lambda y read'(x,y)]](r)]]$

According to the translation (69-b) of (69-a), (69-a) presupposes that no two men read exactly the same books. This is in conflict with an intuition given in Higginbotham & May (1981:fn.5) where (69-a) is claimed to presuppose that no book was read by more than one man. I will not enter this swamp and leave it to the reader to decide which proposal is further away from the actual facts.

[20]Lahiri (1991: 31f), trying to extend Berman's (1991) analysis of Quantificational Variability, also discusses the use of sums of pairs of individuals.

4 Conclusion

I have presented an account for uniqueness presuppositions associated with which–interrogatives embedded under "`know`". I have located the presupposition trigger in the semantics of "`know`". This allows to take over Karttunen's (1977) analysis with minor changes. Two alternatives proposed in the literature have been shown inadequate in view of additional data. Many questions have been left open, some of which I will mention here. First, I consider it an open question whether uniqueness presuppositions associated with unembedded interrogatives should really be analyzed by assuming an invisible matrix predicate, as Karttunen & Peters (1976) do. Second, it remains to be seen whether presuppositions of interrogatives embedded under verbs other than "`know`" can be derived among similar lines. Finally, while simple which–interrogatives seem more or less well–behaved, multiple which–interrogatives are misterious creatures. The data in section 1.5 are beyond the scope of the present analysis.

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