

# Scope Ambiguities in *How Many*-Questions

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Paper presented at the annual LSA meeting  
Los Angeles, 10 January 1993  
Revised and extended version, Summer 1993

## 0. Introduction

Questions involving *how many* are potentially ambiguous in scope<sup>1</sup> (Kroch 1989). For instance, (1) has two readings depending on whether the *wh*-phrase *how many books* has wide or narrow scope with respect to the verb *want*.

- (1) How many books does Chris want to buy?
- a. What is the number *n* such that there are *n* books that Chris wants to buy?
  - b. What is the number *n* such that Chris wants to buy *n* books?

The wide scope, or *de re*, reading of the sentence is paraphrased in (1a). Under this reading, it is assumed that there are certain books which Chris wants to buy and the speaker asks how many such books there are. (1b) paraphrases the narrow scope, or *de dicto*, reading of the sentence. On this reading it is not assumed that there are any specific books that Chris wants to buy, but rather that he wants to buy a certain number of books, without having any particular books in mind.

The primary goal of this paper is to show how scope ambiguities in *how many*-questions can be accounted for in a model-theoretic semantics for questions. In particular, I will demonstrate

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<sup>1</sup> This is a slightly revised and extended version of the paper I presented at the annual LSA meeting in Los Angeles on January 10, 1993. Special thanks are due to Henriëtte de Swart with whom I co-authored an earlier paper on the same topic (Rullmann and de Swart 1992) in which we developed a PTQ-style analysis of *how many*-questions. The main innovation of the present paper is in the syntax/semantics interface, especially the role played in the semantic interpretation by the *wh*-traces. Without my many discussions with Henriëtte this paper would not have existed. I also would like to thank Barbara Partee, Angelika Kratzer, Anna Szabolcsi, and Jeff Runner for many stimulating and helpful comments.

that the various readings of such questions can be derived without a syntactic operation of "reconstruction" which lowers the *wh*-phrase (or part of it) back to the position of the trace, as proposed by Dobrovie-Sorin (1992). The paper gives explicit rules which translate S-structure representations into expressions of an intensional logic (Two-sorted Type Theory, or Ty2). This interpretation procedure is compositional and in principle the logical language is dispensable. To a certain extent the translation proceeds in a type-driven fashion.

In my account, the semantics of the traces left by *wh*-movement plays a central role. The ambiguity of *how many*-questions hinges on the distinction between two types of traces: those which represent individual variables of type *e* ("small traces") and those which stand for variables of a higher type ("big traces"). A noteworthy feature of the analysis is that more complicated cases in which the *how many*-phrase can take scope between two scope-bearing elements are derived by taking into account the semantic function of intermediate traces. Intermediate traces are usually viewed as a purely syntactic device without any semantic import. If my analysis is correct, they play an important role for semantic interpretation as well. However, intermediate traces are interpreted in exactly the same way that traces in argument positions are, and no semantic rules are introduced that apply specifically to intermediate traces.

The account proposed also has potential implications for the theory of weak *wh*-islands, a topic which has gotten a good deal of attention recently. In the second part of the paper I will address some of these consequences. It will be shown how a syntactic theory of weak islands like that of Rizzi (1990) can be restated so that it exploits the distinction between small traces and big traces that I introduce. However, more recently, a number of alternative proposals have been developed which attempt to account for weak island effects in semantic or pragmatic terms. I will argue that, maybe despite appearances, my analysis in this paper is completely compatible with these proposals. My analysis shows how to derive the various readings of a *how many*-question in a compositional manner from S-structure; the semantic and pragmatic accounts of the weak island effect found in the literature each attempt to explain why under certain conditions some of these readings are semantically or pragmatically ill-formed.

## 1. A closer look at the scope ambiguities

Consider again the two readings of sentence (1), repeated here for convenience.

- (2) How many books does Chris want to buy?
- a. What is the number *n* such that there are *n* books that Chris wants to buy?
  - b. What is the number *n* such that Chris wants to buy *n* books?

(3) gives two slightly more formal paraphrases of the two readings of this sentence.

- (3) a. What is the number  $n$  such that  $n$  is the cardinality of the set  $\{x \mid x \text{ is a book and Chris wants to buy } x\}$ ?
- b. What is the number  $n$  such that Chris wants the cardinality of the set  $\{x \mid x \text{ is a book and you buy } x\}$  to be equal to  $n$ ?

The wide scope reading of the sentence asks what the cardinality is of the set of objects  $x$  such that  $x$  is a book and Chris wants to buy  $x$ . This paraphrase is given in (3a). (3b) paraphrases the narrow scope reading.

To demonstrate that this kind of scope ambiguity in *how many*-questions is real, I give two examples in (4) and (5) in which one of the two readings is more salient than the other for pragmatic reasons.

- (4) How many books that he can't afford does Frank want to buy?
- (5) How many unicorns does Mary want to catch?

In (4) the wide scope reading is more prominent than the narrow scope reading, because the narrow scope reading would imply that Frank has the wish to buy books that he can't afford. In (5), on the other hand, the narrow scope reading is more plausible, because it does not commit the speaker to the existence of unicorns. Mary may want to catch a certain number of unicorns, even if in actual fact, unicorns do not exist.

Sentences that are more complex than (1) may have more than just two readings. Sentence (6), for instance, is three ways ambiguous. *How many books* can have wide scope over both the verb *think* and the verb *want* (6a), or it can have narrow scope with respect to *want*, but wide scope with respect to *think* (6b), or it can have narrow scope with respect to both verbs (6c):

- (6) How many books do you think Mary wants to buy?
- a. What is the number  $n$  such that there  $n$  books which you think Mary wants to buy?
- b. What is the number  $n$  such that you think there are  $n$  books which Mary wants to buy?
- c. What is the number  $n$  such that you think that Mary wants to buy  $n$  books?

(7) gives more formal paraphrases of these three readings:

- (7) a. What is the number  $n$  such that  $n$  is the cardinality of the set  $\{x \mid x \text{ is a book and you think Mary wants to buy } x\}$ ?
- b. What is the number  $n$  such that you think that  $n$  is the cardinality of the set  $\{x \mid x \text{ is a book and Mary wants to buy } x\}$ ?
- c. What is the number  $n$  such that you think that Mary wants the cardinality of the set  $\{x \mid x \text{ is a book and Mary buys } x\}$  to be equal to  $n$ ?

## 2. Two types of *wh*-traces

In this paper I outline a formal syntactic and semantic analysis of the scope ambiguities in *how many*-questions. In earlier work with Henriëtte de Swart (Rullmann and de Swart 1992), we gave a model-theoretic semantics for *how many*-questions within the framework of the theory of questions developed by Groenendijk and Stokhof (1982). I will assume essentially the same semantics here. In the earlier paper, our main concern was with the purely semantic aspects of *how many*-questions. In this paper, I want to focus on the way in which the various readings of *how many*-questions are derived from their syntactic representations. The analysis of Rullmann and de Swart (1992) was formulated in terms of parallel syntactic and semantic rules in the style of Montague's PTQ. Since it is well known that Montague-grammar is syntactically completely unconstrained, it is an interesting question whether the same semantic interpretations can be assigned compositionally to syntactic representations of the kind assumed by current theories in the Government and Binding tradition. The syntactic structures I will be presupposing are roughly those found in Chomsky (1986) and related work.

Before I go on, I should say something about the logical language into which the sentences will be translated. Following Groenendijk and Stokhof I will use Gallin's (1975) Two Sorted Type Theory (Ty2) rather than Montague's Intensional Logic (IL). Ty2 differs from IL in that it has  $s$  (the type of possible worlds or indices) as a basic type. Ty2 furthermore uses a designated variable  $a$  of type  $s$  which can be thought of as denoting the "current" world.  $\lambda$ -abstracting over  $a$  corresponds to the  $\wedge$  operator of IL. Applying an expression  $\alpha$  to  $a$  means taking the extension of  $\alpha$ , and corresponds to the  $\vee$  operator in IL.<sup>2</sup>

In my analysis a central role is played by the way in which *wh*-traces are translated as variables. Traces will sometimes be translated as variables of type  $e$  which range over individuals in the domain of discourse, and sometimes as variables of higher types, in particular the type of NP-intensions,  $\langle s, \langle \langle s, \langle e, t \rangle \rangle, t \rangle \rangle$ . To distinguish these two kinds of traces typographically, I will indicate a trace of type  $e$  by a lower case  $t$  (referred to as "small trace"), but a trace of a type higher than  $e$  by an upper case  $T$  ("big trace").<sup>3</sup> I will assume that the type of the trace is independent of that of its antecedent. So a *wh*-phrase which itself denotes a generalized quantifier, is free to leave either a big trace or a small trace. This ability to leave either type of trace is what brings about the scope ambiguity. For instance, the two readings of the embedded question *how many books John needs* will be represented as in (8) ( $e_i$  is the phonetically empty head  $C$  which is coindexed with its Specifier *how many books* <sub>$i$</sub>  under Spec-Head agreement):

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<sup>2</sup> For a good brief introduction to Ty2, see Gamut (1991).

<sup>3</sup> In the examples discussed in this paper the only "high" type we are dealing with is  $\langle s, \langle \langle s, \langle e, t \rangle \rangle, t \rangle \rangle$ , the type of generalized quantifier intensions. However, in a more inclusive fragment big traces could also stand for variables of other high types such as  $\langle s, \langle e, t \rangle \rangle$ , the type of predicative NP's (Partee 1987) and possibly intensional objects (Zimmermann 1992).

- (8) ... how many books John needs
- a.  $[_{CP} [_{NP} \text{how many books}]_i [_{\bar{C}} [_C \mathbf{e}_i] [_{IP} \text{John needs } \mathbf{t}_i]]]$  (*wide scope*)
- b.  $[_{CP} [_{NP} \text{how many books}]_i [_{\bar{C}} [_C \mathbf{e}_i] [_{IP} \text{John needs } \mathbf{T}_i]]]$  (*narrow scope*)

On the wide scope reading, represented in (8a), the object of *need* (*i.e.* the trace  $\mathbf{t}_i$ ) is an individual variable, and the trace is therefore a small one. On the narrow scope reading given in (8b), John bears the *need*-relation to some higher type intensional object, and hence we have a big trace  $\mathbf{T}$ . The presence of this big trace, which is going to be translated as a variable of a higher type, will make it possible for us to give the *wh*-phrase narrow scope without making appeal to a syntactic reconstruction rule that puts the *wh*-phrase back in its D-structure position. In the context of *how many*-questions, syntactic reconstruction of *wh*-phrases has been proposed by Dobrovie-Sorin (1992). I take it as an advantage of the present analysis that it obviates the need for syntactic reconstruction.<sup>4</sup>

I can now state some of the translation rules that are central to my analysis. First the translation rule for traces:

(9) **Trace translation rule**

- a.  $[_{NP} \mathbf{t}_i] \implies x_i$  (where  $x_i$  is of type  $e$ )
- b.  $[_{NP} \mathbf{T}_i] \implies X_i(a)$  (where  $X_i$  is of type  $\langle s, \langle \langle s, \langle e, t \rangle \rangle, t \rangle \rangle$ )

Small traces are translated as variables of type  $e$  and big traces as variables of the type of generalized quantifier intensions. In the logical translation language I will also use the convention that lower case variables are of type  $e$  and upper case variables of type  $\langle s, \langle \langle s, \langle e, t \rangle \rangle, t \rangle \rangle$ .

It is important to realize that, since I am assuming that *wh*-phrases are free to leave either a big trace or a small trace, I might as well have used just one kind of trace in the syntax which could then be translated as either a variable of type  $e$  or as a variable of type  $\langle s, \langle \langle s, \langle e, t \rangle \rangle, t \rangle \rangle$ . I will keep distinguishing between small traces and big traces in the syntax, however, for two reasons. The first reason is convenience. Keeping big and small traces typographically distinct allows me to make the semantic function of traces of different types perspicuous in the syntactic representations. The second reason is a more principled one. There might be syntactic rules or principles that are sensitive to the distinction between the two kinds of traces. In section 8, I will

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<sup>4</sup> A problem for any theory that assumes syntactic reconstruction is that scope reconstruction does not always pattern together with the reconstruction of binding relations. As Cinque (1991) and Kroch (1989) note, scope reconstruction of a *how many*-phrase is blocked by a weak island (see section 8 below), but reconstruction of binding relations is not:

- (i) How many books did the editor wonder whether to publish next year (*only wide scope*)
- (ii) It's of herself<sub>i</sub> that I don't wonder whether she<sub>i</sub> thinks

But more recently Heycock (1992) has drawn attention to an extremely interesting set of cases in which reconstruction for the purposes of binding is affected in a subtle but systematic way by weak islands.

in fact formulate a potential candidate for such a principle. Whether we actually want a principle of this kind will be discussed in section 9. Until then at least, I want to keep open the possibility that syntactic principles are sensitive to the distinction between big and small traces.

The next rule we need is one that translates  $\bar{C}$ . It embodies the idea that the semantic function of the (usually empty) head  $C$  is to act as a  $\lambda$ -operator, exploiting the fact that  $C$  is coindexed with the  $XP$  in the Spec of  $CP$ . This  $\lambda$ -operator binds the variable corresponding to the trace left by this  $XP$ . If this trace is a small one, then the  $\lambda$ -operator abstracts over a variable of type  $e$ ; if the trace is big, then the abstraction is over a variable of type  $\langle s, \langle \langle s, \langle e, t \rangle \rangle, t \rangle \rangle$ .  $IP'$  is the translation of  $IP$ :<sup>5</sup>

(10)  $\bar{C}$  translation rule

- a.  $[\bar{C} C_i IP] \implies \lambda x_i IP'$  if  $C_i$  locally binds a small trace  $t_i$  in  $IP$ .
- b.  $[\bar{C} C_i IP] \implies \lambda X_i IP'$  if  $C_i$  locally binds a big trace  $T_i$  in  $IP$ .

We next move up to the  $CP$  level. The phrase in the Spec of  $CP$  will either act as the functor that takes the  $\bar{C}$  as its argument or *vice versa*, depending on the types of the two expressions. In the formulation of the rule we can simply allow for both options, making the translation procedure type-driven in the sense of Klein and Sag (1985).

(11)  $CP$  translation rule

$$[{}_{CP} XP \bar{C}] \implies XP'(\lambda a \bar{C}') \text{ or } \bar{C}'(\lambda a XP')$$

To illustrate how the  $\bar{C}$  and  $CP$  translation rules work in tandem, I give partial translations for (8a) and (b) in (12a) and (b), respectively:

- (12) a.  $\text{how\_many\_books}'(\lambda a \lambda x_n [\text{need}(a)(j, x_n)])$  (*wide scope*)
- b.  $\lambda X_n [\text{need}(j, X_n(a))](\lambda a [\text{how\_many\_books}'])$  (*narrow scope*)
- $\equiv \text{need}(j, \text{how\_many\_books}')$

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<sup>5</sup> It might be objected that the  $\bar{C}'$  translation rule as stated here is not strictly compositional, because it has to look inside the syntactic representation of the  $IP$  to find the type of the trace. There are two possible solutions to this problem. One possibility is to introduce a special mechanism in the syntax which indexes each moved phrase with the type of the trace it left behind when it was moved. Another, perhaps more attractive option is to leave the type of the variable bound by the  $\lambda$ -abstractor unspecified. Any type mismatches between the lambda operator and the variable it is supposed to bind must then be filtered out as semantically or pragmatically deviant because of the presence of "left-over" variables which did not get bound in the course of the derivation. This latter option would require us to make sure that in cases of type mismatch between the variable and its binder, the variable cannot somehow get bound by accident later in the derivation, producing a pragmatically acceptable (but wrong) interpretation of the sentence. I leave this issue for further research.

For the moment I leave the *wh*-phrase *how many books* unanalyzed. (12a) represents the wide scope reading. Here *how many books* is the function that takes the intension of the expression formed by abstracting over  $x_n$  as its argument. (12b) represents the narrow scope reading. In this case the intension of *how many books* is the *argument* of the  $\lambda$ -expression formed by abstraction over  $X_n$ . We can then apply  $\lambda$ -conversion, which in effect replaces the variable  $X_n$  with *how\_many\_books'*. This illustrates how we can "reconstruct" the moved *wh*-phrase back to its D-structure position without actually using a syntactic lowering rule. In other words, the device of higher type ("big") traces combined with the standard semantic tools of the  $\lambda$ -calculus makes it possible to obtain the effect of a syntactic reconstruction rule in a purely semantic manner with direct compositional translation of S-structure.

### 3. The translation of *how many*

Since the translation of *wh*-phrase has narrow scope in (12b), how can this expression represent the meaning of an (embedded) question? The answer is, in a nutshell, that the translation of *how many books*, which so far has been left unanalyzed, contains a free variable which will get bound at the level of the question. In this section the translation of *how many*-phrases will be given, and then in the next section I will show how the two readings of a *how many*-question like (8) are derived.

In (13) I define a cardinality operator # for the logical translation language:

(13) **Cardinality operator #**

If  $\alpha$  is an expression of type  $\langle e, t \rangle$ , then  $\#\alpha$  is an expression of type  $e$ .

$\llbracket \#\alpha \rrbracket^{M,g} = | \llbracket \alpha \rrbracket^{M,g} |$  (the cardinality of the set denoted by  $\alpha$ ).

Syntactically this operator takes an expression of type  $\langle e, t \rangle$  and gives an expression of type  $e$ . Semantically,  $\#\alpha$  denotes the cardinality of the set denoted by  $\alpha$ .

We can use the cardinality operator to give the meaning of a sentence like *Five books are new* and of an NP like *five books*, as in (14).

- (14) *Five books are new*  $\implies \#\lambda y[\text{book}(a)(y) \ \& \ \text{new}(a)(y)] = 5$   
*five books*  $\implies \lambda Q[\#\lambda y[\text{book}(a)(y) \ \& \ Q(a)(y)] = 5]$

The NP *how many books* will be translated as follows:

- (15) *how many<sub>i</sub> books*  $\implies \lambda Q[\#\lambda y[\text{book}(a)(y) \ \& \ Q(a)(y)] = x_i]$

This translation is the same as that of *five books*, except that the number 5 is replaced by a free variable  $x_i$ , which ranges over numbers. The idea behind this is that when someone asks a *how many*-question, they want to know for which value (or values) of this variable  $x_i$  the sentence is

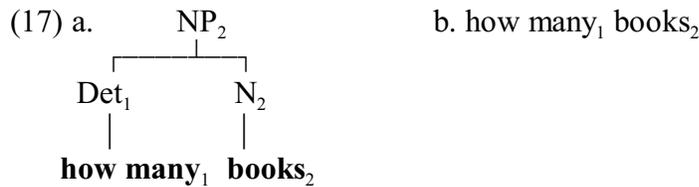
true. So asking a *how many*-question is asking for the specification of a number that can be taken as the value for the variable  $x_i$ .

Note that I am treating numbers here as entities of type  $e$ . To distinguish them from ordinary entities we could assign them to a special sort. Still, this treatment is undoubtedly too simplistic. For a more adequate account we should probably treat numbers as entities of some higher type such as the type of determiners  $\langle\langle s, \langle e, t \rangle \rangle, \langle\langle s, \langle e, t \rangle \rangle, t \rangle\rangle$ . Note for instance that a question line (16a) can be answered with (16b):

- (16) a. How many books are we supposed to read?  
 b. Between seven and ten.

The expression *between seven and ten* can obviously not be viewed as denoting an entity of type  $e$ . For the purposes of this paper, however, I will keep treating numbers as entities of type  $e$ , leaving a generalization to higher types for further research.

It is important to note that the index  $i$  on the determiner *how many* in (15) is not the same as the index on the NP as a whole. This is shown explicitly in the tree representation of the NP *how many books* in (17a).

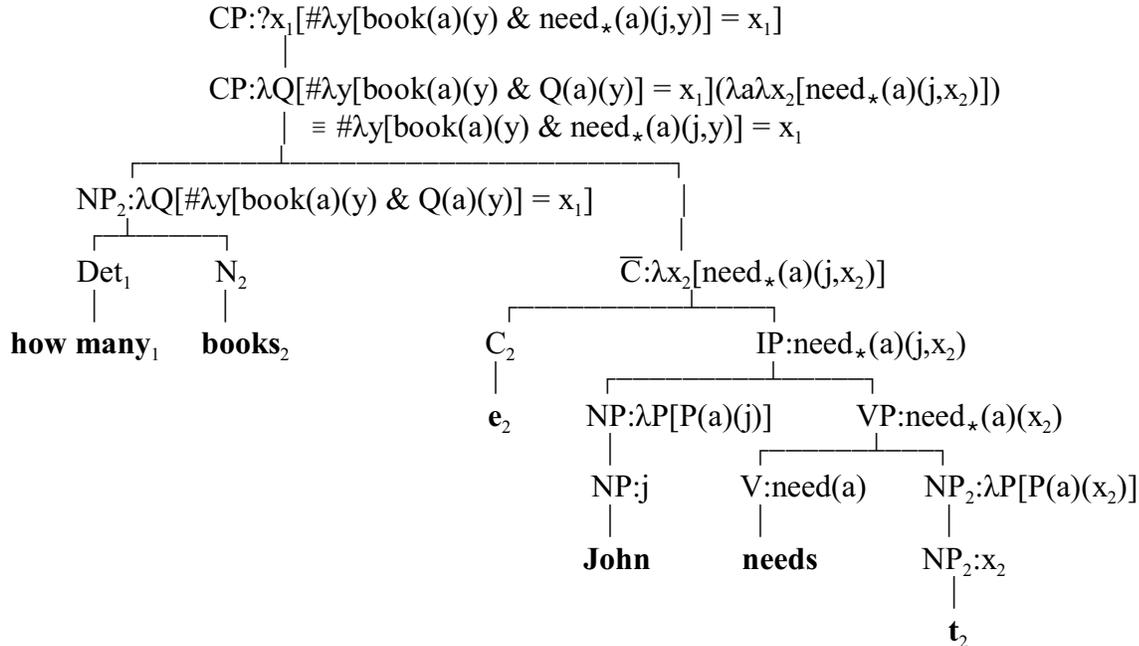


To distinguish the two indices, I will refer to the index on the NP as the "NP-index" and to the index on the determiner as the "*wh*-index". The motivation for this is that the *wh*-index can be thought of as corresponding to the *wh*-feature on the determiner *how many*. (The importance of this will become clear later on.) In (17a) the *wh*-index is 1 and the NP-index is 2. I will adopt the convention of writing the *wh*-index as a subscript on *how many* and the NP-index as a subscript on the noun, as indicated in (17b).

#### 4. Deriving the wide and narrow scope readings

I can now give a schematic derivation of the wide scope reading of (8):

(18) ... how many<sub>1</sub> books<sub>2</sub> John needs t<sub>2</sub>? (wide scope)



Some comments are in order here. On the wide scope (or *de re*) reading of the sentence the *wh*-trace is "small" and therefore translated as a variable of type  $e$ . Since the verb *needs* requires a NP of type  $\langle\langle s, \langle e, t \rangle \rangle, t \rangle$  as its argument, the interpretation of the trace has to be type-raised. I will assume the following rule that raises NP's from type  $e$  to type  $\langle\langle s, \langle e, t \rangle \rangle, t \rangle$ . Presumably, this rule follows from more general type raising principles (Partee 1987).

(19) **Type raising rule**

$NP \implies \lambda P[P(a)(NP')]$

Under Spec-Head agreement, the empty head  $C$  is coindexed with the *wh*-phrase in the Spec of CP. Because  $t_2$ , the trace locally bound by  $C$ , is a small trace, clause (a) of the  $\bar{C}$  translation rule (10) applies. The translation of the CP is obtained in two steps. First, the CP translation rule (11) is applied. Because of type driven translation, the NP *how many books* which sits in the Spec of CP, takes the  $\bar{C}$  as its argument. The resulting translation of the CP has a free variable  $x_1$  which stands for the number of books. In the second step, this free variable gets bound. This is done by the question rule given in (20) (this rule can be regarded as a special kind of type raising):

(20) **Question rule**

- a. Official:  $CP \implies \lambda i[\lambda x_i CP' = (\lambda a \lambda x_i CP')i]$   
b. Unofficial:  $CP \implies ?x_i CP'$

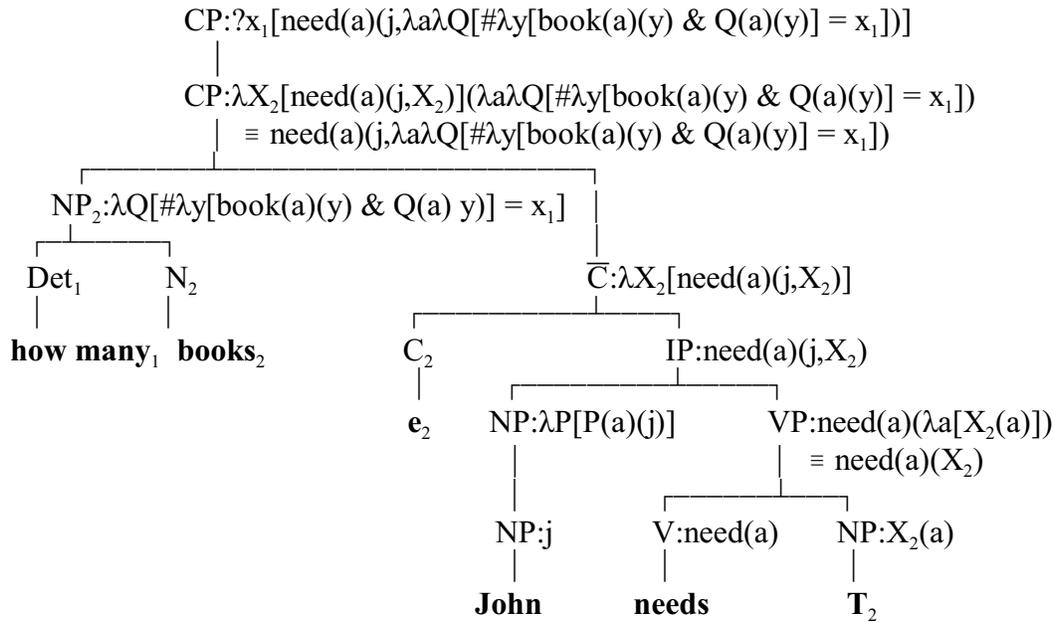
where  $i$  is the *wh*-index of the constituent in the Spec of CP.

The question rule has two versions, an official one and an unofficial one. The official version interprets the question in accordance with Groenendijk and Stokhof's theory. The translation of *how many*-questions that results is identical to the one proposed in Rullmann and de Swart (1992). In this paper my main concern is not with the precise interpretation of *how many*-questions as such, but rather with the way in which these interpretations are derived from the syntactic representations. Therefore I will use the unofficial version of the question interpretation rule that is given in (20b) as a convenient shorthand for the official version. In the unofficial version I use the operator  $?$  to bind the variable  $x_i$ . The formula  $?x_i CP'$  can be thought of intuitively as "for which value of  $x_i$  is it the case that CP". The unofficial version of the question rule does not commit itself to any particular theory of questions. It would be easy, for instance, to interpret the  $?$ -operator in accordance with the theory of questions proposed by Karttunen (1977).

Note that the Question rule needs to know what the *wh*-index of the constituent in the Spec of CP is in order to bind the right variable. This is where the correspondence between the *wh*-index and the *wh*-index that I mentioned above becomes important. I will assume that the *wh*-feature of the determiner, being a foot feature in the sense of Gazdar *et al.* (1985), must percolate up to the NP level, characterizing the whole NP as a *wh*-phrase. By saying that the *wh*-index corresponds to the *wh*-feature I will simply mean that the *wh*-index percolates up together with the *wh*-feature. We can think of the *wh*-index as part of the *wh*-feature. I will furthermore assume that the *wh*-feature, and hence also the *wh*-index, are "visible" on the CP-level, the level at which the Question rule applies. Note by the way that identifying the *wh*-index with the *wh*-feature gives the right result for *wh*-phrases like *how many people's parents*. This whole NP is a *wh*-phrase because of the *wh*-feature which percolates up from *how many*. As a result, the free variable that gets bound by the question rule will be the free number variable corresponding to *how many*.

The narrow scope reading of (8) is derived as follows:

(21) ... how many<sub>1</sub> books<sub>2</sub> John needs **T**<sub>2</sub>? (*narrow scope*)



On the narrow scope reading of the sentence, *how many books* leaves a big trace. In accordance with the trace interpretation rule (9), this big trace is translated as a variable ranging over generalized quantifier intensions. Since the object of *need* has the right type now, type-raising is unnecessary. This time, the empty head  $\bar{C}$  locally binds the big trace  $\mathbf{T}_2$ , and hence clause (b) of the  $\bar{C}$  translation rule applies. The interpretation of the CP is again derived in two steps. This time, the type-driven translation procedure makes the NP *how many books* the argument of the  $\bar{C}$ . By  $\lambda$ -conversion the intension of *how many books* ends up as the argument of the predicate *need*. Subsequently, the question rule (20) applies and the free variable  $x_1$  gets bound by the ?-operator.

## 5. The role of intermediate traces

So far, we have considered the two readings of a simple sentence involving only one intensional verb. More interesting cases arise if we make the sentence more complex. Consider for instance (22), which has three readings, a wide scope reading (a), an intermediate scope reading (b), and a narrow scope reading (c):

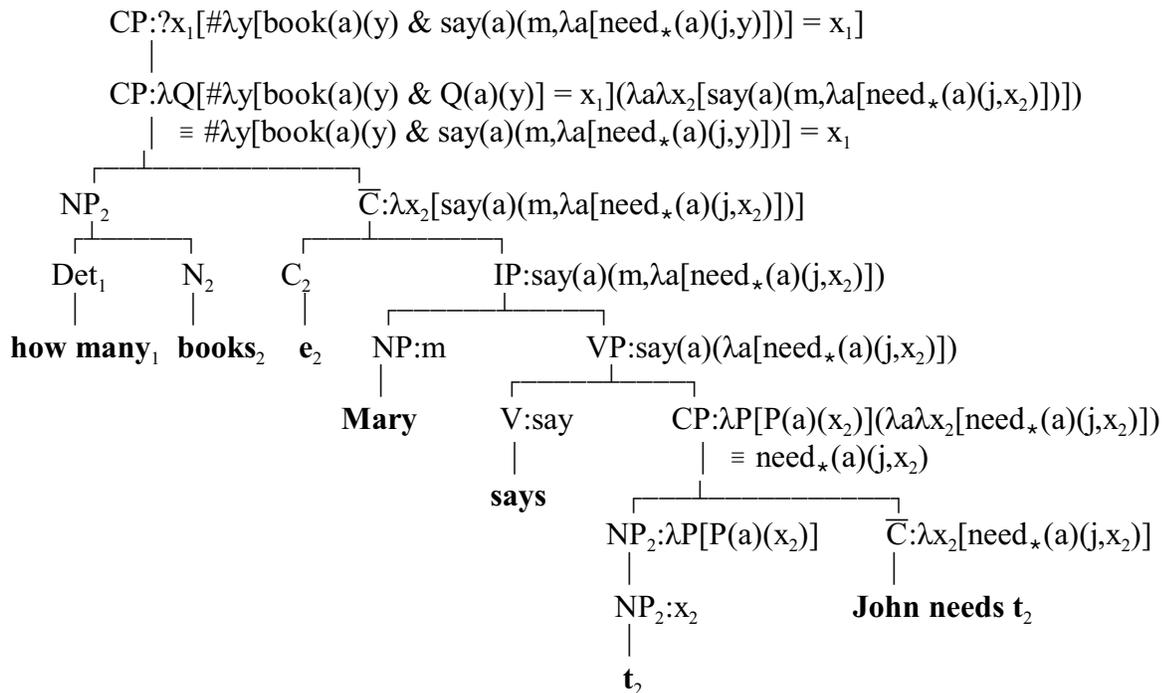
- (22) How many books did Mary say John needs?
- What is the number  $n$  such that there  $n$  books which Mary says John needs?
  - What is the number  $n$  such that Mary says there are  $n$  books which John needs? ( )
  - What is the number  $n$  such that Mary says John needs  $n$  books?

We can account for these three readings if we take seriously the role played by the intermediate trace left in the Spec of CP of the embedded clause. Just like traces in argument positions, intermediate traces can be either small or big. This gives us the following four logically possible syntactic representation of the sentence:

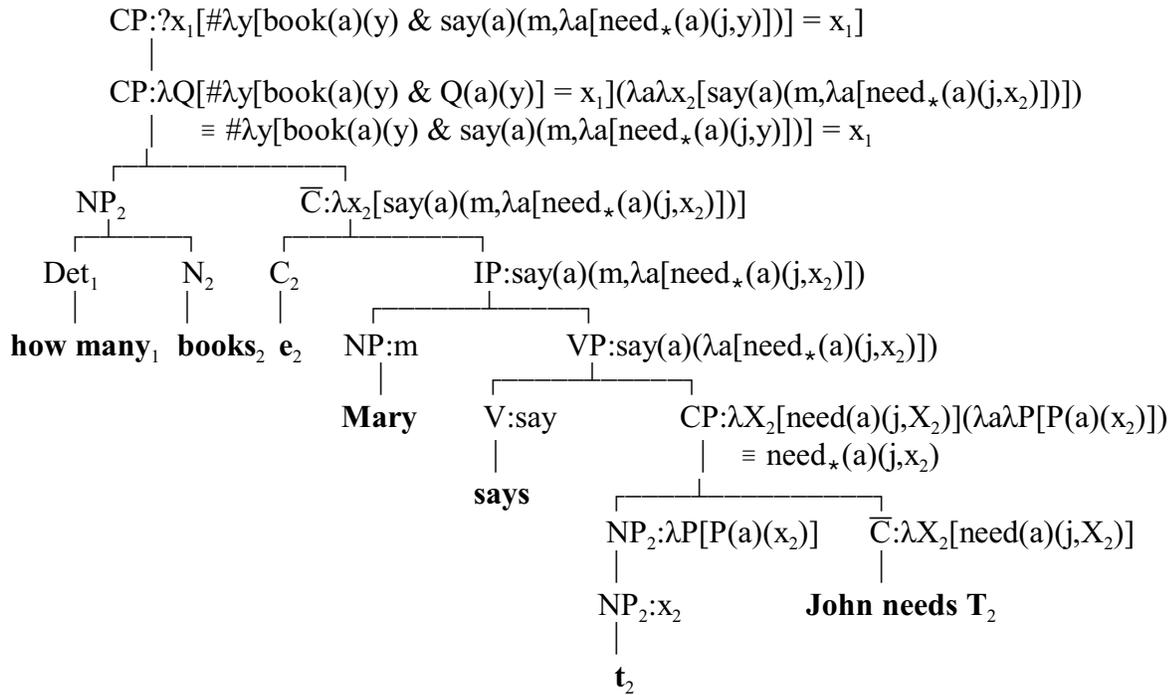
- (23) a. How many books did Mary say **t** John needs **t**?  
 b. How many books did Mary say **t** John needs **T**?  
 c. How many books did Mary say **T** John needs **t**?  
 d. How many books did Mary say **T** John needs **T**?

With these four syntactic representations, the translation and type raising rules we already have are sufficient to derive the three readings of the sentence that are distinguished in (22). (23a) and (b) both result in the wide scope reading, (c) represents the intermediate scope reading, and (d) gives the narrow scope reading. The four derivations are given in (24) below (the question is given in its embedded form in the derivations). It should be noted that in the two derivations of the wide scope reading in (24a) and (b) the intermediate trace in the Spec of CP undergoes type raising, which is forced by the type driven translation procedure of the CP translation rule.

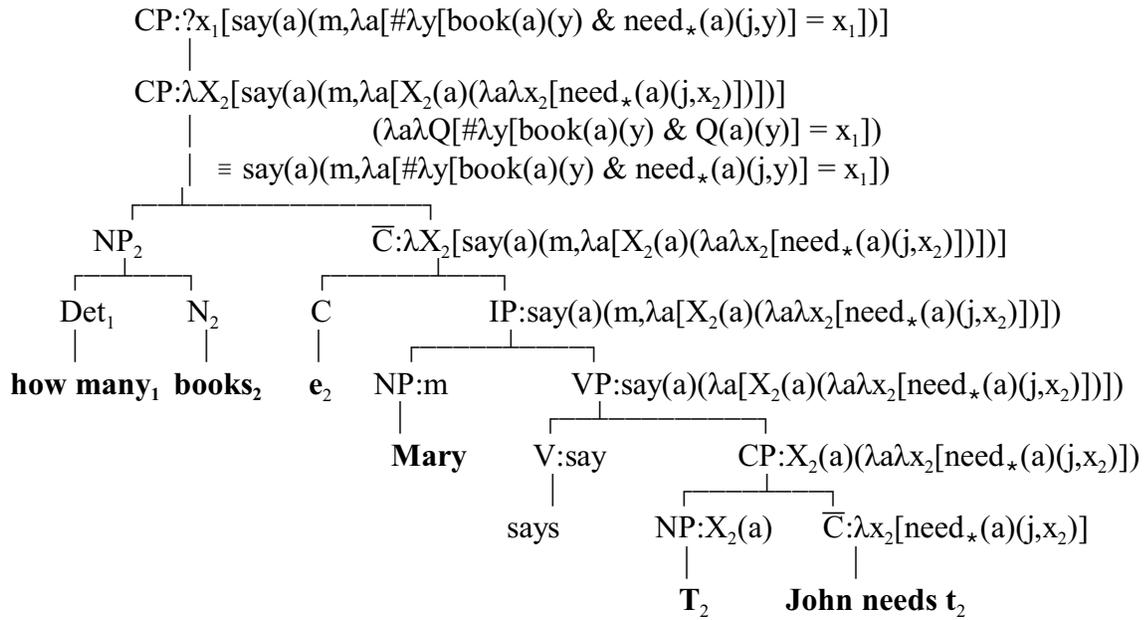
- (24)  
 a. ... how many<sub>1</sub> books<sub>2</sub> Mary says **t**<sub>2</sub> John needs **t**<sub>2</sub> (*wide scope*)



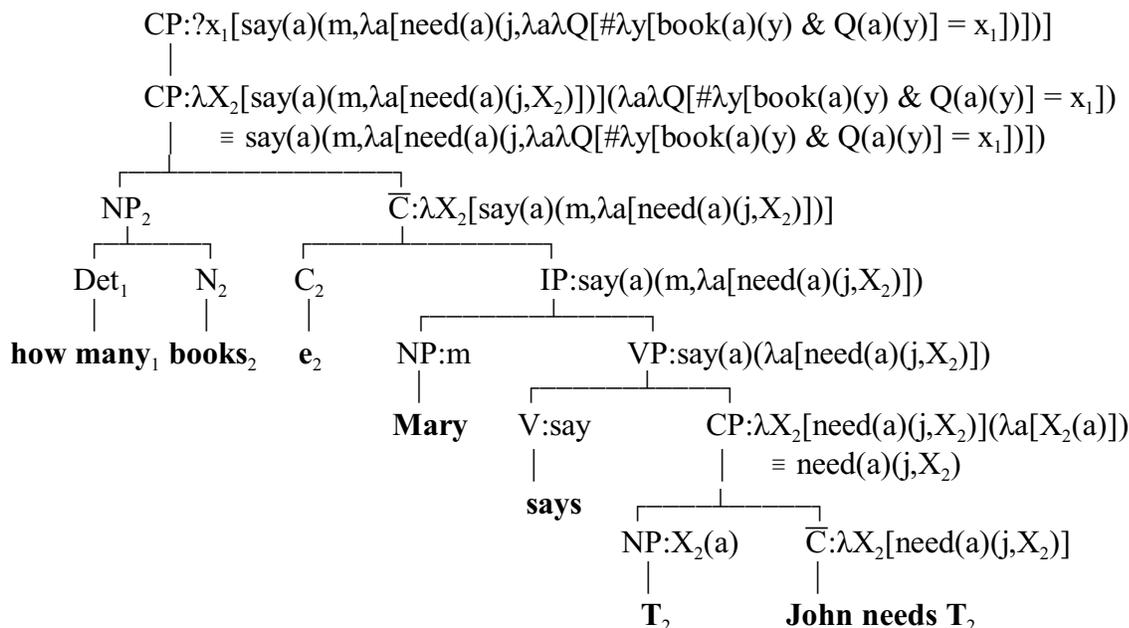
b. ... how many<sub>1</sub> books<sub>2</sub> Mary says **t**<sub>2</sub> John needs **T**<sub>2</sub> (*wide scope*)



c. ... how many<sub>1</sub> books<sub>2</sub> Mary says **T**<sub>2</sub> John needs **t**<sub>2</sub> (*intermediate scope*)



d. ... how many<sub>1</sub> books<sub>2</sub> Mary says T<sub>2</sub> John needs T<sub>2</sub> (*narrow scope*)



It is worthwhile to stress once more that no other syntactic or semantic devices are necessary to obtain the three readings of this sentence than those that were introduced earlier in order to account for the two readings of (8). Intermediate traces are interpreted in exactly the same way that traces in argument positions are. It is obvious, moreover, that the analysis will work equally well in more complex sentences that have more than three potential sites where the *how many*-phrase can take scope. In any given sentence the scope of the *how many*-phrase is determined by the distribution of big and small traces in the chain it heads. In general, given a chain (*how many*  $N, \tau_1, \dots, \tau_n$ ), where for each  $i$  ( $1 \leq i \leq n$ )  $\tau_i$  is either a small trace  $t$  or a big trace  $T$  coindexed with *how many*  $N$ , the *wh*-phrase will take scope in the position of the big trace  $\tau_m$  such that: (i) for all  $i$  ( $1 \leq i \leq m$ )  $\tau_i$  is a big trace; (ii)  $\tau_{m+1}$  is a small trace. Thus in a chain like (25), *how many*  $N$  has scope in the position of the trace indicated by the star:

(25) *how many*  $N$  ....  $T$  ....  $T$  ....  $T^*$ ....  $t$  ....  $T$  ....  $t$  ....  $t$  ....

Note that all traces c-commanded by the leftmost small trace in the chain are irrelevant for the determination of scope, in the sense that it doesn't make a difference for the truth conditions of the sentence whether these traces are big or small; cf. the derivations of the equivalent (23a) and (b).

Because of the importance of intermediate traces in determining the scope of *wh*-phrases, the analysis proposed here has some important consequences for their theoretical status. In Government and Binding Theory, the existence of intermediate traces has always been motivated on purely syntactic grounds, such as locality constraints on movement. It has even been assumed

that intermediate traces can be deleted at the level of Logical Form because they supposedly lack "semantic content" (Lasnik and Saito 1992). If my analysis is correct, however, intermediate traces play a crucial role in semantic interpretation. For one thing, this means that intermediate traces cannot arbitrarily be deleted without affecting the range of possible interpretations of the sentence. A further implication, and a potentially more interesting one, is that, on the basis of the present analysis, we can start looking for empirical evidence for the presence or absence of intermediate traces in certain constructions. In the remainder of this paper, I will turn to one potential source of such evidence: the scope of *how many*-phrases under extraction out of so-called "weak" islands.

## 6. Extraction out of weak islands

Kroch (1989) has shown that, when extracted out of a "weak" island such as a *wh*-island, *how many*-phrases lose their narrow scope reading:

- (26) a. How many books did the editor decide to publish next year? (*ambiguous*)  
b. How many books did the editor wonder whether to publish next year? (*only wide scope*)

Similar effects can be observed if we extract from an embedded clause that contains a quantified NP. (27) is adapted from an Italian example found in Cinque (1991) (who credits Longobardi 1987 for the observation):

- (27) a. How many patients do you think that every doctor can visit in one hour?  
(*ambiguous*)  
b. How many patients do you wonder whether every doctor can visit in one hour? (*only wide scope*)

(27a) can have a singular answer (for instance: "seven") or a pair-list answer ("Doctor X. can visit seven patients in one hour, doctor Y. eight, and doctor Z. five."). By contrast, (27b) does not allow a pair-list answer. Cinque suggests that this contrast can be described in terms of the "referentiality" of the *wh*-phrase. In his theory, only referential *wh*-phrases can be extracted from weak islands, and therefore *how many patients* in (27b) must be referential which should make it impossible for it to interact in scope with the quantifier *every doctor*.<sup>6</sup> It can easily be shown that this explanation cannot be correct, as pointed out by Kroch (1989) and Frampton (1991). Consider the following two examples:

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<sup>6</sup> Cinque seems to assume that the availability of the pair-list reading in a question is a matter of scope interaction between the *wh*-phrase and a quantifier, an assumption which is common (Groenendijk and Stokhof 1982; May 1985), but which has not gone unchallenged (Engdahl 1986, and especially Chierchia 1992).

- (28) a. How many books did you tell him that the editor wonders whether to publish next year?  
 b. How many patients did every nurse wonder whether the doctor can visit in one hour?

In both sentences the *wh*-phrase is extracted out of a weak island, and should therefore be referential according to Cinque's theory, which would make it impossible for it to interact in scope with other elements in the sentence. This prediction is not borne out, however, since (28a) and (b) are both ambiguous, in just the same way that (26a) and (27a) are. In (28a) *how many books* can have either wide or narrow scope with respect to the verb *tell*, although it can only have wide scope with respect to *wonder*. (28b) allows both a singular answer (e.g. "Every nurse wonders whether the doctor can visit more than ten patients in an hour") and a pair-list answer (e.g. "Nurse X. wonders whether the doctor can visit eight patients in an hour, Nurse Y. wonders whether he can visit nine patients in an hour, etc."). These examples show that the semantic effect caused by the extraction from a weak island cannot be due to a binary property of the *wh*-phrase, like referentiality. It must be a matter of scope.

Based on the observations in (26)-(28) we can formulate the following empirical generalization:

- (29) A *how many*-phrase extracted out of a weak island has wide scope over everything inside the island and over the verb of which the island is the complement.

The question is how to account for this generalization. In principle, explanations for (29) could be formulated in syntactic, semantic, or pragmatic terms and, in fact, proposals from each of these three domains can be found in the literature. In the next section I will explore a syntactic approach suggested by Frampton (1991), and then in section 8 I will discuss some arguments favoring a semantic or pragmatic solution as opposed to a syntactic one.

## 7. A syntactic approach to weak island effects

In response to Rizzi's and Cinque's work, a very interesting suggestion has been made by Frampton (1991). Frampton argues that what is at stake in the examples cited above is not the referentiality of the *wh*-phrase, but that of its trace. In (26b) and (27b) the trace inside the weak island behaves as an individual variable. In terms of the analysis proposed in this paper, this means that extraction out of a weak island is possible only if the trace inside the island is a small one. Frampton's suggestion, then, is captured by the following filter:<sup>7</sup>

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<sup>7</sup> Kiss (*to appear*) proposes the following filter, which bears an obvious formal similarity to (30):

- (i) Specificity Filter:  
 If  $Op_i$  is an operator which has scope over  $Op_j$  and binds a variable in the scope of  $OP_j$  then  $OP_j$  must be specific.

(30) The following structure is ruled out:

...  $\alpha_i$  ... [YP ...  $\mathbf{T}_i$  ... ] ...

where YP is a weak island and  $\alpha_i$  locally binds  $\mathbf{T}_i$ .

According to this filter, the options for the distribution of traces in (26a) and (b) are as follows:

- (31) a. How many books <sub>$i$</sub>  did the editor decide  $t_i/\mathbf{T}_i$  to publish  $t_i/\mathbf{T}_i$  next year  
b. How many books <sub>$i$</sub>  did the editor wonder whether to publish  $t_i/*\mathbf{T}_i$  next year

It should be clear that, in conjunction with the interpretation procedure for traces proposed in this paper, (30) makes the correct predictions concerning the scope possibilities of the *how many*-phrase.

Frampton provides a very suggestive piece of evidence for his proposal. Heim (1987) has argued that the subject position in an existential *there*-sentence cannot be filled by an individual variable. This can be shown most easily with definite pronouns:

- (32) a. Every suspect denied he was at the scene of the crime  
b. Every suspect denied there was he/him at the scene of the crime

Since small traces represent individual variables, this means that small traces cannot fill the subject position of a *there*-sentence. The prediction, then, is that in cases of extraction out this position only the narrow scope reading is available. This is borne out by the contrast between (33a) and (b):

- (33) a. How many police officers did they claim [<sub>IP</sub>  $\mathbf{T}/t$  were at the scene of the crime]?  
(*ambiguous*)  
b. How many officers did they claim [<sub>IP</sub> there were  $\mathbf{T}/*t$  at the scene of the crime]? (*only narrow scope*)

The presence of *there* in the embedded clause in (33b) forces the narrow scope reading.<sup>8</sup>

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The notion of specificity argued for by Kiss is an extension of that of Enç (1991). The main difference between Kiss' Specificity Filter and (30) is that the Specificity Filter is a condition on the *operator* (the extracted *wh*-phrase) whereas (30) is a condition on the *trace*.

<sup>8</sup> Note by the way that it would not be sufficient to state the prohibition against individual variables in the subject position of *there*-sentences as a syntactic restriction against small traces. This is because an intermediate trace that is small would still result in the wide scope reading, even if the trace in the subject position is big (cf. the derivation in (24b)):

Another prediction is that extraction out of a weak island from the subject position of a *there*-sentence should be bad. This is also confirmed by the data:<sup>9</sup>

- (34) \*How many police officers did they wonder whether [<sub>IP</sub> there were **T**/t at the scene of the crime]?

Because of the presence of *there*, the trace in (34) can't be big; because of the weak island it can't be small. As a result, the sentence is ungrammatical.

Of course the filter (30) is still not more than a descriptive generalization, albeit on a more abstract level than (29). There are various ways in which (30) could be incorporated in recent theories of locality within the Government and Binding framework. I will just sketch one possibility here, based on Rizzi (1990). Rizzi distinguishes two ways in which a trace can be connected to its antecedent: binding and antecedent government. The option of binding is only available for phrases that bear an index. Only constituents that are assigned a "referential theta-role" bear an index, so the binding option is only available for these referential expressions. Traces of non-referential expressions, which do not have indices, must be antecedent governed, and are therefore subject to a tighter locality conditions than traces of referential expressions, which only have to obey the relatively weak Subjacency constraint. In the present proposal, all displaced constituents and their traces have to bear indices, of course, because this is necessary for the translation procedure. (See Frampton 1991 for some penetrating criticism of the lack of a theory of the semantic import of referential indices in Rizzi's account.) But we can restate Rizzi's condition of antecedent government as a requirement on big traces, instead of on traces without indices. This leads to the following formulation of the syntactic principle accounting for the filter (30):

- (35) A big trace **T** must be antecedent governed

A trace inside a *wh*-island cannot be antecedent-governed from outside the island, because of the presence of the intervening *wh*-phrase in the Spec of CP. Because this intervening *wh*-phrase is in an A'-specifier position, it blocks antecedent-government between the extracted *wh*-phrase and its trace under Rizzi's principle of Relativized Minimality.

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- (i) How many police officers did they claim [<sub>CP</sub> t that [<sub>IP</sub> there were **T** at the scene of the crime]]?

There are independent arguments to assume that the prohibition against individual variables in the subject position of *there*-sentences must be semantic rather than syntactic, since it is just a special case of the general prohibition against strong quantifiers in that position (Barwise and Cooper 1981), and the latter constraint is clearly of a semantic nature.

<sup>9</sup> The same observation is made by Kiss (*to appear*).

Of course various other candidates for the syntactic principle behind (30) could be considered, depending on one's preferred theory of locality. All syntactic approaches will have one fundamental property in common, namely that they presuppose that the distinction between small and big traces is not only a semantic distinction, but also a syntactic one. Since there is no other reason why big and small traces should be distinguished syntactically (apart from typographical convenience), adopting a principle like (35) amounts to opting for a more powerful theory, namely one that allows syntactic rules and principles to refer to the distinction between small and big traces. This leads to the question whether a syntactic principle like (35) cannot be dispensed with altogether in favor of a semantic or pragmatic theory of weak islands. In the next section I will briefly discuss some empirical arguments pointing in the same direction.

## 8. Arguments against a syntactic approach to weak islands

The only instances of weak islands I have discussed so far have been *wh*-islands. For these cases the syntactic approach outlined in the previous section seems to work just fine. More problematic issues arise when we turn to another case of weak islands, the so-called negative or "inner" islands (Ross 1984). Just like *wh*-islands, negative islands force a wide scope reading of the extracted *wh*-phrase:

- (36) a. How many books was John able to read?  
 b. How many books was John not able to read?

The (a) sentence is ambiguous between a wide scope reading and a narrow scope reading, but the presence of the negation in the (b) sentence blocks the narrow scope reading. The negative island effect is not restricted to negation; it can be observed with other downward entailing elements as well:

- (37) a. How many books did nobody read?  
 b. How many books did few people read?

These sentences are both unambiguous: they only allow a reading in which *how many books* has wide scope. Contrast this with the following ambiguous examples:<sup>10</sup>

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<sup>10</sup> In fact, (38b) seems to be three ways ambiguous. Besides the wide scope and the narrow scope readings, it has a pair-list reading. The three readings can be paraphrased as follows:  
 (i) *wide scope*: what is the number *n* such that there are *n* books *x* such that for every person *y*, *y* read *x*?  
 (ii) *narrow scope*: what is the number *n* such that for every person *y* there are *n* books *x* such that *y* read *x*?  
 (iii) *pair list*: for every person *y*, what is the number *n* such that there are *n* books *x* such that *y* read *x*?

See Rullmann and de Swart (1992) for some discussions of these three readings.

- (38) a. How many books did everybody read?  
b. How many books did many people read?

Rizzi (1990) accounts for these contrasts by stipulating that *not* is an A'-specifier and therefore prevents the *wh*-phrase from antecedent-governing its trace, under his principle of Relativized Minimality. He furthermore assumes that monotone decreasing quantifiers such as *nobody* and *few people* move to an A'-specifier position (the specifier of CP) at LF, and thereby block antecedent-government of the trace at that level. Rizzi's proposal raises considerable problems. Because of his assumption that all weak island effects are syntactic in nature, he is forced to find a syntactic property that distinguishes downward entailing elements from others. Although it cannot be excluded that such a property can be found (Rizzi argues that being in an A'-specifier position at the level of LF is the relevant property), it is clear that the class of downward entailing elements is one that is more readily definable in semantic than syntactic terms.

Another problem for purely syntactic accounts like Rizzi's is the fact that discourse factors such as specificity and "D-linking" (a notion introduced by Pesetsky 1987) can have a considerable effect on the acceptability of extractions from weak islands. To cite just one relevant observation, Kroch (1989) notes that the following sentence is quite acceptable in a situation like a game show or sports contest in which the rules state that certain infractions are to be penalized with the deduction of specific numbers of points:

- (39) How many points are the judges arguing about whether to deduct?

An adequate theory of weak islands should be able to explain how discourse factors can have an influence on the acceptability of such examples. This is obviously problematic if the theory is couched entirely in syntactic terms, but that is not to say that it is impossible. (See Cinque (1991) for an attempt to factor "D-linking" into a syntactic theory of weak islands.)

Both of these problems (weak islands and the influence of discourse context) are not necessarily insurmountable for a syntactic theory of weak islands, but they do force such a theory to "translate" purely semantic and pragmatic notions (such as downward entailment and specificity) into syntactic terms. This may suggest that a syntactic approach to weak islands is actually on the wrong track, and that a semantic or pragmatic analysis is called for. Many researchers have pursued this line of research recently, spawning a rapidly expanding body of literature on the topic; see Comorovski (1989), Kroch (1989), Kiss (*to appear*), Szabolcsi and Zwarts (1989), Szabolcsi (1992), de Swart (1992), and Szabolcsi and Zwarts (*to appear*). I will not try to summarize or evaluate these works here, but merely indicate how, in general, semantic and pragmatic approaches to the problem of weak islands relate to the analysis of *how many*-questions presented in this paper.

The analysis of scope ambiguities in *how many*-questions I have proposed in the first part of this paper lends itself quite easily to the kind of syntactic approach to weak islands sketched in section 8. It is important to realize, though, that my analysis is equally compatible with a semantic

or pragmatic approach like the ones found in the works cited above. My treatment of *how many*-questions tries to explain how the various scope readings of such questions can be derived. Semantic and pragmatic theories of weak islands attempt to explain why certain of these readings are ruled out, either for semantic or for pragmatic reasons. There is no conflict between these two goals. Semantic or pragmatic theories of weak islands do have an important consequence for the theoretical status of the distinction between big and small traces. Unlike a syntactic approach, they don't need to assume that the big/small distinction is in any way reflected in the syntax. If a semantic or pragmatic theory of weak island is correct, there is no need for a syntactic rule or principle that is sensitive to the distinction between big and small traces. Thus, in the syntax we could have just one kind of trace, which would translate as a variable of either type  $e$  or  $\langle s, \langle \langle s, \langle e, t \rangle \rangle, t \rangle \rangle$ . If there is only one kind of trace in the syntax, there could be no syntactic rule or principle that is sensitive to the semantic type of the trace. This hypothesis leads to a more restrictive and therefore less powerful theory of the syntax/semantics interface. This kind of theory is preferable on *a priori* grounds; whether it can be maintained empirically is still an open question.

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