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The Semantics of 'how many'-questions

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1. Introduction[1]

Recently, the discussion of *wh*-movement has been broadened from *wh*-phrases like *who* or *which man* to other, so-called 'non-referential' interrogatives such as *how* and *how many men* (Kroch 1989, Rizzi 1990, Cinque 1991, Frampton 1991, Szabolcsi and Zwarts 1991). In this paper, we investigate a number of problems in the semantics of *how many*-questions, which arise when the *wh*-phrase interacts with other scope-bearing elements such as quantifiers and intensional verbs. We will propose an interpretation of *wh*-complements involving *how many*-phrases in the theory of questions developed by Groenendijk and Stokhof (1982, 1984). In this framework, scope relations can be treated in the classical Montagovian way. The ambiguities *how many*-questions display then fall out as a meaning effect of the scope of the *wh*-expression. An interesting consequence of this approach is that extraction out of weak islands can be related to the relative scope of the operator with respect to the *wh*-phrase.

2. Ambiguities, referentiality and scope

Questions that involve a phrase of the form *how many N* can be ambiguous (cf. Kroch 1989, Frampton 1991). An example is given in (1):

(1) How many books does Jane want to buy?

One reading of the question can be paraphrased as (2a), the other as (2b):

(2) a There are n books that Jane wants to buy. What is n?
b Jane wants to buy n books. What is n?

In the first reading of (1) it is presupposed that there are certain books of which it is true that Jane wants to buy them and the speaker asks how many such books there are. Under the second reading it is presupposed that Jane

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[1] The first author is from the University of Massachusetts at Amherst, the second author is presently at Stanford University. We wish to thank Peter Blok, Angelika Kratzer, Barbara Partee and an anonymous reviewer for comments and discussion.

has the wish to buy a certain number of books (say n) and the speaker wants to know what that number n is. The second reading does not presuppose that there are any books of which it is true that Jane wants to buy them. Jane may simply want to fill her book shelves without having any specific books in mind that she wants to buy.

The ambiguity displayed by (1) is reminiscent of the familiar de re/de dicto ambiguity found in declarative sentences like (3):

(3) Jane wants to buy five books

Just like (1), (3) has two readings depending on the scope of the numeral with respect to the intensional verb *want*:

(4) a There are five books that Jane wants to buy
b Jane wants the number of books she will buy to be five

In this perspective it is not surprising that Kroch (1989) and Frampton (1991) characterize the difference between the two readings of (1) in terms of scope. Both authors discuss the relation of these facts with the distinction between referential and non-referential *wh*-expressions introduced by Rizzi and Cinque. Rizzi (1990) ties referentiality to theta roles: referential NPs bear argumental theta-roles (agent, theme, patient, experiencer, goal, etc.), whereas non-referential NPs bear quasi-argumental roles (manner, measure, atmospheric role, etc.). Referential *wh*-phrases allow extraction out of weak islands, because they exploit binding. Non-referential *wh*-phrases need to be linked to their traces via an (antecedent-)goverment chain. Cinque (1991) recalls Pesetsky's (1987) notion of D(iscourse) linking and claims that, of all the phrases that receive a referential theta role, only those can be long *wh*-moved that refer to specific members of a pre-established set.

Both Kroch and Frampton question the relevance of referentiality in extraction contexts. For instance, Kroch notes that questions like (5) are not ambiguous, but are always referential in some sense:

(5) How many books did Jane buy?

If we leave referentiality out of the analysis of *how many*-phrases and favor a scope analysis, the interpretation of (5) is straightforward: there is no operator present in the sentence with which the *wh*-expression can enter into a scopal relation. In such a configuration no (scope) ambiguities are to be expected. Of course this is not a decisive argument against a (lexical) ambiguity thesis, as Kratzer (p.c.) points out, but the observation is certainly suggestive.

The interpretation in (4a) is usually called the 'de re' reading, while (4b) corresponds to the 'de dicto' reading. In analogy to this, we will call the reading of (1) that is paraphrased in (2a) the de re reading of the question, and the one in (2b) the de dicto reading. The contrast between de re and de dicto readings of *how many*-questions is brought out more clearly in the following pair:

(6) a How many things that she can't afford does Jane want to buy?
b How many unicorns does Jane want to catch?

A speaker can utter (6a) without thereby ascribing to Jane the wish to buy things she cannot afford. (6b) can be uttered truthfully and sincerely by a speaker who does not believe in the existence of unicorns. An analysis in terms of scope can also explain the interaction of *how many*-phrases with quantified NPs, as in (7):

(7) a How many books did every student read?
b How many books did no student read?

The universal quantifier can take wide scope so that we ask for all students how many books they have read. In section 5 below, we will see that wide scope of the universal quantifier allows either an answer of type 'Every student read five books' or a pair-list answer of the type 'Jane read five books, Joan thirteen and Mary-Ann just one'. Under the narrow scope reading of the quantifier we ask how many books are such that everyone has read them. Unlike (7a), (7b) is not ambiguous: the question can only ask for the number of books which are such that no student read them. It turns out that, in general, monotone decreasing quantifiers do not take scope over *wh*-expressions. It is unclear what could be the contribution of the notion of (non)-referentiality here: it would be hard to explain why the *wh*-phrase *how many books* can take up a referential reading in (7a), but not in (7b).

Kroch and Frampton show that the notion of (non-)referentiality is problematic in a number of extraction contexts. As an alternative, they propose to analyze the ambiguities of *how many*-questions in terms of scope. However, they do not present a fully worked out semantics for *how many*-questions. In this paper, we develop a uniform semantics of *how many*-phrases and explain the type of ambiguity related to questions like (1) in terms of scope only. We formulate our analysis in the type-logical theory of questions proposed by Groenendijk and Stokhof (1982, 1984) (henceforth G&S).

3. Groenendijk and Stokhof's semantics for questions

As a starting point for their semantics of questions, G&S consider inference patterns such as the one in (8):

(8) Jane knows whether Mary walks
Mary walks
Therefore: Jane knows that Mary walks

This type of inferences allows them to characterize the denotation of *whether Mary walks* as follows: at an index at which it is true that Mary walks, it denotes the proposition that Mary walks, and at an index at which Mary doesn't walk it denotes the proposition that Mary doesn't walk. *Wh*-complements thus denote propositions, and they do this in an index dependent way. This leads G&S to the choice of the two-sorted type-logical language Ty2 (Gallin 1975), in which reference can be made to indices. In Ty2, s is a basic type, just like e and t. All translations of basic expressions in this language contain the same free index variable a. The rules for translating PTQ English into Ty2 can be obtained by using the fact that $\lambda a\alpha$ expresses the same function in Ty2 as $^\wedge\alpha$ in IL, $\alpha(a)$ is the same as $^\vee\alpha$. At an index i *whether Mary walks* thus denotes that proposition p such that for every index k, p holds true at k iff the truth value of *Mary walks* at k is the same as at i. In Ty2 this can be expressed by the index dependent proposition denoting expression (9), the interpretation of which is given in (10):

(9) $\lambda i[walk(a)(m) = walk(i)(m)]$

(10) $[\![\lambda i[walk(a)(m) = walk(i)(m)]]\!]_{M,g}$ is that proposition $p \in \{0,1\}^I$ such that for every index $k \in I$: $p(k) = 1$ iff $[\![walk(a)(m)]\!]_{M,g} = [\![walk(i)(m)]\!]_{M,g[k/i]}$

So, at the index g(a), (9) denotes the characteristic function of the set of indices at which the truth value of *Mary walks* is the same as at the index g(a). Similar interpretations are developed for questions involving *wh*-expressions such as *who* and *which man*. For instance, if Jane knows who walks and it is true at that index that Anne and Mary walk, then Jane knows that Anne and Mary walk.[2] So at an index i, the *wh*-complement *who walks* denotes that proposition p which holds true at an index k iff the denotation of *walk* at k is the same as its denotation at i. Constituent complements involving *who* are formed from so-called *abstracts* (AB's), expressions of category t///e. The rule of abstract formation and its translation are given in (11) (cf. G&S: 108):

(11) (S:AB1) If $\varphi \in P_t$, then $F_{AB1,n}(\varphi) \in P_{t///e}$
(T:AB1) If $\varphi \rightarrow \varphi'$, then $F_{AB1,n}(\varphi) \rightarrow \lambda x_n(\varphi')$

The translation of an abstract is a predicate denoting expression. From these abstracts *wh*-complements are formed by means of a category changing rule. The corresponding translation rule turns predicate-denoting expressions into proposition-denoting expressions (cf. G&S 1984: 108):

2 Actually, the interpretation G&S develop is even stronger in that it guarantees exhaustiveness. That is, if Jane knows who walks, she also knows who doesn't. The issue of exhaustiveness will not be taken up in the present paper, cf. G&S for more details.

(12) (S:CCF*) If $\chi \; \varepsilon \; P_{t///e}$, then $F_{CCF}(\chi) \; \varepsilon \; P_{t'}$
(T:CCF*) If $\chi \rightarrow \chi'$, then $F_{CCF}(\chi) \rightarrow \lambda i[\chi' = [\lambda a \chi'](i)]$

This leads to the following analysis tree of *Jane knows who walks*:

(13)
Jane knows who walks, t
$know_*(a)(j,\lambda i[\lambda x[walk(a)(x)] = \lambda x[walk(i)(x)]])$

Jane, T
$\lambda P[P(a)(j)]$

know who walks, IV
$know_*(a)(\lambda i[\lambda x[walk(a)(x)] = \lambda x[walk(i)(x)]])$

know, IV/t'
know(a)

who walks, t'
$\lambda i[\lambda x[walk(a)(x)] = \lambda x[walk(i)(x)]]$

who walks, t///e
$\lambda x_0[walk(a)(x_0)]$

he_0 walks, t
$walk(a)(x_0)$

In this paper, we will not make use of individual concepts. That is, we introduce no expressions of type <s,e>, IVs, CNs and ABs are of type <e,t>, Ts of type <<s,<e,t>>,t> etc. For transitive verbs it is useful to maintain the distinction between transparent verbs (*buy, know*, etc.) and referentially opaque verbs (*want, wonder*, etc.). G&S extend the substar convention of Montague grammar to Ty2 and we will follow them here. That is, transitive verbs which are referentially transparent will be marked with a *; they are taken to be extensional in that they do not operate on the intension of their object, but on the object itself. For further details concerning the theory of questions adopted here, the reader is referred to G&S (1982, 1984).

4. A semantics for 'how many'

In order to better understand the meaning of *how many*-phrases, we will study inference patterns similar to the ones given by G&S:

(14) Bill knows how many books Jenny bought
Jenny bought six books
Therefore: Bill knows that Jenny bought six books

This inference shows the following: at an index at which Jenny bought six books, the *wh*-complement in (14) denotes the proposition that Jenny bought six books. More generally, at an index k at which Jenny bought n books (for any number n) it denotes the proposition that Jenny bought n books. In other words, the intension of the *wh*-complement in (14) is that function h that maps every index i onto the proposition that Jenny bought n books, where n is the number of books that Jenny bought at i. To capture this intuition we will need a way to refer to cardinalities of sets. For that purpose we use the cardinality operator # which is defined as follows:

(15) If α is a Ty2 expression of type <e,t>, then $\#(\alpha)$ is a Ty2 expression of type e; $[\![\#(\alpha)]\!]_{M,g} = |\,[\![\alpha]\!]_{M,g}|$

Application of # to an expression of type <e,t> gives us the cardinality of the set of individuals denoted by that expression. We use #, among other things, to represent sentences containing numerals as determiners. The derivation of the sentence *Jenny bought five books* is given in (16):

(16) Jenny bought five books, t
$\#(\lambda y[book(a)(y) \;\&\; bought_{\bullet}(a)(j,y)]) = 5$

Jenny, T
$\lambda P[P(a)(j)]$

bought five books, IV
$\lambda x[\#(\lambda y[book(a)(y) \;\&\; bought_{\bullet}(a)(x,y)]) = 5]$

bought, TV
$bought(a)$

five books, T
$\lambda P[\#(\lambda y[book(a)(y) \;\&\; P(a)(y)]) = 5]$

five, Dnum
$\lambda Q\lambda P[\#(\lambda y[Q(a)(y) \;\&\; P(a)(y)]) = 5]$

book, CN
$book(a)$

We now[3] have the tools to analyze *wh*-complements like the one in (17):

(17) Bill knows how many students are drunk

The *wh*-complement denotes an index-dependent proposition, as usual. At an index i, *how many students are drunk* denotes that proposition p, which holds true at an index k iff the number of students drunk at k is the same as at i. This is reflected in the formula in (18):

(18) $\lambda i[[\#(\lambda x[student(a)(x) \;\&\; drunk(a)(x)])] =$
$[\#(\lambda x[student(i)(x) \;\&\; drunk(i)(j,x)])]]$

To capture this idea about the interpretation of *how many* questions we will introduce a variable *that-many* of type DNum in the derivation. The translation of *that-many* contains a variable k_n of type e, ranging over natural numbers. At

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3 (16) represents that 'exactly'-reading of the determiner. The 'at least'-reading can be obtained by replacing the = sign with the ≥ sign.

a later point in the derivation, k_n is abstracted over in a way similar to G&S's treatment of *who*-complements. (19) gives us the derivation tree for (17):

(19) Bill knows how many students are drunk, t
$know_*(a)(b,\lambda i[[\lambda k_7[\#(\lambda x[student(a)(x) \& drunk(a)(x)])] = k_7] = [\lambda k_7[\#(\lambda x[student(i)(x) \& drunk(i)(j,x)])] = k_7]])$

Bill, T
$\lambda P[P(a)(b)]$

know how many students are drunk, IV
$know_*(a)(\lambda i[[\lambda k_7[\#(\lambda x[student(a)(x) \& drunk(a)(x)]) = k_7]] = [\lambda k_7[\#(\lambda x[student(i)(x) \& drunk(i)(x)]) = k_7]])$

know, IV/t'
$know(a)$

how many students are drunk, t'
$\lambda i[[\lambda k_7[\#(\lambda x[student(a)(x) \& drunk(a)(x)]) = k_7]] = [\lambda k_7[\#(\lambda x[student(i)(x) \& drunk(i)(x)])] = k_7]]]$

how many students are drunk, t///e
$\lambda k_7[\#(\lambda x[student(a)(x) \& drunk(a)(x)]) = k_7]$

that-many$_7$ students are drunk, t
$\#(\lambda x[student(a)(x) \& drunk(a)(x)]) = k_7$

that-many$_7$ students, T
$\lambda P[\#(\lambda x[student(a)(x) \& P(a)(x)]) = k_7]$

drunk, IV
$drunk(a)$

that-many$_7$, DNum
$\lambda Q\lambda P[\#(\lambda x[Q(a)(x) \& P(a)(x)]) = k_7]$

student, CN
$student(a)$

The translation derived in (19) for the embedded question is equivalent to (18). In general, for any two expressions α and β of type <e,t>, (20) and (21) are equivalent (provided k does not occur free in α and β):

(20) $\lambda k[\#\alpha = k] = \lambda k[\#\beta = k]$
(21) $\#\alpha = \#\beta$

The equivalence of (20) and (21) will be used in some of the derivations that follow. The abstract formation rule used in (19) is formulated in (22):

(22) (S:AB$_5$) If $\alpha \in P_t$, then $FAB_{5,n}(\alpha) \in P_{t///e}$. Condition: α contains exactly one occurrence of the term $[_T$ that-many$_n$ $\beta]$
$FAB_{5,n}(\alpha) = [_{AB}$ [WHT how many β] $[_t\ \alpha']]$, where α' comes from replacing the occurrence of $[_T$ that-many$_n$ $\beta]$ in α with a trace.

(T:AB$_5$) If $\alpha \rightarrow \alpha'$, then $FAB_{5,n}(\alpha) \rightarrow \lambda k_n(\alpha')$

5. Scope ambiguities

On the basis of the proposals outlined in section 4, we can give a formal analysis of the scope ambiguities in *how many*-questions. As noted in section 2, sentence (23) has (at least)[4] two readings, depending on the scope of the *how many*-phrase and the quantified NP:

(23) John knows how many students every professor likes

Just like the corresponding questions with *who* and *which N* discussed by G&S, this sentence has at least a de re and a pair list reading:

A de re reading
Question: How many students does every professor like?
Answer: There are five students liked by every professor, namely Joan, Alice, Peter, Mary-Ann and Eric

B pair-list reading
Question: How many students does every professor like?
Answer: Joan likes five students, Alice three, and Eric ten

The de re reading is derived in the following way from the term *that-many students* and the sentential structure *every professor likes him$_0$*:

(24) how many students every professor likes, t' [de re]
$\lambda i[[\#\lambda y[student(a)(y) \& \forall x[professor(a)(x) \rightarrow likes_*(a)(x,y)]]] = [\#\lambda y[student(i)(y) \& \forall x[professor(i)(x) \rightarrow likes_*(i)(x,y)]]]]$

how many students every professor likes, t///e
$\lambda k_7[\#\lambda y[student(a)(y) \& \forall x[professor(a)(x) \rightarrow likes_*(a)(x,y)]] = k_7]$

every professor likes that many$_7$ students, t
$\#\lambda y[student(a)(y) \& \forall x[professor(a)(x) \rightarrow likes_*(a)(x,y)]] = k_7$

that many$_7$ students, T
$\lambda P[\#\lambda y[student(a)(y) \& P(a)(y)] = k_7]$

every professor likes him$_0$, t
$\forall x[professor(a)(x) \rightarrow likes_*(a)(x,y_0)]]$

every professor, T
$\lambda P[\forall x[professor(a)(x) \rightarrow P(a)(x)]]$

likes him$_0$, IV
$likes_*(y_0)$

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4 Groenendijk and Stokhof (1982) also discuss scope ambiguities which involve interaction with the matrix verb. In this paper, we will only study scope ambiguities within the *wh*-complement.

If, at an index a, there are five students such that every professor likes those students, then (24) denotes the proposition that there are five students such that every professor likes those students. This is clearly the de re reading we are looking for. The pair-list reading is derived by quantifying the NP *every professor* into the *wh*-complement. This gives the quantified NP wide scope over the *wh*-phrase:

(25) how many students every professor likes, t' [pair-list]

$$\lambda i[\forall x[professor(a)(x) \rightarrow [[\#\lambda y[student(a)(y) \,\&\, likes_*(a)(x,y)]] = [\#\lambda y[student(i)(y) \,\&\, likes_*(i)(x,y)]]]]]$$

every professor, T

$$\lambda P[\forall x[professor(a)(x) \rightarrow P(a)(x)]]$$

how many students he_3 likes, t'

$$\lambda i[[\#\lambda y[student(a)(y) \,\&\, likes_*(a)(x3,y)]] = [\#\lambda y[student(i)(y) \,\&\, likes_*(i)(x3,y)]]]$$

how many students he_3 likes, t///e

$$\lambda k_7[\#\lambda y[student(a)(y) \,\&\, likes_*(a)(x_3,y)] = k_7]$$

he_3 likes that $many_7$ students, t

$$\#\lambda y[student(a)(y) \,\&\, likes_*(a)(x_3,y)] = k_7$$

At an index a, (25) denotes the set of indices i such that for every professor x at i it holds that the number of students x likes at i is the same as the number of students x likes at a. Obviously, this allows for different professors to like different numbers of students. This corresponds to the pair-list reading of the question.[5] But there is another interpretation possible, which is paraphrased under C:

C Question: How many students does every professor like?
 Answer: Every professor likes five students (but not necessarily the same students)

The C-reading is somewhat in between a proper de re reading and the pair-list reading. In contrast to the de re reading, it is not presupposed that there are certain students that every professor likes. The C-reading just presupposes that every professor likes the same number of students and the question is: what is that number. In our framework, this means that the number is read de re,

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5 Following G&S (1982, 1984: chapters 2 and 3), we obtain the pair-list reading by quantifying an NP into the question. In G&S (1984: chapter 6), an altogether different method of representing the pair-list reading is proposed. Recently, Chierchia (1991) has argued that quantification into questions can be dispensed with and that pair-list readings are a special case of the functional reading of questions. We believe that these alternative ways of representing the pair-list reading are equally compatible with the semantics of *how many*-questions we propose in this paper.

whereas the students are read de dicto.[6] This is reflected in the following derivation:

(26) how many students every professor likes, t [C-reading]

$\lambda i[[\lambda k_7[\forall x[professor(a)(x) \rightarrow [[\#\lambda y[student(a)(y) \,\&\, likes_*(a)(x,y)]] = k_7]]]]$

$= [\lambda k_7[\forall x[professor(i)(x) \rightarrow [[\#\lambda y[student(i)(y) \,\&\, likes_*(i)(x,y)]] = k_7]]]]]$

how many students every professor likes, t///e

$[\lambda k_7[\forall x[professor(a)(x) \rightarrow [[\#\lambda y[student(a)(y) \,\&\, likes_*(a)(x,y)]] = k_7]]]]$

that-many$_7$ students every professor likes, t

$[\forall x[professor(a)(x) \rightarrow [[\#\lambda y[student(a)(y) \,\&\, likes_*(a)(x,y)]] = k_7]]]$

every professor, T

$\lambda P[\forall x[professor(a)(x) \rightarrow P(a)(x)]]$

likes that-many$_7$ students, IV

$\#\lambda y[student(a)(y) \,\&\, likes_*(a)(y)] = k_7$

In a similar way, we account for ambiguities in *how many*-questions which involve an intensional verb, such as (27):

(27) Bill knows how many unicorns Joan seeks

The de re reading of the question is generated in the same way as in (24), but keeping in mind the intensional character of *seek*:

(28) how many unicorns Joan seeks, t' [de re]

$\lambda i[[\#\lambda x[unicorn(a)(x) \,\&\, seek_*(a)(j,x)] =$

$[\#\lambda x[unicorn(i)(x) \,\&\, seek_*(i)(j,x)]]]$

how many unicorns Joan seeks, t///e

$\lambda k_7[\#\lambda y[unicorn(a)(y) \,\&\, seek(a)(j,(\lambda a\lambda P[P(a)(y)]))] = k_7]$

Joan seeks that-many$_7$ unicorns, t

$\#\lambda y[unicorn(a)(y) \,\&\, seek(a)(j,(\lambda a\lambda P[P(a)(y)]))] = k_7$

that-many$_7$ unicorns, T

$\lambda P[\#\lambda y[unicorn(a)(y) \,\&\, P(a)(y)] = k_7]$

Joan seeks him$_2$, t

$seek(a)(j,(\lambda a\lambda P[P(a)(x2)]))$

Joan, T

$\lambda Q[Q(a)(j)]$

seeks him$_2$, IV

$seek(a)(\lambda a\lambda P[P(a)(x_2)])$

6 An anonymous reviewer suggests that the easiest way to get this reading is by construing it as an echo-question.

In this formula, $\lambda u[\text{unicorn}(a)(u)\ \&\ \text{seek}_*(a)(j,u)]$ corresponds to the set of all unicorns which Joan seeks (de re). The question denotes the proposition p such that, for every index k, p(k) = 1 iff the number of unicorns of which it is true (de re) that Joan seeks them in k is identical to the number of unicorns of which it is true that Joan seeks them in k.

What is referred to in the literature as the non-referential reading of *how many*, is generated by introducing the term *that many unicorns* much earlier in the derivation, so that it is under the scope of the intensional verb. This is in accordance with the regular PTQ way of deriving de dicto readings:

(29) how many unicorns Joan seeks, t' [de dicto]

$\lambda i[[\lambda k_7[\text{seek}(a)(j,(\lambda a\lambda Q[\#\lambda y[\text{unicorn}(a)(y)\ \&\ Q(a)(y)] = k_7]))]] =$
$[\lambda k_7[\text{seek}(i)(j,(\lambda a\lambda Q[\#\lambda y[\text{unicorn}(a)(y)\ \&\ Q(a)(y)] = k_7])]]]$

how many unicorns Joan seeks, t///e

$\lambda k_7[\text{seek}(a)(j,(\lambda a\lambda Q[\#\lambda y[\text{unicorn}(a)(y)\ \&\ Q(a)(y)] = k_7]))]$

Joan seeks that-many$_7$ unicorns, t

$\text{seek}(a)(j,(\lambda a\lambda Q[\#\lambda y[\text{unicorn}(a)(y)\ \&\ Q(a)(y)] = k_7]))$

Joan, T — $\lambda P[P(a)(j)]$

seeks that-many$_7$ unicorns, IV — $\text{seek}(a)(\lambda a\lambda Q[\#\lambda y[\text{unicorn}(a)(y)\ \&\ Q(a)(y)] = k_7])$

The analysis tree in (29) gives the *wh*-phrase narrow scope with respect to the intensional verb *seek*. If, at a certain index, Joan seeks five unicorns (de dicto), then (29) denotes the proposition that Joan seeks five unicorns. This reading does not entail the existence of unicorns in the actual world.

6. Weak islands and split constructions

In this paper we argued that ambiguities which are referred to in the literature as referential/non-referential readings can in fact be explained as scope ambiguities. We worked out a semantics of *how many*-questions, based on Groenendijk and Stokhof's (1982, 1984) theory of questions. This analysis handles the ambiguities mentioned above in the classical, Montagovian way. However, there are cases in which our analysis yields too many readings. An example is (7b), repeated here as (30):

(30) How many books did no student read?

Unlike similar examples involving monotone increasing quantifiers, (30) is not ambiguous: the question can only ask for the number of books which are such that no student read them. Groenendijk and Stokhof (1984: 454-455) argue that monotone decreasing quantifiers do not take scope over *wh*-expressions, because they always contain the empty set as one of their elements. If a monotone decreasing quantifier were to have wide scope over a *wh*-expression, a reading would result on which the interrogative could be answered by saying nothing at all, i.e. by answering no question. This is of course absurd, so it is easy to understand why this reading is missing in (30) (cf. also Chierchia 1991 for discussion). Downward entailing NPs like *no students* are said to create negative islands.

This example shows that there may be independent reasons to rule out one of the potential readings of a *wh*-question. Another example of this phenomenon is found in Kroch (1989), who discusses the contrast in (31):

(31) a How many books did Bill say that the editor would publish this year?
 b How many books did Bill ask whether the company was interested in publishing?
 c *How much money was John wondering whether to pay

(31a) has two readings depending on whether *how many books* has wide scope or narrow scope with respect to the matrix verb *say*. By contrast, (31b), in which the *wh*-phrase is extracted out of a *wh*-island, only has the reading in which *how many books* has wide scope with respect to the matrix verb. Rizzi (1990), Cinque (1991) and others have argued that long movement of the *wh*-phrase is only possible if it gets a referential reading. (31c) is strange, because *how much money* does not get a referential reading. According to Kroch, (31c) presupposes there was a sum of money John was wondering whether to pay. He claims that this presupposition is semantically well-formed, but odd. The oddness lies in its stating that there be a specific sum of money, say twenty dollars, that could be uniquely identified in the discourse by having the property that John was wondering whether to pay it (Kroch 1989: 8).

In the present context, we reinterpret the data in terms of scope. (31a) is ambiguous because there are two scope-bearing operators present in the sentence. It is easy to see that *how many books* in (31b) is read de re, and takes scope over *ask*. The fact that verbs like *to ask, to wonder*, etc. cannot take wide scope puts them in the same class as the monotone decreasing quantifiers discussed above: they both restrict the number of possible readings a question can get. Now, what happens in (31c) is nothing else but a clash between two scope-bearing elements, each of which refuses to take scope over the other one. The *wh*-expression cannot be interpreted as having narrow scope with respect to the verb, because inbedding under *to wonder* creates a weak island. Therefore, *how much money* is supposed to take wide scope over the wondering, and yield an interpretation similar to (31b). As explained by Kroch, such an interpretation is ruled out for pragmatic reasons in (31c).

De Swart (1992) discusses a very similar pattern found in certain split constructions in French and Dutch. Interestingly, (32a) is ambiguous, just like its English counterpart in (7a), but the split construction in (32b) is not ambiguous: the narrow scope reading of the universal quantifier is missing.

(32) a Combien de livres ont-ils tous lu?
how many of books have they all read
b Combien ont-ils tous lu de livres?
how many have they all read of books

Just like *wh*-islands and negative islands, then, split-constructions like (32b) can be characterized as weak islands, and as such they do not allow the intervening quantifier to take narrow scope. That is, we can only use (32b) to ask for all persons how many books they have read. Consider now (33), in which the universal quantifier *tous* is replaced by the downward entailing NP *aucun étudiant* ('no student'):

(33) a Combien de livres est-ce qu'aucun étudiant n'a acheté?
how many of books WH-PART no student NEG has bought
b *Combien est-ce qu'aucun étudiant n'a acheté de livres?
how many WH-PART no student NEG has bought of books

Unlike (32a), (33a) is not ambiguous: the question can only ask for the number of books which are such that no student bought them. This is due to the fact that the monotone decreasing quantifier always takes narrow scope with respect to the *wh*-operator. But as we pointed out with respect to (33b) above, split-constructions and weak islands in general require the intervening quantifier to take wide scope. Again, we observe a clash between two scope bearing elements, neither of which wants to take scope over the other. As a consequence, monotone decreasing quantifiers cannot intervene in split constructions and (33b) is ungrammatical. For a more extensive discussion of the facts in French and related data from Dutch, the reader is referred to De Swart (1992).

Summarizing, we can state the following generalizations: *wh*-expressions are prohibited from taking scope within the weak island that they have been extracted from. Ungrammaticalities arise if the scope requirements on the *wh*-phrase get into conflict with those on the operator intervening between the *wh*-phrase and its trace. The next question to ask is of course why certain expressions create weak islands, whereas others do not. The question is not addressed in this paper (but see Kroch 1989, Szabolcsi 1992 and Szabolcsi and Zwarts 1992 for a number of different proposals). Whatever explanation is proposed for the restriction of mon$\downarrow$ quantifiers, verbs like *wonder*, split constructions, etc. to narrow scope readings with respect to *wh*-expressions, it will be clear from the results presented here that a generalized analysis of weak islands is best formulated in terms of relative scope of the operator involved with respect to the *wh*-phrase. By giving a detailed model-theoretic analysis of the scopal relations in *how many*-questions, we hope to have made a contribution to the ongoing discussion about weak islands and referentiality.

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