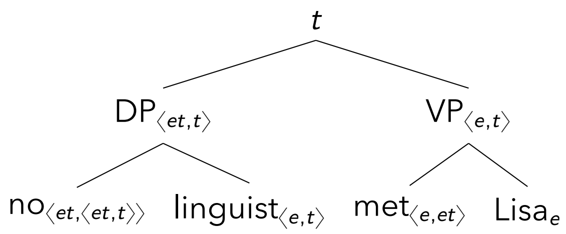
PLIN0020 Advanced Semantic Theory — Yasu Sudo
Quantifier Scope — Autumn 2018

1 Quantifiers in Object Position and Quantifier Raising

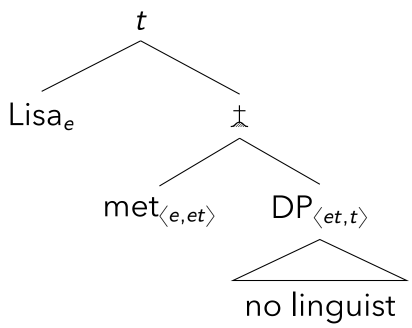
To review, we analyze the denotations of quantificational DPs to be Generealized Quantifiers, i.e. functions of type $\langle et, t\rangle$. This allows us to compute sentences like (1).

(1)



But a problem arises when we consider sentences containing quantificational DPs in object position.

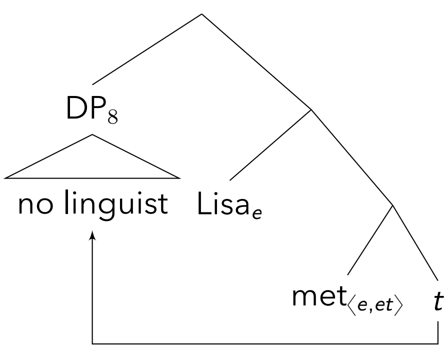
(2)



There is a type-mismatch between the transitive verb of type $\langle e, et\rangle$ and the quantificational DP!

In order to solve this problem of object quantificational DPs, we adopt the hypothesis that quantifiers undergo *covert movement* called *Quantifier Raising (QR)*, as illustrated by the following tree diagram.

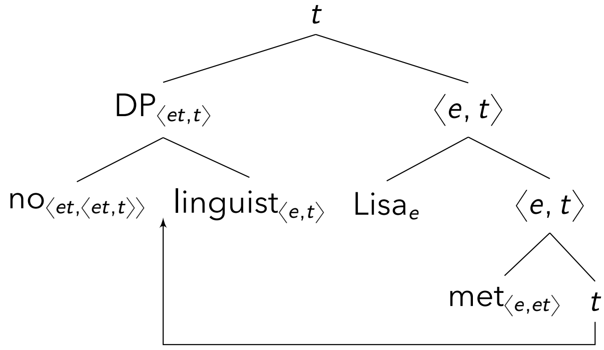
(3)



This is not the structure that is pronounced, which is to say that it's not the structure that the phonology 'sees', but let's assume that it is what the semantic gets from the syntax. This level of representation is often called LF (for Logical Form).

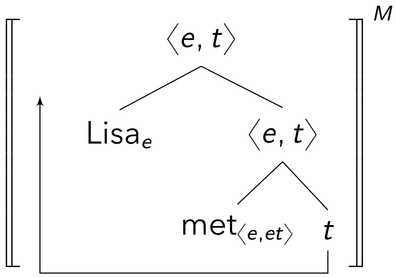
For reasons of time, we will not go into the details of how exactly structure with movement gets interpreted.[1] Crucially, however, the structure in (3) solves the type mismatch. Specifically, the movement is assumed to create a constituent of type $\langle e, t\rangle$, as depicted in (4).

(4)



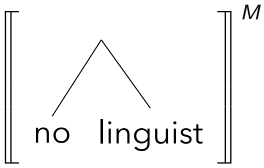
The sister constituent to the quantificational DP is interpreted here as the following type-$\langle e, t\rangle$ function. For expository purposes, let's treat the movement arrow as part of the structure:

(5)



$= [\lambda x \in D_e.\ 1 \text{ iff Lisa met } x \text{ in } M]$

When combined with $[\![\text{no linguist}]\!]^M$, this type-$\langle e, t\rangle$ function yields the correct truth-conditions:



$([\lambda x \in D_e.\ 1 \text{ iff Lisa met } x \text{ in } M])$

$= [\![\text{no}]\!]^M([\![\text{linguist}]\!]^M)([\lambda x \in D_e.\ 1 \text{ iff Lisa met } x \text{ in } M])$

$= 1$ iff there is no $y \in D_e$ such that $[\![\text{linguist}]\!]^M(y) = 1$ and $[\lambda x \in D_e.\ 1 \text{ iff Lisa met } x \text{ in } M](y) = 1$

iff there is no $y \in D_e$ such that $[\lambda x \in D_e.\ 1 \text{ iff } x \text{ is a linguist in } M](y) = 1$ and $[\lambda x \in D_e.\ 1 \text{ iff Lisa met } x \text{ in } M](y) = 1$

iff there is no $y \in D_e$ such that y is a linguist in M and Lisa met y in M

2 Scope Ambiguity

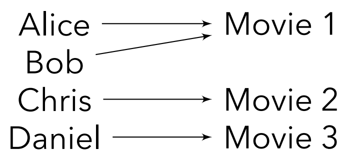
We can see Quantifier Raising (QR) as the mechanism behind quantifier scope. There are several important properties of quantifier scope in natural language, one of which is scope ambiguity. To illustrate, consider the following sentence.

(6) Somebody saw every movie.

[1]If you are interested, read Heim & Kratzer 1998, *Semantics in Generative Grammar* and/or Jacobson, 2014, *Compositional Semantics: An Introduction to the Syntax/Semantics Interface*. They also discuss an alternative way to solve the type mismatch, namely, *type shifting*.

Suppose that there are three movies, Movie 1, Movie 2, and Movie 3, and four people, Alice, Bob, Chris, and Daniel. Suppose further that Alice and Bob saw Movie 1, Chris saw Movie 2 and Daniel saw Movie 3. This situation can be represented as (7).

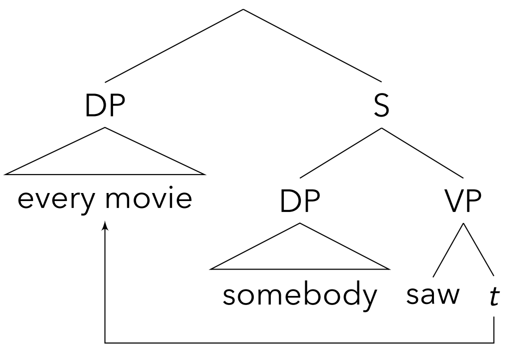
(7)



In this situation, (7) is judged to be true.

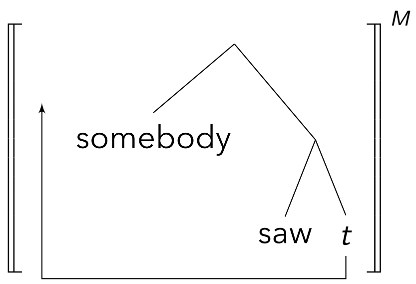
This judgment is in fact predicted by QR. QR is necessary to resolve the type mismatch, and after the QR, the structure of (7) looks like (8).

(8)



Again glossing over the details, the constituent labeled S here with the movement arrow is interpreted as a type-$\langle e, t \rangle$ function, which can serve as an argument for $[\![\text{every movie}]\!]^M$.

(9)



$= [\lambda x \in D_e.\ 1 \text{ iff somebody saw } x \text{ in } M]$

Then, (8) will be true (with respect to a model M) iff for every movie x (in M), somebody saw x (in M). In the above example situation, each movie indeed is paired with at least one person who saw it, so the sentence is correctly predicted to be true.

As you might have learned in other modules, the sentence in (15) is said to have a different reading with different truth-conditions. Specifically, it is often assumed that (15) has a reading that is true iff there is one particular person who saw every movie. This reading is false in the above scenario (7), because no one saw every movie.

As good linguists, let us be skeptical here: Is there really a separate reading that is false in the above scenario, in addition to the reading that is true? It is not immediately clear whether this is the case, because the second reading, which is false in the scenario in (7), entails the first reading, which is true in (7), but not vice versa. To facilitate the following discussion, let's give names to these two readings. We call the first reading the *inverse scope reading*, because the order of quantifiers in the semantic/LF representation is the inverse of the order of quantifiers as phonologically realized, and the second reading the *surface scope reading*, as the order of quantifiers matches between the two representations.

(10) a. *Inverse Scope Reading*:
For every movie, there is somebody who saw it.
b. *Surface Scope Reading*:
There is somebody who saw every movie.

As can be seen easily, whenever the surface scope reading (10b) is true, the inverse scope reading (10a) is also true. If there is a single person who saw every movie, then every movie has at least one person who saw it. But the entailment is only one way, as demonstrated by the above scenario (7). In (7), the inverse scope reading (10a) is true, but the surface scope reading (10b) is false, so the former does not entail the latter.

This asymmetric entailment relation has confused a lot of linguists, and led them to claim that one of these two readings is actually not there as a separate reading.[2] The idea is that one of the readings subsumes the other reading, so there is no real empirical evidence for the subsumed reading and hence it is dispensable. Interestingly, some claimed that only the inverse scope reading was necessary, while others claimed that only the surface scope reading was necessary.

Those who thought that only the surface scope reading was necessary are plainly wrong. Their reasoning seems to be the following. The surface scope reading entails the inverse scope reading, which means that whenever the surface reading is true, the inverse scope reading is also true, so the inverse scope reading is superfluous. This reasoning is simply fallacious. It is indeed true that whenever the surface scope reading is true, the inverse scope reading is also true, but because the entailment here is only one-way, there are situations where the inverse scope reading is true but the surface scope reading is false. One such case is given above in (7). There, only the inverse scope reading is true. So this shows that we at least need to say that the sentence has the inverse scope reading, because the sentence is judged as true there.

The other view is more sensible, according to which the sentence only has the inverse scope reading. The idea is as follows. The inverse scope reading is true in a superset of situations where the surface scope reading is true, so whether or the surface scope reading exists, the set of situations where the sentence is true will be the same, namely the situations where the inverse scope reading is true.

We will give five reasons to think that both the inverse scope and surface scope readings exist. Some of the arguments are indirect and weak, but jointly they make it plausible that the surface scope reading does exist.

2.1 Double Judgments

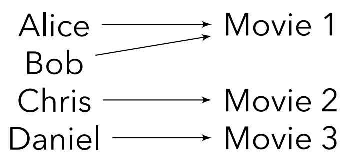
Consider the sentence (15) again.

(15) Somebody saw every movie.

[2] If you are interested, read Eddy Ruys (2001) Wide scope indefinites: the genealogy of a mutant meme, unpublished manuscript, Universiteit Utrecht, http://www.let.uu.nl/~Eddy.Ruys/personal/download/indefinites_v2.pdf.

In the above situation in (7), repeated here, we said that the sentence is judged as true.

(7)



The inverse scope reading is true here, while the surface scope reading is false. If the sentence really has these two readings, it should be judged as true and false at the same time. If you (or your native speaker informants) think that the sentence is both true and false at the same time, this is good evidence that both readings exist.

Notice that similar double judgments arise with other ambiguous sentences, e.g.

(11) a. I went to the bank on Wednesday. (lexical ambiguity)
b. John saw the man with binoculars. (structural ambiguity)

2.2 Embedding

When the sentence is embedded under certain linguistic contexts (more precisely, non-upward monotonic contexts), the entailment relation changes. To see this, consider the following sentence.

(12) It's false that somebody saw every movie.

The two readings of this sentence are now:

(13) a. *Inverse Scope Reading*:
It's false that for every movie there is somebody who saw it.
b. *Surface Scope Reading*:
It's false that there is somebody who saw every movie.

Now the entailment goes from (13a) to (13b). If the inverse scope reading is true, i.e. it's false that for every movie, there is somebody who saw it, then there is a movie that nobody saw. This also makes the surface reading true, because if there is a movie that nobody saw, then it's guaranteed to be false that there is somebody who saw every movie. On the other hand, the entailment from (13b) to (13a) does not go through. You can easily imagine a context where (13b) is true but (13a) is false. And notice that such a context will be evidence that the surface scope reading exists, because if the sentence is judged true against such a context, that must be because of the surface reading. In fact, the context in (15) is such a context. There, the surface scope reading is true, while the inverse scope reading is false.

2.3 Switching the Quantifiers

Another way to change the entailment patter is by switching the quantifiers, as in the following example.

(14) Everybody saw some movie.

Now the universal quantifier 'everybody' is the subject. The two readings of the sentence are as in (15).

(15) a. *Inverse Scope Reading*:
There is some movie that everybody saw.
b. *Surface Scope Reading*:
For everybody, there is some movie that he or she saw.

Now, the inverse scope reading (15a) entails the surface scope reading (15b), but not vice versa. Then, we can create a context where only the weaker reading, namely the surface scope reading, is true. The scenario in again serves as a test case. If the sentence in (14) is judged as true, that must be because the sentence has a surface scope reading. And (14) indeed seems to be judged as true.

2.4 Other Quantifiers

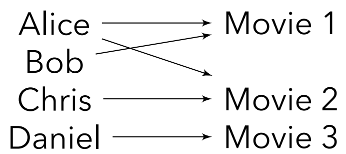
There are quantifiers that don't give rise to asymmetric entailment patterns. Consider, for example, (16).

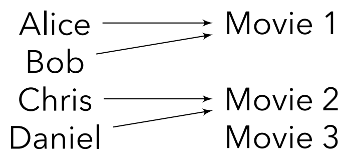
(16) Somebody saw exactly two movies.

The two readings of (16) are paraphrased as (17).

(17) a. *Inverse Scope Reading*:
There is somebody who saw exactly two movies.
b. *Surface Scope Reading*:
For exactly two movies, there is somebody who saw them.

These two readings do not stand in any entailment relation. To see this concretely, consider the following two situations.

(18)


(19)


In (18), only the surface scope reading is true, while in (19), only the inverse scope reading is true. Whether (and how easily) the inverse scope reading is available is not very clear, but everyone would agree that the surface scope reading exists, i.e. the sentence is judged true in (18).

2.5 Other Languages

In certain languages (e.g. Korean, Mandarin Chinese, Japanese, German, Russian), a translation of (15) doesn't have an inverse scope reading, i.e. the sentence is judged false in the scenario depicted in (7). Here's a Japanese translation of (15).

(20) dareka-ga subeteno eiga-o mita.
someone-NOM all movie-ACC saw
'Someone saw all the movies.'

Side note: Interestingly, the judgments change if a different word order is used. In Japanese, the object can optionally precede the subject (a phenomenon known as 'scrambling'), in which case, both readings seem to be available. Generally, the word order matters for scope judgments in many languages.

The Japanese sentence in (20) is judged true precisely when the surface scope reading is predicted to be true. Thus, the surface scope reading exists at least in languages like Japanese. Then there must be a mechanism that generates the surface scope reading. Of course, this does not necessarily mean that the English sentence in (15) has the surface scope reading, but it at least shows that it would not be so outlandish to assume that it has the surface scope reading as well.

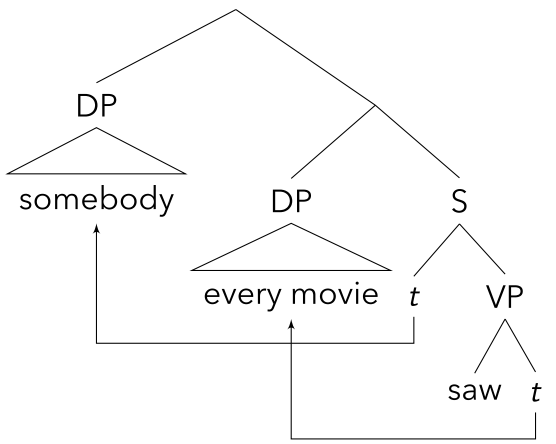
2.6 How to Derive the Surface Scope Reading

Some of the above arguments are weak. For instance, the last one one is not about English, so you can't actually directly conclude that the English sentence in (15) has a surface scope reading. Also, the second, third, and fourth arguments are about different sentences than (15), which leaves open the possibility that there are sentences that have surface scope readings but (15) does not have one. Yet, generally speaking, our semantic theory needs to be able to generate the surface scope reading, in addition to the inverse scope reading.

As we have seen, the inverse scope reading is easily captured by QRing the object quantifier above the subject, as demonstrated above. How do we derive the surface scope reading?

One way to do so is by applying QR to the subject quantifier as well, as depicted in (21):

(21)



For reasons of time, we will not go into the details of how to interpret such structures (see the sources cited in fn.1), but the above structure derives the surface scope reading.

To sum up, QR can be seen as the mechanism that decides the scopes of quantificational DPs. In particular it accounts for scope ambiguity by assigning different LF structures for the same surface string.

3 Locality Constraints

One consequence of the above discussion is that the scope of a quantifier is not completely determined by the surface form of the sentence. However, at the same time, it is known that quantifier scope is not free, in fact quite constrained, in natural language. In order to understand such constraints, we continue to assume that quantifier scope is determined by Quantifier Raising (QR), according to which constraints on quantifier scope can be seen as constraints on the syntactic operation QR. The discussion here is largely open-ended, but we will see some peculiar properties of quantifier scope in natural languages that we need to explain.

It is instructive to compare overt movement like *wh*-movement and QR, as QR is a type of movement after all. As you have learned in syntax modules, *wh*-movement is known to be subject to a number of locality constraints known as *island constraints*. Here are two examples of island constraints:

(22) *Complex NP Island*
*Which novel did somebody meet a man that has read *t*?

(23) *Coordinate Structure Island*
*Which novel did somebody [read *t* and watched TV] before going to bed?

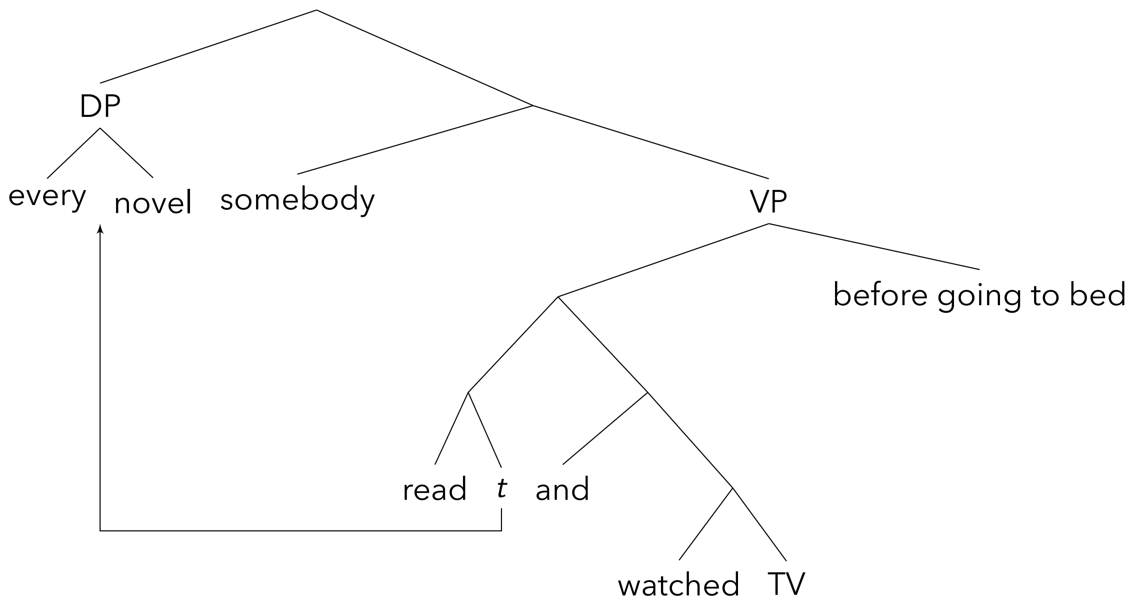
Interestingly, quantifier scope seems to be subject to these constraints as well. For example, *every novel* cannot take scope over *somebody* in the following examples.

(24) *Complex NP Island*
Somebody met a man that has read every novel.

(25) *Coordinate Structure Island*
Somebody [read every novel and watched TV] before going to bed.

This observation follows nicely under the assumption that *wh*-movement and QR are subject to the same constraints. Specifically, in order to derive the hypothetical inverse scope readings of these examples, the quantifier *every novel* would have to move out of an island, as depicted in the following diagram for (25).

(26)



Si it seems that the constraints on overt movements like *wh*-movement and those on QR are at least partially identical. Then, it is natural to expect that the constraints on quantifier scope are syntactic constraints, and a semantic theory does not need to say anything about them. However, this issue is not so simple, because, as it turns out, the constraints on *wh*-movement are not completely identical to the constraints on quantifier scope. Below, we will discuss three such discrepancies, namely clause-boundedness, scope freezing, and nested DPs.

3.1 Clause Boundedness

It is a well-known fact that *wh*-movement can cross indefinitely many finite-clause boundaries, as illustrated by the following examples.

(27) a. Which novel did somebody say that John wrote *t*?
b. Which novel did you think that somebody said that John wrote *t*?
c. Which novel did Bill claim that you thought that somebody said that John wrote *t*?

Unlike *wh*-movement, quantifier scope is generally clause-bounded. Consider the following examples.

(28) Somebody said that John wrote every novel.

The inverse scope reading of (28) seems to be absent, i.e. it cannot mean: for every novel, there is somebody who said that John read it. Generally, QR cannot cross a tensed clause boundary, unlike *wh*-movement.

However, there are some interesting potential exceptions to this generalization.

(29) a. I demanded that you read not a single book. (Fox 2003:85)
b. Determine whether each number in the list is even or odd. (Szabolcsi 2010:107)
c. Somebody said that they can solve every problem that John did. (Syrett 2015)

These examples seem to have the following readings:

(30) a. No book is such that I demanded that you read it.
(The speaker is fine if you read some books)
b. For each number in the list, determine whether it is even or odd.
(Your task is not evaluate the truth of the following sentences: "Each number in the list is even" vs. "Each number in the list is odd")
c. For every problem that John said that he can solve, someone said that they can solve it as well.

But arguably, such examples are exceptions, rather than the rule, and generally, quantifier scope cannot extend beyond the local tensed clause.

3.2 Scope Freezing Effects

Another difference between *wh*-movement and QR crops up in the double object construction. (31a) shows that the direct object in a double object construction can *wh*-move, but the corresponding quantification sentence in (31b) lacks an inverse scope reading (Larson 1990, Bruening 2001)

(31) a. Which doll did you give a child?
b. You gave a child each doll.

This suggests that *each doll* cannot QR across *a child*. Notice that if the double object construction is not used, the indirect and direct objects can generally scopally interact, which shows that this is not a problem of meaning. Concretely, both of the sentences below are scopally ambiguous.

(32) a. You gave each doll to a child.
b. You gave a doll to each child.

Interestingly, this restriction is only about the relative scope of the indirect and direct objects in the double object construction, and the direct object can take scope over the subject, for example, as illustrated by (33).

(33) A teacher gave me every book.

This shows that the direct object (*every book* here) needs to be able to undergo QR, but for some reason, the indirect object always needs to take scope over the direct object.

These effects that the double object construction creates on scope possibilities is called *scope freezing effects*. It is likely to be a syntactic phenomenon, but whatever the correct explanation is, it does not apply to *wh*-movement.

3.3 Nested DPs

In the above two cases, quantifier scope is more constrained than *wh*-movement. There are also cases where *wh*-movement is more constrained. For instance, *wh*-movement is subject to the *Subject Island Constraint*, as shown by (34).

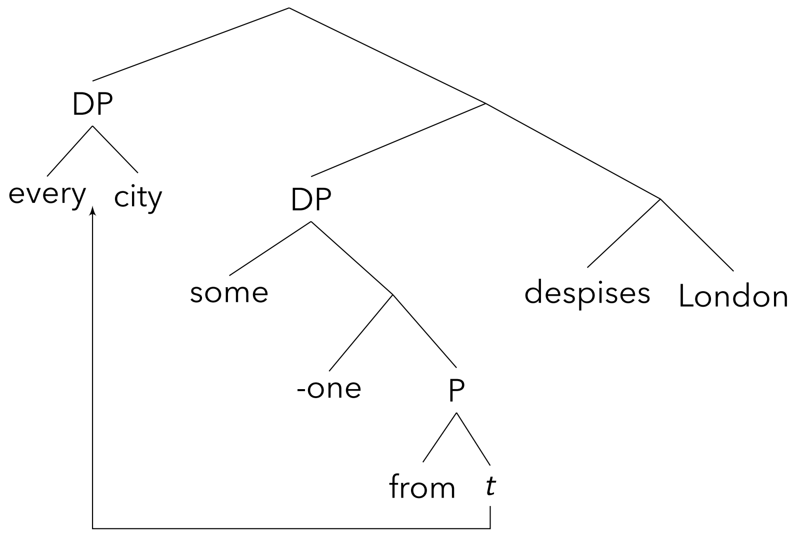
(34) *Which city does somebody from *t* despise London?

However, the inverse scope reading is possible in this configuration, as shown by (35) (May 1977, 1985, May & Bale 2006, Sauerland 2005).

(35) Someone from every city despises London.

The surface scope reading of this sentence would be a strange one, as it says that there is someone who is from every city. The more natural reading says that for every city, there is someone from it who despises London. In order to derive this reading, the quantifier *every city* needs to QR out of the subject DP *someone from every city* in violation of the Subject Island Constraint, as shown in the following diagram:

(36)



3.4 Interim Summary

The above observations suggest that overt movement like *wh*-movement and covert movement like QR are subject to overlapping but different sets of constraints. This of course does not mean that QR is not a syntactic operation, but it needs to be explained why overt and covert movement differ in these particular ways. In the current literature on quantifier scope, there are some theoretical attempts to explicate each of the above constraints on quantifier scope, but we still don't have a good understanding of why we have such constraints to begin with.

4 Semantic Restrictions on Quantifier Scope

Independently from the syntactic constraints like the ones we have just seen, quantifier scope is also restricted semantically. Generally speaking, downward entailing quantifiers like *no NP* and *few NP* do not show scope ambiguity. Consider the following examples.

(37) a. A boy climbed every tree.
b. A boy climbed many trees.

(38) a. A boy climbed no tree.
b. A boy climbed few trees.

The examples in (38) do not seem to have inverse scope readings, unlike those in (37). The inverse scope readings of (38) would be the following:

(39) a. For no tree, is there a boy who climbed it. (or in other words, no boys climbed any tree)
b. For few trees, is there a boy who climbed it.

Notice that according to our theory of quantifiers, QR should apply equally to all types of quantifiers. In fact, in cases like above with a quantificational object, QR must apply, even in (38). But for some reason, the subject quantifier in (38) needs to take scope over the object quantifier. As far as I know, no one has an insightful theory of why this is so (which is very embarrassing, considering the amount of time that's been spent on studying quantifiers). But there is a particularly interesting approach suggested by an unpublished paper by Mayr & Spector (2012).

Following Fox's (2000) influential idea, Mayr & Spector (2012) propose an interesting generalization, according to which the inverse scope reading is only possible when it does not entail but is entailed by the surface scope reading.[3] This generalization nicely applies to (37a). The two readings of this example are:

(40) a. Surface scope: There is a boy who climbed every tree.
b. Inverse scope: For every tree, there is a boy who climbed it.

Here, the surface scope reading entails the inverse scope reading, and the inverse scope reading does not entail the surface scope reading, and we have an inverse scope reading.

The entailment pattern becomes different with different quantifiers. For (38a), the two readings are:

(41) a. Surface scope: There is a boy who climbed no tree.
b. Inverse scope: For no tree, is there a boy who climbed it.

The surface scope reading does not entail the inverse scope reading. Concretely, suppose that Andrew climbed no trees, but Bill climbed some trees. Then (41a) is true but (41b) is false. Therefore, there is no inverse scope reading. ((41b) entails (41a), provided that there are boys, but this is not relevant here).

This also predicts that non-monotonic quantifiers like *exactly three NP* and *between five and ten NP* should not give rise to inverse scope readings, because the two readings will be logically independent. Consider the following examples:

(42) a. Every student read exactly two books before the exam.
b. Every student read between five and ten books before the exam.

The inverse scope readings of these sentences would be:

(43) a. Exactly two books are such that every student read them before the exam.
b. Between five and ten books are such that every student read them before the exam.

These are logically independent from the surface scope readings, which are actually available for (42), which is to say that there is no entailment in either direction between the two

[3]This is actually one analytical possibility that they mention, and they mostly consider a weaker constraint that says that the inverse scope is possible only when it does not entail the surface scope reading. however, this weaker version wrongly predicts that (38a) has an inverse scope reading.

readings. Now the question is are these readings really absent? I do not know any firm empirical study on this.

However, Mayr & Spector's (2012) generalization is not without problems, and they propose some refinements in their paper. Whether their generalization turns out to be correct or wrong, it seems that a semantic constraint like that is at play in natural language.

5 Indefinites and Exceptional Wide Scope

The final thing to note about quantifier scope is the well-known behavior of *indefinites*. Indefinites are quantificational DPs like *a NP*, *some NP*, *two NP*, etc. They create a different set of issues, because they are exempt from all the constraints mentioned above. That is, they freely give rise to inverse scope readings.

For example, the following examples show that the scope of an indefinite is not limited by island constraints:

(44) a. Every student had to buy a book that a professor at UCL wrote.
b. If some relative of John's dies, he'll inherit a fortune.

These sentences are ambiguous, but crucially, they have the following readings:

(45) a. There is a professor at UCL such that every student had to buy a book he she wrote.
b. There is some relative of John's such that if he or she dies, he'll inherit a fortune.

Such interpretations are not possible with other types of quantificational DPs:

(46) a. Every student had to buy a book that every professor at UCL wrote.
b. If every relative of John's dies, he'll inherit a fortune.

These cannot mean:

(47) a. Every professor at UCL is such that every student had to buy a book he/she wrote.
b. Every relative of John's is such that if he or she dies, he'll inherit a fortune.

Needless to say, *wh*-movement is not possible from these positions:

(48) a. *Which professor at UCL did every student have to buy a book that *t* wrote?
b. *Which relative of John's will he inherit a fortune, if *t* dies?

The examples in (46) already demonstrate that the scope of an indefinite can extend beyond the local tensed clause. The same point can be made with the following example, where *a student of mine* can easily take wide scope over *every colleague of mine*.

(49) Several people asked me if a student of mine was in my class today.

Similarly, indefinites are exempt from the scope freezing effects of the double object construction. For example, (50) can be understood as saying that there is a particular book about λ-calculus that John has decided to assign to every student.

(50) John has decided to assign every student a book about λ-calculus.

In order to explain such exceptional wide scope readings of indefinites, Fodor & Sag (1982) proposed that indefinites can sometimes be used as referring expressions, and are ambiguous between a type-$\langle et, t\rangle$ interpretation and a type-e interpretation. The thought is that when an indefinite is used as a type-e expression, it behaves as if it takes the widest scope in the sentence, because it just pick out a particular individual and it takes the same individual even in the scope of quantifiers. Or, in other words, just like proper names are scopeless, type-e indefinites are also scopeless.

This analysis, however, has a problem with intermediate readings like (51).

(51) Every student has to read every paper that is about a topic of their choice.

This sentence has a reading where *a topic of their choice* takes scope between the two universal quantifiers:

(52) For every student, there is a topic of topic of their choice such that he or she has to read every paper about it.

If *a topic of their choice* is a referring expression and type-e, there is not way that it can vary across different students. Schwarzschild (2002) proposes a more refined version of Fodor & Sag's (1982) theory that can account for such intermediate readings.

In addition, there are several other theories of indefinites that also attempt to explain wide scope readings of indefinites. Reinhart (1997), Winter (1997), Kratzer (1998), Matthewson (1998), Chierchia (2001) and Schlenker (2006), among others, make use of *choice functions* to account for wide scope readings, although this approach has certain problems, as pointed out by Schwarz (2004). Recently Charlow (2014) puts forward a completely novel approach to this issue.

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