The final version of this paper will appear in: K. von Heusinger & U. Egli (eds.). *Reference and Anaphoric Relations*. Dordrecht: Kluwer (Studies in Linguistics and Philosophy).

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SOME REMARKS ON CHOICE FUNCTIONS AND LF-MOVEMENT*

1 THE SCOPE OF THIS PAPER

It is well known that indefinite phrases are more liberal in taking scope than other quantifying phrases. In general, the scope of indefinites is not limited by the finite clause in which they occur, although the scope of universal quantifiers is. *Wh*-phrases behave very much like indefinites: in languages with *wh in situ*, their scope need not be restricted by anything like clause boundedness.

In a recent paper, Tanya Reinhart has proposed to explain the difference between indefinites and *wh*-phrases on the one hand and non-indefinite quantifiers on the other hand by means of the following assumptions (cf. Reinhart 1994).

- Like Heim (1982) it is assumed that indefinites do not have quantificational force of their own. Whereas Heim assumes that the logical subject of an indefinite is an individual variable, Reinhart proposes that it may be a choice function.
- Whereas individual variables are bound by the nearest c-commanding quantifier at LF in Heim's framework, choice function variables can be existentially generalized at any place according to Reinhart.
- *wh*-morphemes behave essentially like indefinite articles. The difference is that they are existentially generalized at the COMP position of an interrogative clause.

The rule Quantifier Raising (QR) still exists and obeys island restrictions whatever they are exactly, say clause boundedness (cf. May 1985). According to Reinhart, indefinites are ambiguous between the choice variable reading and the individual variable reading. Like Winter (1997) I want to investigate the stronger assumption that the subject of an indefinite term invariably is a choice function variable. Similarly for *which*-phrases and *wh*-phrases in general.

* The discussion is indebted very much to the lucid representation given in Heim (1994) which, in several respects, is more elaborate than the account given here. Furthermore, I wish to thank Graham Katz, Manfred Kupffer, Cecile Meier and Wolfgang Sternefeld for discussion and help. The article has profited enormously by the comments of two anonymous referees and several detailed suggestions by Klaus von Heusinger. This article was presented as a talk in 1996 at the Konstanz conference, and much progress has been made since. With a few exceptions, I have not tried to do justice to the new literature, because that would have meant writing a new article. I have tried, however, to build in most of the suggestions made by the two highly competent referees.

Reinhart's proposal can then be viewed as an attempt to give a principled explanation for the difference between the scoping behaviour of indefinite terms and that of other quantifiers. It seems that there is no semantic reason for LF movement of indefinites or *wh*-phrases.

One might consider the approach as an essential step towards ridding ourselves of QR altogether. Surface syntacticians, e.g. categorial grammarians, never have accepted that rule, and recently even advocates of the Minimalist Program have argued against the rule (Lasnik (1993)). The ideal outcome might be that there is no semantically motivated LF movement at all.

In this article I want to discuss some data, notably reconstruction facts and scrambling accross negative polarity items in Korean, which suggest that we cannot get rid of semantically motivated LF movement. In particular, there is a well-motivated analog of *wh*-movement at LF which is restricted by a general filter on LF movement ("Beck's filter"), which will be discussed below. The conclusion of this paper will be that most of the arguments for choice functions in semantics are not compelling. In most cases we can achieve the same results with classical methods when they are combined with reconstruction and the use of Skolem functions. On the other hand, we will see that modern theories, notably the Minimalist Program seem to be only compatible with a semantics that makes use of choice functions. Thus, if these theories are on the right track, the method will considerably gain in importance.

The organization of the paper is as follows. In the first part I will repeat what has been said about choice functions in the literature. Then I will come to facts which drive the seemingly simple approach into complexity. Next, I will come to the reconstruction and scrambling data. Finally I will discuss an alternative formulation of QR which doesn't scope the NP but only the article. Certain anaphora puzzles seem to drive us toward such an analysis. Furthermore, this version of QR seems to be the only one which is compatible with the so-called Miminalist Program. Since this alternative version of QR requires the use of choice functions, most recent development in syntactic theory support this kind of semantics.

2 CHOICE FUNCTIONS AND INDEFINITES

2.1 The plot

I will assume that the following two generalizations about QR are by and large valid.

(1) a. The scope of strong quantifiers is "roughly" clause bounded (May 1985, Reinhart 1997).
    b. Indefinites and weak quantifier in general scope freely (Abusch 1994).

The generalization (1b) has been criticized by Reinhart (1997) and Winter (1997) on conceptual and empirical grounds. None of the empirical arguments has convinced me. I will discuss some of the relevant examples in 2.3 and 2.4. Thus I will defend generalization (1b): the generalization might turn out to be wrong, but not for the reasons given by Reinhart and Winter.

I will investigate the questions of whether the need to apply QR to indefinites can be eliminated altogether by the choice function method. The idea is that any LF of the form (2a) is replaced by an LF of the form (2b):

(2) a. ∃x [P(x) ∧ Q(x)]
b. ∃f Q(f(P)), where f is a choice function variable

(2a) is a configuration which is created by QRing the existential quantifier "∃x P(x)" from its base position – the x-argument of Q. No QRing of an existential quantifier is involved in the formula (2b). Thus, the QRing of indefinites is not necessary. Indefinites are interpreted by a different mechanism, namely existential generalization of choice function variables. This is a step toward an explanation of the exceptional behaviour of indefinites. This line of explanation is in agreement with Reinhart (1997), although she defends a stronger claim: she argues that (1b) is empirically wrong, choice functions make better predictions, and therefore we have to use them.

I think that this stronger claim is not substantiated by the behaviour of indefinite terms that are not *wh*-phrases. So I want to make the point that we can proceed either way as long as only indefinite terms are concerned: they can be analyzed by means of QR or by means of choice functions.

While this conclusion involves a rather conservative view, I hold a stronger view with respect to the possibilitiy to analyze the scope of indefinites without QR. Yoad Winter and referee #1[1] tell me that it is not possible to exempt indefinites from QR. This is an empirical question. I will review the arguments against the elimination, and will refute them.

2.2 Simple choice functions

I start with the interpretation of indefinite terms. For the discussion, I will assume an extensional typed language in the style of Gallin (1975). That means that expressions of type *e* denote individuals, expressions of type *s* denote possible worlds, *t* is the type of the truth values. The simplest choice functions are entities of type $\langle\langle e,t\rangle,e\rangle$. A choice function f assigns to any non-empty set of individuals a member of this set.

(3) **Definition.** f is a choice function iff for any P, P(f(P)), where f is of type $\langle et,e\rangle$ and P is non-empty.

Let us use the notation ch(f) for "f is a choice function". In first approximation we can represent then the first order existential statement (4a) as (4b) or (4c).

(4) a. ∃x [P(x) ∧ Q(x)]
b. ∃f [ch(f) ∧ P(f(Q))]
c. ∃f [ch(f) ∧ Q(f(P))]

The formulae are equivalent only if P and Q denote non-empty sets. If Q is empty, f(Q) is undefined. Consequently the formula (4b) is undefined. The same holds for (4c) if P is empty.

As Winter (1997) points out, this semantics is a problem for the analysis of a sentence like (5a), which should have the LF (5b) and the translation (5c).

(5) a. A unicorn sneezes.
b. ∃f [a_f unicorn sneezes]
c. ∃f [ch(f) ∧ sneeze(f(unicorn))]

Now, if the extension of the concept unicorn is empty, as it happens to be the case, the formula is not defined, but we want it to be false in this case. Winter proposes to type-lift choice functions: the indefinite article doesn't denote an ordinary choice function variable but a higher order choice variable: for a non-empty set P, f gives us the set of properties of a certain invidual in P. If f applies to an empty set P, it delivers the empty generalized quantifier. The formula representing (5b) would therefore be:

(6) ∃f [ch(f) ∧ (f(unicorn))(sneeze))]

This certainly makes the formula false and equivalent to the usual first order representation. If I am not following Winter's proposal here exactly, it is because a lot of the attraction of working with choice functions in semantics is that we can interpret indefinites *in situ*. Winter has gone back to the usual Montagovian nominal which we have to move at LF if it occurs in object position and if we forbid type lifting as an interpretive device (see Beck 1996 for relevant arguments). Thus, in Winter's account, sentence (7a) must have the LF (7b), whereas Reinhart (and me) would like to have the simpler LF (7c), which does it without QR:

(7) a. Max is reciting a poem.
b. ∃f [[a_f poem]$_i$[Max is reciting t_i]]
c. ∃f [Max is reciting a_f poem]

To be sure, Winter still can differentiate between indefinites and other quantifiers: QR does the local scoping and is a very local rule. Thus, the object cannot move very far. But the article still is a choice function and in virtue of this fact, the indefinite can extend its scope at libitum.

I think, the following "Fregean" account will do for our purposes. Let us assume that * is an object not in any semantic domain (it could be the universe). We then stipulate that f(P) = * if P is empty and f is a choice function. In other words, the revised definition is:

(8) **Revised definition.**
Let f be of type $\langle et, e\rangle$. f is a *choice function* iff (a) and (b) hold:
(a) P(f(P)) if P is non-empty.
(b) f(P) = * if P is empty.

The consequence of the revision is that we can work with choice functions of the simple type. Henceforth, I will assume this semantics for choice variables.[2] The anonymous referee #1 comments on definition (8) in the following way:

> This definition is not quite accurate under standard type-theoretical assumptions. An element of type (et)e is normally treated as a function from the D_{et} domain to the D_e domain. Since * is not a member of D_e, this definition is not completely well-defined.

I don't want to try to repair the definition here. Let us rather assume that * is some very remote object not satisfying any known predicate of natural language. This is Frege's original strategy and has the consequence that a statement of the form Q(f(P)) is false for every known predicate Q of natural language if P denotes the empty set.

As of consequence of our semantics for choice functions we have the following theorems, which will be used later:

(9) For any two first order predicates of natural language of type $\langle e,t\rangle$, the following equivalences are valid:

(a) $\exists x\, [P(x) \wedge Q(x)] \leftrightarrow \exists f\, [Q(f(P))]$

(b) $\exists f\, [Q(f(P))] \leftrightarrow \exists f\, [P(f(Q))]$

Since $\wedge$ is a symmetric connective, the predicates P and Q can switch places in the right hand representation.

2.3 Scoping indefinites without QR

Recall that the purpose of the section is to exempt indefinites from QR in favour of their treatment by means of choice functions. This subsection deals with the following objection of referee #1:

> Von Stechow assumes that when using CFs there is no need to assume that indefinites QR. This is not quite correct, as Reinhart and I point out in our papers. Consider a sentence like (I).
>
> (I) A guard is standing in front of three buildings in this town.
>
> CFs do not give the prominent reading of this sentence, with "three buidings" distributing over "guard".

I am not convinced by this objection. The objection can be met by a somewhat in depth analysis of the syntax of the example. The referee has in mind a distributive reading which can be paraphrased as: "There is a set of three buildings in this town such that for each of them there is a guard standing in front of it". I will argue that the LF which determines this reading is not obtained by one application of QR, but by two applications. The first application moves the term "each of three buildings in this town". This is a strong quantifier obeying clause boundedness. The second application of QR gives wide scope to the indefinite "three buildings of this town" with respect to the universal quantifier containing it. The second movement can be avoided by the choice function method.

It is very important to realize that the source of distributivity in an invisible distributor *D*, in fact a determiner, for the example given. In the next subsection a criticism of the generalization (1b) by Reinhart is also based on a different assumption on the source of distributivity. Hence I will spend some effort to make this point really clear.

Consider the LF which the referee #1 seems to have in mind:

(10) D(three buildings in this town)$_i$ A guard is standing in front of t$_i$

D is a distributor meaning something like "each of". So the LF can be read as "For each x of three buildings, a guard is standing in front of x". This gives us the intended reading, and we certainly cannot obtain it by leaving the indefinite *in situ* plus giving wide scope to the existential quantifier which binds the choice variable. The LF

(11) ∃f [A guard is standing in front of f(three buildings in this town)]

doesn't yield the reading under discussion. The LF rather expresses the collective reading that a guard is standing in front of three particular buildings. This presupposes that the guard is very big or the buildings are very small. This is my understanding of the objection.

A closer inspection of the LF (10) reveals, however, that we didn't QR the indefinite. We rather QRed a nominal of the form [D+indefinite term]. In other words, we didn't QR the weak quantifier *three buildings in this town* but the strong quantifier *D(three buildings in this town)*. To be more precise, consider a derivation in classical style by means of QR:

(12) a. DS: A guard is standing in front of D(three buildings)
b. LF: three buildings$_j$[D(t_j)$_i$ [A guard is standing in front of t_i]]
c. three buildings λX [D(X) λx [A guard is standing in front of x]]
= ∃X [X is a set of 3 buildings ∧ ∀x ∈ X [A guard is standing in front of x]]

The LF (12b) is obtained from the d-structure (12a) by two applications of QR: first we QR *D(three buildings)* from its base position to the adjunction position in front of the sentence; then we QR *three buildings* from the complement position of *D* to the most external position. The interpretation (12c) presupposes the following meaning rules:

(13) a. *three buildings* is of type $\langle\langle et,t\rangle,t\rangle$.
||*three buildings*||(P) = 1 iff ∃X: X is a set of three buildings & P(X) = 1.
b. *D* is a symbol of type $\langle\langle e,t\rangle,\langle et,t\rangle\rangle$.
||*D*||(X)(P) = 1 iff ∀x ∈ X: P(x) = 1.

In other words, *three buildings* is interpreted as an existential quantifier of plural predicates. *D* is a normal universal quantifier expressing the subset relation. If we want to avoid a type clash, we have to QR the generalized quantifier *three buildings*, which leaves a trace of type $\langle e,t\rangle$, the correct input for the distributor D.

An inspection of the LF (12b-c) shows that we can get rid of the second application of QR if we interpret *three buildings* as a plural property of type $\langle et,t\rangle$ and doing the quantification by means of the choice functions device. The relevant LF would then be this:

(14) ∃f [ch(f) ∧ D(f(three buildings)) λx [A guard is standing in front of x]]

To avoid confusion, I add the meaning rule for *three buildings*:[3]

(15) *three buildings* is of type $\langle et, t\rangle$.
$||$*three buildings*$||$(X) = 1 iff X is a set of three buildings.

And these are the possible structures of the nominal *three buildings*:

(16) a. $[_{DP,weak}$ f $[_{NP,pl}$ three buildings]]
b. $[_{DP,strong}$ Distributor $[_{DP,weak}$ f $[_{NP,pl}$ three buildings]]]
c. $[_{DP,strong}$ each $[_{PP}$ of $[_{DP,weak}$ f $[_{NP,pl}$ three buildings]]]]

The features weak/strong just remind you the semantic class of the quantifiers involved. It is important to realize that the distributor *D* converts a weak quantifier of pluralities into a strong quantifier of singularities. The structure of (16b) parallels that of (16c). The analysis of example (I) involves the QRing of the structure (16b), not the QRing of the structure (16a). We *could* QR (16a), but that would give us the the collective reading, not the distributive one:

(17) a. $[_{DP,pl}$ f $[_{NP,pl}$ three buildings]]$_i$[a guard is standing in from of t_i]
b. = ∃X [X are three buildings and a guard is standing in front of X]

This is the moment to compare our analysis of distributivity with the one assumed in Reinhart (1997, 366). Her LF in terms of QR is (18a), and the replacement of the existential quantifier over sets by means of the choice function method would be (18b):

(18) a. ∃X (two(X) & building(X) & X Dλz ∃y (guard(y) & y is standing in front of z))
b. ∃f [f(λX (two(X) & building(X)) Dλz ∃y (guard(y) & y is standing in front of z))]

This looks almost like our LF (14), but it is not the same. Reinhart's *D* is Link's (1991) distributor, which is a predicate modifier and says that the predicate distributes over the atomic parts of the subject, where the latter is a plurality. In other words, in Reinhart's LF the indefinite term *two buildings* is not an object of a distributor in determiner position. Rather, the LF is generated by applying QR to the indefinite. The *D* modifier may modify any predicate, if the predicate applies to a plural argument. If we proceed this way, some indefinite terms must undergo QR indeed.

Now, I think that the rule introducing the distributor is too general. I believe that Schwarzschild (1996, 75) is correct in assuming that the VP-modificator *D* is introduced by a rule interpreting plural VPs (Schwarzschild's rule (181)). In other words, a VP of the form [D VP] requires that the VP is plural and the subject of the VP is plural as well.[4] But our example fulfills neither requirement: the subject of example (I) above is a singular term and the VP is in the singular as well. Thus, I believe that Reinhart (slightly) misanalyzes the sentence. Since the referee #1 relies on Reinhart's analysis, my criticism carries over to his objection.

2.4 Unwarranted readings by free scoping of indefinites?

We now take up the criticism that principle (1b) heavily overgenerates and is therefore empirically indaquate. This criticism by referee #1 is based on an example due to Ruys (1995):

(19) a. If three relatives of mine die, I will inherit a house.
b. There are three relatives of mine such that, if each of them dies, I will inherit a house.
c. *For each of three relatives of mine, if he dies, I will inherit a house.

It is argued that the non-existent reading (19c) is an unwarranted application of QR to the indefinite *three relatives of mine*, which is scoped out of the *if*-clause. The analysis of these data by Reinhart (1997, 368) is this:

(20) a. [three relatives of mine] λz (if z dies, I inherit a house)
b. ∃X [three relatives of mine & (if X Dλz (z dies), I inherit a house)]
c. ∃X [three relatives of mine & X Dλz (if z dies, I inherit a house)]

(20b) is the correct reading, but (20c) is not intuitively available. According to Reinhart and Winter this reading cannot be blocked if we allow free scoping of indefinite terms. In other words, principle (1b) is too liberal.

My reaction is the same as in the last section. The distributor in (20c) is not licensed, because *D* can only be a determiner or it must attach to a plural VP, but it cannot attach to a (complex) finite sentence. On the other hand, the distributor in (20b) is licensed: it attaches to a plural VP. Thus the grammaticality pattern exhibited by (19) has nothing to do with the generalization (1b).

We obtain the same results if we analyze Ruys' example by means of a distributor in determiner position, which we have to do anyway if the distributor is phonetically visible (= *each of*):

(21) a. [three relatives of mine]$_i$ [If [D t_i] die, I will inherit a house]
b. *three relatives of mine$_j$[D[t_j]]$_i$ [If t_i die, I will inherit a house]

(21a) represents the good reading; here we have scoped the indefinite out of an island and the result is fine. (21b) exhibits a violation of principle (1a), i.e., the strong quantifyer [*D three relatives of mine*] cannot moved out of an island.

The pattern remains the same if we eliminate the existential quantifiers over sets by appropriate choice functions.

(22) a. ∃f [ch(f) ∧ [if [*D* f(three relatives of mine)] die, I will inherit a house]]
b. *∃f [ch(f) ∧ [*D* f(three relatives of mine)]$_i$ [if t_i die, I will inherit a house]]

(22b) exhibits an unwarranted application of QR: we have scoped the nominal [*D f(three relatives of mine)*] "each of f(three relatives of mine)" out of the entire sentence, a violation of an island constraint. Nothing of the sort happened in (22a): existential generalization of the choice variable is free.

Let me make it very clear once more: I don't say that the free scoping principle for indefinites cannot overgenerate. The only thing I have said is that the arguments against that principle haven't convinced me so far. Thus let us look at more data.

2.5 Indefinites as free choice function variables?

The problem of overgeneration arises not only with the free scoping of indefinites: another potential source of overgeneration is the unrestricted existential closure of choice function variables which is assumed in the literature. Kratzer (1998) wants to prevent the generation of unwanted LFs by interpreting indefinites as free choice function variables whose value is determined by the context. The relevant sentence discussed is due to Abusch (1994):[5]

(23) Every professor rewarded every student who read a book he had recommended.

The sentence has a reading where the object of the embeddded clause *a book he had recommended* has intermediate scope between the matrix subject and the matrix object, a violation of the clauseboundedness condition, which is usually observed for QR. The analysis in terms of choice functions is given in (24a). (24b) sketches the classical QR analysis and shows that QR has to violate an island constraint in order to derive this interpretation.

(24) a. Every professor x ∃f [ch(f) ∧ x rewarded every student who read f(book x had recommended)]
b. Every professor x ∃y [[y a book x had recommended] x rewarded every student who read y]

It should be clear from the paraphrases that we can avoid non local QR. The job is taken over by a non local binding of the choice variable.

The possibility that indefinites widen their scope freely has been disputed in the literature by Fodor & Sag (1982) and, recently, by Kratzer (1998). Kratzer argues that the scope extension of indefinites requires a bound pronoun somewhere in the indefinite. Kratzer holds the view that the choice variables remain free at LF; the context specifies their value. She observes that in the following pair of examples only (25a) has an intermediate reading.

(25) a. Every professor rewarded every student who read a book he had recommended.
b. Every professor rewarded every student who read a book Professor K. had recommended.

Kratzer wants to account for the contrast by representing these sentence as (26a) and (26b), respectively.

(26) a. Every professor x rewarded every student who read f(book x had recommended).
b. Every professor x rewarded every student who read f(book Professor K. had recommended).

In most cases the choice in (26a) covaries with the different instances of x whereas in (26b) there is no such variation. In some cases, however, there is no such covariation: under the not very likely scenario that each professor recommended the same books, the choice is the same for each student even for the representation (26b).

The following example, which illustrates the same point, is perhaps more suggestive:

(27) a. Every professor invited a colleague from his university.
b. Every professor x invited f(colleague from x's university)
c. $\forall$x [professor(x) $\rightarrow$ $\exists$y [colleague from x's university(y) $\wedge$ invite(x,y)]]

Suppose the professors are from the same university. Then the choice will be the same for each of them if we choose representation (27b). The first order representation (27c) makes sure that the choice may be a different for each professor. Clearly, (27a) has this reading under the scenario. On the other hand, the same-choice reading is absent as Yoad Winter has pointed out in the discussion. (I think I remember a discussion of the same point by Irene Heim, but I cannot find the reference.)

Kratzer's account has to say something on the nonavailabilty of the reading discussed. Furthermore, her solution has the consequence that we need an additional device for accounting for the narrow scope reading of the indefinite. Kratzer (1998) assumes that the indefinite article is ambiguous between the existential quantifier and a choice function. If we say that the existential closure of the choice function variable is possible everywhere, we won't be able to explain Kratzer's contrast. We will, however, take this line in the sequel.

2.6 Indefinites and discourse referents

For Heim (1982) and Kamp (1981) indefinites introduce new file cards/discourse referents, whereas definite terms and pronouns are anaphoric to discourse referents that have been introduced already. In classical notation, the DRT representation of (28a) is (28b):

(28) a. Eva has a new cat. Her name is Tabata.
b. $\exists$x [new cat(x) $\wedge$ have(Eva,x) $\wedge$ [x's name = Tabata]]

In order to obtain the LF (or DRS) (28b) from the surface (28a), we have to QR the indefinite term *a new cat* from its object position in front of the first sentence. It is interpreted as the open proposition *new cat(x)*. The variable x is picked up by the definite term *her name*, which is interpreted as *x's name*. The free variable x is existentially closed at the text level.

The theory crucially assumes that indefinite terms express open propositions. The question to be addressed here is how we can represent the text given in a theory that interprets indefinites by the choice function method. I am not aware of any discussion addressing this question.[6]

The first representation that comes to the mind is the following one:

(29) $\exists$f [ch(f) $\wedge$ Eva has f(new cat)$_i$ $\wedge$ [Her$_i$ name is Tabata]]

Recall that *f(new cat)* is an expression of type *e*, i.e., something like a name. Names cannot bind an anaphoric variable simpliciter. We need a theory of coreference. The DRT method (cf. Kamp & Reyle 1993) is to interpret a name with an index as an equation between the name and a new variable which is existentially bound at the text level. This amount to the LF (30a). Another method is to QR the name to the next text node. The result is the representation (30b):

(30) a. $\exists$f [ch(f) $\wedge$ $\exists$i [f(new cat) = i $\wedge$ [Eva has $t_i \wedge$ [Her_i name is Tabata]]]]
= $\exists$f [ch(f) $\wedge$ $\exists$x [f(new cat) = x $\wedge$ [have(Eva,x) $\wedge$ [x's name = Tabata]]]]

b. $\exists$f [ch(f) $\wedge$ f(new $cat)_i$[Eva has $t_i \wedge$ [Her_i name is Tabata]]]
= $\exists$f [ch(f) $\wedge$ f(new cat)λx [have(Eva,x) $\wedge$ [x's name = Tabata]]]

Note that both LFs involve scoping of the indefinite term. It would seem then that we cannot get rid of QR in an analysis in terms of simple choice functions, contrary to what we have said so far. You have to bear in mind, however, that the scoping involved in these examples is motivated by a different reason: we want to express the anaphoric relation between a pronoun and an antecedent. The only decent method I know is to do that by scoping and variable binding. There might be another method to achieve the same result, for instance, by restricting the variable assignment appropriately. The issue is very seldom addressed in the literature and no commonly accepted semantics of coreference is known to me. I will therefore assume that something along the lines sketched here is correct.

If we compare the LFs in (30) with the DRT representation (28), we have to admit that the latter is simpler. Thus, textual phenomena don't provide motivation for an analysis of indefinites in terms of choice functions. They rather support the DRT analysis. This would become even more obvious if we did consider the syntax and semantics of donkey sentences. On the other hand, we should not overestimate the complications arising with the examples discussed here; the difficulties are due to the interpretation of coreference: if indefinites are like names, they must be scoped if they bind an anaphoric pronoun.

2.7 Intermediate conclusion

The data discussed do not force us to take the choice function approach. We could achieve the same results by analyzing indefinites in the classical way combined with the insights of Heim (1982) and adding the stipulation that the QRing of indefinites and weak quantifiers in general is not restricted by islands, whereas the QRing of strong quantifiers obeys island restrictions. This is essentially the solution advocated by Abusch (1994), at least in my understanding. Thus, in order to convince people (including myself) of the necessity that we actually need choice functions for the LF representation of natural language, more conclusive data must come into play. The syntax and semantics of questions may provide the relevant evidence and we turn to interrogatives next.

3 CHOICE FUNCTIONS AND *wh*-PHRASES

3.1 In situ-interpretation of wh-phrases

The idea of making use of choice functions for the interpretation of questions goes back to Engdahl (1980). It has been revived by Reinhart in recent papers (cf. Reinhard 1992, 1994, 1997). The interpretation of questions by this method is particularly attractive for languages without *wh*-movement like Japanese or Korean. (Chomsky 1995, 291) seems to have this method in mind when he writes:

> Suppose that a language has weak Q [= the interrogative feature in COMP]. In that case the structure (63) [= Q [$_{IP}$ John gave DP to Mary]] will reach PF without essential change. If DP = which book, it will remain *in situ* at PF, (and also at LF, apart from covert raising for Case). The *wh*-feature [= the feature of the *wh*-phrase] does not adjoin to Q; both are Interpretable and need not be checked for convergence. If the language has only the interpretive options of English, it will have no intelligible *wh*-questions and presumably no evidence for a *wh*-feature at all. But languages commonly have *wh in situ* with the interpretation of (65c) [= (guess) which x, x a book, John gave x to Mary]. They must, then, employ an alternative interpretive strategy for the construction Q[... *wh*- ...], interpreting it, perhaps, as something like unselective binding. On different grounds, Reinhart (1994) proposes a similar analysis.

For a long time, the standard assumption in Generative Grammar was that *wh*-phrases had to move at LF for semantic reasons, more precisely, for reasons of scope. In recent work, Chomsky seems to hold the view that *wh*-movement serves the purpose of clause typing, i.e., a fronted *wh*-clause marks a construction as an interrogative construction. In other words, *wh*-movement is not motivated semantically but syntactically. The *in situ* interpretation by means of choice functions seems to provide a method to implement this idea semantically.

If we forget the availabilty of choice functions and try to implement Chomsky's suggestion, the first idea that comes to mind is to proceed like in Heim (1982): *wh*-questions are indefinites and therefore have a free individual variable, the *wh*-variable. Unselective binding of *wh*-variables means existential quantification of these individual variables from COMP. This is the road Nishigauchi (1990) takes for his analysis of *wh*-questions in Japanese, a *wh in situ* language. The result is that the predicted meanings for questions are not correct, as the following example from Nishigauchi shows:

(31) a. Kimi-wa dare-ga kai-ta hon-o yomi-masi-ta ka?
you-TOP who-NOM write-PAST book-ACC read-do-PAST Q
'For which person x, you read a book that x wrote'

b. Nishigauchi's LF:
[$_{CP}$ [[dare-ga$_j$ kai-ta] hon-o]$_i$ [$_{C'}$ kimi-wa t$_i$ yomi-masi-ta ka$_{ij}$]]
[$_{CP}$ [[who$_j$ wrote book]$_i$ [$_{C'}$ you t$_i$ read Q$_{ij}$]]

c. Predicted interpretation:
'For which x,y, x a book, y a person that wrote x, did you read x?'

d. Interpretation wanted:
'For which person x, did you read a/the book that x wrote?'

Nishigauchi's theory predicts that the Japanese question (31a) is synonymous with "Which book that someone wrote did you read?". But the Japanese question doesn't mean that. It has the meaning paraphrased in (31d). Thus unselective binding in the style of Heim (1982) cannot be used for an interpretation of *wh in situ*.[7] Nishigauchi's account has been discussed in detail in Stechow (1996). Von Stechow defends a standard LF, in which the *wh*-phrase undergoes long *wh*-movement.

(32) a. $[_{CP}$ dare-ga$_2$$[[_{NP}$ $[_{CP}$ t_2 kai-ta] hon-o$]_1$ $[_S$ kimi-wa t_1 yomi-masi-ta] ka]

b. $\lambda p\ \exists x_2\ [\text{person}(x_2) \wedge p = \exists x_1\ [\text{book}(x_1) \wedge x_2 \text{ wrote } x_1 \wedge \text{ you read } x_1]]$

The LF (32a) violates the Ross constraint, but it correctly represents the meaning of the question as the one-to-one translation (32b) shows, which is a Hamblin/Karttunen formula.

As the reader may guess, choice functions provide the resources to overcome this problem. We can interpret *wh*-phrases *in situ* via unselective binding and nevertheless have the correct semantics. We assume that the *which*-determiner, or the *wh*-morpheme quite generally, expresses a choice function variable, which is existentially bound from COMP. COMP itself contains an interrogativizer meaning "p =", where p is a proposition variable λ-bound at the CP level. The correct formulation of Nishigauchi's question is then:

(33) a. Revised LF for Nishigauchi
$[_{CP}\ \exists j\ [_{C'}\ \exists i\ [_S$ kimi-wa [[dare-ga$_j$ kai-ta] hon-o$]_i$ yomi-masi-ta] ka]]

b. Interpretation
$\lambda p\ \exists f\ [ch(f) \wedge p = \lambda w\ \exists g\ [ch(g) \wedge$
$\text{read}_w(\text{you}, g(\text{book}_w \text{ that } f(\text{person}_{w_0}) \text{ wrote}_w)]$

c. Classical LF
$\lambda p\ \exists x\ [\text{person}_{w_0}(x) \wedge p = \lambda w\ \exists y\ [\text{book}_w \text{ that x wrote}_w(y) \wedge$
$\text{read}_w(\text{you}, y)]$

The LF (33b) is equivalent to the classical LF (33c). It is important to realize that the choice function for the non-interrogative indefinite "a book ... " is quantified in the scope of the interrogativizer. A similar analysis of Nishigauchi's data is given in Heim (1994).

The method extends to more than one *wh*-phrase *in situ*, and to cases in which we can have a *wh*-phrase in COMP and one or more *in situ*. In the latter case we may consider the *wh*-phrase moved as a genereralized quantifier, whereas the *wh*-phrase *in situ* has its choice variable bound from COMP. Here is the analysis of such an example:

(34) a. which book did which student read t_1

b. [which book$]_1\exists_2$ did [which$_2$ student read t_1]

c. $\lambda p\ \lambda P\ \exists g\ [ch(g) \wedge P(g(\text{book}_{w_0}))]$
$(\lambda x_1 \exists f_2\ [ch(f_2) \wedge [p = \lambda w\ [\text{read}_w(f_2(\text{student}_{w_0}), x_1)]]]])$
$= \lambda p\ \exists g\ [ch(g) \wedge$
$\exists f_2\ [ch(f_2) \wedge [p = \lambda w\ [\text{read}_w(f_2(\text{student}_{w_0}), g(\text{book}_{w_0}))]]]]$

To be sure, $\lambda P\ \exists g\ [ch(g) \wedge P(g(book_{w_0}))]$ is the generalized quantifier phrase which translates *which book*. Its type is the usual type of generalized quantifiers, viz. $\langle et, t\rangle$.

The examples given can be analyzed by *wh*-movement at LF. The following example, which contains a *which*-phrase with an embedded *which*-phrase, is a notorious problem for classical accounts:

(35) Which mountain in which country did you climb? The Tödi in Switzerland and Mount Cook in New Zealand.

The answers suggest that we should have two *wh*-variables in the nucleus of the question. But *wh*-movement leaves only one *wh*-trace:

(36) [Which mountain in which country]$_i$ did you climb t$_i$?

According to the standard semantics, the question means something like "Which mountain in some country did you climb?". A good answer would then be: "I climbed the Tödi and Mount Cook." To be sure, an interpretation by means of the choice function method is not entirely straigthforward, because we have to reconstruct the *wh*-phrase, but the rest of the job is easy.

(37) a. ∃i ∃j [$_{C'}$ did you climb which$_i$ mountain in which$_j$ country]
b. λp ∃f [ch(f) ∧ ∃g [ch(g) ∧ [p = λw.climb$_w$(you, f(mountain$_{w_0}$ in g(country$_{w_0}$)))]]]

For an analysis along these lines, see Heim (1994). One might think that one could obtain the same result by means of the standard method plus a copy theory of traces in the style proposed by Chomsky (1995). This however is not so. Try to give a paraphrase of the question in conventional terms and you will see the difficulty. The nearest paraphrase that comes to mind is something like this:

(38) For which x, x a mountain and for which y, y a country, you climbed the z which is that x and which is in that y?

It is not at all obvious whether there is a principled way to get that information from a standard LF. If the analysis in terms of choice function is correct, then this example is the only one I am aware of that a classical approach cannot treat.

4 CHOICE FUNCTIONS AND THE EXTENSIONALITY OF *which*-PHRASES

A closer inspection of the LFs for questions given so far reveals a problem. Most semanticist hold the view that the predicate in the restriction of a *wh*-determiner is extensional with respect to the interrogativizer. Now, example (37) has shown that the restriction of a *which*-phrase has to be reconstructed to its base position and the choice function applies there. In order to garantee the extensionality of the restriction we have used the variable w_0 without discussion. By convention, the free variable w_0 refers to the actual world. But this extensionality doesn't follow from the grammar so far. Therefore we have to constrain our formalism. This is the aim of this section.

In order to make the problem clear, consider the old chestnut (39a). The standard analysis according to Hamblin/Karttunen is (39b).

(39) a. Which students came to the party?
b. $\lambda p\ \exists x\ student_w(x) \wedge p = \lambda w.come\text{-}to\text{-}party_w(x)$

The world variable of *student* is free (39b). The method developed so far gives us two possibilities to represent this reading in terms of choice functions:

(40) a. $\lambda p\ \exists f\ ch(f) \wedge p = \lambda w.come\text{-}to\text{-}party_w(f(student_{w_0}))$
b. $\lambda p\ \lambda P\ \exists f\ [ch(f) \wedge P(f(student_{w_0}))]\ \lambda x\ [p = \lambda w.come\text{-}to\text{-}party_w(x)]$

(40a) uses double indexing, (40b) interprets *which students* as a generalized quantifier and moves it to COMP. After λ-conversion we obtain the formula (40a). The formula is equivalent with (39b). I think the latter approach is not interesting because it amounts to a complicate reformulation of the standard account in terms of generalized quantifiers. Therefore we return to the *in situ* interpretation exhibited by (40a).

The question to be addressed next is which principles prevent that (39a) has the representation (41):[8]

(41) $\lambda p\ \exists f\ ch(f) \wedge p = \lambda w\ come\text{-}to\text{-}party_w(f(student_w))$

Note first that this representation makes the question equivalent to the classical *in situ*-interpretation

(42) $\lambda p\ \exists x\ p = \lambda w\ [student_w(x) \wedge come\text{-}to\text{-}party_w(x)]$

Here are just two of many arguments against this kind of *de situ*-interpretation, which have been given in the literature. Heim (1993) observes that the approach makes the following two questions synoymous:

(43) a. Which toys are gifts?
$= \lambda p\ \exists x\ [p = \lambda w\ [toy_w(x) \wedge gift_w(x)]]$
b. Which gifts are toys?
$= \lambda p\ \exists x\ [p = \lambda w\ [gift_w(x) \wedge toy_w(x)]]$

The corresponding representations in terms of choice functions are these:

(44) a. $\lambda p\ \exists f\ [ch(f) \wedge p = \lambda w.gift_w(f(toy_w))]$
b. $\lambda p\ \exists f\ [ch(f) \wedge p = \lambda w.toy_w(f(gift_w))]$

The equivalence of the two formulae follows directly from the theorems in (9). The two questions in (43) are, however, not equivalent.

Another relevant example is due to Reinhart (1997, 359):

(45) Who will be offended if we invite which philosopher?

A *in situ*-interpretation by the Karttunen method gives us the reading :"For which person x and for which y: x will be offended if y were a philosopher and we invited y", as the reader may check for her/himself. In this particular case, we can obtain a more or less correct analysis by the method introduced so far, i.e., we can analyze (45) as

(46) $\lambda p\ \exists f\ [ch(f) \wedge \exists g\ [ch(g) \wedge p = \lambda w\ [invite_w(we, philospher_w) \rightarrow offended_w(f(person_w))]]$

Irrelevant details aside, this is the analysis given in Reinhart (1997, 376). But, the analysis cannot be entirely correct as it stands. This becomes obvious as soon as a *wh*-phrase occurs in the scope of an intensional predicate, for instance, a modal:

(47) Who must read which book?

Suppose, *must* has a deontic interpretation. Then our method gives us the reading:

(48) a. For which x and y: it follows from the law that x is a person & y is a book & x reads?
b. $\lambda p\ \exists f\ \exists g\ [ch(f) \wedge ch(g) \wedge p = \lambda w\ [MUST_w(\lambda w.read_w(g(book_w))(f(person_w)))]]$

The meaning for MUST is given by the this interpretation:

(49) MUST is a symbol of type $\langle s, \langle st, t\rangle\rangle$.
$||MUST||(w)(p) = 1$ if p follows from the law in w.

The law in w is a (very informative) proposition. For a more refined analysis of modality, see Kratzer (1978). Clearly, the formula (48b) doesn't capture a reading of (48a). The reason is that the *wh*-choice is done under the intensional predicate. So this has to be repaired.

The extensionality of *which*-phrases is guaranteed by taking up a proposal made in Reinhart (1994), who introduces choice functions which operate on properties *in intenso* and pick up an individual which is in the extension of the property when it is evaluated with respect to the world of a higher [COMP, +wh]. In our extensional framework, we have to say this:[9]

(50) a. Let F be of type $\langle\langle s, et\rangle, e\rangle$. F is a *generalized choice function* iff for every $P \neq \emptyset$ in the domain of F, P(w)(F(P)), for every w. (If $P = \emptyset$, then F(P) = *.)
b. F is *a choice for world w* – $ch_w(F)$ – iff P(w)(F(P)) for any P in the domain of F and any world w.

The terminology *generalized choice function* is ad hoc. I use it in order to distinguish this kind of choice functions from the ordinary ones. The term *choice for w* is taken from Heim (1994).

Let us henceforth forbid to use the simple choice functions for *wh*-words. We replace them by generalized choice functions which are w-choices, where w is the "world of COMP". This eliminates the intensional readings discussed above because the two sentences (43) only have the following representations:

(51) a. $\lambda p\ \exists F\ [ch_w(F) \wedge p = \lambda w.gift_w(F(toy))]$
b. $\lambda p\ \exists F\ [ch_w(F) \wedge p = \lambda w.toy_w(F(toy))]$

Thus, the slight complication of the type of choice functions increases the descriptive adequacy of the system.

To be sure, there remain many issues to be discussed: in fact, I believe that none of the existing theories of questions is fully correct. We need a *de re* approach which guarantees that a *which*-NP has wide scope with respect to the interrogativizer. Neverthess, a property relating the subject of the attitude to each of the alternatives asked for enters the content of the question. I am not aware of the existence of such a theory.[10] Hence, I will simply assume that *which*-phrases are extensional with respect to the interrogativizer of their clause.

4.1 Further complications: Choice of concepts and Skolem functions

Generalized choice functions work on intensions, but they give us a bare individual, i.e., nothing intensional. In the literature, it has been argued that sometimes *which*-phrases ask for individual concepts. Heim (1994) gives the following example:

(52) Which of your classmates do you want to be friends with? The one with the best grades (whoever she may be)

Thus, the choice from a property *in intenso* must be an individual concept which assigns to any world an individual which is a P in that world. Heim (1994) calls this kind of choice functions "intensional choice functions".

(53) Let f be of type $\langle\langle s, et\rangle\langle s, e\rangle\rangle$. f is an *intensional choice function* – i-ch(f) – iff P(w)(f(P)(w)) for every P in the domain of f and every w.

The interpretation for (52) is then the following one:

(54) $\lambda p\ \exists f\ [\text{i-ch}(f) \wedge p = \lambda w\ [want_w(you, \lambda w\ [friend\text{-}with_w(you, f(your\ class\ mates))]]]]$

While this might turn out to be the correct analysis, more would have to be said to justify the formula. Above all we would have to analyze what it means to be friends with an individual concept. Presumably, this means that one is friends with the value of the concept. If we analyze "want" as "In every world where the wishes of the subject are fulfilled", the formula would express that you are friends with f(your classmates) in every wanting world. I will not further investigate the consequences of this analysis here. In most cases, then, *which*-determiners are interpreted as generalized choice functions.

And even this complication is not sufficient to deal with all the interrogatives discussed in the literature. Functional readings of questions demand a further type of choice functions. Engdahl (1986) treats questions like this one:

(55) a. Which of his books does every author prefer? His latest.
b. $\lambda p\ \exists f\ \forall x$ [one of x's $books_w(f(x))][p = \lambda w\ \forall y\ [author_w(y) \rightarrow prefer_w(y, f(y))]]]$

Here, f is a Skolem function of type $\langle e,t\rangle$ which is restricted by the 2-place relation $\lambda x \lambda y$ [*y is one of x's books in w*]. This means that f satisfies the requirement $\forall x\ R(x)(f(x))$, where R is of type $\langle e,\langle e,t\rangle\rangle$. Again, this restriction is evaluated at the world of COMP. A choice functions approach wants to have the restriction *in situ*. I will first give the formula which represents Engdahl's meaning, and then I will introduce the appropriate type of choice functions. Here is the formula:

(56) $\lambda p\ \exists\Phi\ [s\text{-}ch_w(\Phi) \wedge p = \forall y\ [author_w(y) \rightarrow prefer_w(y, \Phi(\lambda y\ \lambda w\ \lambda x.x$ one of y's $books_w)(y))]]$

Φ is a function which operates on a two-place relation *in intenso* R of type $\langle s,\langle e,et\rangle\rangle$ and chooses a Skolem function f for every world w such that this f which chooses an individual in R(w)(x). In this particular case, $\Phi(\lambda w\ \lambda y\ \lambda x.x$ one of y's $books_w)$ is the Skolem function which picks out one of y's books for each y. Let us call such functions Skolem choice functions. More accurately, we have this:

(57) a. Let Φ be of type $\langle\langle s,\langle e,et\rangle\rangle,ee\rangle$. Φ is a *Skolem choice function* iff for any R in the domain of Φ, $\Phi(R)$ is a Skolem function f such that for any x in the domain of f, R(x)(w)(f(x)) for any w.
b. In analogy to what we did earlier, we introduce for any such function the predicate "Skolem choice for w" – $s\text{-}ch_w$ –:
$s\text{-}ch_w(\Phi) = 1$ iff for any R in the domain of Φ and any x in the domain $\Phi(R)$: $R(w)(x)(\Phi(R)(x)) = 1$.

I remember that this definition is due to Heim (1994), but I have not been able to verify the reference.

4.2 Second intermediate conclusion

In the view of modern research, notably the Minimalist Program, the possibility to interpret *wh*-phrases *in situ* certainly is an attractive one. The extra complications discussed in the last section will arise in any framework, as far as I can see. Furthermore, there is at least one sentence that cannot be treated by the classical method, viz. (37). Or, more cautiously, *I* don't know how to treat it in terms of *wh*-movement. Reinhart claims that data from sluicing provide further evidence in favour of the *in situ*-interpretation. I don't want to review her account here, but I refer the reader to Reinhart (1997), notably section 2.2.

5 THE *de dicto-de re* AMBIGUITY

Graham Katz has asked me how this approach can deal with object opaque verbs, i.e. Montague's (1974) celebrated example *Jones seeks a unicorn*. Montague embeds the intension of a nominal under *seek*, and we can lift the term *a unicorn* to a nominal in our approach. That would be the term (58a). Zimmermann (1993) has shown that a simpler solution is available and preferable: we can embed the property *in intenso* of being a unicorn. In terms of choice functions that would be the term (58b).

(58) a. λw λP $\exists$f ch(f) $\wedge$ P(f(unicorn$_w$))
b. λw λx $\exists$f ch(f) $\wedge$ f(unicorn$_w$) = x

In each case, we have enough information to implement one or the other analysis of opacity.[11] The anonymous referee #1 adds the further comment:

> I think the main problem of intensional contexts and CF is not the de dicto reading that von Stechow mentions but rather the de re one: how do we garantee that wide scope existential closure of CFs is equivalent to the classical de re reading? I don't think this problem should be solved in this paper . . . .

I think the problem can be solved in analogy to the semantics for *wh*-phrases, which was presented in section 4. The interpretation given to *wh*-phrases in the preceding section can be used to analyze *de re*-readings of terms occurring in opaque contexts. Recall that the referee said that the hard problem is to automatically derive an extensional interpretation if a choice variable is bound by an existential quantifier outside the intensional operator in which the definite occurs. Here is the *de dicto* analysis of Montague's celebrated sentence:

(59) a. Jones seeks a unicorn.
b. seek$_w$(j, unicorn)

The analysis follows Zimmermann (1993) in assuming that object opaque verbs embed properties and not quantifiers. The meaning of the verb *seek* can be described as follows:

(60) *seek* is a symbol of type $\langle s, \langle\langle se, t\rangle, \langle e, t\rangle\rangle\rangle$.
||seek||(w)(P)(x) = 1 iff for every w'[If x finds in w' everything x is searching in w, then $\exists$y [P(w')(y) and x finds y in w']].

If we assume that *unicorn* is of type $\langle s, et\rangle$, the formula (59b) gives us the correct intensional reading.

Let us take up the *de re*-interpretation next. We have a slight problem of type compatibility here: if we apply a choice function variable to a property, the result is an expression of type *e* whereas the intensional verb *seek* requires an object of type $\langle s, et\rangle$. Therefore, we have to lift the individual expression to an expression of that type. (61a) is the relevant type shifting operation and (61b) is the formula representing the *de re* reading, using generalized choice functions as introduced in (50).

(61) a. $\star$:= λx λw λy [x = y]
b. $\exists$F [ch$_w$(F) $\wedge$ seek$_w$(j,$\star$(F(unicorn)))]
= $\exists$F [ch$_w$(F) $\wedge$ seek$_w$(j,λw λy [F(unicorn) = y])]

(61b) is true in a world w iff there is a unicorn x in w and for every w' such that Jones finds in w' everything he is searching in w: there is a y, y = x and Jones finds y in w'. This is equivalent with the statement: there is a unicorn x in w and for every w' such that Jones finds in w' everything he is searching in w: Jones finds x in w'.

We could simplify the approach if we assumed an extensional pendant for the verb *seek*, i.e. a lexical entry of type $\langle e, et\rangle$. The description of the meaning of this verb should be obvious. If we assume this additional entry, the formula expressing the *de re* reading in terms of choice functions is simply this:

(62) $\exists F\ [ch_w(F) \wedge seek_w(j, F(unicorn))]$

Note that the procedures sketched in this section are entirely standard. Montague's quantifying into opaque contexts uses a type lifting operation as well. The simplest (extensional) formula which represents Montague's UG analysis is this:

(63) $\lambda P\ \exists x\ [unicorn_w(x) \wedge P(x)](\lambda x\ [seeks_w(j, \star(x))])$,
with P of type $\langle e, t\rangle$ and $\star = \lambda x\ \lambda w\ \lambda P\ P(x)$.

The essential ingredient for the solution is the requirement that we always have to use generalized choice functions when the choice concerns a property *in intenso*. This requirement doesn't seem to involve a particular stipulation: in an intensional context, the choice has to involve an intension. And we have to say of course, in which world the choice is done. Generalized choice functions encode these two requirements.

I think that this analysis gives a satisfying account of the *de re-de dicto* ambiguity for indefinites occurring in the object position of object opaque verbs. Like Zimmermann's (1993) analysis, it predicts that the ambiguity occurs only with quantifiers that stand in a one-to-one correspondence with one place properties, i.e., weak quantifiers. Strong quantifiers have to be QRed in order to match the type of the object. Thus, (64a) can only have the extensional representation (64b):

(64) a. Jones seeks every unicorn.
b. $\lambda P\ \forall x\ [unicorn_w(x) \rightarrow P(x)](\lambda x\ [seeks_w(j, \star(x))])$
$= \forall x\ [unicorn_w(x) \rightarrow seeks_w(j, \star(x))]$

No opaque representation is possible, an empirically welcome prediction.

6 CHOICE FUNCTIONS AND LF-BARRIERS

In this section I will discuss phenomena whose explanation requires *wh*-movement at LF. The essential goal of a theory which interprets *wh*-phrases by means of choice functions is of course to get rid of this movement. I will investigate how the effects of LF movement can be simulated in a choice function approach.

Beck (1996) considers the following contrast in German:

(65) a. *Wann hat niemand wem geholfen?
When has no one whom helped?
b. Wann hat wem niemand geholfen?
When has whom no one helped?

The difference between the two structures is that in (65b), the *wh*-phrase *wem* is scrambled over the subject whereas it is in situ in (65a). Beck's theory, which derives the contrast, is that LF-movement cannot cross a negation or quantifier in general. Overt movement, on the other hand, can go across a negation or a quantifier. In order to spell out the theory, Beck distinguishes LF-traces from surface traces by means of the superscript *LF*. She formulates the following LF-filter which I will name "Beck's filter" (the original name is "Minimal Quantified Structure Constraint" [MQSC]).

(66) **Beck's LF-filter** (Beck 1996)
No structure of German may exhibit the following configuration:
α_i ... Neg or Quant ... t_i^{LF} ..., t_i^{LF} an LF-trace of α.

Let me stress that Beck's filter is a descriptive principle which is valid for German only. It is not at all clear how it can be extended to other languages. In the first draft of this paper, the relativization to German was not highlighted enough. So the referee #1 thought that the filter made claims about English and he gave counter examples. English works quite differently. The referee #2 asked a similar question about French. Beck (1996) has nothing to say about these languages, and I don't know whether her approach has been generalized since. The following section is nothing but an attempt to reformulate Beck's description in terms of choice functions.

These are Beck's LFs for (65a) and (65b):

(67) a. *Wann$_1$ wem$_2$ [$_{C'}$ hat **niemand** t_2^{LF} t_1 geholfen]
when$_1$ whom$_2$ has no one t_2^{LF} t_1 helped
b. Wann$_1$ wem$_2$ [$_{C'}$ hat t_2^{LF} **niemand** t'$_2$ t_1 geholfen]

(67a) violates Beck's LF-filter, (67b) doesn't. The LF-barrier is indicated in boldface print. Obviously, the theory presupposes a classical analysis of interrogatives, where the *wh*-phrases undergoes movement to COMP at LF. This immediately raises questions which a theory that doesn't assume LF movement of *wh*-phrases has to answer and the interpretation of *wh*-phrases by means of choice function variables is precisely such a theory.

Before I take up the challenge let me mention some more examples of Beck (1996) which are explained by the filter. The following sentences require reconstruction of pied-piped material:

(68) a. Wieviele Bücher hat Karl nicht gelesen?
How many books has Karl not read?
b. For which n, there are n books which Karl did not read?
c. *For which n, not: there are n^{LF} books which Karl did read?

If one assumes an LF along the lines of the paraphrase (68c), the ungrammaticality follows, for the structure violates Beck's filter. To be more concrete, let us consider the derivation of the two LFs in more detail. To facilitate the understanding, I give an interlinear translation of German into English:

(69) a. S-structure: [How many books]$_i$ has Karl not t$_i$ read?
b. [How many$_n$[t_n^{LF} books]$_i$] has Karl not t$_i$ read?
(QR-ing *how many* to its NP)
c. LF1: How many$_n$ has [t_n^{LF} books]$_i$ Karl not t$_i$ read?
(Reconstruct [t_n^{LF} books]$_i$ to the highest adjunction site of IP)
d. LF2: *How many$_n$ has Karl not [t_n^{LF} books]$_i$ t$_i$ read?
(Reconstruct [t_n^{LF} books]$_i$ to the highest VP adjunction site under the negation)

LF2 is the structure that contains the offending trace because the relation between *How many$_n$* and t_n^{LF} crosses a negation. It should be obvious that the two LFs have a straightforward translation into a Hamblin/Karttunen formula. In order to make the theory work we need a number of auxiliary assumptions. One is that reconstruction leaves no trace. This is mentioned in Beck (1996) and Stechow (1996). Another assumption that seems required is that the offending trace t_n^{LF} is not present at S-structure already. Suppose, the adjunction of *how many* to its own NP were an admissible S-structure operation, i.e., (69b) were an S-structure and would therefore not contain a trace with the superscript *LF*. Then LF2 would not contain a trace with the superscript and would therefore not violate Beck's filter. As far as I know, Beck (1996) does not discuss this detail. For the time being, let us assume a principle like the following:

(70) No string vacuous adjunction at S-structure.

This ban against local QR is rather reasonable, because local QR merely serves the purpose of potentially binding a variable by means of λ-abstraction. Thus, it is a genuine interpretive operation. I will come back to this point below.[12]

Other examples illustrating the same point are these:

(71) a. Wieviele Bücher hat jeder gelesen?
how many books has everyone read?
b. For how many$_n$: there are t_n^{LF} books such that everyone read them?
c. *For how many$_n$: everyone is such that there are t_n^{LF} books read read by him?

In (71c), the relation betwen the antecedent an its LF-trace crosses "everyone", again a violation of Beck's filter. Beck (1996) notices that (71a) can have a distributive interpretation, i.e., it can mean something like:

(72) a. For everyone, how many books did he read?
b. For everyone$_i$, for how many$_n$: for t_i^{LF} there are t_n^{LF} books read them?

(72b) is a somewhat more explicit paraphrase of the reading. Never mind how distributive questions are exactly interpreted, a notoriously difficult problem, the paraphrase suffices for an illustration of Beck's explanation of the availability of the distributive reading: the possible intervener "everyone" is scoped over the CP and is no barrier anymore between *many* and its LF-trace.

The theory has an unexplained residue which should be mentioned here. If we look at the reconstruction data, we see that the reconstructed nominal "t_n books" is always interpreted as "there is a group/set of t_n books". Now, "there is" is obviously an existential quantifier. How is it possible, then, that this quantifier doesn't give rise to a violation of Beck's filter? In each case, the binding relation between the LF-trace and its binder crosses this quantifier. Beck (1996) solves the problem by stipulation: indefinites do not count as quantifiers in the sense of the filter. This move weakens the explanatory adequacy of the filter, because Beck has in mind a semantic definition of quantifiers. Anything that expresses a second order relation, i.e., a relation between sets, including the existential quantifier, should therefore be a quantifier.

One might think that the choice function approach could help to overcome the problem because the indefinite article is a function variable and hence no LF intervener. This, however, is an illusion. The choice variable has to be bound and, for the critical example, at a lower position than the antecedent of the LF-trace. The result is an LF configuration which is alike to the one assumed by Beck in the relevant respects. Thus, I have nothing better to offer, and we have to continue to live with the stipulation that existentially interpreted indefinites are not LF barriers.

A further example discussed in Beck's theory is *wer-alles*-split in German.

(73) a. [Wen alles]$_i$ hat niemand t_i gesehen?
Whom all has nobody seen?
b. *Wen$_i$ hat niemand [t_i alles] gesehen?
c. Wen$_i$ hat [t_i alles]$_j$ niemand t_j gesehen?

(73a) and (73c) mean the same: we ask for the people which are a seen be nobody and we want to have an exhaustive answer. The exhaustivity operator is *alles*. (73b) is ungrammatical, but the grammaticality is restored if we scramble the object before we extract the *wh*-phrase. In both cases, *alles* is stranded.

Beck explains the contrast by assuming the following two LFs for (73b) and (73c), respectively.

(74) a. alles$_j$ [$_{\text{CP}}$ [Wen t_j^{LF}]$_i$? niemand t_i gesehen hat]
b. *alles$_i$ [$_{\text{CP}}$ Wen$_i$? niemand [$t_i t_j^{LF}$] gesehen hat]

In other words, *alles* is scoped to the CP adjunction site at LF. (74b) is ruled out by Beck's filter because *niemand* "nobody" is an LF-barrier. To make the movement of *alles* to CP plausible, let us introduce Beck's semantics for the "exhaustor" *alles*:

(75) $\text{ALL}(Q) = \{\bigcap X \mid X \subset Q\}$

Thus, (75a) is roughly translated as:

(76) $\text{ALL}(\lambda p\ \exists x\ [p = \text{nobody saw x}])$
$= \{\bigcap X \mid X \subset \lambda p\ \exists x\ [p = \text{nobody saw x}]\}$

Inspection of the formula reveals that we do not find any reflex of the trace t_j^{LF}, which figures in (74). Beck has to say that the LF-movement of *alles* is type driven: the exhaustor requires the question type. Therefore it must adjoint to the interrogative CP. A trace is not interpretable, but the theory requires that there is one, otherwise we could not explain the contrast. The reader might not be satisfied by this stipulation, but it is the best account known to me. Faute de mieux, let us therefore assume that it is correct.

As I said, Beck's filter is intended for German. But Korean exhibits similar data, so let us assume that this language makes use of the principle as well. Exactly as in German, Scrambling can rescue an ungrammatical structure. The following data are from Beck & Kim (1996).

(77) a. *amuto muôs-ûl sa-chi anh-ass-ni?
anyone what-ACC buy-CHI not-do-PAST-Q
b. muôs-ûl$_i$ amuto t_i sa-chi anh-ass-ni?
what-ACC$_i$ anyone t_i buy-CHI not-do-PAST-Q
"What did nobody buy?"

The LFs offered which explain the contrast according to Beck & Kim are roughly these:

(78) a. *muôs-ûl$_1$ [$_{C'}$ **NEG** amuto t_1^{LF} sa-chi anh-ass-ni?]
b. muôs-ûl$_1$ [$_{C'}$ t_1^{LF} **NEG** amuto t_1 sa-chi anh-ass-ni?]

It is important to be aware of the fact that these LFs mean exactly the same under the standard analysis for questions. (78a) and (78b) are translated into the formulae (79a) and (79b), respectively. (79b) is equivalent to (79a) by λ-conversion.

(79) a. $\lambda p\ [\lambda P\ \exists x_1\ [\text{thing}_{w_0}(x_1) \wedge P(x_1)]\ (\lambda x_1\ [p = \lambda w\ \neg\exists x_2\ \text{person}_w(x_2) \wedge \text{buy}_w(x_2,x_1)])]$
$= \lambda p\ \exists x_1\ [\text{thing}_{w_0}(x_1) \wedge p = \lambda w\ \neg\exists x_2\ \text{person}_w(x_2) \wedge \text{buy}_w(x_2,x_1)]$
b. $\lambda p\ [\lambda P\ \exists x_1\ [\text{thing}_{w_0}(x_1) \wedge P(x_1)]$
$(\lambda x_1[x_1\ \lambda x_1[p = \lambda w\ \neg\exists x_2\ \text{person}_w(x_2) \wedge \text{buy}_w(x_2,x_1)]])]$

Thus there are no semantic reasons for the ungrammaticality of (77a). The structure simply violates an LF output condition. The same point can be made with questions that require a functional answer:

(80) a. *Amuto [chaki-ŭi tonglyo-change nuku-lŭl] chochoha-chi anh-ni?
anyone self-GEN colleague-among who-ACC like-CHI not-do-Q.
b. [chaki-ŭi tonglyo-change nuku-lŭl]$_i$ amuto t_i chochoha-chi anh-ni?
c. Chaki-ŭi kyŏchaengcha
Self's competitor.

The question means "Which of his colleagues does nobody like?". An answer may be "His competitor". This might be interpreted as the Skolem function which assigns to any person his competitor among the real persons, or the intensional version thereof, i.e., the Skolem function which assigns to any x and w the competitor of x among x's colleagues in w. Adapting the theory of Engdahl (1986) to the example, we can represent the two readings as (81a) and (81b).

(81) a. $\lambda p\ \exists f\ \forall x$ [among x's colleagues$_w$(f(x))]
$\wedge\ p = \lambda w\ \neg\exists x$ [person$_w$(x) $\wedge$ like$_w$(x,f(x))],
f of type $\langle e, e\rangle$.
b. $\lambda p\ \exists f\ \forall w\ \forall x$ [among x's colleagues$_w$(f$_w$(x))]
$\wedge\ p = \lambda w\ \neg\exists x$ [person$_w$(x) $\wedge$ like$_w$(x,f$_w$(x))],
f of type $\langle s, \langle e, e\rangle\rangle$.

The explanation of the ungrammaticality of (80a) is exactly as before: if "who among his colleagues" has to undergo LF movement to COMP, it has to cross a negation and thus violates Beck's filter. If, on the other hand, we scramble the nominal to a position higher than the negation, we have circumvented the LF-barrier and the question is grammatical. The LFs for the ungrammatical sentence and the grammatical one are (82a) and (82b), respectively.

(82) a. $*$[who among self's$_j$ colleagues]$_f$? **NEG** anyone$_j$ likes $t^{LF}_{f(j)}$
b. LF for scrambled object:
[who among self's$_j$ colleagues]$_f$? t^{LF}_f λf [**NEG** anyone$_j$ likes $t_{f(j)}$]

I think these few examples show that Beck's (1996) theory can derive a number of rather disparate, hitherto unexplained facts. The theory relies on LF movement, an idea against the spirit of a semantics that uses choice functions for the interpretation of indefinites and *wh*-phrases. Let us therefore ask ourselves whether we can mimic Beck's filter in a choice function approach.

The idea that comes to mind is that there must be no LF intervener between an existential quantifier $\exists f$ and the choice function variable f bound by it. Unfortunately, such a principle would not be correct in the general case, because indefinite NPs can outscope universal quantifiers as we know from previous discussion. If we interpret an indefinite by means of a choice function variable, the relation of existential generalization, which binds the variable, must be able to cross an LF intervener in such cases. We therefore have to restrict the principle to the existential generalization of *wh*-variables. Let call this version of Beck's filter "*wh*-filter".

(83) **The *wh*-filter**: Existential generalization of function *wh*-variables, i.e., choice function variables indexed with *wh*, is not possible across Neg or Quant.
$*\exists$F ... Neg or Quant ... wh$_F$ ...
where F is a variable for generalized choice functions.

Please keep in mind that the filter is only intended for German and Korean. In particular, it does not apply to English in this form. The filter can account for the examples discussed so far with the exception of (74b). Before I comment on the reasons, let us look at some of the examples from the choice function perspective. Here is the alternative analysis for (68a).

(84) a. Wieviele Bücher hat Karl nicht gelesen?
How many books has Karl not read?

b. $\lambda p\ \exists F\ ch_{w_0}(F) \wedge p = \lambda w\ \exists g\ ch(g) \wedge g([how_F\ many]\ books_w)_i$ **not** Karl $read_w\ t_i$

c. $*\lambda p\ \exists F\ ch_{w_0}(F) \wedge p = \lambda w$ **NOT** $\exists g\ ch(g) \wedge$ Karl $read_w\ g([how_F\ many]\ books)$

In both cases we have reconstructed the entire nominal. (84b) is a well formed structure but (84c) violates the *wh*-filter.

Some comments are in order. The precise structure of *how many books* is this: $[_{NP}\ [_{Det}\ SOME_g]\ [_{N'}\ [_{Num}\ how_F\ many]\ books]]$. "many" is the set of numbers. "SOME" is the invisible indefinite plural article. Note that the requirement that the choice is made for w_0 is redundant in this particular case because the set of numbers is the same in each world.

Next let us take up the Korean examples. The formula which is equivalent to (81a) is (85).

(85) $\lambda p\ \exists F\ ch_{w_0}(F) \wedge p = \lambda w\ \neg\exists x\ [person_w(x) \wedge like_w(x, F(\text{among x's colleagues}))]$

The LF which expresses this formula violates the *wh*-filter. We expect that scrambling of the *wh*-phrase in front of the negative quantifier can circumvent the filter, but we cannot use generalized choice functions for the interpretation of the LF because then we would have the variable x free, whereas it should be bound by "nobody". In other words, (86) does not render one of the readings of (80b).

(86) $\lambda p\ \exists F\ ch_{w_0}(F) \wedge p = \lambda w\ F(\text{among x's colleagues})\lambda y\ \neg\exists x\ [person_w(x) \wedge like_w(x, y)]$

Recall, however, that we have introduced Skolem choice functions for the formalization of the Engdahl readings (cf. 4.1). Using this method, we can formalize our Korean examples correctly:

(87) a. $\lambda p\ \exists\Phi\ s\text{-}ch_{w_0}(\Phi) \wedge p = \lambda w.\ \Phi(\lambda x\ \lambda w\ \text{among x's colleagues}_w)$
$\lambda f\ \neg\exists x\ [person_w(x) \wedge like_w(x, f(x))]$

b. $*\lambda p\ \exists\Phi\ s\text{-}ch_{w_0}(\Phi) \wedge p = \lambda w\ \neg\exists x\ [person_w(x) \wedge$
$like_w(x, \Phi(\lambda x \lambda w.\text{among x's colleagues}_w)(x))]$

Here, Φ is of the type of the Skolem choice functions, whereas f is of the Skolem function type. The two formulae are equivalent by λ-conversion. (87a) is the translation of the sentence where the nominal "who among his colleagues" is scrambled over the negation, the admissible LF. The equivalent LF (87b) violates the *wh*-filter.

As mentioned already, the approach doesn't cover yet every example treated by Beck's filter. The ungrammaticality of (73b), here repeated as (88) does not follow from the *wh*-filter.

(88) *Wen$_i$ hat niemand [t$_i$ alles] gesehen?

Recall that we have to scope the exhaustor *alles* at the adjunction site of CP. This movement is no *wh*-movement and therefore not ruled out by the *wh*-filter. On the other hand, Beck's filter derives the impossibility of this particular *alles*-movement. Hence we have at least one case of semantically driven movement which the theory cannot eliminate. The result of this section is that a theory that works with choice functions can explain almost all of the data, but it cannot do it with fewer stipulations than a theory which works with LF movement.

7 CHOICE FUNCTIONS AND DETERMINER SCOPING

In this section I want investigate the thesis defended recently in the literature that either there is no rule QR or this rule just scopes the quantifier head, i.e., the article expressing the higher order relation "every", "most" and so on. If this thesis is true, then we seem to have a compelling argument for the use of choice functions in semantics, because choice functions are the only method known to me that can make sense of the thesis, as far as the semantic side of language is concerned. Chomsky (1981) observes that QR and LF *wh*-movement cannot repair violations of principle C at S-structure.

(89) a. Which book that John$_i$ read did he$_i$ like?
b. *He$_i$ liked every book that John$_i$ read.
c. *Who said that he$_i$ liked which book that John$_i$ read.

The relevant LF configurations which should rescue the C violation observed in (89b) and (89c) are these:

(90) a. [every book that John$_i$ read]$_j$ [he$_i$ liked t$_j$]
b. [which book that John$_i$ read]$_j$ Who said that he$_i$ liked t$_j$

(Lasnik, 1993, 29) makes the same point with principle A:

(91) a. John$_i$ wonders which picture of himself$_i$ Mary showed to Susan.
b. *John$_i$ wonders who showed which picture of himself$_i$ to Susan.
c. John$_i$ said that every picture of himself$_i$, Mary likes.
d. *John$_i$ said that Mary likes every picture of himself$_i$.

Since we have been discussing *wh*-movement for a while, let us take up QR here. The LF for (91d) generated by QR is identical with the grammatical structure (91c), but (91d) isn't grammatical. In the GB framework we can say that Principles A and C are satisfied at S-structure, whereas LFs can violate them. In the minimalist framework (cf. Chomsky 1995), where LF is the only syntactic interface, no such move is possible. Therefore, Lasnik (1993) formulates the following hypothesis:

> If the general program [= the minimalist program] is correct, either there is no QR, or QR raises just the quantifier head, and not the entire quantificational expression. Similarly for LF *wh*-movement.

A version of QR which moves just the D-part of the quantifier has been proposed in Hornstein & Weinberg (1990). Their LF for (91d) would be the following structure:

(92) *John$_i$ said that [$_S$ every$_j$ [$_S$ Mary likes t$_j$ picture of himself$_i$]]

Clearly, this structure still violates Principle A. Hornstein & Weinberg (1990) don't offer an interpretation for the structure. Adopting the standard methods, no interpretation seems possible because the determiner *every* expresses the subset relation and requires two sets as arguments. The first argument, i.e., the restriction of the quantifier, is obviously expressed by *picture of himself$_i$*. The representation (92) suggests, however, that the quantifier has only one argument, viz. the S to which it is adjoined. There seems no way to have access to the restriction *picture of himself$_i$*.

With choice functions in the semantic domain we have a method for interpreting Hornstein & Weinberg's version of QR, for we can say that the QRed determiner quantifies over choice functions. For instance, the wide scope reading of (93a) would be represented as in (93b).

(93) a. Someone or other read every book by professor K.
b. every' λf [someone read f(book by professor K.)]

The translation of *every* is given in (94a), and (93b) is therefore equivalent to the formula (94b).

(94) a. *every*' = $\lambda P\ \forall f\ [ch(f) \rightarrow P(f)]$, where P is of type $\langle\langle et, e\rangle, t\rangle$.
b. $\lambda P\ \forall f\ [ch(f) \rightarrow P(f)]\ \lambda f$ [someone read f(book by professor K.)]
= $\forall f\ [ch(f) \rightarrow$ [someone read f(book by professor K.)]

Recall our convention that a choice function picks out the falsifying object in case the property it applies to is empty. This makes the formula equivalent to the first order formalization in most cases. But the formalizations do not mean the same, if the restriction of the quantifier is empty:

(95) a. $\forall x\ [P(x) \rightarrow Q(x)]$
b. $\forall f\ [ch(f) \rightarrow Q(f(P))]$

If P is empty, then (95a) is true but (95b) is false. Reinhart (1997) would obtain the same result. She discusses the issue in section 6.5.1. According to Reinhart, no negative consequence seems to follow from this semantics, but I am not sure of this. Consider, for instance, the following sentences:

(96) a. Not every unicorn neighs.
b. There is a unicorn which doesn't neigh.

Our semantics makes (96a) true. But we certainly don't want to have (96b) true as well. Under the classical account, the two sentences mean the same. So this semantics deserves further investigation.

The new semantics doesn't allow us to get rid of QR entirely, because we still need it for binding pronouns.

(97) [every professor]$_1$ read a report about himself$_1$

The binding of the reflexive requires λ-abstraction, i.e., we need at least an extremely local version of QR, where the NP is adjoined to the XP in which it is contained. We can combine this local QR with the operation that scopes the determiners, and we obtain (98a), which is translated as the formula (98b).

(98) a. every$_2$ [[t$_2$ professor]$_1$ ∃$_3$[t$_1$ read a$_3$ report about himself$_1$]]
b. $\forall$f [ch(f) $\rightarrow$ $\exists$g [ch(g) $\wedge$ f(professor) λx [read(x, g(report about x))]]]

One might think that superlocal QR is spurious, because it automatically reconstructs to its base position via λ-conversion, given that *f(professor)* is of type *e*. A closer inspection, however, reveals that this is not so: *f(professor)* is "reconstructed" both to the subject position and to the position of the reflexive:

(99) $\forall$f [ch(f) $\rightarrow$ $\exists$g [ch(g) $\wedge$ [read(f(professor), g(report about f(professor)))]]]

But, of course, "every professor" was never at the latter position. Thus, QR does an indispensable job for binding. The classical rule QR would then split into two operations:

(100) **Modularizing QR**

a. **Binding**: The adjunction of α_i to the smallest XP in which α_i occurs, leaving trace t_i, where α_i is an NP (or DP) with movement index *i*.
b. **Determiner Scoping**: Scoping is done via movement of the determiner to an adjunction position, leaving a coindexed trace.

In both cases, the created configuration $\alpha_i[\ \dots\ t_i\ \dots\ ]$ is translated as $\alpha\lambda x_i[\ \dots\ x_i\ \dots\ ]$.

Semantic binding is a remnant of QR, though an extremely local version. The new shape of the theory should disappoint everyone who believed that the use of choice functions would enable us to have LFs much nearer to the surface forms. On the contrary: the new LFs are even more abstract than the classical LFs. On the other hand, the modification is compatible with Lasnik's (1993) hypothesis.

A semantically equivalent formulation of the rule Binding would be a type lifting rule for the verb. Suppose we are given an NP α_i and an intransitive verb of type $\langle e,t\rangle$ which expresses the predicate P. In order to combine the two, we lift the verb to the type $\langle\langle et,t\rangle,t\rangle$ and interpret the lifted predicate as $\lambda Q.Q(\lambda x_i.P(x_i))$. It is crucial that the index of the NP corresponds to the bound variable, because it is precisely this correspondence which achieves the binding. In other words, a lifting operation which doesn't depend on the index of the argument NP could not do the job. We cannot interpret the verb independly of the argument NP, contrary to what is generally assumed by theorists who advocate this kind of lifting operation. To my mind this shows that QR is indispensable for doing the binding.

It is an interesting question whether the modularization of QR increases the expressive power of the system in comparison to the traditional account. For instance, we can now have the following situation: the object contains a pronoun bound by the subject, but the quantifier of the object has wide scope with respect to the quantifier of the subject:

(101) a. Every student_1 read a report mentioning him_1.
b. $a_4[\text{every}_2[[t_2 \text{ student}]_1[t_1 \text{ read } t_4 \text{ report mentioning him}_1]]]$
c. $\exists g\ [ch(g) \wedge \forall f\ [ch(f) \rightarrow f(student)\lambda x\ [read(x, g(report\ mentioning\ x))]]]$

As we mentioned earlier, this is not always equivalent with the classical reading in which the subject has wide scope with respect to the object. Suppose that there are two reports mentioning each student. Then the LF can only be true if each student read the same report. This is an instance of the "same choice"-problem, which we discussed in 2.5. There it was argued that there is no such reading.

The referee #1 comments on this:

> I think it is quite clear that the reading in question is not there .... This is indeed not too obvious from examples like these, where the reading in question entails the standard reading, but consider a case like
>
> (i) every student who read a report mentioning him was happy
>
> The relevant "reading" is:
>
> (ii) $\exists f\ \forall x\ [[student(x)\ \&\ read(x, f(report\ mentioning\ x))] \rightarrow happy(x)]$
>
> Suppose that every report mentioned all the students. Under this assumption consider the situation where there was one report r_1 that two happy students read. Assume that all other students didn't read this report but did read another one and were not happy. In this case (ii) will be true. To see this, consider the function f that assigns r_1 to the set of reports. For the two students who read r_1: (ii) is of course true because these students were happy. For the other students (ii) is vacuously true because these students didn't read r_1. However, (i) is clearly false in this situation because every student read some report that mentioned him, but not all students were happy.

The counterexample is pertinent, but the argument based in the vacuous truth is not quite correct, because the referee has in mind the usual semantics for the universal quantifier. But our formalizations are a bit different. Here are the formulae representing the narrow scope and the wide scope reading of the indefinite article, respectively:

(102) a. $\forall g\ [ch(g) \rightarrow H(g(\lambda x\ [S(x) \wedge \exists f\ [ch(f) \wedge R(x,f(\lambda y.B(y,x)))]]))]$
b. $\exists f\ [ch(f) \wedge \forall g\ [ch(g) \rightarrow H(g(\lambda x\ [S(x) \wedge R(x,f(\lambda y.B(y,x)))]]))]$

The formalizations use the abbreviations S for "student", H for "happy", R for "read" and B for "report mentioning ... ". The wide scope reading is true if we take the f described by the referee. There is no vacuous truth involved here. I mention this point in order to make the reader aware of the unusual features of this semantics. Clearly, we have to bar this kind of determiner scoping then.

In a recent talk (cf. Sauerland 1998), Uli Sauerland has investigated the question wether the approach sketched here can be extended to non-standard quantifiers such as *most*. In fact, this is not so easy. We cannot analyze

(103) Most professors are stressed.

along the paraphrase "There are more choice functions f which make the statement "stressed(f(professor))" true than there are f's which make it false". Due to the globality of the choice functions this is easily falsified. Sauerland solves the problem by stipulating that we quantify over pointwise different choice functions. The approach seems to work for positive quantifiers, but not for negative ones such as "less than two books". I cannot go into the details in this paper.

There is much more to say about the matter, however. We have to restrict the range of the rule Determiner Scoping by something like Beck's filter. Consider the following standard pattern:

(104) a. Everyone read some book professor K. wrote. ($\exists \succ \forall$)
b. No one read some book professor K. wrote. ($\exists \succ \neg\exists$)
c. No one read every book professor K. wrote. ($*\forall \succ \neg\exists$)
d. Everyone read no book professor K. wrote. ($*\neg\exists \succ \forall$)

The impossibility of scoping a universal quantifier or a negative quantifier over a negative universal quantifier and a universal quantifier, respectively, is not explained in May (1985), as far as I know. The pattern shows once more that indefinites play a special role, they do not block the scope widening of other determiners nor is their scope restricted by other determiners. Thus, we might speculate that non-indefinite determiners are scope barriers for non-indefinite determiners. Whatever the correct generalization may be, it should be obvious that it doesn't fall out from the fact that indefinites articles can be interpreted by means of choice functions.

In the last years, many descriptive insights into the facts having to do with the relative scope of quantifiers have been gained. As to German, I have in mind Pafel (1998). In this article, I have made no attempt to incorporate these insights, because that would have lead to an entirely new paper. In a number of articles, Urs Egli and Klaus von Heusinger have argued that the method extends to the interpretation of the definite article. In this paper I haven't touched this issue at all. See, for instance, Egli & Heusinger (1995). The point made in this section is that we can extend the analysis to determiners such as the universal quantifier, and if the authors quoted in this section are right, we even have to do this.

8 CONCLUSION

I have investigated a number of phenomena which might give support to the view that indefinite articles and *wh*-determiners should be analyzed in term of choice functions. While this might turn out to be the correct approach, the data do not force us to such a conclusion, it seems to me. In almost each case, we can have an alternative account in terms of traditional scoping (QR), provided, we work with somewhat sophisticated methods. I don't think that a framework that works with choice functions can describe the facts with less stipulations than traditional accounts which assume *wh*-movement at LF and QR. To be sure, I have investigated only a particular range of data and other data might give more empirical support for one view over the other, but I am not aware of such data. For the time being, the arguments for or against choice functions in semantics remain highly theory internal: the treatment of *wh*-movement and of quantification a minimalist framework seems to require this technique. In any case, the method provides a genuine alternative to the usual way of theorizing and might shed new light on quantification. Therefore it should be studied in greater detail and it should be tested against a larger set of data.

NOTES

[1] The two stand presumably in the same semantic relation as the Thane of Cawdor and the Thane of Glamis.

[2] The convention which Reinhart (1997) introduces for the application of choice functions to an empty set amounts to the same, as far as I can see. Reinhart analyzes predicates as functions from sets to truth-values, i.e., predicates are of type $\langle et,t\rangle$. The reason is that she wants to analyze singularities and pluralities in a uniform way: singularities denote unit sets and pluralities denote sets proper. Suppose now that S is an empty predicate and F is a choice function. For this case, Reinhart defines

(i) F(S) is the empty set of type $\langle et\rangle$ (= (93b), p. 391).

She adds the stipulation

(ii) The extension of any lexical predicate in natural language excludes the empty set (= (94), p. 391).

Thus, Reinhart's empty set is just my remote individual *.

[3] f has to be of type $\langle\langle et,t\rangle,\langle e,t\rangle\rangle$. I don't want to commit myself seriously to the view that plural predicates take aguments the set type. I believe that Schwarzschild's (1996) account which doesn't distinguish the types of singular and plural individuals and their predicates is the correct approach. The meaning rules introduced here are *ad hoc* but essentially sound.

[4] To be sure, Schwarzschild's treatment of distributivity is more general. The LF of an elementary plural statement is roughly this:

(i) plural-subject Part(Cov) + VP, where Part(Cov) is a VP-modifier.

And the statement is true if Cov is a cover of the subject and VP is true of each cell of Cov.

[5] Klaus von Heusinger has informed me that a similar example is found already in Farkas (1981):

(i) Each student has to come up with three arguments which show that some condition proposed by Chomsky is wrong.

[6] Klaus von Heusinger informs me that the problem has been taken up in Peregrin & von Heusinger (1995). I have not been able to evaluate their proposal for this paper.

[7] It might be helpful to explain this argument, which is due to Stechow (1996), in some more detail in view of the fact that it was not clear to the referee #1, who gives the following comment:

> vS says that "Nishigauchi's theory predicts that (31a) is synonymous with "which book that someone wrote did you read?". But the predicted interpretation given in (31c) is not the same. Which of the two is a correct statement of the prediction?

The predicted interpretation is the same. This is obscured by the paraphrase given in (31c), which we automatically interpret in the correct way when we read it. In order to realize that the meaning is not the intended one, you have to inspect the nucleus of the question "you read x", and you discover that it contains only a variable for books, but none for persons. If we translate Nishigauchi's paraphrase into a Karttunen formula, we obtain something like this:

(i) $\lambda p\ \exists x_2$ [person(x_2) $\wedge\ \exists x_1$ [book(x_1) $\wedge\ x_2$ wrote $x_1 \wedge$ p = you read x_1]]

This is exactly the meaning expressed by (31c).

Related arguments against unselective binding for the interpretation of *wh*-questions are found in Reinhart (1997), section 3.1.

[8] The referee #1 comments on this:

> It is not clear to me why the problem raised with (39c) is a problem for CFs: don't we generate the same indices on the descriptions under any other interpretation of wh's?

Compare the choice function account with the classical account. Written in logical no- tation, the "direct" translation of the d-structure of (39a) into the logical language is:

(i) $\lambda p\ p = \lambda w.\text{come-to-party}_w(\lambda P\ \exists x\ \text{student}_w(x) \wedge P(x))$

This formula is not well-formed for type reasons. *wh*-movement of the quantifier $\lambda P\ \exists x$ [student$_w$(x) $\wedge$ P(x)] to the COMP-position (the position directly under λ p) creates the well-formed expression (39c) after λ-conversion. The world variable w of *student* is free and refers to the actual world by convention. We could write this variable as w_0 in order to make the notation more suggestive, but we don't have to use double indexing here. The result is automatically correct, because there is no potential binder for the world variable in the formula.

The situation is different for a formalization in terms of choice functions. An extensional version of Montague's intensional logic has one world variable only. The d-structure of (39a) in a choice function approach would then be this:

(ii) $\lambda p\ [p = \lambda w.\text{come-to-party}_w(f(\text{student}_w))]$

Existential closure of the choice variable f yields (41). I see no way to block this derivation without an extra stipulation.

[9] Reinhart uses an intensional language and defines a predicate G which plays the role of our ch(w). Her definition is (cf. Reinhart 1997):

[Reinhart's (98)] $G = \{f : \forall P\ {}^{\vee}P \neq \emptyset \rightarrow f(P) \in {}^{\vee}P\ \}$
P of type $\langle s, \langle e,t \rangle\rangle$, or $\langle s, \langle\langle e,t\rangle ,t\rangle\rangle$

I mentioned before that 1-place predicates have the type $\langle s, \langle\langle e,t\rangle,t\rangle\rangle$ in Reinhart's theory. (It is not clear to me why we need the simpler type as well.) The sentence

(i) Who invited which philosopher?

would then be represented as

(ii) λp ∃f ∃g [G(f) ∧ G(g) ∧ p = ^(invite(g(^philosopher), f(^person)))]

Our definition (50) is equivalent to Reinhart's. I take it that Reinhart has to add the qualification that f(P) = ∅ if ˇP = ∅.

[10] Suppose, Laura and Andreas are the students. John is aquainted with Laura by the description "the smart girl who has studied Mathematics, who wears such and such glasses, who I met on occasion x, ... ". Call this egocentric description D_1. A similar relation of aquaintance D_2 connects John with Andreas. Suppose Laura came to the party and Andreas didn't. Then John knows which student came to the party, if he knows that the D_1 came to the party and he knows that the D_2 did not come to the party. The point is that neither Laura nor Andreas are part of the proposition known viz. not known by John. Nor is the information that they are students part of these propositions. To be sure, the content of the said propositions should be properties ("being someone who is D_1 related to a unique individual who came to the party") for the reasons given in Lewis (1979). The elaboration of such a theory might actually turn out to be a bit complicated for the choice function approaches discussed here, because *de re* interpretations allways assume that the res is in a transparent position with respect to the relevant intensional operator, here the interrogativizer.

[11] The simplest approach would be assumption that indefinite articles of predicative NPs are semantically empty. Together with the assumption that *seeks* embeds first order properties in intenso, that assumption would make the correct predictions. It would force us, for instance, to analyze *Jones seeks no unicorn* as "There is no unicorn which Jones seeks" or as "It is not the case that Jones seeks a unicorn", but not as "Jones tries to find no unicorn" as the Montague analysis incorrectly predicts.

[12] As it stands, this principle is too general, I suppose. These days, virtually everyone admits local QR for the interpretation of the VP, i.e., the arguments of the verb are interpreted *in situ*. This makes the principle rather doubtful. But without the principle, Beck's approach doesn't work.

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