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THE SEMANTICS OF RECONSTRUCTION AND CONNECTIVITY

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ABSTRACT. Building on Montague's (1970) idea that "a model should assign to a basic expression not a denotation but a *denotation function*, that is, a function that maps each infinite sequence of individuals onto a possible denotation of the expression" (Montague (1974, p. 194)), it can be shown that there is a compositional way of dealing with bound variable pronouns that are not c-commanded by their antecedents. In particular, I will demonstrate that *reconstruction* and *connectivity* phenomena can be accounted for by a compositional semantic interpretation of surface structures.

1. Overview

This paper focuses on a compositional *in situ* semantics for constructions like

(1) Pictures of himself$_j$ Mary thinks that nobody$_j$ likes t.

The relevant property of (1) and similar examples is that the antecedent does not c-command the pronoun, hence no formal binding relation can be established between the anaphor and its binder. It has therefore been argued that any adequate compositional semantics forces **syntactic reconstruction** of the *picture*-phrase into the position of its trace, since the pronoun *himself* can be interpreted as a bound variable only in that position. The usual method of **semantic reconstruction** via lambda conversion fails, because the lambda calculus does not permit the conversion of an element α (here: the translation of *pictures of himself*) if the result of that operation places a variable free in α (namely: the translation of *himself*) into the syntactic scope of a binder of that variable (namely: *nobody*).

Contrary to what seems to be dictated by purely logical considerations, I will argue that a compositional surface semantics for (1) is nonetheless feasible. Reformulating ideas of Heim (1994) within the formal apparatus of Bennett (1979), it can be shown that an encoding of pronouns as functions from sequences of individuals to individuals leads to a system that bans free variables from the translation of any natural language expression. Since no translation of any expression of English contains a free variable, the restriction against lambda conversion becomes irrelevant.

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The system developed to account for (1) will then be shown to cover further cases of binding without c-command as well. For example, it extends to so-called connectitvity effects in sentences like (2) which cannot be explained by invoking syntactic reconstruction.

(2) What everyone$_i$ saw was a picture of himself$_i$.

This independent motivation for semantic reconstruction raises the general question of whether syntactic reconstruction can be dispensed with *in toto*. I will attempt a positive answer with respect to standard arguments proposed in the context of **interrogative semantics** and **binding theory**.

The suitableness of a non-standard interpretation of pronouns is further corroborated by the fact that it automatically predicts the effects of **dynamic binding** illustrated in (3):

(3) A man$_k$ came in. He$_k$ whistled.

The only additional tool needed to achieve this is Groenendijk & Stokhof's (1990) technique of representing the (dynamic) meaning of a sentence by the set of propositions compatible with it. Given that the first sentence in (3) is represented as something like $\lambda p.\exists x_k(S \wedge p)$ and given that lambda conversion can apply without restriction, the scope of the existential quantifier extends automatically to the second clause of (3). I will then discuss whether or not **inversed linking** should be analyzed as a subcase of dynamic reconstruction.

Finally, I will sketch and then reject Pesetsky's (1995) treatment of **binding out of PPs** as ilustrated in (4):

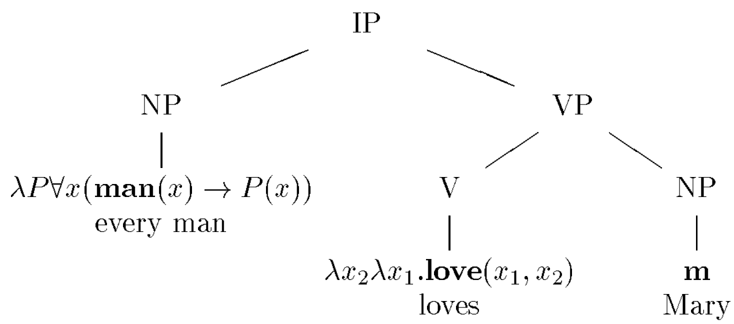
(4) John talks with everyone$_i$ about himself$_i$

Here again the pronoun does not c-command the anaphor. The solution proposed to account for this problem is independent from the issue of reconstruction, but rests on the general framework adopted in this paper, which treats predicates as open propositions. Presupposing a Davidsonian semantics of events, the argument of the preposition *with* is simultaneously an argument of the predicate *talk*. The semantic system outlined in this paper implies that an index is needed for binding the argument slot of a predicate. This index must be attached to the entire PP *with everyone* rather than to the NP within the PP, so that NPs and PPs must have the same logical type. Given that syntactic rules for anaphors are stated in terms of the objects that actually perform the semantic binding (*ie.* the index attached to the PP), there is a straightforward explanation for (4): Although it appears that the anaphor is "bound but not c-commanded" by *everyone*, the real semantic binding relation holds between the index of the entire PP and the anaphor, hence no violation of c-command is involved.

2. Bound Variable Pronouns

2.1. The Problem. In what follows, I will adopt Montague's (1973) strategy of translating natural language expressions into a formal language of semantic representation. Writing these translations directly into an LF-tree, a so-called transparent LF (TLF) for *Every man loves Mary* could have the following representation:

(5)



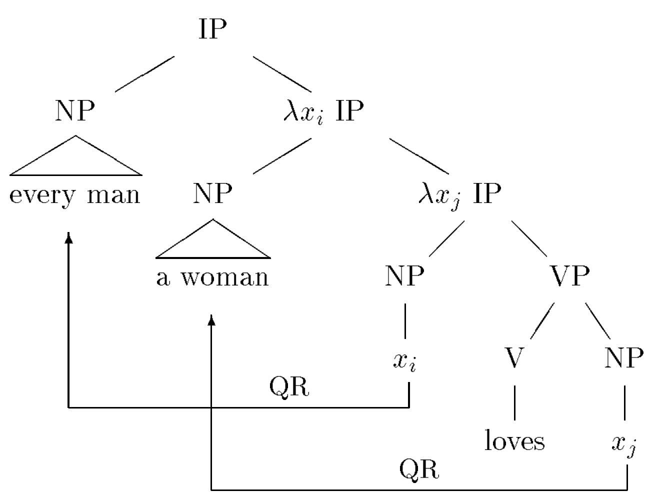
In order to calculate the truth conditions of the sentence, one only has to interpret each branch of a binary tree as a functional application between its constituents.

However, as is well-known, there is no such simple way of constructing TLFs for the sentences in (6):

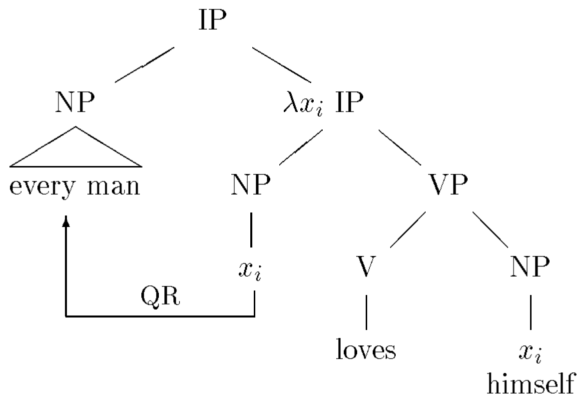
(6) a. Every man loves a woman.
b. Every man loves himself.

The usual technique of analyzing (6) is via quantifier raising, whose semantics is exactly analogous to Montague's rule of "quantifying-in":

(7) a.



b.



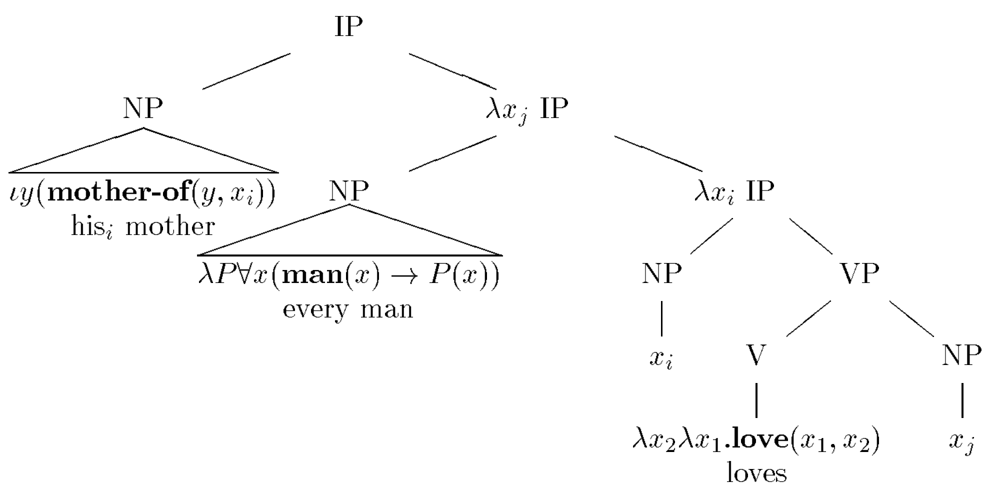
As (7) illustrates, TLFs can be derived from traditional LFs by adding lambda abstraction and other logical operators which appropriately link the nodes of a traditional LF.

The question then arises whether this method can also account for the meaning of (8):

(8) $[_{\mathrm{NP}}$ His$_i$ mother $]_j$ every man loves t$_j$

By analogy to (7), a TLF for (8) might be something like (9):

(9)



This representation, however, does not yield the correct truth conditions, because the variable x_i within the topicalized NP is still free. Application of lamdba conversion, which is the usual semantic method of reconstruction (*cf.* Jacobs (1989), Cresti (1995), and others) is not permitted here, because the semantics of predicate logic allows lambda conversion only if the expression to be converted does not contain a variable that would become bound as a result of conversion. For example, conversion is permitted in (10-a) and (10-b), but not in (10-c), a lambda-free alphabetic variant of which is given in (10-d):

(10) a. $\lambda x_1 \forall x_2 R(x_1, x_2)(x_3) = \forall x_2 R(x_3, x_2)$
b. $\lambda x_1 \forall x_2 R(x_1, x_2)(x_1) = \forall x_2 R(x_1, x_2)$

c. $\lambda x_1 \forall x_2 R(x_1, x_2)(x_2) \neq \forall x_2 R(x_2, x_2)$
d. $\lambda x_1 \forall x_2 R(x_1, x_2)(x_2) = \forall y(R(y, x_2))$.

Consequently, many other cases where reconstruction is called for evade a semantic analysis. For example, (11-a) cannot be interpreted as it stands, since an *in situ* translation would come out as (11-b):

(11) a. [$_{\mathrm{AP}}$ proud of himself][$_{\mathrm{IP}}$ everyone was t]
b. [$_{\mathrm{IP}}$ everyone was proud of him]

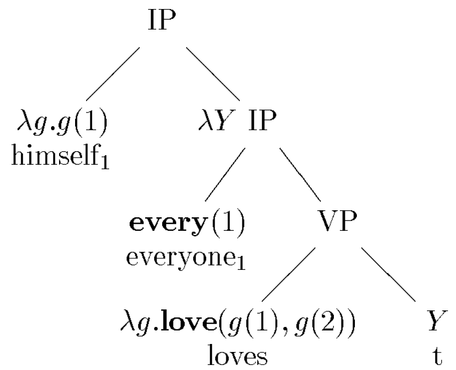
Intuitively, the pronoun in (11-b) cannot be understood as bound by the quantifier, contrary to the intended interpretation of (11-a). It has therefore been argued that the surface is uninterpretable and that only syntactic reconstruction at the level of LF can solve the problem.

2.2. **Sketch of a Solution.** Is there any possibility to maintain surface compositionality? I propose that the reason for the above failure of surface semantics can be identified in the tradition of translating pronouns as variables whose denotation depends on a value assignment, as in Montague's "Proper Treatment of Quantification" (PTQ; *cf.* Montague (1973)). However, the situation becomes very different if we conceive of variables the way Tarski did, namely as functions from sequences of individuals to individuals. This algebraic method has also been adopted in Montague's (1970) "English as a Formal Language" (EFL). Here, the meaning of a pronoun he_n is the function which maps every sequence of individuals to its nth member. This is what Montague calls a **denotation function**. In general, each expression of EFL has as its meaning a denotation function, which is a function from sequences of individuals to an "ordinary" denotation.

In EFL, semantic interpretation of a certain fragment of English proceeds directly via translation into the meta-language, whereas in PTQ, the fragment is interpreted indirectly via translation into intensional predicate logic. Bennett (1979) has combined EFL with PTQ by translating the denotation functions of EFL into the predicate logic of PTQ. Let me sketch somewhat informally how this might help to overcome our problem, leaving most technical details of the semantics and the translation procedure to subsequent sections.

I will first simplify the problem by analyzing only the three word sequence *Himself everyone loves*. Assuming that g is a variable that ranges over sequences of individuals, a (provisional) LF is illustrated by the tree in (12), with the corresponding translations of basic expressions and the trace stated explicitly in (13):

(12)



(13) **Translation of Basic Expressions**:

a. he/him(self)$_j \rightsquigarrow \lambda g.g(j)$, (traditionally: x_j)

b. loves$_{i,j} \rightsquigarrow \lambda g.\mathbf{love}(g(i), g(j))$ (traditionally: $\mathbf{loves}(x_i, x_j)$)

c. everyone$_i \rightsquigarrow$ **every**(i) (traditionally: $(\forall x_i)$)

d. t $\rightsquigarrow Y_n$, where Y_n is a variable having the same logical type as *he/him(self)* (traditionally: x_n)

Intuitively, g is the argument of a denotation function in EFL and plays exactly the same role that a variable assignment in PTQ does. In both systems, the translation of a pronoun depends on its index, but while this index determines a particular individual as being the "meaning" of a pronoun in PTQ, the index in EFL identifies a particular position in each assignment function. The value of this denotation function is not a particular individual, but varies for each sequence g.

(13-b) shows that predicates translate as "open propositions" whose semantic values depend on some choice of indices prescribed by convention, *eg.* by a numeration and a function SELECT in the sense of Chomsky (1995). Strictly speaking, this denotation does not denote an *open* proposition, because it does not contain a free variable. However, the similarity to the traditional translation is obvious, so I will adhere to the traditional terminology. Moreover, expressions like g(j) clearly function as placeholders for variables of the traditional system; they will henceforth be called **pseudo-variables**.

Turning to (13-c), the semantics of **every** is defined exactly as in predicate logic, the only difference being that the quantifier expression takes an index as an argument, rather than being composed of a quantifier and a variable. Within the traditional framework, this index is the index of a variable, but in Bennett's system it is part of the ontology to be defined in the following section.

(14) **Definition of Universal Quantification:**

$\mathbf{every}(i)(\alpha) := \lambda g \forall x(\alpha(g[x/i]))$

Here α is the denotation function of a proposition and $g[x/i]$ is the sequence which is like g except for the possible difference that $g(i) = x$, where x is the first variable that does not occur in α. It will be our main objective in the next section to show that $g[x/i]$ is a well-formed expression in the object-language.

Turning now to the interpretation of (12), note that this tree is not yet a TLF in the sense that its constituents can be combined by functional application only. I will turn to an explicit treatment of compositional interpretation in Section 4. Here I will only sketch how such an interpretation can be arrived at intuitively.

Going from bottom to top in (12), it is clear that the translation of the VP proceeds by putting Y into the object position of *love*. Since the type of Y is that of a pronoun, but the expected type of the argument of the verb is an individual, we must apply Y to the assignment function g. The result is shown in (15):

(15) Step 1:

IP

$\lambda g.g(1)$ $\quad$ λY IP

$\mathbf{every}(1)$ $\quad$ $\lambda g.\mathbf{love}(g(1), Y(g))$

The next step is to interpret universal quantification with respect to the subject slot of the predicate. Application of (14) is preformed as illustrated in (16):

(16) Step 2:

IP

$\lambda g.g(1)$ $\quad$ λY IP

$$\lambda g.\forall x(\lambda g.\mathbf{love}(g(1), Y(g))(g[x/1])) =$$
$$\lambda g \forall x(\mathbf{love}(g[x/1](1), Y(g[x/1]))) =$$
$$\lambda g \forall x(\mathbf{love}(x, Y(g[x/1])))$$

The derivation terminates with reconstruction of the pronoun, which is done in the usual manner, namely by lambda conversion. The underbraced constituent undergoes conversion into the position overbraced in the subsequent step of the derivation:

(17) Step 3:
$$\underbrace{\overbrace{\lambda g.g(1)}^{himself}} \lambda Y \overbrace{\lambda g.\forall x(\mathbf{love}(x, Y(g[x/1])))}^{IP} =$$
$$\lambda g.\forall x(\mathbf{love}(x, \overbrace{\lambda g.g(1)}^{Y}(\underbrace{g[x/1]}))) =$$
$$\lambda g.\forall x(\mathbf{love}(x, \overbrace{g[x/1]}^{g}(1))) =$$
$$\lambda g.\forall x(\mathbf{love}(x, x))$$

Note that the expression that is converted, namely the translation of *himself*$_1$, no longer contains a free variable, but denotes a constant function, so that the usual restrictions against lambda conversion have become inoperative.

One should now ask how all this can be done in a systematic way; specifically: How do the translations of higher constituents come about and how do they fit into a general theory of TLF? Before offering a solution to this problem, it must be proven that the logical system employed above is sound. In particular, we have to show that the assignment variable g and the modified assignments $g[x/i]$ can be given their correct meanings. This will be shown in the next section.

3. Bennett's System

As mentioned above, the first PTQ-like version of EFL is contained in Bennett's (1979) paper, where the basic idea is attributed to Belnap and Thomason. Because the paper has never been published in a journal, I will, for the benefit of the reader, restate some of Bennett's definitions. The formal system itself is a rather conservative extension of the intensional logic Montague defined in PTQ. For the present purpose, it will suffice to focus on the extensional subsystem; I have therefore removed the intensional part, which could easily be reintroduced by adding possible worlds and intensional operators. Furthermore, I will refrain from discussing any of Bennett's applications of the system. Concentrating on the formal language, Bennett's only innovation is the inclusion of natural numbers:

(18) **Bennett's Extension:**
 a. a set D_n of non-negative integers which is added to the set of possible denotations,
 b. a corresponding type n, and
 c. appropriate constants and variables of type n that denote non-negative integers.

Apart from this, the language and its interpretation are identical to the standard system of type theory. Accordingly, the set of types is defined in (19), and the set of possible denotations in (20):

(19) **Types:**
 The set *Type* of types is the smallest set Y such that
 a. e, n, and t are in Y,
 b. whenever a and b are in Y, $\langle a, b\rangle$ is in Y.

(20) **Possible Denotations:**
 D_a is understood to be the set of *possible denotations*, characterized by the following recursive definition:
 a. $\mathrm{D}_e = \mathrm{I}$, the set of individuals
 b. $\mathrm{D}_n = \mathrm{N}$, the set of natural numbers
 c. $\mathrm{D}_t = \{0,1\}$, the set of truth values

d. $D_{\langle a,b\rangle} = {D_b}^{D_a}$, the set of functions from D_a into D_b.

The set of expressions is standard, except for the inclusion of variables and constants of type n, which denote numbers. Accordingly, the formal language contains the symbols $v_{\mathrm{n},a}$ and $c_{\mathrm{n},a}$ for each non-negative integer n and each type a. In order to ensure that the nth constant of type n denotes the number n, we define interpretations as in (21):

(21) **Interpretation of Constants:**
Assuming that Con_a denotes the set of expressions $c_{\mathrm{n},a}$ for each non-negative integer n and each type $a \in \mathit{Type}$, an *interpretation* is a function F having as its domain the set $\bigcup_{a \in \mathit{Type}} Con_a$, such that
a. $\mathrm{F}(c_{\mathrm{n},n}) = \mathrm{n}$ for any non-negative integer in N, and
b. if $\alpha \in Con_a$ for any type a other than n, $\mathrm{F}(\alpha) \in \mathrm{D}_a$.

The logical language, its meaningful expressions, and its truth conditions are defined exactly as in the standard system.[1]

It is the notion of a modified assignment which enables us to express "binding" of an argument position contained in an "open proposition." The content of the following definition is that of the customary meta-linguistic definition; its only unusual feature is that it is expressed in the formal object-language itself:

(22) **Modified Assignments** (taken from Bennett (1979, p. 8)):
If $\alpha \in \mathit{Var}_{\langle n,e\rangle}$, $\beta \in \mathit{ME}_{\langle n,e\rangle}$, $\mathrm{u} \in \mathit{Var}_e$, $\mathrm{n} \in \mathit{Var}_n$, and $i \in \mathit{ME}_n$, then

$$\beta[\mathrm{u}/i] := \iota\alpha((\alpha(i) = \mathrm{u}) \wedge \forall \mathrm{n}(\neg(\mathrm{n} = i) \rightarrow (\alpha(\mathrm{n}) = \beta(\mathrm{n}))))$$

As a result, all formulas that occurred as translations in the last section are well-formed expressions of the object-language and can be interpreted as intended. This concludes our short exposition of Bennett's system.

4. Compositionality and Transparent Logical Form

Let us now return to TLFs. The general strategy for combining constituents is "type driven interpretation," that is, considerations as to what logical material must be inserted in order to remove a type-mismatch. However, this alone hardly constitutes a satisfactory theory, since it permits entirely *ad hoc* representations which give us no idea of what the general semantic principles are that tie constituents together.[2,3]

Another issue concerns compositionality of the material inserted between the nodes of a traditional LF. In most cases this additional glue cannot be given a meaning of its own, but must be interpreted *syncategorematically.* Lambda abstraction, for example, is not truth-functional, because the meaning of $\lambda x.p$ (a set) does not depend on the meaning of p (a truth value). One may ask, of course, whether this is so by accident or by necessity.

In what follows, I will suggest that TLFs must respect compositionality in a rather strong sense. In order to clarify the issue, I distinguish three different types or degrees of compositionality:

A. *Weak Compositionality:*

a. Given certain natural assumptions about the logical types of the basic expressions of natural language, semantic interpretation cannot proceed in a strictly compositional fashion; the interpretation of compound constituents necessitates "inserted" material not present in the meaning of lexemes.

b. This additional semantic glue cannot always be interpreted in a truth functional manner; *ie.*, semantic interpretation is *syncategorematic.*

B. *Strong Compositionality:* Agrees with (a.), but rejects (b.) by interpreting additional glue compositionally.

C. *Strict Compositionality:* Rejects both (a.) and (b.) and insists that composition is functional application.

Henceforth, I will adopt strong compositionality as the guiding idea that determines much of the following discussion.

As for strict compositionality, one could think of several ways of analyzing our above sentences *Every man loves himself/a woman* by employing functional application only. For example, one could translate the anaphoric pronoun *himself* as $\lambda R \lambda x.R(x)(x)$, or one could distinguish between the translation of nominative and accusative determiners, encoding the non-pronominal accusative NP as $\lambda R \lambda x \forall y(\mathbf{woman}(y) \rightarrow R(x,y))$. In both cases, however, there is good reason to reject such translations as being too construction-specific: both work only in the configuration $[_{\mathrm{VP}}$ V NP$]$ but would not work with bitransitive verbs or in the context of Exceptional Case Marking.

In general, it seems that the goal of strict compositionality is unattainable, even if we allow for various sorts of type-lifting that have been proposed in the literature.[4] For example, Keenan (1992) has shown that a wide range of natural language constructions involve "non-Fregean quantification," which is analyzed as a simultaneous quantification over more than one variable. This cannot be expressed as a compositional iteration of unitary quantifiers. In general, then, it seems to be agreed upon that certain aspects of natural language go beyond strict compositionality.

Concerning the aim of strong compositionality, explicit and successful proposals towards that end are rare.[5] Nonetheless, the idea of maintaining as much compositionality as possible is attractive enough to be taken seriously, especially since Bennett's system already provides the means to reach this goal. For example, recall from (14) restated below that we already have defined universal quantification in a non-syncategorematic way. By analogy, it is easy to define lambda abstraction in the same entirely compositional manner:

(23) **every** $:= \lambda i \lambda \alpha \lambda g \forall x(\alpha(g[x/i]))$
lambda $:= \lambda i \lambda \alpha \lambda g \lambda x(\alpha(g[x/i]))$

Once we have compositional lambda abstraction at our disposal, TLFs can be built up compositionally by inserting into a traditional LF additional nodes whose meaning involves compositional lambda abstraction. Although representations like (7) suggest that this additional glue attaches to VPs or IPs,[6] I will proceed in a slightly different way to be explained immediately, namely by attaching this additional glue to NP-nodes and their syntactic indices, rather than to VPs or IPs.

Following Heim (1993), let us first distinguish between the index of a binder and the index of a bindee. An NP like *himself*, for example, has two indices. One is its so-called inner index, which traditionally translates as the index of a bound variable (a bound pronoun) and which is interpreted as the number n in $\lambda g.g(n)$. This is the index of a bindee. The second index, the so-called outer index, is the argument of compositional lambda abstraction, *ie.* it is the index of a binder that identifies the slot of a predicate. In Heim (1994), it is suggested that this outer index be interpreted *in situ*, as a function i taking an NP as its argument and forming another function NP_i that operates on an "open proposition." In the present system, indices are semantically interpreted as numbers, which allows us to define one single operator, say γ (for "glue"), that mediates between the NP, the index of the NP, and the open proposition. For example, *every man snores* has the structure in (24) (order of γ and i irrelevant); the meaning of γ is defined in (25):

(24) $[_{\mathrm{IP}}\ [_{\mathrm{NP}}\ \gamma\ [_{\mathrm{NP}}\ [_{\mathrm{NP}}$ every man $]\ ]\ i\ ]\ [_{\mathrm{VP}}$ snores$_i\ ]\ ]$ or
$[_{\mathrm{IP}}\ [_{\mathrm{NP}}\ [_{\mathrm{NP}}\ [_{\mathrm{NP}}$ every man $]\ \gamma\ ]\ i\ ]\ [_{\mathrm{VP}}$ snores$_i\ ]\ ]$

(25) **Binding of Slots by an NP**
(cf. Bennett's (1979, p. 11) rule of *Ordinary Quantification*):
Let s be the type $\langle n, e\rangle$ and s the variable $v_{0,s}$.
(sequences or "assignments")
Let p be the type $\langle s, t\rangle$ and p the variable $v_{0,p}$. (propositions)
Let P be the type $\langle e, t\rangle$ and P the variable $v_{0,P}$. (properties)
Let Q be the type $\langle s, \langle P, t\rangle\rangle$ and $\mathcal{Q}$ be the variable $v_{0,Q}$. (NPs)
Then

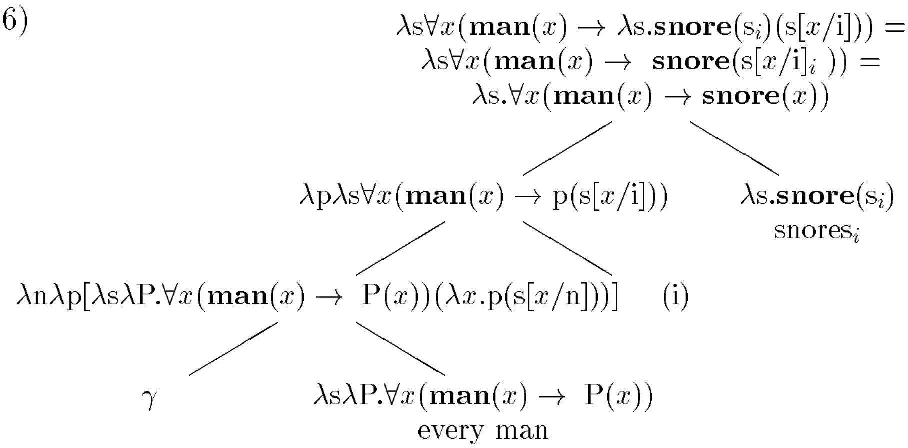
$$\gamma(\mathcal{Q})(\mathrm{n})(\mathrm{p}) := \lambda \mathrm{s}.\mathcal{Q}(\mathrm{s})((\mathbf{lambda}(\mathrm{n})(\mathrm{p}))(\mathrm{s})),$$

or equivalently:

$$\gamma := \lambda \mathcal{Q} \lambda \mathrm{n} \lambda \mathrm{p}[\lambda \mathrm{s}.\mathcal{Q}(\mathrm{s})(\lambda x.\mathrm{p}(\mathrm{s}[x/\mathrm{n}]))].$$

In (25), I followed Bennett in using the letter "s" as a variable for sequences, in order to avoid confusion with the use of "g" as a variable for assignments in the meta-language. Abbreviating s(i) as s_i we can now analyze (24) as (26):

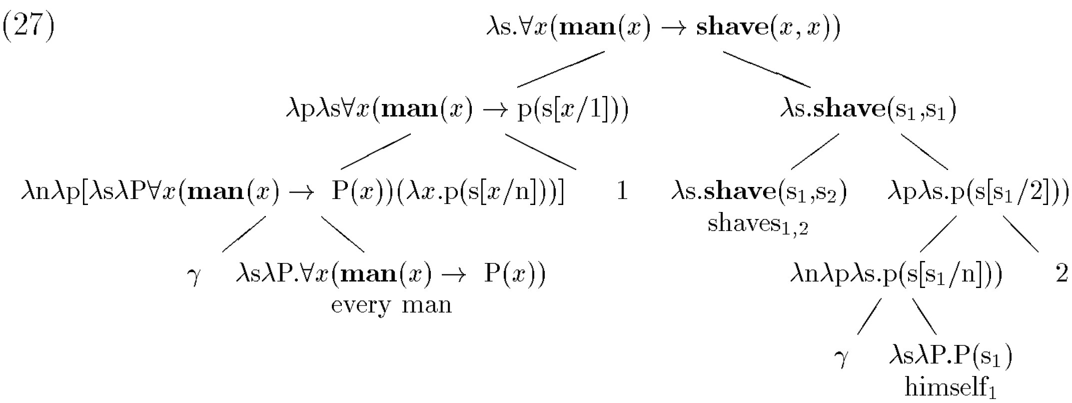
(26)



The third line down of (26) is the result one would expect.[7]

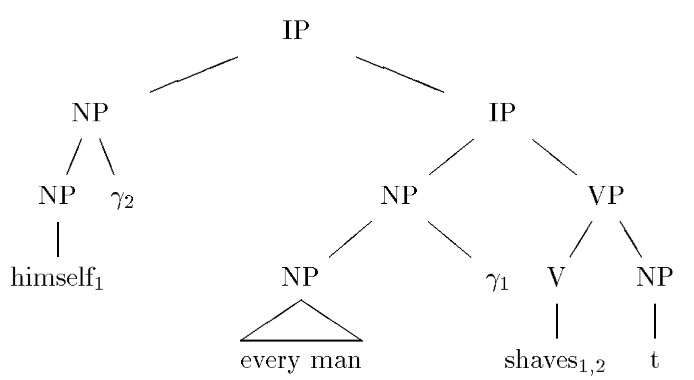
To maintain PTQ's uniformity of types of NPs, I adopt the standard assumption that pronouns and names are translated as generalized quantifiers. Hence, an indexed pronoun *he*$_i$ or *him*$_i$ is translated as $\lambda s\lambda P.P(s_i)$. Accordingly, our analysis of *every man shaves himself* amounts to the following:

(27)



Let us now return to the crucial sentence *Himself every man shaves*. In order to keep trees manageable, I will adjoin the index of an NP directly to γ, so that $[_{NP}\ [_{NP}\ \gamma\ NP\ ]\ i\ ]$ is written as $[_{NP}\ NP\ \gamma_i\ ]$. Consider now (28):

(28)



(28) does not yet represent the intended meaning: the formal make-up of the types involved reveals that the trace cannot receive a semantic interpretation, causing (28) to lack a semantic landing site for reconstruction. As shown in Section 2.2, this can be remedied easily; one only has to interpret the trace as an NP-variable and attach lambda abstraction to the IP as shown in (29):

(29) himself$_1$ $\lambda\mathcal{Q}$ [every man$_{\gamma(1)}$ hates$_{1,2}$ $\mathcal{Q}_{\gamma(2)}$]
$= \lambda\mathcal{Q}\lambda\mathrm{s}(\forall x(\mathbf{man}(x) \rightarrow \gamma(\mathcal{Q})(2)(\lambda\mathrm{s}.\mathbf{hate}(\mathrm{s}_1,\mathrm{s}_2))))(\mathrm{s}[x/1])(\lambda\mathrm{s}\lambda\mathrm{P}(\mathrm{P}(\mathrm{s}_1)))$
$= \lambda\mathrm{s}(\forall x(\mathbf{man}(x) \rightarrow \gamma(\lambda\mathrm{s}\lambda\mathrm{P}(\mathrm{P}(\mathrm{s}_1))(2)(\lambda\mathrm{s}.\mathbf{hate}(\mathrm{s}_1,\mathrm{s}_2))))(\mathrm{s}[x/1]))$
$= \lambda\mathrm{s}.\forall x(\mathbf{man}(x) \rightarrow \mathbf{hate}(\mathrm{s}_1,\mathrm{s}_1))(\mathrm{s}[x/1])$
$= \lambda\mathrm{s}.\forall x(\mathbf{man}(x) \rightarrow \mathbf{hate}(x,x))$

However, although the truth conditions are determined correctly, (29) still does not satisfy the requirement of strong compositionality. This is because assignments and modified assignments have only been defined for sequences of individuals, so that lambda abstraction could be defined compositionally only for the semantic type e of individuals. What is needed to express lambda abstraction compositionally in (29) is the inclusion of sequences of higher-type entities. This holds true even without pronouns being encoded as generalized quantifiers. As suggested by (12) reconstruction can be dealt with adequately only if there is compositional lambda abstraction over variables like Y that have (at least) the logical type of pronouns, namely $\langle\langle n, e\rangle, e\rangle$. Moreover, reconstruction should be able to apply compositionally to constituents other than NPs, as in (30):

(30) [$_{\mathrm{VP}}$ Criticize himself$_i$]$_j$ Alice thinks that no one$_i$ will t$_j$

Moving a predicate away from its argument always necessitates reconstruction of the "open proposition" (regardless of whether or not the subject has been generated VP-internally), hence we also need compositional lamda abstraction for (open) propositions. In general, there seems to be no *a priori* restriction on the types that can reconstruct. What is needed, then, is a generalization of our previous assignment function s that covers all types.

The above considerations concern only the issue of strong compositionality. But even on the basis of weak compositionality an empirical argument can be made showing that semantic reconstruction calls for a more general theory. The following is grounded on the observation that the above system cannot handle reconstruction via (weakly compositional) lambda abstraction as soon as the dislocated phrase contains a variable whose type is higher than that of an individual. Such a case, where the required type of pseudo-variable is that of a generalized quantifier, is exemplified by topicalization in German. (31-a) exhibits German's basic verb final SOV word order before any dislocation; this sentence can of course be interpreted *in situ*:

(31) a. daß er [$_{VP}$ [$_{VP}$ [$_{VP}$ jedem nur ein einziges Buch geben]
that he to-everyone only a single book give
müssen] wird]
have-to will
'that he will have to give to everyone only a single book'

b. daß er [$_{NP}$ nur ein einziges Buch]$_1$ [$_{VP}$ [$_{VP}$ [$_{VP}$ jedem t_1 geben]
müssen] wird]

In (31-b), the existentially quantified NP is scrambled out of its VP. This transformation can, but need not preserve scopal relations, so that the scrambled phrase can still be interpreted as being in the scope of the universal quantifier *to-everyone*. Assuming this, (31-b) involves semantic reconstruction that interprets the trace as an NP-variable. This can still be handled in a weakly compositional system. But now consider verb-second main-clause order. The finite verb moves to the C-position, and some constituent, *eg.* a VP, undergoes topicalization, as in (32):

(32) [$_{VP}$ [$_{VP}$ jedem t_1 geben] müssen]$_2$ wird$_3$ er nur ein einziges Buch$_1$
[$_{VP}$ t_2 t_3]

Assuming still that topicalization preserves meaning, the existentially quantified phrase remains in the scope of the universal quantifier. Accordingly, topicalization of the remnant VP has to be reconstructed. This time, however, semantic reconstruction encounters a problem, because the topicalized item contains a trace t_1 corresponding to a free variable of the NP-type Q. By analogy to the simple cases of reconstruction considered previously, it is clear that replacing the real variable in the remnant VP by a pseudo-variable does the job. But as it is, Bennett's system only allows for pseudo-variables with the semantic type e of an individual, rather than the type of an NP, which is needed to account for (32). This clearly shows that the proposed method—which accounted for reconstruction of pronouns only—is not general enough: in order to account also for reconstruction of quantifier scope we have to enlarge the formal language by including expressions that help to mimic assignments to variables of all types.

5. Generalizing Bennett's System

This can be achieved by an extension of Bennett's system. Suppose we replace expressions like λs.P(s(1), s(2)) by expressions of the form λg.P(g(e, 1), g(e, 2)) where g takes two arguments: a type and an integer. By analogy to Bennett's own extension, both components of ordinary variables become semantic entities of the model. As with n for integers, we now have to add new meta-linguistic type, say "*type*," for the the new objects in the ontology. Furthermore, we need a new type g for generalized value assignments. Since types will occur only as arguments of assignments, it is not necessary to combine them systematically with any other objects in the ontology. We may thus define the enlarged set of types and possible denotations as follows:

(33) **Types:** The set *Type*$^+$ of types is the set Y$\cup\{type\}$, where Y is the smallest set such that

a. e, n, t and g are in Y,

b. whenever a and b are in Y and $b \neq g$, then $\langle a, b\rangle$ are in Y.

(34) **Added Denotations:**

a. $D_{type} = Type$ (= the old set of types defined in Section 2).

b. $D_g = \{f\colon f(\mathrm{n}, a) \in D_a$ for all $a \in Type$ and $\mathrm{n} \in D_n\}$ (= the set of assignments).

c. Whenever $\langle a, b\rangle$ is in *Type*$^+$, $D_{\langle a,b\rangle} = {D_b}^{D_a}$.

Observe that assignments are defined in (34-b) only with respect to the original set *Type* rather than *Type*$^+$.

The next step is to extend the language. We add constants for each type (where a type is taken as a name for itself), and add a new symbol **type** which takes a variable as input and yields the type of the variable as output:

(35) **Added Constants for Types:**

a. If $\alpha \in Type$, then $\alpha \in Con_{type}$.

b. For any $a \in Type$, if $\beta \in Var_a$, then $\mathbf{type}(\beta) \in Con_{type}$.

c. No other expression is in Con_{type}.

(36) **Interpretation of Constants for Types:** F^+ is an extension of F such that

a. if $\alpha \in Con_{type}$, α has the form $\mathbf{type}(\beta)$, $\beta \in Var_a$, and $a \in Type$, then $F^+(\alpha) = a$.

b. if $\alpha \in Con_{type}$, α does not have the form $\mathbf{type}(\beta)$, then $F^+(\alpha) = \alpha$.

In order to define $[\![\,\cdot\,]\!]^{F^+,g}$ we must define meaningful expressions and truth conditions simultaneously, because the type of certain expressions depends on the value of variables of the type *type*, which can only be determined with respect to an assignment and a model. Apart from this slight complication, the remaining clauses are the standard ones:

(37) **Meaningful Expressions and Truth Conditions:**

a. All constants and variables introduced above are meaningful expressions of their respective types.

b. If $\tau \in Var_{type}$, then $[\![\tau]\!]^{F^+,g} = g(\tau)$.

c. If $\tau \in Con_{type}$, then $[\![\tau]\!]^{F^+,g} = F^+(\tau)$.

d. If $\mathrm{n} \in ME_n$, $\tau \in ME_{type}$, and $\mathrm{h} \in Var_g$, then

(i) $\mathrm{h}(\tau,\mathrm{n}) \in ME_\alpha$, where $\alpha = [\![\tau]\!]^{F^+,g}$ and

(ii) $[\![\mathrm{h}(\tau,\mathrm{n})]\!]^{F^+,g}$ is $[\![\mathrm{h}]\!]^{F^+,g}([\![\tau]\!]^{F^+,g},[\![\mathrm{n}]\!]^{F^+,g})$.

e. If $\alpha \in ME_a$ and $\beta \in ME_a$, then $(\alpha = \beta) \in ME_t$ and $[\![(\alpha = \beta)]\!]^{F^+,g} = 1$ iff $[\![\alpha]\!]^{F^+,g} = [\![\beta]\!]^{F^+,g}$.

f. etc.

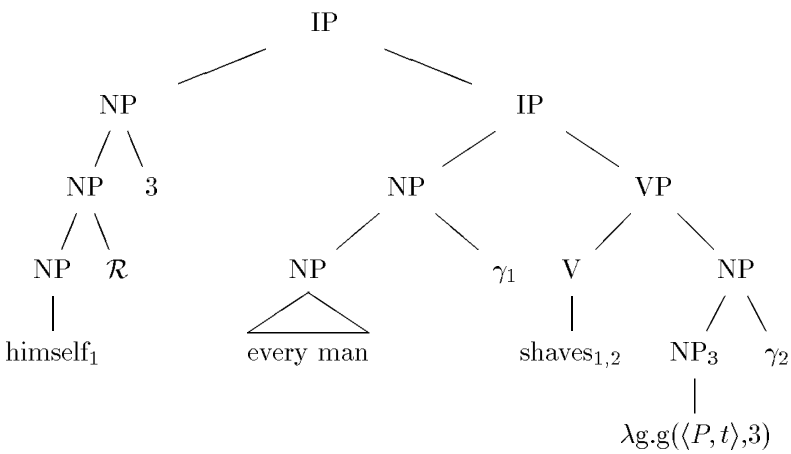
As in Section 3, our ultimate goal is to define modified assignments:

(38) **Modified Assignment:** If $\alpha \in \mathit{Var}_g$; $\beta \in \mathit{ME}_g$; $\mathrm{u} \in \mathit{Var}_a$ for any $a \in \mathit{Type}$; $\mathrm{n} \in \mathit{Var}_n$; $i \in \mathit{ME}_n$; and $t \in \mathit{Var}_{type}$, then

$$\beta[\mathrm{u}/i] := \iota\alpha((\alpha(\mathbf{type}(\mathrm{u}), i) = \mathrm{u}) \wedge \forall \mathrm{n} \forall t(\neg(\mathrm{n} = i) \vee \neg(\mathbf{type}(\mathrm{u}) = t)) \rightarrow (\alpha(t, \mathrm{n}) = \beta(t, \mathrm{n})))$$

This, in turn, was necessary for the definition of a reconstruction operator $\mathcal{R}$ which interprets a structure like the following (with the index 3 of the pseudo-variable chosen at random):

(39)



Intuitively, $\mathcal{R}$ replaces the pseudo-variable g($\langle$P,t$\rangle$,3) with its first argument, so that the index of the pseudo-variable is the second argument of $\mathcal{R}$, and the type of the pseudo-variable is the type of the first argument of $\mathcal{R}$. This can now be formalized as shown in (40):

(40) **The Reconstruction Operator**:
If $\alpha \in \mathit{ME}_{s,\tau}$, $\mathrm{y} \in \mathit{Var}_\tau$, and $\mathrm{p} \in \mathit{ME}_{\langle s,t\rangle}$, then

$$\begin{aligned}\mathcal{R}(\alpha)(\mathrm{n})(\mathrm{p}) &:= \lambda \mathrm{g} \lambda \mathrm{y}.\mathrm{p}(\mathrm{g}[\mathrm{y}/\mathrm{n}])(\alpha(\mathrm{g})) \\ &= \lambda \mathrm{g}.\mathrm{p}(\mathrm{g}[\alpha(\mathrm{g})/\mathrm{n}])\end{aligned}$$

For example, consider: "every y shaves$_{1,2}$ NP," where NP is translated as a pseudo-variable with index 3. The translation after application of γ_2 and γ_1 is this:

(41) $\lambda \mathrm{g} \forall y(\mathrm{g}[y/1](Q, 3)\lambda x.\mathbf{shave}(y, x))$

Let us now apply $\mathcal{R}_3$ to *himself*$_1$ and (41). Formally, this yields

(42) $\lambda \mathrm{g} \forall y(\mathrm{g}[\lambda \mathrm{P}.\mathrm{P}(\mathrm{g}(e, 1))][y/1](Q, 3)\lambda x.\mathbf{shave}(y, x))$

The crucial question is how to interpret $\mathrm{g}[\lambda \mathrm{P}.\mathrm{P}(\mathrm{g}(e, 1))][y/1](Q, 3)$. By the definition of modified assignments, $\mathrm{g}[y/1]$ in (41) is some expression of the following form:

(43) $(\iota \mathrm{g}') \ldots \ \mathrm{g}'(1) = y \ \ldots \ \mathrm{g}(\mathrm{n}) = \mathrm{g}'(\mathrm{n}) \ \ldots$

Note that in (42), g has been modified as g[λP.P(g(e, 1))], so that the assignment g of (43) must also be modified, but is otherwise like g′. This g″ has λP.P(g(e, 1)) as its value. But because of (43) it holds that g(e, 1) = g′(e, 1) = y, so that (42) is equivalent to

(44) $\lambda g \forall y \lambda P.P(y) \lambda x.\mathbf{shave}(y, x))$
$= \lambda g \forall y \mathbf{shave}(y, y))$

This is exactly the result expected. As a detailed demonstration of how the truth conditions work, one may examine the tree on the following page.

One last remark concerning the use of indices: In order to block overgeneration we must ensure that the outer index of the NP is actually the index of a trace that translates as a pseudo-variable with the same index. In general, correct indexing—whether between a trace and its antecedent, or between an argument expression and its slot—should follow from an adequate version of the θ-criterion, a topic that will not be addressed here.

I leave it as an excercise for the reader to establish that a corresponding analysis of (32) also yields the correct result.

6. Connectivity in Equational Sentences

A number of constructions discussed in Barss (1986) pose the now familiar problem of unbound anaphors, but differ from the standard examples in that the particular kind of construction discussed makes a syntactic reconstruction approach highly unlikely:

(45) a. [$_{NP}$ a picture of himself$_i$] was what$_j$ everyone$_i$ saw t$_j$
b. [$_{CP}$ what$_i$ everyone$_j$ saw t$_i$] was a picture of himself$_j$
c. What John$_i$ is is proud of himself/*him$_i$
d. What Bill$_i$ did was wash himself/*him$_i$

As argued by Higgins (1979) and Barss (1986, 247ff), literal reconstruction is inapplicable in these and other cases to be discussed further below. To account for the connectivity effect, Barss develops a syntactic theory of indexing which explains why the anaphors in (45) are grammatical. I will return to this in Section 11. Even with such an interpretative account of anaphoric binding for (45), this still leaves us with the problem of how to semantically interpret the apparently unbound "bound variable pronoun." Such a precise semantics can be easily developed within the present framework.

As an intuition to begin with, let me quote from Akmajian (1970, p. 19):

> ... the initial clause of the pseudo-cleft contains what is essentially a semantic variable, a semantic 'gap' which must be 'filled' or specified by the focus item ... The focus item must specify a value for the variable of the clause, and it thus follows that the focus item must belong to the appropriate semantic class, i.e. the class represented by the variable.

$$\lambda g \lambda g' \forall y(\mathbf{man}(y) \rightarrow \lambda g''.g''(\langle P,t\rangle,3)(\lambda g'''\lambda x.\mathbf{shave}(g'''(e,1),g'''(e,2))(g''[x/2])(g'[y/1])))(g[\lambda g''''\lambda P.P(g''''(e,1))(g)/3]) =$$

$$\lambda g \lambda g' \forall y(\mathbf{man}(y) \rightarrow \lambda g''.g''(\langle P,t\rangle,3)(\lambda x.\mathbf{shave}(g''[x/2](e,1),g''[x/2](e,2))(g'[y/1])))(g[\lambda P.P(g(e,1))]/3) =$$

$$\lambda g \lambda g' \forall y(\mathbf{man}(y) \rightarrow g'[y/1](\langle P,t\rangle,3)(\lambda x.\mathbf{shave}(g'[y/1][x/2](e,1),g'[y/1][x/2](e,2))))(g[\lambda P.P(g(e,1))/3]) =$$

$$\lambda g \forall y(\mathbf{man}(y) \rightarrow g[\lambda P.P(g(e,1))/3][y/1](\langle P,t\rangle,3)(\lambda x.\mathbf{shave}(g[\lambda P.P(g(e,1))/3][y/1][x/2](e,1),g[\lambda P.P(g(e,1))][y/1][x/2](e,2)))) =$$

$$\lambda g \forall y(\mathbf{man}(y) \rightarrow g[\lambda P.P(g(e,1))/3][y/1](\langle P,t\rangle,3)(\lambda x.\mathbf{shave}(y,x))) =$$

$$\lambda g \forall y(\mathbf{man}(y) \rightarrow g[\lambda P.P(g[y/1](e,1))/3](\langle P,t\rangle,3)(\lambda x.\mathbf{shave}(y,x))) =$$

$$\lambda g \forall y(\mathbf{man}(y) \rightarrow g[\lambda P.P(y)/3](\langle P,t\rangle,3)(\lambda x.\mathbf{shave}(y,x))) =$$

$$\lambda g \forall y(\mathbf{man}(y) \rightarrow \lambda P.P(y)(\lambda x.\mathbf{shave}(y,x))) =$$

$$\lambda g \forall y(\mathbf{man}(y) \rightarrow \lambda x.\mathbf{shave}(y,x)(y)) =$$

$$\lambda g \forall y(\mathbf{man}(y) \rightarrow \mathbf{shave}(y,y))$$

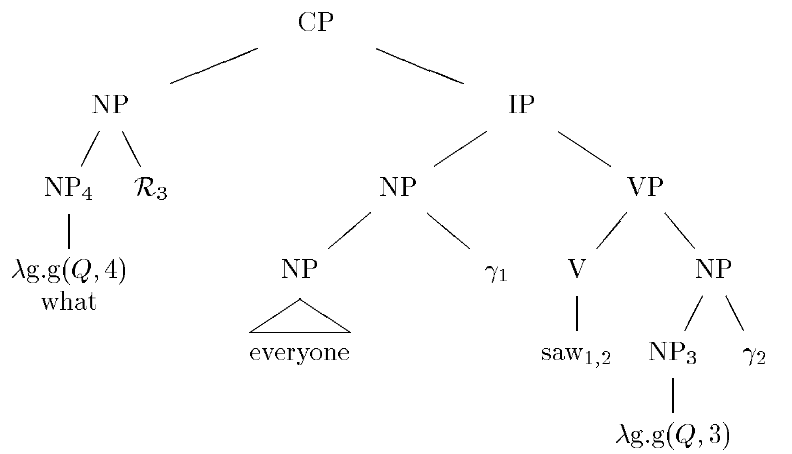
- NP
  - $\lambda g \lambda P.P(g(e,1))$
    - himself$_1$
  - $\mathcal{R}_3$
- $\lambda g \forall y(\mathbf{man}(y) \rightarrow \lambda g'.g'(\langle P,t\rangle,3)(\lambda g''\lambda x.\mathbf{shave}(g''(e,1),g''(e,2))(g'[x/2])(g[y/1])))$
  - NP
    - NP
      - every man
    - γ_1
  - $\lambda g.g(\langle P,t\rangle,3)(\lambda g'\lambda x.\mathbf{shave}(g'(e,1),g'(e,2))(g[x/2])$
    - $\lambda g.\mathbf{shave}(g(e,1),g(e,2))$
      - shaves$_{1,2}$
    - NP
      - NP
        - $\lambda g.g(\langle P,t\rangle,3)$
      - γ_2

But which class can this be? From the example above we know that it must be a generalized quantifier, for otherwise *a picture* cannot reconstruct into the scope of *everyone*. According to what was said above, a compositional analysis requires a pseudo-variable, say $g(Q, 4)$, in the object position:

(46) $\lambda g.\text{everyone}_1$ saw $g(Q, 4)$

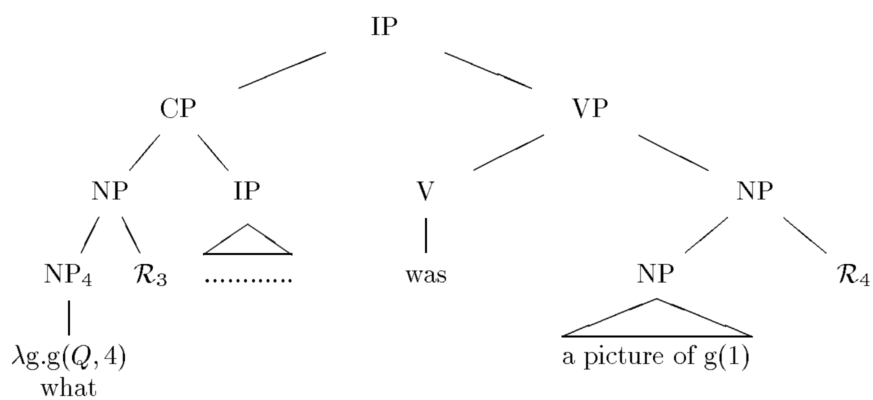
The compositional contribution of *what* is simply that of being a pseudo-variable which at the same time reconstructs semantically into its base position. Assuming that *what* is $g(Q, 4)$ which moves and reconstructs, we arrive at the representation in (47):

(47)



The final step in determining truth conditions (ignoring presuppositions and a more fine-grained analysis of focus) is to reconstruct *a picture of himself*$_1$ into the position of $g(Q, 4)$. This can be achieved as by indexing the NP with $\mathcal{R}$ and 4, which happens to be the index of the pseudo-variable chosen in the translation of *what*.

(48)



Here, the copula is meaningless (or the identity function), so that the *picture*-NP takes the CP as its argument. By transitivity of reconstruction, this finally ends up semantically in the object position of *saw*.[8]

Another construction discussed by Barss (in fact one to which Higgins (1979) attributes essential properties of pseudo-clefts) is *tough*-movement (cited from Barss (1986, p. 253)):

(49) $[_{\mathrm{NP}_j}$ pictures of himself$_i$] are easy [for John$_i$] $[_{\mathrm{CP}}$ OP$_j$ [PRO$_i$ to like t$_j$]]

Here, the subject is too far away from the trace, hence considerations of binding theory block movement between the overt subject and the trace. Nonetheless, it is easy to give a correct interpretation of (49) by semantic reconstruction into the position of the trace. We simply have to interpret the empty operator the same way as *what*$_j$ in (48); the adjective then takes a proposition as its only complement, and by coindexation of OP$_j$ (= *what*$_j$) with the subject NP we guarantee that the subject is semantically reconstructed via $\mathcal{R}$ into the object position of *like*.

Another connectivity effect where literal reconstruction is inapplicable is exemplified by (50) (similar examples, but without bound variable pronouns, are discussed in Higgins (1979)):

(50) Being insulted by his ex-wife is a thought no one would be shocked by

Here again, it is impossible to move the subject of the copula into the syntactic scope of *no one*; nonetheless, the intuitive understanding of the sentence involves the binding of *his* by *no one*.

As a first attempt at a semantic paraphrase, consider (51):

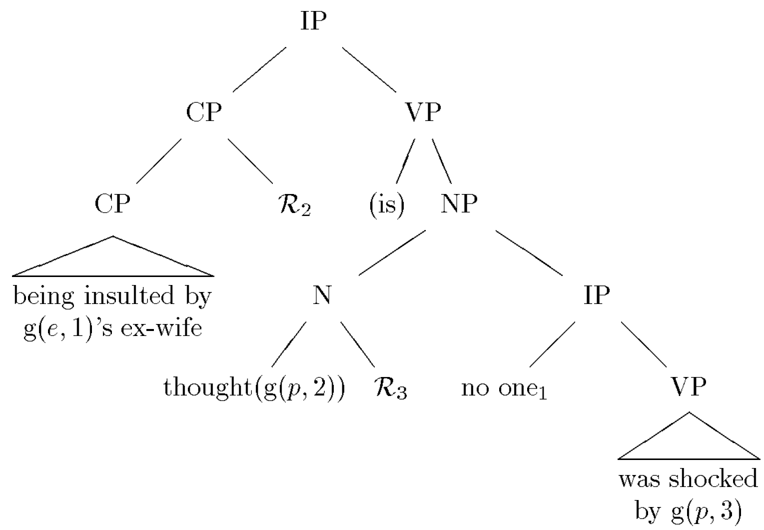
(51) (λg.being insulted by g(i)'s ex-wife) λp(thought(p) $\wedge$ no x_i was shocked by p(g[x/i]))

(51) implies the correct binding of the pseudo-variable, namely that no x was shocked by being insulted by x's ex-wife. However, (51) also implies that the object of a thought is not an ordinary proposition, but a denotation function which still depends on assignments. I am not sure whether this should be permitted; perhaps the analysis in (52) is preferable:

(52) No one$_i$ was shocked by the thought of being insulted by his$_i$ ex-wife

Comparing this with the surface expression, where *thought* is the head of a relative clause outside the scope of *no one*, (52) implies the necessity for some semantic version of reconstructed Vergnaud raising (*cf.* Vergnaud (1974)), as shown in (53) (where I simply ignore the indefinite article and the copula):[9]

(53)



Having established that there is independent motivation for adopting a semantic account of "extended binding"—in fact, one whose range of application is somewhat broader than literal reconstruction—I will now turn to another major area of reconstruction phenomena.

7. Questions

7.1. **Functional Answers.** Before going into reconstruction in the next subsection, I will show that denotation functions help to solve an independent problem in the semantics of questions. According to Engdahl (1980), Engdahl (1986), Chierchia (1991), Chierchia (1993), Stechow (1996), and many others, questions like (54) have the two analyses shown in (54-a) and (54-b).

(54) Who does nobody hate?
- a. For which x: nobody hates x
- b. For which f: no x hates $f(x)$

An appropriate answer to (54-a) would be "John," an appropriate answer to (54-b) would be "His mother." The first analysis is the common one, the second is the so-called functional one. The problem here is that the two analyses are forced to stipulate a lexical ambiguity in the question word *who*, which intuitively does not exist.

Upon closer scrutiny, it even becomes doubtful whether the analyses really capture an intuitively existing ambiguity. Since constant functions cannot be formally excluded as values for f, each answer to (54-a) would also be an answer to (54-b). A second problem, therefore, is whether or not (54) has a reading which semantically excludes answers of the functional type. It is doubtful that this is the case.

The present perspective suggests to assimilate *wh*-phrases to pronouns. Such an analysis would predict that functional answers are permitted just in case the question word or its trace is in the scope of a quantifier. The analysis of

(54) would then be something like (55), where Y is the pronominal variable introduced in (12):

(55) For which Y: nobody$_1$ hates$_{1,2}$ Y

Y can be replaced either by a name like λg.**John**, by a pronoun like λg.g(1) (= *himself*), or by a description like $\lambda g\iota x$(**mother-of**(x,g(1))) (= *his mother*). It thus follows that the "functional dependency" is a property of the answer (the possible value of the variable Y), but not of the logical form of the question itself.

A related problem has been discussed by Bennett (1977) who claims that (56) has at least three different analyses:

(56) John wonders where two unicorns live

The decisive reading is the one Bennett associates with the LF *John wonders: two unicorns live where?*, in which the respective unicorns can live at different places (with *where* in the scope of *two unicorns*, and *two unicorns* in the scope of *wonders*.) According to his intuition, the syntactic fronting operation does not necessarily have a semantic effect.[10]

From the present perspective, it is clear that if the value of the *wh*-term is a denotation function, it can be interpreted in a scope-dependent way. Accordingly, an answer to the question where two unicorns live might involve a description which specifies different places for each unicorn, given a distributive reading of the subject NP. Hence, it is not presupposed that the unicorns (*in intenso*) live in the same place. Since *two unicorns* is, by definition of the problem, not quantified-in (*ie.* the NP is still in the scope of *wonders*), we cannot talk about them as individuals and list for each of them where it lives; hence their respective living places can only be specified by a description. But this is precisely what our semantics predicts.

7.2. **Reconstruction in Questions.** It has frequently been argued that syntactic reconstruction cannot be disregarded in order to get the correct semantics of questions like (57):

(57) a. Whose mother died?
b. How many books did everyone read?

Most authors presuppose a Karttunen-style formalization of questions as sets of true or possible answers, and I will adopt this. The problem can informally be illustrated by the following paraphrases of (57):

(58) a. For which x is it the case that: x's mother died?
b. (i) For which n is it the case that: there are n books such that everyone read them?
(ii) For which n is it the case that: for everyone there are n books such that he read them?

The paraphrase in (58-a) reveals that the property that has been pied piped along with *whose* must be reconstructed into the IP, *ie.* into the scope of the question operator in C. (58-b-i), which is a paraphrase of the ambiguous (57-b), implies that the most informative answer gives us the maximal number of books such that everyone read every book in that set. The second paraphrase in (58-b-ii) implies that we ask for the smallest number n such that everyone read at least n books. In the first paraphrase, the set of books has wide scope with respect to the readers; in the second, it has narrow scope. In both cases, the existential statement *there are n books* is inside the scope of the operator *is it the case that:*, whereas the operator is inside the scope of the *for-which*-phrase. On the basis of these paraphrases and their formalization, it has been concluded that any semantic analysis is doomed to fail. The argument goes as follows:

a. Since part of the fronted *wh*-phrase has to be lowered for scopal reasons,
b. and since lowering is not necessarily reconstruction into the base position, as evidenced by the wide-scope reading (58-b-i),
c. nor is it necessarily reconstruction into a position that can host a trace (if movement into SpecC were to create an intermediate trace, it would violate the Principle of Unambiguous Binding; cf. Müller & Sternefeld (1993));

it follows that semantic reconstruction and in particular the copy theory of movement cannot work.

I will now show that such an argument, which was taken as compelling evidence in favor of a *syntactic lowering* theory, is premature. Let us first clarify our basic assumptions concerning the semantics of questions.

a. Questions are represented as sets of propositions (their possible or true answers).
b. C contains a question operator (whose semantics will be described below).
c. In multiple questions, there is no LF-movement of *wh*-phrases into SpecC; all *wh*-phrases are interpreted in their surface position.
d. For this purpose, the operator in C is indexed with the set of indices of *wh*-phrases that have the same scope as the fronted *wh*-phrase.
e. The semantics of *wh*-phrases is basically that of indefinites in Heim's (1982) theory, meaning that they are or contain a "free variable."
f. The operator in C simultaneously binds these "variables."

Since propositions are intensional objects, any explicit and complete elaboration of these assumptions would force us into a discussion of intensions—a topic we have hitherto tried to avoid. Fortunately, however, the relevant features of our analysis can be fully explained without going into intensions.

Beginning with property (c.), let us assume that all *wh*-phrases stay *in situ*, as is the case in many of the world's languages. The semantics of question formation will be independent of any movement of *wh*-phrases. According to property (d.), the only effect of *wh*-movement is that of forcing an index on C, otherwise the choice of an index for *in situ* *wh*-phrases is free (*modulo* certain syntactic restrictions that are irrelevant in the present context).

For ease of exposition, let us confine ourselves to simple cases like (59-a), provisionally adopting the vacuous movement hypothesis and the oversimplified logical paraphrase in (59-b):

(59) a. $\mathrm{C}_{i,j,k}$ who_i gave what_j to whom_k ?
b. $\lambda \mathrm{p} \exists x_i \exists x_j \exists x_k\ \mathrm{p} = \textbf{give-to}(x_i, x_j, x_k)$

(59-b) is basically Karttunen's analysis. If the operator in C is to simultaneously bind the variables, and if this is to work compositionally, we must give an explicit account of "selective binding", *ie.* a binding operation that simultaneously binds more than one variable (but does not necessarily bind *all* variables, since some *wh*-phrases left *in situ* might be bound by a higher COMP; the term "unselective binding" frequently used in this context is a misnomer).

Let us solve this problem first. The first step is to represent the set of indices in C as a characteristic function, *ie.* a mapping from numbers to truth values. This is needed to generalize modified assignments with respect to indices of C and **sequences** of values; *cf.* (60):

(60) **Generalized Modified Assignments:**
If $\alpha \in Var_{\langle n,a\rangle}$, β and $\delta \in ME_{\langle n,a\rangle}$, $\mathrm{N} \in Var_{\langle n,t\rangle}$, and $\mathrm{n} \in Var_n$, then

$$\beta[\delta/\mathrm{N}] := \iota\alpha(\forall \mathrm{n}((\mathrm{N}(\mathrm{n}) \to \alpha(\mathrm{n}) = \delta(\mathrm{n})) \wedge (\neg \mathrm{N}(\mathrm{n}) \to (\alpha(\mathrm{n}) = \beta(\mathrm{n})))))$$

Selective quantification can then be defined compositionally, with respect to pseudo-variables, as follows:

(61) **Generalized Selective Quantification:**
Let N and δ be defined as in (60). Then:
a. $\vec{\forall}(\mathrm{N})(\mathrm{p}) := \lambda \mathrm{s} \forall \delta \mathrm{p}(\mathrm{s}[\delta/\mathrm{N}]))$
b. $\vec{\exists}(\mathrm{N})(\mathrm{p}) := \lambda \mathrm{s} \exists \delta \mathrm{p}(\mathrm{s}[\delta/\mathrm{N}]))$

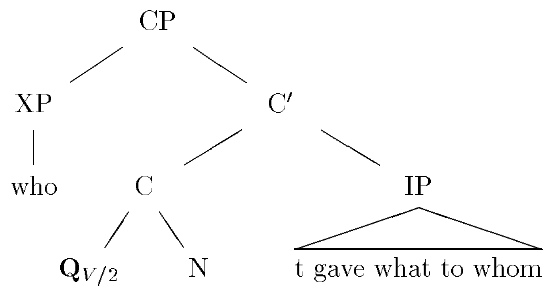
Selective quantification will now be part of the definition of the question operator, which maps the meaning of an open proposition to a set of propositions. Such an operator, call it **Q**, takes scope over an IP and can be defined as in (62):

(62) **The Q-Operator**:
$\mathbf{Q}(\mathrm{N})(\mathrm{IP}) := \lambda \mathrm{s} \lambda \mathrm{p} \exists \delta(\mathrm{p}(\mathrm{s}) = \mathrm{IP}(\mathrm{s}[\delta/\mathrm{N}]))$

As shown in the last section, the logical type of *wh*-phrases and pronouns should be the same. For ease of exposition, however, I will assume the standard encoding, with the variables in (59-b) ranging over individuals. This implies that the assignment function δ in (61) to (62) has type $\langle n, e\rangle$. Adopting the notational convention of writing characteristic functions as sets, this yields the following analysis of (59-a):[11]

(63) a. $\mathbf{Q}(\{i,j,k\})(\lambda s.\mathbf{give\text{-}to}(s_i,s_j,s_k)) =$
b. $\lambda s \lambda p \exists \delta (p(s) = \lambda s.\mathbf{give\text{-}to}(s_i,s_j,s_k)\ (s[\delta/\{i,j,k\}])) =$
c. $\lambda s \lambda p \exists x_i \exists x_j \exists x_k (p(s) = \mathbf{give\text{-}to}(x_i, x_j, x_k))$

Let us next turn to a language with *wh*-movement into SpecC. We thus have to interpret the structure (64), which requires a slightly different operator in C, defined in (65):

(64)


(65) **The Verb-Second Q-Operator**:
$\mathbf{Q}_{V/2}(N)(IP)(XP) := \mathbf{Q}(N)(XP(IP))$

Semantically, $\mathbf{Q}_{V/2}$ works like $\mathbf{Q}$ except that it mimics adjunction of XP to IP. This works for all types of *wh*-phrases, because IPs always denote open propositions, and the fronted constituent is always a function from an open proposition to (possibly open) propositions.

Returning to (57-b), it is clear that the set N is a singleton. The task, then, is to calculate the truth conditions of (66-a). Given that x ranges over numbers, (65) predicts the adjunction structure (66-b) as an intermediate step:

(66) a. $[_{NP}\ s_i$ many books $]_k\ \mathbf{Q}_{V/2}(\{i\})([IP$ everyone read $t_k]) =$
b. $\lambda s \lambda p \exists x (p(s) =$
$[_{NP}\ s_i$ many books $]_k\ ([_{IP}$ everyone read $t_k])](s[x/i]))$

Now two possibilities arise, corresponding to the two readings of the sentence. If NP_k is indexed with γ, this yields the reading (58-b-ii), whereas (58-b-i) is the result of indexing NP_k with $\mathcal{R}$ and interpreting the trace as an NP-variable.

Refining the analysis a bit, we have to take into account that *wh*-phrases like *who* or *where* are synonymous with *which person* or *at which place* respectively. *Which*-questions bring up the issue of intensions again, because what has been called the *restriction* of the *wh*-operator can be interpreted ex- or intensionally; *cf.* Groenendijk & Stokhof (1982). Continuning to ignore the issue of intensionality and adopting a proposal by Reinhart (1992), *which* is interpreted as a choice function that selects an element from the extension of a property:

(67) f is a **choice function** iff $\forall P(P(f(P))$.

The LF of *which*$_1$ *man loves which*$_2$ *woman* is to be represented by something like (68-a), where f_1 and f_2 are pseudo-variables for choice functions. Accordingly, the operator **Q** has to quantify over such functions (rather than over individuals), so that the truth conditions would be that in (68-b).

(68) *Which man loves which woman?*
 a. $f_1(\mathbf{man})\ \mathbf{Q}_{V/2\{1,2\}}\ \mathbf{love}\ f_2(\mathbf{woman}) =$
 b. $\lambda p \exists f_1 \exists f_2(p = \mathbf{love}(f_1(\mathbf{man}), f_2(\mathbf{woman}))$

These refinements, however, add nothing essential to the analysis.

Note in passing that the strict *in situ* character of the analysis automatically accounts for the data in (69) (cf. Higginbotham (1980)):

(69) a. *Whose$_i$ mother hates him$_i$?
 b. *Whose$_i$ mother does he$_i$ love ?
 c. *Which picture of which man$_i$ did he$_i$ see ?

In these cases, we do not—in contrast to the usual approach in terms of syntactic reconstruction—raise *whose* or *which man* out of their NPs. Accordingly, neither these NPs nor the operator **Q** can bind the pronouns in (69); hence, an *in situ* semantics of *wh*-phrases correctly predicts that an interpretation of the pronouns as bound variables is not possible.[12]

8. Binding Theory

In this section, I would like to evaluate data from binding theory (henceforth: BT) that were advanced in favor of a theory of syntactic reconstruction. Adopting Barss's theory of chain binding I will show that none of these can lend support to a convincing, rock-solid argument against semantic reconstruction.

8.1. The Trapping Effect.

Lebeaux (1991) and many before him argued that principle (A) of BT should be checked during derivation. However, in Lebeaux (1994), he considers the following data, arguing that such a theory would not predict the non-ambiguity of (70-b):

(70) a. Two women$_i$ seem t$_i$ to be expected t$_i$ to dance with every senator (ambiguous)
 b. Two women$_i$ seem to each other$_i$ t$_i$ to be expected t$_i$ to dance with every senator (unambiguous)[13]

Whereas reconstruction (combined with clause bounded QR[14]) is optional in (70-a), (70-b) exhibits what Lebeaux calls the "Trapping Effect:" Due to the presence of the reciprocal in the matrix clause, the quantifier is trapped there and cannot reconstruct into the embedded clause. But given that principle (A) is checked in the course of the derivation, this might seems unexpected;

as argued by Lebeaux there must be, in addition, a so-called "coherence condition" which states that "LF must be a coherent representation, in the sense that an element occupies a particular position at LF (rather than occupying several positions at once, in the sense of chain-binding (Barss, 1986))." Since the scope of the binder *two women* is read at LF, binding of the anaphor must also be checked *there*, in contrast to other cases of binding that do not involve scope-inducing quantifiers.

Although Lebeaux is certainly right in arguing for a single level which interprets bound variables and scope, he is wrong in concluding that this must have any impact on the question where BT applies. Lebeaux's coherence condition seems to confuse morpho-syntactic conditions on the distribution of pronouns with conditions on semantic interpretation. As an illustration, consider

(71) His$_i$ mother thinks Bill loves everyone$_i$

Given that QR is clause bound, the pronoun cannot recieve an interpretation as a bound variable, but no one would expect this to be explicable in terms of condition (B) of binding theory. Likewise, reconstruction in (71-b) does not yield any violation of principle (A) of BT, but leads to an uninterpretable structure: Via reconstruction as lambda abstraction, the indefinite NP ends up inside the scope of the universal quantifier (modulo QR). But for the anaphor to be interpretable as suggested by our pre-theoretic expectations about the indexing, it would be necessary to reconstruct the anaphor as well, which is impossible in (71): there is no place left to reconstruct the anaphor into the scope of the quantifier. It follows that the non-ambiguity of (71-b) can be explained semantically, without invoking principles of BT.

There are also empirical arguments against the assumption that binding of variables interacts with principle (A), so that both have to be checked at the same level. Consider the following sentences:

(72) a. Noone$_i$ knows how many pictures of himself$_i$ Diana wants to sell.
b. Noone$_i$ knows how many stories about himself$_i$ Diana is likely to invent

For semantic reasons, the *picture*-phrase has to reconstruct into the scope of the modals so that, given a movement approach to reconstruction, the closest antecedent of *himself* at LF would be *Diana*. Nonetheless binding by *noone* is admissible, contrary to what one would expect from BT at LF. I conclude that there is no genuine interaction between reconstruction and principle (A) OF BT.

8.2. **Principle (C).** Notwithstanding the above conclusion, reconstruction is precisely the place where we look for arguments in favor of applying principle (C) at LF. For example, it has been argued that the difference between (73-a) and (73-b) is due to the availability of reconstruction (cf. Heycock (1995, p. 560)): In (73-a) the lies must be understood intensionally, *ie.* reconstructed into the scope of *planning*; whereas in (72-b), Clifford takes the existence of lies for granted. The same contrast is illustrated in (74):

(73) a. *[How many lies aimed at exonerating Clifford$_i$]$_j$ is he$_i$ planning to come up with t$_j$
b. [How many lies aimed at exonerating Clifford$_i$]$_j$ did he$_i$ claim that he$_i$ had no knowledge of t$_j$

(74) a. Which stories about Diana$_i$ did she$_i$ most object to?
b. *How many stories about Diana$_i$ is she likely to invent ?
c. *How many stories about Diana$_i$ does she want Charles to invent ?

The decisive observation is that binding options do not depend on the understood subject of *stories* or *lies*, nor on the nature of the *wh*-phrase (*which vs. how*). Instead, the data suggest that condition (C) violations occur only if reconstruction is involved; hence, BT is dependent on reconstruction and must therefore take LF into account.

This conclusion is corroborated by examples from Lebeaux (1994):

(75) a. [[His$_j$ mother's]$_k$ bread]$_i$ seems to every man$_j$ t$_i$ to be known by her$_k$ t$_i$ to be the best there is.
b. *[[His$_j$ mother's]$_k$ bread]$_i$ seems to her$_k$ t$_i$ to be known by every man$_j$ t$_i$ to be the best there is.

(76) a. [Which paper that he$_j$ gave to Bresnan$_k$]$_i$ did every student$_j$ think t$'_i$ that she$_k$ would like t$_i$
b. *[Which paper that he$_j$ gave to Bresnan$_k$]$_i$ did she$_k$ think t$_i$ that every student$_j$ would like t$_i$

According to Lebeaux, the relative clause of (76-a) is "read" at LF in the intermediate Comp, which is the only position where the pronoun is c-commanded by its binder and the R-expression is free:

(77) [Which paper $\_\__n$]$_i$ did every student think (that he gave to Bresnan)$_n$ that she would like t$_i$

Although (77) seems to be the only structure consistent with BT, any compositional surface semantics for (77) calls for much additional machinery that is entirely construction specific. It is therefore very improbable that a structure like this is a well-formed LF. The present framework, however, allows for reconstruction of the entire *which*-phrase into the position of the intermediate trace, as shown in (78):

(78) a. [Which paper that he$_j$ gave to Bresnan$_k$]$_{\mathcal{R}_i}$ $\mathbf{Q}_{V/2}$ every student$_j$ think $[\mathcal{Q}_i]_{\gamma_2}$ that she$_k$ would like$_{1,2}$
b. *[Which paper that he$_j$ gave to Bresnan$_k$]$_{\mathcal{R}_i}$ $\mathbf{Q}_{V/2}$ she$_k$ think t$_i$ that every student$_j$ would like$_{1,2}$ $[\mathcal{Q}_i]_{\gamma_2}$

This analysis captures the semantic facts correctly[15], but it also raises the question of how this interaction with BT can be modelled in a systematic way.

Before making this more explicit, recall that Lebeaux's theory was a derivational one that took into account D-structure and S-structure as well. In order to simplify things somewhat, let us adopt such a theory, so that our present task can be reduced to an analysis of the effects that show up at LF, namely the effects of reconstruction. Following Barss, this can be done by describing a **path** that leads from an R-expression to the root of the tree. This set of nodes is a **subtree** of the entire tree. Condition (C) says that an R-expression does not tolerate an antecedent that is a sister node of (or c-commands) a node of this subtree (or path). The relevant property of the subtree is that it includes the trace of a constituent if and only if this trace is a reconstruction site. This can be defined as follows:

(79) **Binding Theory** (Principle (C)):
- a. Principle (C) must be satisfied at every stage of the derivation.
- b. Adjuncts can be inserted in the course of a derivation.
- c. An R-expression is A-free (*ie.* not A-bound).

(80) **A-Binding**: α is A-bound by β iff
- a. α and β are coindexed,
- b. β is in an A-position, and
- c. β is a sister of some node in the binding tree of α.

(81) **Binding Tree:**
Given a structure Σ and a node $\alpha \in \Sigma$, the binding tree for α is the smallest subtree $T \subseteq \Sigma$ such that
- a. $\alpha \in T$,
- b. the root of T is the root of Σ,
- c. if $\beta \in T$, β is indexed with $\mathcal{R}$, and γ translates as a pseudo-variable coindexed with $\mathcal{R}$, then $\gamma \in T$.

For example, the binding tree of *Bresnan* in (78) contains all and only the nodes that dominate *Bresnan* and $[\mathcal{Q}_i]_{\gamma_2}$. Coindexation between *Bresnan*$_i$ and *she*$_i$ results in a BT violation in (78-b) but not in (78-a). Similarly, the sentences in (73) can be explained straightforwardly: if there is semantic reconstruction, the tree contains the position of the reconstruction trace, which effects a violation of principle (C); if there is no semantic reconstruction, a principle (C) violation is avoided by continuing up the path of *Clifford* directly to the root.

Lebeaux's distinction between adjuncts and arguments does not interact with reconstruction. For example, reconstruction of adjuncts and arguments may equally lead to a condition (C) violation. The difference shows up only in cases like (82), which do not involve reconstruction:

(82)
- a. *Which claim that John$_i$ was asleep was he$_i$ willing to discuss t?
- b. Which claim that John$_i$ made was he$_i$ willing to discuss t?

Arguments as opposed to adjuncts must be present at D-structure, otherwise principle (C) could not be violated in (82-a). In contrast, the adjunct in (82-b) is inserted after movement, so that both D-structure and S-structure satisfy principle (C). Since uninterpreted traces cannot enter a binding tree, (82-b) is predicted to be grammatical also at LF. This captures Lebeaux's and Heycock's data in a simple, straightforward manner.

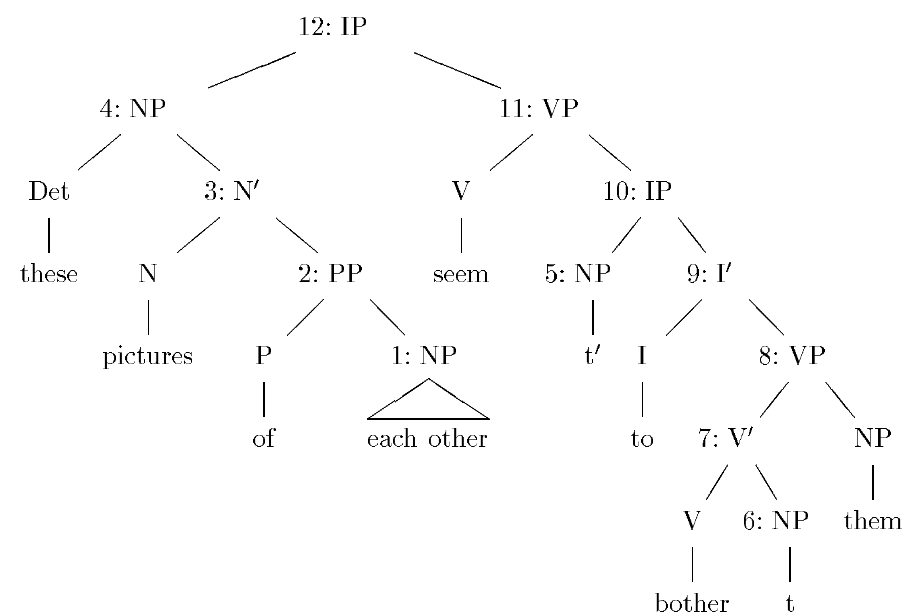
8.3. **Principle (A).** Above we concluded that reconstruction of movement does not necessitate reconstruction of binding; nonetheless the connectivity phenomena discussed by Barss and Higgins show that in these cases the only way an anaphor can be bound to an antecedents is via a binding tree. We thus have to extend the concept in order to capture connectivity effects with anaphors.

Principle (A) involves a locality condition not operative in (C). We therefore have to impose an ordering on the nodes of a binding tree—Barss's *accessibility sequence*—so that the first (accessible) subject dominated by such a sequence determines the local domain of anaphoric binding. This ordering of nodes of a tree is defined in (83):

(83) **Ordered Binding Tree:**
An ordering of a binding tree is BT-compatible iff it is a strict and total ordering of the nodes of the tree that satisfies the following conditions:
a. if α dominates β, then $\alpha > \beta$, and
b. if α precedes β in a reconstruction chain, then $\alpha < \beta$.

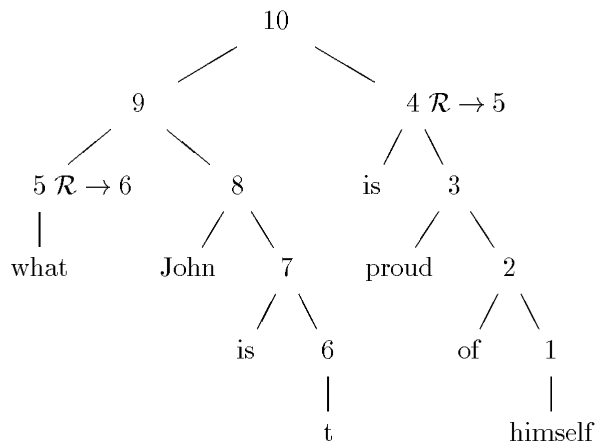
The ordering of a reconstruction chain is determined by c-command. For example, one can order the following tree as indicated by consecutive numbers (the structural analysis is taken from Barss (1986, p. 116)):

(84)



The closest possible binder on the path of *each other* is *them*, and indeed this gives us the correct result. However, since principle (A) can be checked before movement, (84) is in fact irrelevant for this sentence. Relevant examples can result only from reconstruction without movement, which is the case in a pseudo-cleft construction:

(85)



It is obvious that the anaphor can be bound here only via its binding path.

Let us now state the binding condition more explicitly. This requires some care, because we have to distinguish cases like (72), where semantic reconstruction can be ignored, from cases where binding reconstruction is obligatory, as in (86):

(86) a. *John thinks that an admirer of himself Mary became
b. *John does not know how proud of himself Mary is

To account for this difference, Barss added a condition on functional completeness that can be integrated into our definitions as follows:

(87) **Binding Theory** (Principle (A)):
a. Principle (A) is checked at some stage of the derivation.
b. An anaphor α is locally A-bound with respect to a functionally complete, ordered binding tree for α.

(88) A binding tree for α is **functionally complete** iff each argument of a governor of α c-commands a node of the tree.

Since *Mary* is a co-argument of *himself*, any binding tree that ignores reconstruction would be incomplete.

Summarizing so far, the derivational nature of condition (A) "bleeds" reconstruction in cases where the reconstruction site corresponds to a trace; in these cases principle could have been checked before movement and reconstruction. The only data where reconstruction of movement and of binding go parallel involve the functional completeness phenomenon, which happens to enforce obligatory reconstruction. In contrast, we observed significant interaction with principle (C). This interaction results from the obligatory checking of principle (C) at all levels, including LF, where binding paths are sensitive to reconstruction.

8.4. **A Non-Derivational Theory.** Since LF is the level at which all relevant information is preserved, we may reformulate BT as a purely representational LF condition. This necessitates two changes of previous definitions, one concerning principle (C) in connection with the adjunct/argument distinction, the other concerning condition (A) in connection with the derivational aspect of the condition.

Turning first to the argument/adjunct asymmetry, the main task is to capture the derivational history encoded in traces that were previously ignored in the definition of binding trees. These traces will become relevant only for R-expressions that are included in arguments; they will be irrelevant for expressions dominated by an adjunct. This is captured by condition (89-b):

(89) **Binding Tree:**
Given a tree Σ and a node $\alpha \in \Sigma$, the binding tree for α is the smallest subtree $T \subseteq \Sigma$ that satisfies the following conditions:
a. it satisfies the conditions on binding trees stated in (81);
b. if $\beta \in T$ and γ is the local trace of β, then $\gamma \in T$, **unless** α is an R-expression and β (reflexively) dominates an adjunct that dominates α.

(89-b) is the representational counterpart of (79-b), and condition (C) can now be stated as in (79-c).

Above we saw that condition (A) can ignore reconstruction traces, as long as functional completeness is satisfied. With respect to an ordered binding tree, this means that anaphors cannot always be checked against a full binding tree. However, the facts follow if this checking can procede with respect to a freely chosen subtree of the binding tree. This intuition is captured by the following reformulation of the binding theory:

(90) **Binding Theory** (representational version):
a. An R-expression is A-free with respect to its binding tree.
b. If α is an anaphor, α is locally A-bound with respect to some subtree of its binding tree which satisfies the following conditions:
(i) it contains α,
(ii) it is ordered as defined in (83), and
(iii) it is functionally complete.

The derivational asymmetry between (A) and (C) is now captured by the assumption that (C) must be checked against the complete tree, while it is sufficient for (A) to look at an arbitrary subtree only.

Note that the representational theory allows for predictions that differ slightly from those the derivational theory makes. Consider (91), already discussed in Barss (1986, p. 241):

(91) What John wants Mary to paint are pictures of himself

Since Chomsky (1986), it has become standard practice that *want* embeds an IP (at D-structure). In a derivational theory, this implies that there is no landing site where *what* could pick up the relevant information needed to tell *himself* that binding to *John* is an option. In the present system, however, no problem arises, since a partial binding tree for *himself* need not extend downwards to the trace of *what*, but can stop before reaching *Mary*.

Another case in point is this:

(92) Which picture of himself did John tell Mary where to hide t?

Successive cyclic movement should be ruled out in examples like (92), because according to the cycle condition the escape hatch is already blocked by *where*. Hence, the sentence is correctly classified as a mild subjacency violation, but according to the derivational BT, it should turn out at least as ungrammatical as (93):

(93) *John told Mary where to hide pictures of himself.

However, and more correctly, the representational BT sketched above does not imply ungrammaticality for (92). This follows from the fact that the binding path of *himself* can be any subtree that touches an antecedent. This subtree need not contain the trace; it can start with any of the nodes that dominate *Mary*, which therefore does not automatically become the closest antecedent.

A final point in favor of a representational theory can be derived from a language like German. It has often been observed that the ambiguities discovered by Jacobson & Neubauer (1976) in examples like (94) are absent in German.

(94) a. John$_i$ does not know how many pictures of himself$_{i/j}$ Bill$_j$ wants to sell.
b. John$_i$ does not know how many stories about himself$_{i,j}$ Bill$_j$ is likely to invent.

In other words, coreference with *John* is ruled out in German. This cannot be explained in purely derivational terms. Nonetheless, some parametrization is called for. Within the representational theory formulated above, it follows that the long binding options in English rest on the existence of proper subtrees of the binding trees. Now, if in some language this option were unavailable (by parametrization), the non-existence of long binding in these languages would be explained: the accessability sequence for principle (A) would always extend to the most deeply embedded position of the full binding tree, so that locality could not skip the embedded subject *Bill*.

To summarize, a representational LF account seems at least as adequate as a derivational one; the explanatory weakness of condition (89-b) seems to touch on unresolved problems of BT that are independent of the issue of reconstruction.[16]

8.5. **A Side Issue: Negative Polarity.** Another trigger for reconstruction and connectivity is negative polarity, as illustrated in (95):

(95) a. What John didn't buy was any picture of Fred.
b. What nobody did was steal anything

Since negative polarity items usually require c-command by their licensing negation, there is a clear analogy to the binding facts. Accordingly, both phenomena can be explained with reference to binding trees. However, there are also data where semantic reconstruction cannot license NPIs; *cf.* the pseudo-clefts in (96) and other examples in (97):

(96) a. *Any picture of Fred was what John didn't buy
b. *Steal anything was what nobody did

(97) a. *Pictures of anyone John didn't buy.
b. *It was pictures of anyone that John didn't buy
c. *Pictures of anyone are easy to ignore
d. *... but steal anything, nobody did

Obviously, the behavior of NPIs differs from that of anaphors or bound variables. As pointed out to me by Chris Wilder, this difference might be due to an additional restriction necessitating the licensing negation to precede the NPI. This is satisfied in the grammatical cases in (95), but is violated in (96) and (97).

9. Dynamic Binding

I will show in this section that dynamic binding is an automatic consequence of the idea shared by Smaby (1979), Heim (1982), Groenendijk & Stokhof (1990), and others that a proposition α is represented by its context change potential, which is formally encoded as the set of propositions compatible with α. For example, *a man walks* can be represented by the formula in (98), where p is a variable that ranges over intensions, *ie.* over functions from possible worlds to truth values:

(98) $\lambda p(\exists x(\mathbf{man}(x) \wedge \mathbf{walk}(x) \wedge {}^{\vee}p)$

Since intensionality has been ignored throughout the paper, writing p instead of ${}^{\vee}p$ makes no difference for the purpose under discussion. Given this simplification, the main idea is that lambda conversion in (99) is possible on the condition that the variable x in (99), which tranlates the pronoun in *He whistles*, is a pseudo-variable:

(99) $\lambda \mathrm{p}(\exists x(\mathbf{walks}(x) \wedge \ \mathrm{p}))(\mathbf{whistles}(x))$

Since basic predicates are now encoded as dynamic "open" propositions, as shown in (100), predication as performed by γ in previous sections has now to be redefined as in (101):

(100) $\text{walk}_i \rightsquigarrow \lambda \mathrm{g} \lambda \mathrm{q}(\mathbf{walk}(\mathrm{g}(\mathrm{i})) \wedge \mathrm{q}(\mathrm{g}))$
$\text{whistle}_i \rightsquigarrow \lambda \mathrm{g} \lambda \mathrm{q}(\mathbf{whistle}(\mathrm{g}(\mathrm{i}) \wedge \mathrm{q}(\mathrm{g}))$

(101) $\gamma(\mathcal{Q})(\mathrm{n})(\phi) := \lambda \mathrm{g} \lambda \mathrm{q}.\mathcal{Q}(\mathrm{g})(\lambda x.\phi(\mathrm{g}[x/\mathrm{n}])(\mathrm{q}))$, where ϕ is a dynamic open proposition (*ie.* a variable of type $\langle s, \langle\langle s, t\rangle, t\rangle\rangle$).

Now, *A man walks* and *He whistles* are translated as in (102):

(102) a. $\gamma(\text{a man})(\mathrm{i})(\text{walks}_i) =$
$\lambda \mathrm{g} \lambda \mathrm{q} \lambda \mathrm{P} \exists x(\mathbf{man}(x) \wedge \mathrm{P}(x))(\lambda x \lambda \mathrm{g} \lambda \mathrm{q}(\mathbf{walk}(\mathrm{g}(\mathrm{i}))$
$\wedge\ \mathrm{q}(\mathrm{g}))(\mathrm{g}[x/\mathrm{i}])(\mathrm{q})) =$
$\lambda \mathrm{g} \lambda \mathrm{q} \lambda \mathrm{P} \exists x(\mathbf{man}(x) \wedge \mathrm{P}(x))(\lambda x(\mathbf{walk}(x) \wedge \mathrm{q}(\mathrm{g}[x/\mathrm{i}])) =$
$\lambda \mathrm{g} \lambda \mathrm{q} \exists x(\mathbf{man}(x) \wedge \mathbf{walk}(x) \wedge \mathrm{q}(\mathrm{g}[x/\mathrm{i}]))$
b. $\gamma(\text{he}_i)(\mathrm{j})(\text{whistles}_j) =$
$\lambda \mathrm{g} \lambda \mathrm{q}(\mathbf{whistle}(\mathrm{g}(\mathrm{i})) \wedge \mathrm{q})$

Dynamic conjunction is defined in (103) and combines (102-a) with (102-b), which is illustrated in (104):

(103) $\phi \ \&\ \psi := \lambda \mathrm{g} \lambda \mathrm{q}.\phi(\mathrm{g})(\psi(\mathrm{g})(\mathrm{q}))$

(104) A man_i walks_i *&* He_i $\text{whistles}_j \rightsquigarrow$
$\lambda \mathrm{g} \lambda \mathrm{q} \exists x(\mathbf{man}(x) \wedge \mathbf{walk}(x) \wedge \lambda \mathrm{g}(\mathbf{whistle}(\mathrm{g}(\mathrm{i})) \wedge \mathrm{q})(\mathrm{g}[x/\mathrm{i}])) =$
$\lambda \mathrm{g} \lambda \mathrm{q} \exists x(\mathbf{man}(x) \wedge \mathbf{walk}(x) \wedge \mathbf{whistle}(x) \wedge \mathrm{q}(\mathrm{g}[x/\mathrm{i}]))$

Thus, we have shown that integrating dynamic conjunction into Bennett's framework correctly predicts the effects of dynamic binding.

Although Groenendijk and Stokhof (and many others) have pointed out examples like (105-a), it is generally acknowledged that dynamic quantification with non-existential quantifiers is the exception rather than the rule; cf. (105-b) or (105-c):

(105) a. Every player chooses a pawn. He puts it on square one.
b. Every man came in. *He whistled.
c. Nobody entered. *He whistled.

The question then arises of how a more restricted type of quantification could be integrated into the system.

The usual technique of achieving this proceeds by translating the two types of quantifiers in different ways. Pursuing such an approach requires more complex translations of NPs.[17] Alternatively, we can modify the glue between the quantifier and the open dynamic proposition while still adopting the usual method that turns dynamic into static semantics. This is commonly achieved by replacing a variable in a "dynamic context" with a logical constant that prevents dynamic interpretation. The constant function **True** of type $\langle s, t\rangle$ which maps all value assignments onto "true" has such a blocking effect. We may thus define γ' as in (106):

(106) **Static quantification**:
$\gamma'(\mathcal{Q})(\mathrm{n})(\phi) := \lambda \mathrm{g} \lambda \mathrm{q}.\mathcal{Q}(\mathrm{g})(\lambda x(\phi(\mathrm{g}[x/\mathrm{n}])(\mathbf{True}) \wedge \mathrm{q})$

Here, **True** stops dynamic conjunction within ϕ, and introduces a fresh variable q, which does not depend on previous context. It is obvious that applying a dynamic proposition to **True** also blocks dynamic interpretation of binding.

Although this is appropriate for universal quantifiers, γ' is clearly inadequate for indefinite weak quantifiers, which points to certain selectional restrictions of glue. Conversely, γ seems inadequate in the context of strong quantifiers. However, this restriction seems less severe, and I will illustrate further cases of dynamic binding with universal quantifiers in the next section.

10. Scope Reversal and Inversed Linking

This section contains a brief discussion of an alternative encoding of indefinite existentially quantified NPs. If such NPs function basically like free variables, as proposed by Heim (1982), one might expect it to be possible to derive further reconstruction effects by reconstructing such variables into the scope of another quantifier.

Suppose that the denotations of indefinite NPs are the same as those of *wh*-phrases, *ie.* they are choice functions, as suggested in Reinhart (1992) or Stechow (1996). Such a function must be existentially bound by an invisible operator attached to a VP or to some node higher up in the tree. Above, we assumed that the value of such a choice function is not an individual, but a denotation function, so that for any sequence s and any property P of individuals, it holds that P(f(P)(s)). We also presupposed that all NPs are encoded as generalized quantifiers. But assume now that the type-lifting operation that shifts names, descriptions, or choice functions is optional or inexistent. This necessitates a second function γ' which combines a name or description with an open proposition. Assume that this is defined in the obvious way.

As a relevant consequence of these modifications it now might become formally possible to reconstruct such a low level term into an open proposition. Consider, for example, (107-a). Applying $\mathcal{R}$ to the subject term f(**Mac**) yields (107-b):

(107) a. A Mac adorns every desktop.
b. $\lambda \mathrm{s} \exists \mathrm{f}_{cf} \forall x(\mathbf{desktop}(x) \rightarrow \mathbf{adorns}(\mathrm{f}(\mathbf{Mac})(\mathrm{s}),x))$

As one can choose a different Mac for each desktop, it appears that we have captured the narrow scope reading by reconstruction. Upon closer scrutiny, however, it turns out that (107-b) does not represent the correct truth conditions, in particular, (107-b) is not equivilant to (108):

(108) $\lambda s \forall x(\mathbf{desktop}(x) \rightarrow \exists y(\mathbf{Mac}(y) \wedge \mathbf{adorns}(y,x)))$

Ordinary propositions are constant functions where lambda abstaction over s applies vacuously (the proposition does not contain "free variables"). (107), however, is not constant but varies with the values of s. To overcome this problem one would have to require that choice functions assign either individuals or constant designation functions. In either case, however, we would not get a reconstruction effect, *ie.* we would only get the wide scope reading for the indefinite.

However, it is still possible to derive the narrow scope reading by reconstruction, if one admits a combination of choice functions and Skolem functions. As argued above such a function cannot depend on an assignment. Therefore one would need to define such a function as follows:

(109) f_{Scf} is a **Skolem choice function** for P iff
$\forall x \exists y \forall \mathrm{s}(\mathrm{f}(x,\mathrm{P})(\mathrm{s}) = y \wedge \mathrm{P}(y))$

A first informal representation of (107-a) within ordinary predicate logic is something like (110):

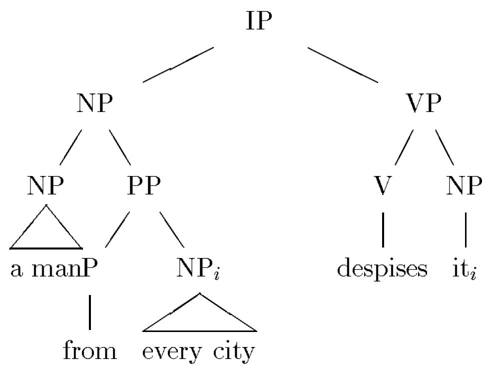
(110) $\exists \mathrm{f}_{Scf}(\mathrm{f}(x,\mathbf{Mac})\lambda y \forall x(\mathbf{desktop}(x) \rightarrow \mathbf{adorn}(y,x))$

The by now familiar idea would be to replace the free variable x inside the indefinite by a pseudo-variable that becomes bound by *every* after lambda conversion, *ie.* by reconstruction of the indefinite into the argument position of **adorn**. This is shown in (111-a), which ultimately reduces to (111-d). In traditional first order notation, this is equivalent to (111-e).

(111) a. $\lambda s \exists \mathrm{f}_{Scf} \mathcal{R}(\mathrm{f}(\mathrm{s}\text{-}2,\mathbf{Mac}))(1)\lambda s.\forall x\ (\mathbf{desktop}(x) \rightarrow$
$\lambda s.\mathbf{adorn}(\mathrm{s}_1,\mathrm{s}_2)(\mathrm{s}[x/2]))$
b. $\lambda s \exists \mathrm{f}_{Scf} \forall x(\mathbf{desktop}(x) \rightarrow \lambda s.\mathbf{adorn}(\mathrm{s}_1,\mathrm{s}_2)(\mathrm{s}[\mathrm{f}(\mathrm{s}_2,\mathbf{Mac})/1][x/2]))$
c. $\lambda s \exists \mathrm{f}_{Scf} \forall x(\mathbf{desktop}(x) \rightarrow \lambda s.\mathbf{adorn}(\mathrm{s}_1,\mathrm{s}_2)(\mathrm{s}[\mathrm{f}(x,\mathbf{Mac})/1][x/2]))$
d. $\lambda s \exists \mathrm{f}_{Scf} \forall x(\mathbf{desktop}(x) \rightarrow \mathbf{adorn}(\mathrm{f}(x,\mathbf{Mac}),x))$
e. $\lambda s \forall x(\mathbf{desktop}(x) \rightarrow \exists y(\mathbf{Mac}(y) \wedge \mathbf{adorn}(y,x)))$

Likewise, we could treat cases of inversed linking by simply combining reconstruction with dynamic conjunction. To sketch the idea, consider (112):

(112)



In English, there seems to exist a bound reading of *it* which can now be accounted for *in situ*, by combining the above interpretation of indefinites with dynamic conjunction. Firstly, dynamic conjunction implies that the predicate *from* is encoded dynamically, *ie.* as (113) shows:

(113) $\text{from}_{1,2} = \lambda s \lambda q.\mathbf{from}(s_1,s_2) \wedge q(s)$

Next, given scope reversal with indefinites as Skolem choice functions, *a man from every city* is equivalent to the following dynamic proposition:

(114) $\lambda p \forall x(\mathbf{city}(x) \rightarrow \exists y(\mathbf{man}(y) \wedge \mathbf{from}(y,x) \wedge p(s[y/1][x/2])))$

It is clear that continuing with the predicate $despise_{1,2}$ (or rather, but equivilantly, $despises_{1,2}$ it_2) yields the correct meaning of (112) by dynamic conjunction. Thus, we can get an *in situ* interpretation of inversed linking: the universal quantifier has, in effect, wide scope over the predicate, although it is syntactically (and "semantically") embedded within the complex NP.

The proposal outlined above correctly predicts that only indefinites, and not real quantifiers, can receive narrow scope. It also follows that one cannot reconstruct too low—a restriction that is illustrated in (115), taken from Fox & Sauerland (1995):

(115) Yesterday, a guide ensured that every tour to the Louvre was fun.

The condition is usually formulated as a restriction on QR by saying that *every tour to the Louvre* cannot be raised into the matrix clause in order to gain scope over *a guide*. Since the higher indefinite NP always has its logical predicate in the matrix clause, this NP cannot be reconstructed into the embedded clause, hence scope inversion is impossible. This explains the clause-boundedness of QR.

On the other hand, neither QR nor reconstruction can explain why the existential quantifier cannot have narrow scope in double object constructions like (116):[18]

(116) Yesterday, I gave a tourist every leaflet

Neither theory can explain why QR seems to be restricted to the universal quantifier, and neither theory can explain why there seem to be language-particular differences.[19]

Moreover, it has been claimed in Hornstein (1984, p. 65, 98) that the following sentences allow wide scope for universal quantification:

(117) a. Someone expects every Republican to be elected
b. Someone wants PRO to marry everyone
c. Someone tried PRO to take every course

Again, neither theory can explain wide scope in the examples involving control (granted that Hornstein's attempt is not really explanatory). However, wide scope in the exceptional case marking example (117-a) can be derived transformationally if QR leaves an anaphoric trace, but would still not be permitted within the present approach, because the NPs are arguments of different predicates.

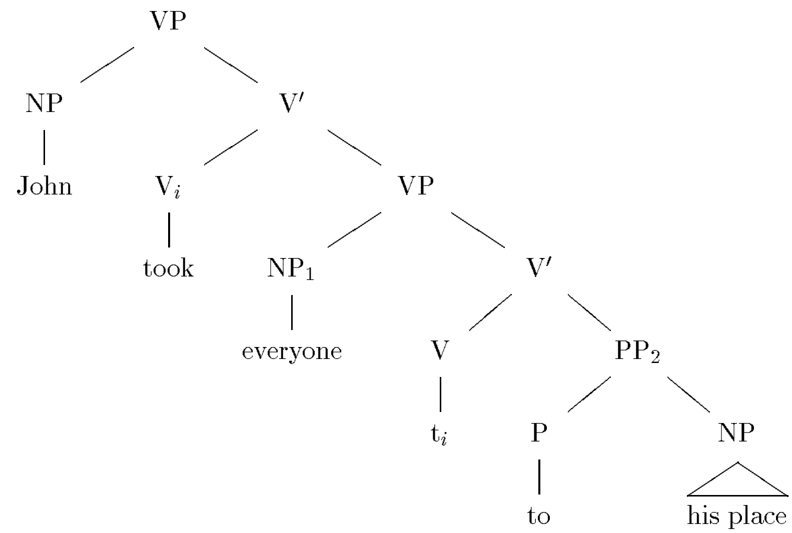
This suggests that QR is more general than reconstruction, so that a theory based on the latter would become obsolete. Moreover, Winter (1996) has argued that choice functions must be encoded as generalized quantifiers. This would, if correct, automatically exclude reconstruction into the predicate. Finally, our above comparison with QR presupposes that QR is as unrestricted as in the original theory of May (1977) and May (1985). Recent developments suggest, however, that QR is sensitive to fine grained distinctions between logical types of quantfiers (cf. Liu (1990)) and involves an elaborate typology of landing sites for different types of quantifiers, *cf.* Beghelli & Stowell (1996). If this is correct, the above formalism should integrate these findings. At present, however, it is hard to see how restrictions on QR[20] and in particular on landing sites of QR can be reformulated as restrictions on reconstruction. I conclude that a heavily restricted mechanism of QR is perhaps more adequate than a less restricted account in terms of reconstruction.

11. Binding "from inside PPs"

11.1. The Problem. Within the last decade, syntactic theories converged on the hypothesis that clause internal structure is "almost right branching," which means that the further to the right a major constituent of a clause appears in linear order, the more deeply embedded it appears in constituent structure.[21] The pioneering work that explores the idea of analyzing (118-a) as (118-b), *ie.* in terms of an almost right branching structure that strictly adheres to $\overline{\text{X}}$-theory, is Larson (1988); cf. also Larson (1990), Haider (1992), Kayne (1994), or Haider (1995).

(118) a. John took everyone to his place

b.

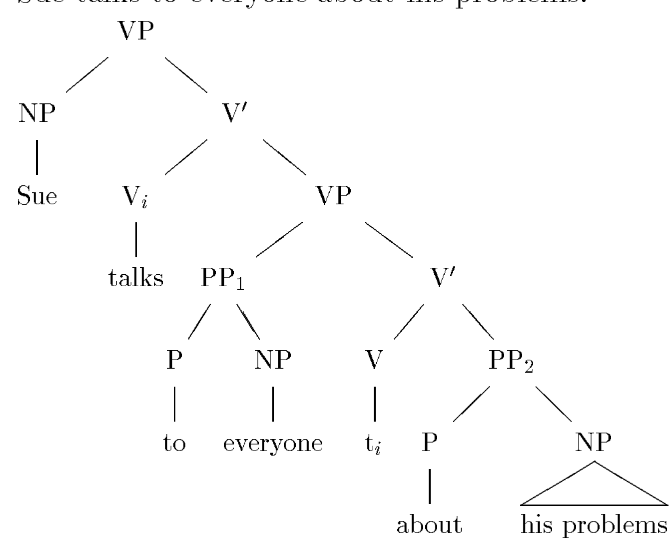


The evidence that led researchers to propose a structure like (118-b) originated from principles of binding, scoping, and negative polarity[22], which imply that any constituent that takes scope over another constituent β must "precede and command" β—a generalization that is naturally captured in terms of constituent structure if (and only if) the linear relation of precedence is encoded by the structural relation of asymmetric c-command.[23] Since PP_1 precedes and asymmetrically c-commands PP_2, (118-b) satisfies this requirement directly.

However, as shown in (119), the correspondence between linear and structural relations is not yet perfect.

(119) a. Sue talks to everyone about his problems.

b.



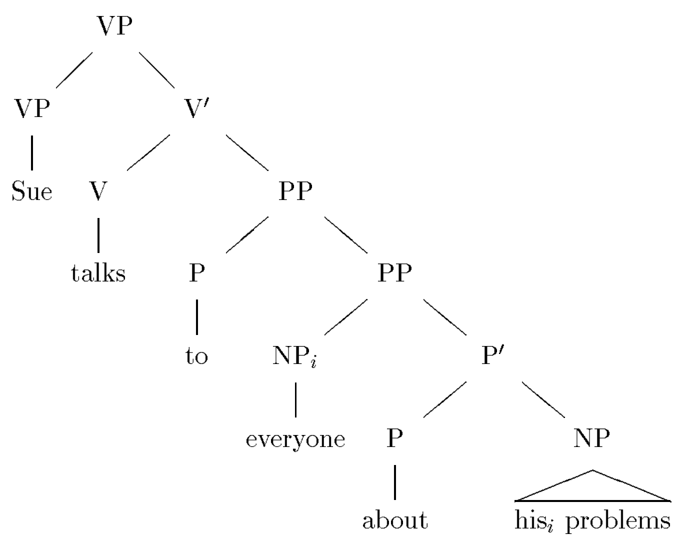
Although we can interpret *everyone* in (119) as the antecedent of *his*, no formal binding relation can be established on the basis of c-command; according to current definitions of command, the NP *everyone* (c- or m-)commands only the preposition *to*; hence, binding between *his* and its antecedent is impossible in the structure given above.

Of course, the phenomenon as such was observed a long time ago in the literature, but there is still no satisfactory solution to the problem.[24] In Section 11.3, I will propose a simple semantic solution in terms of a specific logical typing of expressions in semantic interpretation. As a result, the scopal relation in (119) can be interpreted correctly without a command relation existing between the NP and the scope-dependent element. Before I develop these ideas, let me briefly discuss a recent syntactic solution to the problem.

11.2. **Pesetsky's Solution.**

11.2.1. *The Dual System.* Pesetsky (1995) proposes a new kind of structure, so-called *Cascade Syntax*, which enables the NP *everyone* in (119) to c-command *his*. According to his theory, the structure of (119-a) is (120):

(120)



It is obvious that in (120), the quantifier c-commands and binds the coindexed pronoun, and hence the interpretation of scopal relations between NPs no longer poses a problem.

However, the above structure—although designed to capture certain aspects of semantic interpretation—may not serve as the one and only level of LF. As Pesetsky himself notes, *Cascade Syntax* must not be considered to be a level "that represents semantically contentful relations among items in structure" (p. 289). In particular, the proposed structures cannot capture the relation of predication between heads and their arguments in a way that could be interpreted by any compositional system of logical semantics, *ie.* by a system that calculates truth conditions. The reason for this is that in *Cascade Syntax* a head can take no more than one argument α to its right, so that a second argument β must always be generated as a proper part of α—a configuration that is compositionally uninterpretable. Thus, it seems that Pesetsky's *Cascade Syntax* can handle only certain limited aspects of semantic interpretation; it is essentially confined to matters of scope, and is inadequate regarding matters of argument structure.

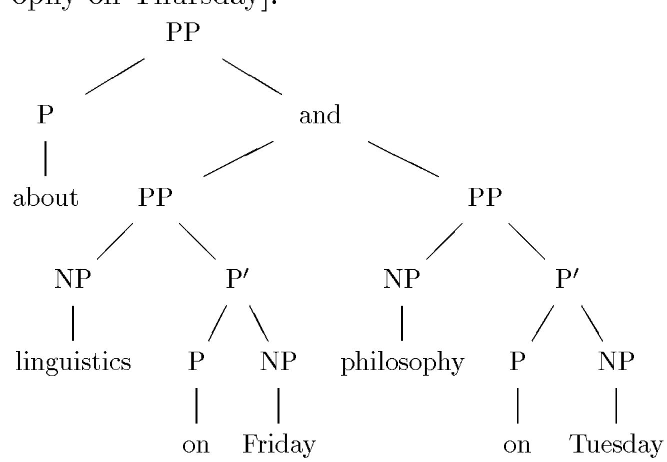
Pesetsky himself recognizes that *Cascade Syntax* is also inadequate as a representation that feeds move-α. For example, *to everyone* in (120) should form a constituent that can be fronted or questioned, which is not possible in *Cascade Syntax*. For these reasons, he proposes a *Dual System* with a traditional structure (called *Layered Syntax*) as a kind of representation that coexists with the *Cascade Syntax*. It thus seems that the latter level is confined to scopal relations between NPs, whereas *Layered Syntax* encodes scopal relations between heads and their arguments.

This bifurcation, however, gives us no unified representation of semantic relations; one might even claim that the *Dual System* as proposed by Pesetsky leaves us with no interpretable structure at all. To date, no theory or mechanism exists that could provide (120) with a compositional semantics. In contrast, however, there is no problem with designing a simple and natural semantic interpretation for structures like (119), as will be demonstrated in Section 11.3.

11.2.2. *Coordination.* Before I go into this, let me touch briefly on the additional support ventured by Pesetsky as further motivation for introducing *Cascades*. This evidence is derived from coordinations as shown in (121) (from Pesetsky (1995, p. 176)):

(121) a. Sue will speak to Mary about [linguistics on Friday] and [philosophy on Thursday].

b.



Since *Cascade Syntax* analyzes the bracketed phrases *linguistics on Friday* and *everyone about his problems* as PPs, nothing more needs to be said about the possibility of coordination in (121-a).

However, as already pointed out by Jackendoff (1990), it is far from clear how coordination interacts with ellipses and gapping. If coordination were simply a matter of constituent structure, it would be inexplicable why the translation of (121) into French is totally ungrammatical:

(122) *Suzanne parlera à Marie de linguistique (le) vendredi et philosophie (le) jeudi.

The same holds for many other languages. Consider, *eg.*, the following examples from German, which *Cascade Syntax* predicts to be grammatical, but which are in fact ill-formed:

(123) a. *Fritz ging in die Schule am Vormittag und den
Fritz went to the school in-the morning and the
Kindergarten am Nachmittag
kindergarten in-the afternoon

b. *Fritz fuhr nach Wiesbaden zu seiner Mutter und Frankfurt zu
Fritz drove to Wiesbaden to his mother and Frankfurt to
seiner Oma
his grandma

Although I have nothing to offer here as an explanation for the observed incongruity, this situation is at odds with the purported universal character of the system[25]. Being a fundamental property of UG, we must look for additional restrictions on coordination that are operative in French and many other languages, but seem to be absent in English. Since it is far from clear how such additional restrictions could be formulated within *Cascade Syntax*, we indeed are left with the familiar "syntactician's trade-off" alluded to in the last footnote. The proposed solution, in fact, leads to an "equal and opposite complication" in languages other than English, which threatens to undermine the validity of the explanation.

11.2.3. *Anaphoric Binding.* Another area where language-specific variation undermines the purported universal character of the *Dual System* is anaphoric binding to a PP-internal antecedent. It has long been observed that certain PPs should, , in the relevant sense, not "count as branching," but if this would hold universally, "an NP they contain should be a possible antecedent for an anaphor. It turns out to be the case that it is not" (quoted from Reuland (1983, p. 240)). For example, whereas (124-a) is considered grammatical in English (*cf. eg.* Reinhart (1983, p. 177)), its analogue in German or Dutch is ungrammatical:

(124) a. I spoke with Rosa about herself

b. daß ich mit Rosa$_i$ über sie$_i$ / sie$_i$ selbst / *sich$_i$ / *sich$_i$
dat ik met Rosa$_i$ over haar$_i$ / haar$_i$ zelf / *zich$_i$ / *zich$_i$
selbst sprach
zelf sprak

The ungrammaticality in (124-b) cannot be due to a general constraint on binding, because there is no problem with quantifier binding or licensing of negative polarity items by NPs within PPs; *cf.* the negative polarity item *jemals* ('ever') in (125-a), the acceptable coindexing in (125-b), and the possibility of interpreting the indefinite expression as scope dependent on the universal quantifier in (125-c):

(125) a. daß Fritz mit niemandem/*jemand jemals darüber sprach
that Fritz with no-one/someone ever about-it spoke

b. daß Fritz [$_{PP}$ mit [$_{NP}$ jedem Kind]$_i$] zu seinem$_i$ Vater
that Fritz with every child to his farther
ging
went

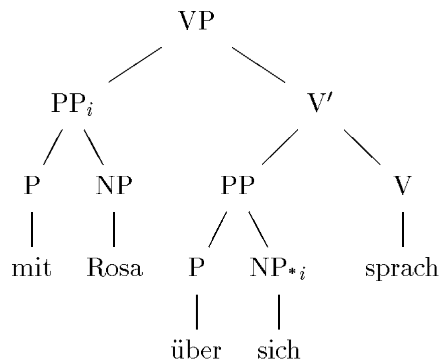
c. daß Fritz in jedem Geschäft ein Spielzeug kauft
that Fritz in every shop a toy buys

It seems, then, that binding of negative polarity items, scoping, and variable binding out of PPs are equally grammatical in German and English, whereas binding of reflexive pronouns is possible only in English. Why should this be so? That is, why is there parametric variation with respect to principles of binding theory but not with respect to scoping?

There is a clear sense in which variable binding and negative polarity are matters of scope and thereby belong to the realm of semantics, whereas the choice between anaphoric and pronominal expressions is largely a matter of syntax. As we don't expect there to be much variation on the semantic side, this division of labor expects uniformity in semantic respects but allows for parametric variation with respect to the syntactic part of the analysis. Accordingly, while binding of the pronouns in (124)—whether grammatical or not—should pose no *semantic* problem, there must be an additional *syntactic* constraint on grammatical binding which is operative only in languages that behave like German.

In what follows, binding of a pronoun will be shown to be achieved with an index which may be attached, at least in principle, to either a PP or an NP, but which for semantic reasons may not be attached to an NP immediately dominated by a PP. It seems, therefore, that the additional *syntactic* constraint on a language like German must be that anaphors do not have the option of being bound by the index of a PP, implying that reflexive pronouns can be bound only by indices of NPs. This restriction rules out the reflexives in (124-b). The relevant part of the structure is given in (126):[26]

(126)



In English, no such uniformity of binding is required; therefore, (124-a) is permitted.

Observe again that *Cascade Syntax* offers no concise way to even formulate the required distinction between PPs and NPs so that, after all, we are led to conclude that this theory is on the wrong track.

11.3. **PPs as Generalized Quantifiers.** The envisaged semantic solution of the binding problem will employ the possibility of treating PPs semantically in the same manner as NPs, namely as generalized quantifiers. As such, they have the same binding potential as NPs, so that the antecedent of the pronoun is, in a certain sense, the PP rather than the NP. This ultimately explains why the command relation *between NPs* seems inapplicable or irrelevant to the case at hand.

Let us now work out the details of this proposal, beginning with verb-related uses of prepositions, which involve a relation between an entity x that denotes an individual (the object of the preposition) and an entity e which denotes an event, a state of affairs, an action, a path, or whatever seems suitable in a given context. For example, *to* might express a relation $\mathbf{goal}(e, x)$ such that e is a transaction or a path, and x denotes the goal of e. We will modify the semantic type of *to* in such a way that when combined with a generalized quantifier, the result is also a generalized quantifier. For example, the result of applying *to* to *every man* is (127-a), and similarly, applying *to* to *no man* yields (127-b):

(127) a. to every man
$= \lambda s \lambda P. \forall x(\mathbf{man}(x) \rightarrow \ (P(x) \wedge \mathbf{goal}(e, x)))$
b. to no man
$= \lambda s \lambda P. \neg\exists x(\mathbf{man}(x) \wedge (P(x) \wedge \mathbf{goal}(e, x)))$

It is obvious that whenever the object of the preposition is downwards-entailing (*ie.*, a quantifier that licenses a negative polarity item), the resulting PP is also downwards-entailing, *ie.*, will also license a Negative Polarity Item. Put differently, the ability of an NP to license an NPI is hereditary; it is passed on to the PP. Therefore, from a semantic point of view, the observed facts about NPIs (cf. (125-a)) follow trivially from a purely compositional interpretation, so that there is no need for any additional syntactic manoeuvering.[27]

More generally, let $\mathcal{Q}$ be a variable that ranges over NP-denotations, and PREP a variable ranging over expressions of the formal language that correspond to prepositions. Then, the categorial encoding of an event-related preposition is (128), where e is a free variable ranging over events, paths, states of affairs, or whatever seems suitable for the preposition in question.

(128) $\lambda \mathrm{s} \lambda \mathcal{Q} \lambda P[\mathcal{Q}(\mathrm{s})(\lambda x[P(x) \wedge \mathrm{PREP}(e, x)]])$

Example 1: Assuming that *to* has the PREP-value **goal**, and *Bill* is translated as $\lambda P.P(\mathbf{b})$, *to Bill* denotes (129-a), which by lambda conversion reduces to the last line of (129):

(129) to Bill

$$\begin{aligned}
&= \lambda \mathrm{s} \lambda \mathcal{Q} \lambda P[\mathcal{Q}(\mathrm{s})(\lambda x[P(x) \wedge \mathbf{goal}(e, x)])](\lambda P.P(\mathbf{b})) \\
&= \lambda \mathrm{s} \lambda P[(\lambda P.P(\mathbf{b}))(\lambda x[P(x) \wedge \mathbf{goal}(x, e)])] \\
&= \lambda \mathrm{s} \lambda P[\lambda x[P(x) \wedge \mathbf{goal}(e, x)](\mathbf{b})] \\
&= \lambda \mathrm{s} \lambda P[P(\mathbf{b}) \wedge \mathbf{goal}(e, \mathbf{b})]
\end{aligned}$$

Example 2: Given that *with* is represented by the two-place relation **with**, *with every knife* is the expression (130-a), which by lambda conversion reduces to (130-d):

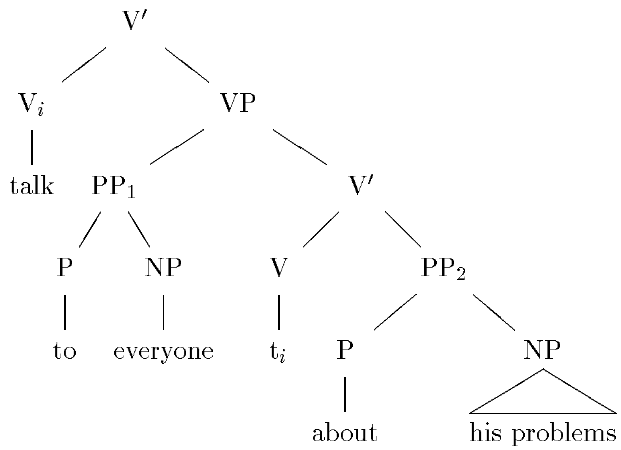
(130) with every knife

$$\begin{aligned}
&= \lambda \mathrm{s} \lambda \mathcal{Q}(\mathrm{s}) \lambda P[\mathcal{Q}(\lambda x.P(x) \wedge \mathbf{with}(e, x))](\lambda P.\forall x(\mathbf{knife}(x) \rightarrow \ P(x))) \\
&= \lambda \mathrm{s} \lambda P[(\lambda P.\forall x(\mathbf{knife}(x) \rightarrow \ P(x)))(\lambda x(P(x) \wedge \mathbf{with}(e, x)))]) \\
&= \lambda \mathrm{s} \lambda P.\forall x(\mathbf{knife}(x) \rightarrow \ \lambda x(P(x) \wedge \mathbf{with}(e, x))(x)) \\
&= \lambda \mathrm{s} \lambda P.\forall x(\mathbf{knife}(x) \rightarrow \ (P(x) \wedge \mathbf{with}(e, x)))
\end{aligned}$$

Here again, the nature of e is immaterial; the only essential assumption is that e also figures as an argument of a predicate. The occurrences of e will become bound in the course of the derivation, *eg.* by means of a general rule to the effect that formation of a VP automatically binds all VP-internal e-arguments by existential quantification. One might also add further parameters like tense or place, but these are irrelevant to what follows.

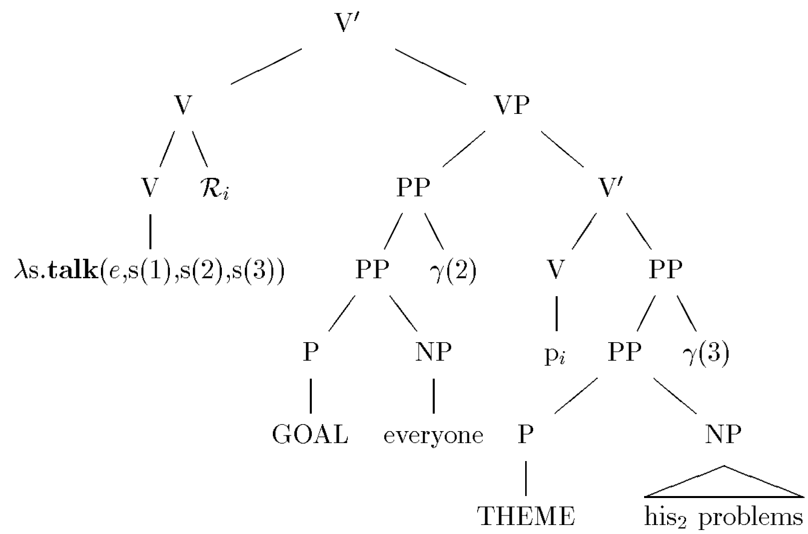
Let us now return to sentence (119), the relevant part of which is shown in (131):

(131)



The TLF of this is (132):

(132)



I leave it as an exercise to calculate that this analysis yields the desired truth conditions shown in (133):

(133) $\lambda s \forall x(\mathbf{human}(x) \rightarrow (\mathbf{goal}(e, x) \wedge \mathbf{theme}(e, x\text{'s problems}) \wedge \mathbf{talk}(e, s_1, x, x\text{'s problems})))$

Note that in the above analysis the goal and the theme were made arguments of the verb. This, however, is not an essential feature of the analysis, and in fact the binding phenomena discussed above are independent of whether the PP is an argument or an adjunct. If the PP is an adjunct, the index of the PP does not match an index of the verb, but the semantics in no way hinges on that and gives precisely the correct result. For example, if neither the theme nor the goal where an argument, the resulting LF would differ from (133) only in having λs.**talk**(e,s(1)) instead of λs.**talk**(e,s(1),s(2),s(3)). Calculation of truth conditions then reveal that this LF is equivalent to (134):

(134) $\lambda s \forall x(\mathbf{human}(x) \rightarrow (\mathbf{goal}(e,x) \wedge \mathbf{theme}(e, x\text{'s problems}) \wedge \mathbf{talk}(e, s_1)))$

11.4. **The Double Object Construction.** The above discussion has shown that arguments may be treated compositionally in the same way as adverbials, in the sense that it is immaterial whether we adopt a Davidsonian or a Neo-Davidsonian style of representation. In the latter case, arguments have indices that do not bind any slot of a predicate, which is precisely what happens to adjuncts in the Davidsonian theory. Although the choice of mechanism is immaterial from a purely formal point of view, it might still be advantageous to adopt the original Davidsonian formalization and represent arguments as slots of predicates. One reason for doing so can be derived from Larson's theory of double object constructions. Recall from Larson (1988) that for a verb to undergo Dative Shift, it is mandatory that the preposition be superfluous in the sense that the θ-role it assigns (*eg.* the role that *to* assigns in (135-a)) is already assigned by the verb (*give*) to the same NP. This is what Larson calls "recoverability of deletion": there is no loss of "information" in the transition from (135-a) to (135-b):

(135) a. John sent a book to me.
b. John sent me a book.

This semantic intuition is formally captured by two properties of a Davidsonian system: First, the fact that the slot x_k is both an argument of the verb and the object of the preposition directly reflects Larson's hypothesis that one and the same position is θ-marked twice. Second, the fact that recoverability demands identity of θ-roles is now more indirectly reflected by the semantics of the verb. Given the meaning postulate in (136), it follows that the preposition is redundant and therefore in a sense "recoverable."

(136) $\mathbf{give}(e, x_i, x_j, x_k) \rightarrow \mathbf{goal}(e, x_k)$

Accordingly, the relevant criterion for recoverability is not (exactly) identity of θ-roles, but semantic entailment. In a certain sense, then, this semantic rephrasing of Larson's condition *explains* why identity of θ-roles is required as a prerequisite for recoverability.

11.5. ***Only.*** I will assume in this section that *only* can occur in at least two syntactic environments, namely as a modifier of VP, as described in Rooth (1985), and as a modifier of NP/PP. Evidence for the latter can be found in German, where only one constituent can be topicalized before the finite verb. From this it follows that, *eg.*, *only a millionaire* is a constituent in (137):

(137) $[_{\mathrm{CP}}\ [_{\mathrm{NP}}$ nur ein Millionär $]_i$ kann$_j$ [IP t$_i$ das bezahlen t$_j$]]
only a millionaire can this afford

The aim of this section is to explain why (138) is ungrammatical:[28]

(138) *John gave the book to only a man

Within the present system, we might conjecture that *only* when combined with an NP or PP is a complex function that operates syntactically like γ. Accordingly, the syntax of *only a man* is as shown in (139), and its semantics is something like in (140), with (140-a) describing the presupposition and (140-b) describing the content of *only*:

(139) $[_{\mathrm{NP}}\ [_{\mathrm{NP}}$ only $[_{\mathrm{NP}}$ a millionare]] n]

(140) a. $\mathrm{ONLY}(\mathcal{Q})(\mathrm{n})(\mathrm{p}) := \gamma(\mathcal{Q})(\mathrm{n})(\mathrm{p})$
b. $\mathrm{ONLY}(\mathcal{Q})(\mathrm{n})(\mathrm{p}) := \lambda \mathrm{s}(\forall x(\mathrm{p}(\mathrm{s}[x/n]) \rightarrow\ \mathcal{Q}(\mathrm{s})(\lambda y.y = x)))$

Ignoring the presupposition, *only a millionaire can afford this* means *If anyone can afford this, he is a millionaire.*

If this is on the right track[29], we can then easily explain the ungrammaticality of (138) where *only* tries to modify an NP within a PP. Since the semantic type of *only* requires two arguments—an NP or PP and a second argument which is interpreted as the scope of *only* and which must be a proposition—constructions like **in only England* are simply uninterpretable, because the semantic type of the *only NP* cannot serve as an argument of a preposition.

12. Conclusion

Comparing the above system to the traditional one and to other type-lifting systems, the striking property of the present theory is its uniformity: each basic expression still belongs to exactly one logical type, and there is only one type-shifting operation which brings us from denotations to denotation functions. Nothing really new comes into play that was not already present in the meta-language that interprets the logic of PTQ.

The conclusion to be drawn from this is that the translation of bound variable pronouns should be different from that of other pronouns whose denotation is determined by coreference with a name-like expression. This has long been recognized in the context of sloppy identity, but has been obscured by the traditional technique of representing the meaning of pronouns uniformly as individuals, rather than as functions.

Another lesson to be learned is this: Current theories of *Dynamic Interpretation*, and also Heim's system of *Flexible Binding*, are notationally very elegant, but nonetheless conceptually extremely complex, with the complexity being hidden in the meta-language. This contrasts sharply with Bennett's system, where all that needs to be expressed is already present in the language of semantic representation. This strikes me as a pedagogical virtue, but whether or not it is a rewarding theoretical advantage remains to be seen.

Notes

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[1] Given the *letters* of predicate logic (*ie.* the set $\{(,), \neg, \wedge, \leftrightarrow, =, \exists, \forall, \lambda, \iota, \ldots\}$), the set ME_a of *meaningful expressions* for any type a is defined as usual. In particular, Var_a denotes the set of expressions $v_{\mathrm{n},a}$ for each non-negative integer n and each type $a \in Type$. Furthermore, the meaning of ME_a is defined relative to an interpretation and an assignment of variables, which is a function g with domain $\bigcup_{a \in Type} Var_a$, such that for any type a, if u $\in Var_a$, then g(u) $\in \mathrm{D}_a$. For any $\alpha \in ME_a$, we define its *meaning* $[\![\alpha]\!]^{\mathrm{F}^+,\mathrm{g}}$ as in (i), with (i-a,b) as the basis of the recursion:

(i) **Interpretation of ME_a**

a. If $\alpha \in Con_a$, then $[\![\alpha]\!]^{\mathrm{F}^+,\mathrm{g}}$ is F(α).

b. If $\alpha \in Var_a$, then $[\![\alpha]\!]^{\mathrm{F}^+,\mathrm{g}}$ is g(α).

c. If $\varphi \in ME_t$, then $[\![\neg\varphi]\!]^{\mathrm{F}^+,\mathrm{g}}$ is 1 iff $[\![\varphi]\!]^{\mathrm{F}^+,\mathrm{g}}$ is 0, and similarly for $\wedge$, etc.

d. If $\varphi \in ME_t$ and u $\in Var_a$, then $[\![\exists \mathrm{u}\varphi]\!]^{\mathrm{F}^+,\mathrm{g}}$ is 1 iff there exists x $\in \mathrm{D}_a$ such that $[\![\varphi]\!]^{\mathrm{F},\mathrm{g}'}$ is 1 where g′ is an assignment like g with the possible difference that g′(u) = x; and similarly for $\forall u\varphi$.

e. If $\alpha \in ME_a$ and u $\in Var_b$, then $[\![\lambda u\alpha]\!]^{\mathrm{F}^+,\mathrm{g}}$ is that function h with domain D_b such that whenever x is in that domain, h(x) is $[\![\alpha]\!]^{\mathrm{F},\mathrm{g}'}$, where g′ is as in (i-d).

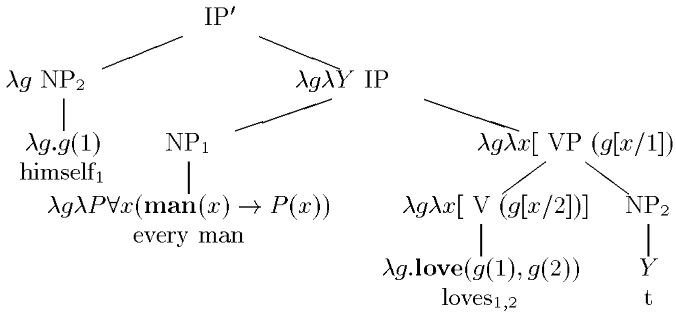
f. If $\alpha \in ME_{\langle a,b\rangle}$ and $\beta \in ME_b$, then $[\![\alpha(\beta)]\!]^{\mathrm{F}^+,\mathrm{g}}$ is the value of the function $[\![\alpha]\!]^{\mathrm{F}^+,\mathrm{g}}$ for the argument $[\![\beta]\!]^{\mathrm{F}^+,\mathrm{g}}$.

g. If $\varphi \in ME_t$ and u $\in Var_a$, then if there exists a unique x $\in \mathrm{D}_a$ such that $[\![\iota u\varphi]\!]^{\mathrm{F},\mathrm{g}'}$ is 1 where g′ is as in (i-d), then $[\![\iota \mathrm{u}\varphi]\!]^{\mathrm{F}^+,\mathrm{g}}$ is x; otherwise, $[\![\iota \mathrm{u}\varphi]\!]^{\mathrm{F}^+,\mathrm{g}}$ is an arbitrary object fixed by the interpretation.

[2] This can be illustrated by looking at a possible, but unilluminating TLF of *Himself every man loves* in (ii). Adopting from EFL the general strategy of combining constituents as defined in (i), the tree in (ii) yields the correct truth conditions, which are calculated in (iii):

(i) **Branchings in an ELF-Tree (Functional Application):**
If $[\![\mathrm{A}]\!]^{\mathrm{F}^+,\mathrm{g}} = \alpha$ and $[\![\mathrm{B}]\!]^{\mathrm{F}^+,\mathrm{g}} = \beta$, and if C immediately dominates A and B, then $[\![\mathrm{C}]\!]^{\mathrm{F}^+,\mathrm{g}} = \lambda g.\alpha(g)(\beta(g))$, where F is the interpretation of a given model, g is a value assignment belonging to the meta-language, and g is a variable of the object-language that ranges over sequences of individuals.

(ii)



$$
\begin{array}{llcl}
\text{(iii)} & \text{VP} & = & \lambda g[\lambda x.\mathbf{love}(g(1),x)(Y(g))] \\
& & = & \lambda g.\mathbf{love}(g(1),Y(g)) \\
& \text{IP} & = & \lambda g[\lambda P\forall x(\mathbf{man}(x) \to P(x))\lambda x\lambda g.\mathbf{love}(g(1),Y(g))(g[x/1])] \\
& & = & \lambda g[\lambda P\forall x(\mathbf{man}(x) \to P(x))\lambda x.\mathbf{love}(g[x/1](1),Y(g[x/1]))] \\
& & = & \lambda g[\lambda P\forall x(\mathbf{man}(x) \to P(x))\lambda x.\mathbf{love}(x,Y(g[x/1]))] \\
& & = & \lambda g\forall x(\mathbf{man}(x) \to \mathbf{love}(x,Y(g[x/1]))) \\
& \text{IP}' & = & \lambda g.g(1)\ \lambda Y\lambda g\forall x(\mathbf{man}(x) \to \mathbf{love}(x,Y(g[x/1]))) \\
& & = & \lambda g\forall x(\mathbf{man}(x) \to \mathbf{love}(x,\lambda g.g(1)(g[x/1]))) \\
& & = & \lambda g\forall x(\mathbf{man}(x) \to \mathbf{love}(x,g[x/1](1))) \\
& & = & \lambda g\forall x(\mathbf{man}(x) \to \mathbf{love}(x,x))
\end{array}
$$

However, it is obvious that the TLF is rather ad hoc, being dictated by the demands of (i) and ad hoc insertion of lambda expressions.

[3] Considerations of type-mismatch are inapplicable at the root of a tree, nonetheless insertion of lambda abstraction at the root is essential for much work done in the framework of TLF. For example, in Karttunen's (1977) explicit compositional treatment of questions and *wh*-phrases, the denotation of a question is a characteristic function of a set of propositions (the true answers), having the general form $\lambda p(\ldots\ p = q)$. Within Karttunen's semantics, it is clear how such a representation comes about compositionally. In terms of TLF, however, lambda abstraction over p is added to the root node CP, which seems unmotivated because this does not remove any type-mismatch between constituents. In order to subsume lamda abstraction at the root under type-driven interpretation, one would need explicit matching conditions to correlate syntactic categories with semantic types. Such a step, however, would bring us close to an explicit translation procedure in the sense of PTQ. I will show below that the problem does not arise in the theory of questions developed in Section 7.

[4] There are a number of strictly compositional treatments of scope ambiguity which all rely on complex type-shifting operations and imply that a natural language expression is assigned infinitely many different types, *cf.* Hendriks (1993) for a representative example. In a certain sense, however, these methods still "stuff in" additional semantic glue, namely the (lexical) type-lifting operation in and of itself. Moreover, I am not aware of any account of binding within such a type-lifting framework.

[5] A remarkably explicit attempt to maintain strong compositionality by using lambda categorial glue can be found in Ballmer's (1975) theory of punctuation. His glue is syntactically located in punctation marks, which reflects the traditional idea of different underlying "*Satzbaupläne*." However, Ballmer's main objective is to overcome syntactic problems posed by word order (*eg.* discontinuous constituency). In

our view, this is explanatorily inadequate because it captures construction-specific syntactic properties only. In contrast, as will be shown below, our use of glue is semantically motivated and goes beyond the range of phenomena that can be treated in a framework like Ballmer's.

[6] A straightforward way of doing so is represented in (i):

(i) every man [$_{\mathrm{VP}}$ **lambda**(1) [$_{\mathrm{VP}}$ [$_{\mathrm{V}}$ **lambda**(2) [$_{\mathrm{V}}$ shaves]] himself]]

In this structure it is tempting to conceive of the additional nodes as representing the meaning of a morphological agreement or transitivity marker, *ie.* the head of some AGR_O or AGR_S projection. Note, however, that such AGR-projections are "interpretable" in the above system—contrary to what has been assumed for AGR_O and AGR_S in Chomsky (1995). Moreover, in Chapter 4 of Chomsky (1995), AGR-projections are dismissed with *in toto*. But even if such functional projections exist, I will, for various reasons, pursue a different analysis than that in (i); in fact one that does not rely on the existence of functional projections of the above kind.

[7] Observe that functional application works as usual, *ie.* as in (i) rather than as defined in footnote 2:

(i) **Functional Application:**
Assume binary branching. Suppose Z immediately dominates X and Y. If X translates as an expression α of type $\langle b, a\rangle$, and Y translates as β of type b, then Z translates as $\alpha(\beta)$ of type a.

[8] Note that strong quantifiers are ungrammatical in several contexts, including the one under discussion:

(i) a. *John is every man
b. *What John baked was every cake

(i-b) of course contrasts with *John baked every cake*, but the contrast cannot be accounted for if the gap in the free relative clause is a quantifier. As argued by Zimmermann (1993), however, indefinite NPs can translate as properties rather than generalized quantifiers, which implies that *what* translates as a pseudo-variable over properties. Adopting this proposal necessitates a number of further adjustments; in fact, several possibilities arise concerning the translation of *what* and the copula (the latter was simply ignored or treated as meaningless in the above discussion). I leave it to the reader to work out the details for the above case; moreover, I will pursue still another possibility of translating indefinites in Section 10.

[9] Of course this is only a sketch for a solution, leaving further questions concerning the semantics of indefinites and the copula unanswered. These issues lie outside the realm of the present paper.

[10] For reasons of type theory, this would be impossible in Karttunen's system. Nor does Bennett (1977) contain any formal semantic analysis that would do justice to this intuition. Bennett (1979) discusses his earlier paper and acknowledges that his formalism does not capture the intuition underlying the discussion of examples like (140); cf. Bennett (1979, p. 23).

[11] (i-a) is already derived by applying γ to the translations of *who*$_i$, *what*$_j$, and *whom*, which are $\lambda s\lambda P.P(s_i)$, $\lambda s\lambda P.P(s_j)$, and $\lambda s\lambda P.P(s_k)$ respectively.

[12] Note that the analysis does not block cross-over violations like (i):

(i) Who$_i$ did his$_i$ mother see.

This is because the *wh*-term itself could possibly bind a crossed-over pronoun.

[13] Some native speakers of (American) English oppose against the grammaticality of this sentence. According to my intuitions, its analogue in German would be ungrammatical as well.

[14] An argument that the lower quantifier is not scoped upward is provided by the following example.

(i) Mary seems to two women to be expected to dance with every senator (unambiguous)

Upward scoping would yield a second reading which is factually inaccessible. I will return to the clause-boundedness of QR in Section 10.

[15] Closer inspection of the truth conditions of (140-a) reveals that they exemplify the so-called functional reading discussed in Engdahl (1980) and Engdahl (1986). It allows answers the form of descriptions, like "his favorite one." By definition, (140-a) this is equivalent to (i):

(i) a. $\mathbf{Q}_{V/2}$[Which$_n$ paper that x_j gave to Bresnan$_k$]$_{\mathcal{R}_i}$(n)(every student x_j think $[\mathcal{Q}_i]_{\gamma 2}$ that she$_k$ would like$_{1,2}$) =
b. $\mathbf{Q}$(n)(every student x_j think [Which$_n$ paper that x_j gave to Bresnan$_k$]$_{\gamma 2}$ that she$_k$ would like$_{1,2}$) =
c. λp$\exists$f(p = every student x_j think λP.P(f(paper that x_j gave to Bresnan$_k$))$_{\gamma 2}$ that she$_k$ would like$_{1,2}$) =
d. λp$\exists$f p = every student x_j think that she$_k$ would like$_{1,2}$ f(paper that x_j gave to Bresnan$_k$)

This agrees with intuition, but requires some discussion of intensionality again, in order to guarantee that the choice function f selects is among the *actual* papers, not just any paper a student could think of. Reconstruction of an expression that is evaluated at some world w implies that this world is still the evaluation index after conversion. On the other hand, if we treat world indices on a par with pronouns bound, but not c-commanded by their antecedent, things may turn out differently, since semantic reconstruction of a world pseudo-variable places it into the scope of *thought*. In general, this seems to be a marked option, but see the discussion in Groenendijk & Stokhof (1982).

[16] For example, it has often been argued that condition (C) effects depend on the depth of nesting of the antecedent (*cf.* Kuno (1972), Reuland (1983), or Riemsdijk & Williams (1986)): the deeper some node is embedded in α, the less likely is the inclusion of α's trace in a binding tree. The point is not that such a condition would be explanatory (how could it be, if it is to adequetely describe the facts?), but that it is a representational condition that cannot be captured derivationally, as was the case in Lebeaux's account of the adjunct/argument asymmetry.

[17] There is independent evidence that the above semantics for quantifiers is indeed too simplistic. For example, material implication as part of the meaning of universally quantified NPs should be replaced by dynamic implication (or by a combination of dynamic conjunction and negation, as in Smaby (1979)), in order to account for the dynamics of binding in donkey sentences with relative clauses.

[18] The universal quantifier *can* gain wide scope if and only if it is understood as a generic NP. But, also in this case it can be shown that one can arrive at the correct interpretation with an *in situ* semantics, cf. Fox & Sauerland (1995).

[19] For me, as a native speaker of German, it is extremely difficult to get the inversed reading, except in special contexts.

[20] A prominent example not mentioned in the text is also the (strong or weak) cross-over restriction.

[21] In a purely right branching structure, it is required that heads always appear on right branches, as, *eg.*, in Japanese. This does not hold for "almost" right branching structures; cf. below. The qualification *almost* should be understood in a very loose sense; I will not attempt a formal definition of the term.

[22] For relevant data, see Barss & Lasnik (1986) or Jackendoff (1990), although the theoretical conclusions reached by these authors are rather different from Larson's.

[23] For a discussion of some formal properties of asymmetric command and linearization, cf. Kayne (1994) and the comments in Sternefeld (1994).

[24] In a very recent article, Baltin & Postal (1996) point to a long tradition of reanalyzing the preposition as a constituent of the verb. For example, Riemsdijk & Williams (1986, p. 203), in dealing with their sentence (31-a), propose that if "(31a) is reanalyzed as (31b), then this case is accounted for, since *Bill* does c-command the reflexive in (31b)."

(31) a. John talked [$_{\text{PP}}$ to Bill] about himself
b. John [talked to] Bill about himself

However, Baltin and Postal show convincingly that a theory of reanalysis is empirically inadequate and doomed to fail. Unfortunately, the authors have nothing to offer as a positive solution, leaving the problem no less enigmatic.

[25] ... which is expressed particularly clearly in the following quote from Pesetsky (1995, p. 291):

> Have we merely ended up with the familiar "syntactician's tradeoff," whereby an analytic simplification of one module of grammar leads immediately to an equal and opposite complication of another module of grammar? I suspect that this has not happened here.
>
> First, the Dual System explains phenomena that were not explained adequately by traditional theories—phenomena unrelated to lexical questions with which we began.
>
> Second, the Dual System is (if correct) a fundamental property of UG [...], not the response of an individual speaker to specific experience.

From this we must conclude that the Dual System does not allow for parametric variation between languages: whether or not a certain phenomenon like coordination must be analyzed on the level of Cascades is not open to parametric variation; otherwise, we would have a learning problem.

[26] German seems less strict with respect to reciprocal pronouns; cf.

(i)	a.	weil	er$_i$ [$_{\text{PP}}$	an alle]$_j$	Bilder	von sich$_{i/*j}$/einander$_j$		schickte
		because	he	to all	pictures of	REFL/REC		sent
	b.	?weil	er mit	allen	gegen	einander	wettete	
		because	he with	all	against	each-other	betted	

It is therefore crucial to restrict the above categorial uniformity condition to the binding of reflexive pronouns only.

As for condition (B) of the binding theory, it is clear that in languages like German, inhomogeneous binding (*ie.*, binding of an NP exercised by a PP) cannot result in a violation of principle (B). Accordingly, the notions A-bound and A-free need some further qualification in the sense that we must distinguish between nominal and non-nominal A-positions. Hence, within its local domain a pronominal in German cannot be bound from a *nominal* A-position (but may very well be bound from a PP).

[27] From another perspective, however, we face a problem. Intuitively, a sentence like *John gave a book to no man* might express the negation of the existence of a certain event. This does not follow on the present assumption, but seems to call for an analysis in terms of a more abstract account of negation, which implies that *no* as part of the NP does not itself express negation but functions as a negative polarity item.

[28] The problem has been addressed recently also by Bayer (1996) and Büring & Hartmann (1996), who reach conclusions that are inconsistent with the solution proposed below.

[29] But compare Fintel (1994), where the semantics for *only a man* is construed rather differently than it is here.

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