A Compositional Semantics for Multiple Focus Constructions*

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Introduction

The subject of this article is the semantics of focus, i.e. the development of a framework in which we can formulate the influence of focus on the semantic and pragmatic interpretation. In section (1), I will discuss such a framework, structured meanings. In section (2), I will point out some of its shortcomings, as it is currently worked out; they have to do with cases involving multiple foci. In (3), I develop a general representation format in which we can cope with these problematic cases. Finally, in (4) I will discuss some extensions and possible problems, among others a combined semantic treatment of focus and topic.

1 The Structured Meaning Approach to Focus

Some common assumptions of current theories on the syntax and semantics of focus, essentially going back to Jackendoff (1972), are the following:

- Focus consists of a feature that is assigned to a node in the syntactic representation of a sentence (in theories that distinguish between different representation levels, focus is assigned at surface structure).
- The focus feature might be associated with a focus operator, such as *only*; the focus operator has to c-command its focus. We call this "bound focus".
- In phonology, the focus feature is spelled out by sentence accent (I disregard other ways of marking focus, such as cleft constructions). In case of a complex category, the position of the sentence accent may be sensitive to syntactic structure and to semantic properties such as givenness. For example, for English and German it has been argued that in a case where a head-argument structure is in focus, the accent is realized on the argument (cf. Selkirk 1984, von Stechow & Uhmann 1987). Also,

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it has been argued that constituents that refer to entities given in the context are deaccented, although they may be part of the focus (cf. Ladd 1980, Lötscher 1983).

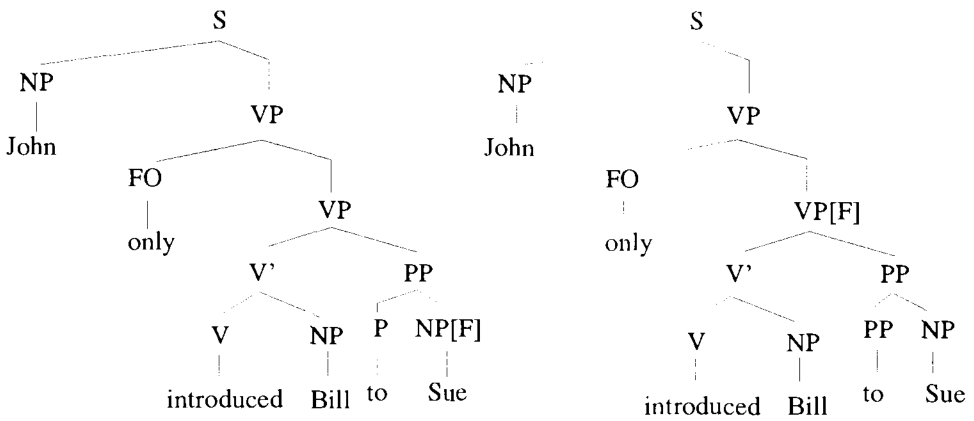
- In semantics, the focus feature induces a partition of the semantic representation of the sentence into the part that is in focus and the complement part that is not in focus, commonly called the background. This partition is essential for the semantics and/or pragmatics of the sentence.

Let us get more specific by looking at an example:

(1) John only introduced Bill to SUE.

This sentence, with accent on *Sue*, has at least two readings: (i) The only person John introduced Bill to is Sue; (ii) the only thing John did is introducing Bill to Sue. For the first case, we can assume that *Sue* is in focus; in the second case, we can assume that *introduced Bill to Sue* is in focus. The rules of focus marking by accent lead to the same result in both cases (in the latter one, accent is realized on the last argument). The adverbial particle *only* c-commands the focus in both cases.

(1') a) b)



There are essentially two representation formats that were designed to capture the contribution of the partitioning into focus and background to the semantic interpretation, namely STRUCTURED MEANINGS (cf. Klein & von Stechow 1982, Jacobs 1983, also Williams 1980) and ALTERNATIVE SEMANTICS (Rooth 1985). Here, I will concentrate on the structured meanings framework; see von Stechow (1989) for a comparison.
A structured meaning is a pair consisting of a background part and a focus part. The background is of a type that can be applied to the focus. If this application is carried out, we arrive at the ordinary semantic representation. Focus-sensitive operators are applied to these structured meanings. The two readings of our example are represented as follows:

(2) a) $\mathbf{only}(<\lambda x.\mathbf{introd}(j,x,b), s>)$
b) $\mathbf{only}(<\lambda P.P(j),\lambda x.\mathbf{introd}(x,s,b)>)$

Let us assume the following semantics for **only**. It says that the background representation applies to the focus representation, and that the background representation applies to no other entity that is comparable with the focus representation (see section 4.7 for a more refined treatment, distinguishing assertional meaning and presuppositional meaning). Comparability, which will be discussed shortly, is expressed by $\approx$.

(3) $\mathbf{only}(<\alpha,\beta>) :\leftrightarrow \alpha(\beta) \ \& \ \forall X[X{\approx}\beta \ \& \ \alpha(X) \rightarrow X{=}\beta]$,
where X is a variable of the type of β.

For our two examples, we get the following representations:

(4) a) $\mathbf{introd}(j,s,b) \ \& \ \forall x[x{\approx}s \ \& \ \mathbf{introd}(j,x,b) \rightarrow x{=}s]$
b) $\mathbf{introd}(j,s,b) \ \& \ \forall P[P{\approx}\lambda x.\mathbf{introd}(x,s,b) \ \& \ P(j) \rightarrow P{=}\lambda x.\mathbf{introd}(x,s,b)]$

This says that John introduced Bill to Sue, and (a) there is no individual comparable but not identical to Sue that John introduced Bill to, or (b) that there is no property comparable but not identical to introducing Bill to Sue that John has.
The limitation to comparable entities is meant to capture contextual and ontological restrictions. For example, the first reading might be true even if John introduced more persons to Sue, but these persons are not contextually salient (this is the case if the sentence is used to answer a question like *Did John introduce Bill and Paul to Sue?*). The second reading depends even more on this restriction; without it, it would express that introducing Bill to Sue is the only property John has, which of course cannot be true, as he has many additional properties, like being a man, or being identical to himself (cf. Lerner & Zimmermann 1983). The restriction can be expressed in various ways, as a condition formulated with respect to the meaning of the expression in focus, as suggested here (cf. also Rooth 1985), or alternatively as a condition formulated with respect to the meaning of the background expression, as suggested in Jacobs (1988). As the precise semantics of *only* and other operators is not at stake here, I will not elaborate on this point further.
We have seen how the partitioning into focus and background affects the interpretation of a sentence containing a focus-sensitive operator. Similarly, it may affect the interpretation of a sentence where no overt focus-sensitive operator is present. For example, the two interpretations of the sentence

(5) John introduced Bill to SUE.

might be used in different contexts, depending on the focus; with focus on *Sue*, it might be an answer to *To whom did John introduce Bill?*, and with focus on *introduced Bill to Sue,* it might be an answer to *What did John do?*.
According to Jacobs (1984), cases of bound focus and unbound ("free") focus are actually not different at all. He proposes that the illocutionary operator that expresses the sentence mood (assertion, question, directive, optative etc.) may bind the focus. Let

us assume ASSERT as assertion operator; then we get the following representations for the two readings:

(6) a) **ASSERT**(<λx.**introd**(j,x,b), s>)
b) **ASSERT**(<λP.P(j), λx.**introd**(x,s,b)>)

Assertion of a structured representation <α,β> can be described as follows, following Jackendoff (1972): At the current point of discourse, the entities X for which α(X) holds are under discussion, and it is stated that, among these entities, it holds for β that α(β). For our example this means that in (a), the persons x for which it holds that John introduced Bill to x are under discussion, and in (b), the properties P that John has are under discussion. In both cases, it is stated that John introduced Bill to Sue. I skip here over different uses of free focus, like presentational vs. contrastive focus as argued for by Rochemont (1986); they might be handled by different illocutionary operators.
The meaning of assertion can be specified more formally, given the concept of an assertion as a modification of shared assumptions of speaker and hearer. Let us call the shared assumptions the "common ground", which is represented simply by a set of possible worlds (cf. Stalnaker 1979), and let us assume that the semantic representation of a sentence Φ is a set of possible worlds [Φ]. Then we can give the following definition of assertion (cf. Krifka 1990):

(7) **ASSERT**(<α, β>) maps a common ground c to a common ground c', where c' is the intersection of c with the set of possible worlds for which α(β) is true, i.e. c'=c∩[α(β)] Felicity conditions (among others):
a) c'≠c (asserting α(β) makes a difference in the common ground),
b) c'≠∅ (the truth of α(β) must not be already excluded by c)
c) There are X, with X≈β and X≠β, such that α(X) could have been asserted with respect to c. That is, it would have changed c, c∩[α(X)]≠c, it would not be excluded by c, c∩[α(X)] ≠ ∅, and would have yielded a different output context, c∩[α(X)] ≠ c∩[α(β)].

Note that the partitioning between focus and background does not play any role for the semantics proper of the assertion operator, but affects only its felicity conditions. Conditions (a) and (b) guarantee that the proposition to be asserted is relevant - it should not already be established or excluded by the current common ground. Condition (c) says that it is relevant which contextually salient alternative is asserted - that is, the alternatives are assertable as well, and their assertion would make a difference. As usual, if the felicity conditions are not satisfied, they may give rise to accommodations in the sense of Lewis (1979).

2 Multiple Foci

The theory of structured meanings seems to work quite well in examples like the ones considered above. However, we also find cases in which a sentence has more than one focus.

One kind of multiple focus that has been discussed (cf. Taglicht 1984, Rooth 1985, von Stechow 1989, Jacobs 1988, to appear) are cases like the following one:

(8) John only introduced BILL to SUE

This sentence has a reading saying that the only pair of persons such that John introduced the first to the second is Bill and Sue. We clearly have two foci, on *Bill* and on *Sue*, that are related to only one focus operator, *only*.
It is relatively straightforward to account for cases like (8): We have to allow for backgrounds to be applied to more than one focus. There are different methods to implement this technically. Perhaps the most perspicuous way is to provide for LISTS in our semantic representation language. Sentence (8) then gets the following analysis:

(9) **only**(<λx•y.**introd**(j, y, x), **b•s**>)

Here, **b•s** is a list of two names, and x•y is a list of two variables (which can be bound by a lambda-operator). If we represent a list variable by h•t (where h is the head and t is the tail), application is defined recursively as λh•t.Φ(a•β) = λt[λh.Φ(α)](β). Given the representation (9) and the interpretation of **only** in (3), we get the following interpretation:

(10) **introd**(j,s,b) & ∀x•y[x•y≈**b•s** & **introd**(j,y,x) → x•y=**b•s**]

This says that John introduced Bill to Sue, and that there is no pair comparable but not identical to Bill and Sue such that John introduced the first to the second. This is an adequate analysis of the natural interpretation of this sentence.
To distinguish this case of multiple foci from others discussed later, I will not call it multiple focus, but COMPLEX focus.
There are cases of true multiple foci, that is, cases with more than one focus operator, as shown by Jacobs (1984, 1988, to appear). To distinguish between different pairs of focus operator and associated focus, I will follow Jacobs in using a coindexing convention (although there will be no coindexing in my final proposal). Perhaps the simplest case is exemplified by the following sentences:

(11) Even_1 $[\text{JOHN}]_{F1}$ drank only_2 $[\text{WATER}]_{F2}$.

Here we have one sentence that contains two focus operators and two foci. In this case, the foci do not overlap. Let us assume that *even* contributes to the meaning that there are alternatives to the focus for which it would be more probable that the proposition holds. For example, *even JOHN came* says that John came, and that there are persons for which it was more likely that they came. Then the meaning of (11) can be rendered as: John drinks water and no other comparable substance, and there are persons for which it would have been more likely that they drink water and no other comparable substance.
The next example shows that within one focus, we can have another pair of focus operator and focus:

(12) [John, who is quite notorious as a party guest, did not only behave well at yesterdays party,]
he $even_1$ [$only_2$ [drank WATER]$_{F2}$]$_{F1}$.

(12) says that John drank water, that John did not do other, comparable things, and that there are activities comparable to drinking water and doing nothing else for which it is more probable that John performed them.
The next case we will consider are examples where two operators seem to share one focus:

(13) [At yesterday's party, people stayed with their first choice of drink. Bill only drank WINE, Sue only drank BEER, and]
John $even_1$ $only_2$ drank [WATER]$_{F2,F1}$

The meaning of (13) can be rendered as: John drank water, John did not drink something that is comparable but not identical to water, and there are things X that are comparable but not identical to water such that it would be more likely that John drank X and only X.
Finally, we have cases where one focus operator forms the focus of another one:

(14) [Most people drank water at some time during yesterday's party.]
John $even_1$ drank [$ONLY_2$]$_{F1}$ [water]$_{F2}$

This means that John drank water and only water (i.e. nothing comparable to water), and that there are alternatives X to *only* such that *John drank X water* would be more probable. It seems that the only alternative to *only* is *also*; witness the common locution *not only..., but also...* . Hence the last part of the meaning has to be spelled out as: It was more likely that John drank also water (i.e. drank water in addition to other things), than that John drank only water.
The phenomenon of multiple focus is of course more widespread when we follow the analysis of "free" foci given in Jacobs (1984). Then every sentence that contains an overt focus operator actually will have at least two foci, one related to the overt operator, and one related to the illocutionary operator. Jacobs (to appear) discussed this case with the following example (15) to which he assigned the two structures (a, b).

(15) Peter kennt nur einen Roman von GOETHE.
(Peter only knows a novel by GOETHE.)
a) $ASSERT_1$ Peter kennt nur_2 einen Roman von [GOETHE]$_{F1,F2}$
b) $ASSERT_1$ Peter kennt [nur_2 einen Roman von [GOETHE]$_{F2}$]$_{F1}$

Jacobs proposes RECURSIVE STRUCTURED MEANINGS for the semantic representation of these cases. For example, the reading (a) is represented as follows:

(16) $\mathbf{ASSERT}(<\lambda x.\mathbf{only}(<\lambda y \exists z[\mathbf{novel}(z)\ \&\ \mathbf{by}(x,z)\ \&\ \mathbf{knows}(\mathbf{p}, z)], x>), \mathbf{g}>)$

Given the informal analyses of **only** and **ASSERT** developed above, we arrive at the following: It is asserted that John knows a novel by Goethe and that John does not know a novel by another, comparable person. And the felicity conditions are that those persons x are under discussion such that John knows only a novel by x. The other reading, (15b), should make the same assertion, but with respect to a different felicity condition, namely that the properties of Peter are under discussion.
For a discussion of the accentual marking of sentences with multiple foci, see Jacobs (1988, to appear). In this article, I will try to give a compositional semantics of sentences with multiple foci, something which has not been done before - for example, Lyons & Hirst (1990) exclude them explicitly from their discussion because they are "semantically complicated". I will presuppose the following assumptions, which are suggested by the examples we have seen so far:

- There is a one-to-one mapping between focus operators and foci. Remember that I assumed cases like (8) to contain only one, albeit complex, focus.
- Focus is assigned to constituents, or (in case of complex focus) to sets of non-overlapping constituents (see section 4.8 for potential counterexamples).
- Focus operators c-command their focus. This is obvious in the cases of overt operators we have considered so far. A potentially problem arises with illocutionary operators. Some illocutionary operators in some languages obviously c-command the whole sentence; one example is the interrogative *est-que ce* in French. In other cases, different sentence moods are expressed by distinctions in syntactic structure (inversion), intonation, or special categories of the finite verb. We have to assume that, on some level of syntactic representation, these markings are spelled out by operators with widest scope. Some potential problems with overt operators are discussed in section 4.2.
- If one focus operator c-commands directly (i.e. without intervening other focus operators) two or more foci, one including the others, then it is associated with the most comprehensive focus:

(17) $FO_{i/*j}$ [α [β [γ]$_{Fj}$ β]$_{Fi}$ α],
where α does not contain focus operators that c-command β.

The only candidate of such a construction we have seen so far is (13), a case where two focus operators seem to be associated with the same focus. This example then has to be analyzed as: *John* $even_1$ $only_2$ *drank* [[*water*]$_{F1}$]$_{F2}$: The focus operator *only* is associated with the most comprehensive focus, F_2. Of course, this example does not really motivate our assumption. However, the discussion of the issues involved here are relatively complicated, and I will come back to it in section 4.6.

- There is a certain tendency that a focus operator occurs as close as possible to its focus. However, it seems that there are no bounding nodes; witness the following example (which goes back to Jackendoff 1972):

(18) Sam $even_1$ saw [$_{NP}$ the man [$_S$ who was wearing a [RED]$_{F1}$ hat]].

In this example, the scope of *even* (not to be confused with its focus) is the phrase *saw the man who was wearing a red hat*; and as it has to c-command its scope, it cannot occur deeper embedded in the syntactic tree. However, its focus *red* is embedded in an NP and an S, thus showing that the operator-focus association does not obey subjacency. Therefore an analysis of focus that implies movement of the focus constituent, such as Chomsky (1977), is questionable (cf. also the discussion in section 4.3).

- Focus-sensitive operators, especially grading particles like *only* and *even*, can be applied to a wide variety of categories - among them VPs and NPs (see examples above) and APs (cf. *an even bigger apple*).

3 Deriving Representations with Focus Compositionally

In this section, I will specify compositional rules for recursive structured meanings. The framework must be flexible enough to cover the cases of complex foci and multiple foci we have considered so far, represented by the following examples:

(19) a) John only$_1$ introduced [Bill]$_{F1}$ to [Sue]$_{F1}$.
b) Even$_1$ [John]$_{F1}$ drank only$_2$ [water]$_{F2}$.
c) John even$_1$ [only$_2$ [drank water]$_{F2}$]$_{F1}$.
d) John even$_1$ only$_2$ drank [[water]$_{F1}$]$_{F2}$
e) John even$_1$ drank [only$_2$]$_{F1}$ [water]$_{F2}$

Focus-background structures will be represented by pairs $<\alpha,\beta>$ of a background meaning α and a focus meaning β. We must provide a type for these structures; if the type of α and β are σ and τ, respectively, the type of $<\alpha,\beta>$ will be denoted by $<\sigma,\tau>$. In general, we assume the following type system:

(20) Definition of Types:
a) e, t are types (entities, truth values)
b) If σ, τ are types, then
- $(\sigma)\tau$ is a type (of functions from σ-denotations to τ-denotations)
- $\sigma\bullet\tau$ is a type (of a list of σ-denotation and τ-denotations)
- $<\sigma,\tau>$ is a type (of a focus-background structure)

I assume that focus-sensitive operators always are applied to entities of a type that ends in t, such as intransitive predicates, type (e)t, predicate modifiers, type ((e)t)(e)t, etc. The only case where this is problematic is names or pronouns, which arguably are of type e. But we can analyse names and pronouns, like NPs in general, as generalized quantifiers, type ((e)t)t, and thus get a type ending in t. This assumption about the types of the operands of focus-sensitive operators will allow a relatively simple treatment, without employing rules of operator raising, quantifying in, or operator storage.

Semantic rules typically involve functional application. But functional application has to be generalized to cover focus-background structures. In particular, we must provide for a rule that allows for focus-background-information to be projected to higher nodes. So we have to define an extended version of functional application that takes care of this case.

(21) Recursive definition of extended application "( )":
a) If α is of type $(\sigma)\tau$ and β is of type σ, then $\alpha(\beta)$ is of type τ and is interpreted as functional application.
b) Focus inheritance from operator:
If $<\alpha,\beta>$ is of type $<(\sigma)(\tau)\mu,\sigma'>$ and γ is of type τ, then $<\alpha,\beta,>(\gamma)$ is of type $<(\sigma)\mu,\sigma'>$, and is interpreted as $<\lambda X_\sigma.[\alpha(X)(\gamma)], \beta>$.
c) Focus inheritance from argument:
If γ is of type $(\sigma)\tau$ and $<\alpha,\beta>$ is of type $<(\mu)\sigma,\mu'>$, then $\gamma(<\alpha,\beta>)$ is of type $<(\mu)\tau,\mu'>$, and is interpreted as $<\lambda X_\mu.\gamma(\alpha(X)),\beta>$.
d) Focus inheritance from operator and argument:
If $<\alpha,\beta>$ is of type $<(\sigma)(\tau)\mu,\sigma'>$ and $<\gamma,\delta>$ is of type $<(\upsilon)\tau, \upsilon'>$, then $<\alpha,\beta>(<\gamma,\delta>)$ is of type $<(\sigma\bullet\upsilon>)\mu,\sigma'\bullet\upsilon'>$, and is interpreted as $<\lambda X_\sigma\bullet Y_\upsilon.[\alpha(X)(\gamma(Y))], \beta\bullet\delta>$, where X, Y are distinct variables.

In these definitions, X_σ stands for a variable of type σ. (21a) describes the basic case of functional application. (b) and (c) say that the focus is stored when a focus-background structure is combined with an argument, or a function that does not take focus-background structures. The variable X makes sure that the original focus can be recovered after the application. (d) is the rule for complex focus; it concatenates two foci and their corresponding variables to a list, which is stored. Note that I do not assume, in general, that the first argument of the background is of the same type as the focus; but in all real applications, these types will stand in the relation of BEING DERIVED FROM. For example, a focus-background structure of type $<(\sigma)\tau, \sigma>$ should be said to be derived from τ (the type of the representation when the background is applied to the focus). Similarly, a complex focus-background structure of type $<(\mu)<(\sigma)\tau, \sigma>, \mu'>$ is said to be derived from type $<(\sigma)\tau, \sigma>$, and ultimately derived from type τ. This suggests the following definition:

(22) a) Definition of "be derived from":
Every type τ is derived from τ; every type $<(\sigma)\tau,\mu>$ is derived from τ; and if τ is derived from τ', and τ' is derived from τ'', then τ is derived from τ''.
b) Definition of "be ultimately derived from":
A type τ is ultimately derived from σ iff τ is derived from σ and σ is a non-structured type.

I give some examples to show how this framework can be used to formulate grammatical rules that cover focus-sensitive constructions. Let us assume the following rules; their syntactic part is deliberately kept simple. If A is a syntactic tree, then [A] is the semantic representation of A in our semantic representation language. I take intransitive verbs to be of the category VP, transitive verbs to be of the category V', and ditransitive verbs to be of the category V. Let x, y, z, x' etc. be variables of type e; P, P' etc. variables of type (e)t; R, R' etc. variables of type (e)(e)t; S, S' etc. variables of type (e)(e)(e)t; and T, T' etc. variables of type ((e)t)t, which will be abbreviated by q. The variable O is used for focus-sensitive operators, which might be of different types; I use fo as an abbreviation of these types fo.

(23) S_1 S -> NP VP;
[[$_S$ NP VP]] = [NP]([VP]),
S_2 VP -> V' NP;
[[$_{VP}$ V' NP]] = λRλTλx.T(λy.R(x,y))([V'])([NP]),
S_3 VP -> V_{to} *to* NP;
[[$_{VP}$ V_{to} *to* NP]] = λRλTλx.T(λy.R(x,y))([V_{to}])([NP]),
S_4 V_{to} -> V NP;
[[$_{Vto}$ V NP]] = λSλTλyλx.T(λz.S(x,y,z))([V])([NP]),
S_F C -> C_F (indexing of arbitrary category C by focus feature F);
[C_F] = <λX.X, [C])>, where X is of the type from which the type of [C] is derived that is not a focus-background type.
S_O C -> FO C (FO: category of focus operators);
[[$_C$ FO C]] = λ<X,Y>λO[λZ.O(<X,Z>)(Y)]([C])([FO]), where <X,Y> is a focus-background structure variable of the type of [C], Z is a variable of the type from which the type of Y is ultimately derived, and O is a variable of the type of the operator [FO].

The first four rules specify the binding of argument places of verbs by NPs. Rule S_F covers the focusation of a constituent. The feature F has to be realized appropriately by sentence accent. Rule S_O covers focus operators; its function will become clear below.
Let us now look at the derivation of some examples. I start with an example of complex focus, (19a), which shows the use of lists. In the following derivation tree, I specify the syntactic expression, its category, its representation, and the type of its representation. I also give the syntactic/semantic rules (23), and sometimes the subclauses for the extended application which I use (21). The terms **John**, **Sue**, **Bill** are taken to be quantifiers; we have e.g. **John** = λP.P(j). In this and the following examples, I first give a representation using coindexing; this is for clarification only and has no theoretical status.

(24) John only$_1$ introduced [Bill]$_{F1}$ to [Sue]$_{F1}$.

```
     Bill ; NP ; Bill ; ((e)t)t (abbrev. q)
     |
SF   Bill ; NPF ; <λT.T, Bill> ; <(q)q, q>
     |
     | introduced ; V ; introd ;(e)(e)(e)t
     |/
S4   introduced Bill ; Vto ;
     λSλTλyλx.T(λz.S(x,y,z))(introd)(<λT.T, Bill>)
a    = λTλyλx.T(λz.introd(x,y,z))(<λT.T, Bill>)
c    = <λT[λTλyλx.T(λz.introd(x,y,z))(λT.T(T))], Bill>
a    = <λTλyλx.T(λz.introd(x,y,z)), Bill> ; <(q)(e)(e)t, q>
     |
     |  Sue ; NP ; Sue ; q
     |  |
     | SF Sue ; NPF ; <λT.T, Sue> ; <(q)q, q>
     |/
S3   introduced Bill to Sue ; VP
     λRλTλx.T(λy.R(x,y)) (<λTλyλx.T(λz.introd(x,y,z)), Bill>) (<λT.T, Sue>)

     Application of first argument:
c    <λT[λRλTλx.T(λy.R(x,y)) (λTλyλx.T(λz.introd(x,y,z))(T))], Bill>
a    = <λT[λRλTλx.T(λy.R(x,y)) (λyλx.T(λz.introd(x,y,z)))], Bill>
a    = <λTλT'λx.T'(λy[λyλx.T(λz.introd(x,y,z))(x,y)]), Bill>
a    = <λTλT'λx.T'(λy.T(λz.introd(x,y,z))), Bill>

     Application of second argument:
     <λTλT'λx.T'(λy.T(λz.introd(x,y,z))), Bill> (<λT.T, Sue>)
d    = <λT•T'[λTλT'λx.T'(λy.T(λz.introd(x,y,z)))(T)(λT.T(T'))], Bill•Sue>
a    = <λT•T'λx.T'(λy.T(λz.introd(x,y,z))), Bill•Sue> ; <(q•q)(e)t, q•q>
     |
     | only ; FO ; only ; fo
     |/
SO   only introduced Bill to Sue ; VP ;
     λ<X,Y>λO[λZ.O(<X,Z>)(Y)](<λT•T'λx.T'(λy.T(λz.introd(x,y,z))),
     Bill•Sue>)(only)

     Application of first argument:
a    λO[λZ.O(<λT•T'λx.T'(λy.T(λz.introd(x,y,z))), Z>)(Bill•Sue)]
a    = λO.O(<λT•T'λx.T'(λy.T(λz.introd(x,y,z))), Bill•Sue>)
     Application of second argument:
a    only(<λT•T'λx.T'(λy.T(λz.introd(x,y,z))), Bill•Sue>)
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Let us assume a meaning postulate for **only** that is like (3) but allows **only** to be applied to all expressions of a type that ends in t:

(25) $\textbf{only}(<\alpha, \beta>) :\leftrightarrow \lambda v[\alpha(\beta)(v) \,\&\, \forall X[X\approx\beta \,\&\, \alpha(X)(v) \rightarrow X=\beta]]$,
where X is a variable of the type of β and v is a (vector of) variable(s) of the types of the arguments of $\alpha(\beta)$.

Then example (24) can be spelled out as follows:

(24') *only introduced Bill to Sue* ; $\lambda x[\textbf{Sue}(\lambda y.\textbf{Bill}(\lambda z.\textbf{introd}(x,y,z)))] \,\&\, \forall T\bullet T'[T\bullet T'\approx \textbf{Sue.Bill} \,\&\, T(\lambda y.T'(\lambda z.\textbf{introd}(x,y,z))) \rightarrow T\bullet T'=\textbf{Sue}\bullet\textbf{Bill}]]$;(e)t

Application of the subject yields the following result:

(24'')
| John ; NP ; John ; q
| /
S_1 *John only introduced Bill to Sue* ; S ;
$\textbf{John}(\lambda x[\textbf{Sue}(\lambda y.\textbf{Bill}(\lambda z.\textbf{introd}(x,y,z)))] \,\&\, \forall T\bullet T'[T\bullet T'\approx\textbf{Sue}\bullet\textbf{Bill} \,\&\, T(\lambda y.T'(\lambda z.\textbf{introd}(x,y,z))) \rightarrow T\bullet T'= \textbf{Sue}\bullet\textbf{Bill}]])$; t

Spelling out the quantifiers will yield the following:

(24''') $\textbf{introd}(\textbf{j},\textbf{s},\textbf{b}) \,\&\, \forall T\bullet T'[T\bullet T'\approx\lambda P.P(\textbf{s})\bullet\lambda P.P(\textbf{b}) \,\&\, \textbf{introd}(\textbf{j},x,y) \rightarrow T\bullet T'= \lambda P.P(\textbf{s})\bullet\lambda P.P(\textbf{b})]$

Now we can assume that quantifiers generated by an individual, such as $\lambda P.P(\textbf{s})$, are comparable only to quantifiers that are generated by an individual as well (note that a sentence like *only John has a car* cannot be refuted by *No, a man has a car, too.*). Furthermore, we should assume that if two lists are comparable, then their respective elements are comparable. Then we can reduce (24''') to the following interpretation:

(24'''') $\textbf{introd}(\textbf{j},\textbf{s},\textbf{b}) \,\&\, \forall x,y[x\approx\textbf{s} \,\&\, y\approx\textbf{b} \,\&\, \textbf{introd}(\textbf{j},x,y) \rightarrow x=\textbf{s} \,\&\, y=\textbf{b}]$

This says: John introduced Bill to Sue, and that there is no x,y comparable, but not identical to Sue and Bill such that John introduced y to x.
Next, we will look at an example with two independent focus operators, (19b). We assume here the following semantics of **even**:

(26) $\textbf{even}(<\alpha, \beta>) :\leftrightarrow \lambda v(\alpha(\beta)(v) \,\&\, \exists X[X\approx\beta \,\&\, \alpha(\beta)(v) <_p \alpha(X)(v)]]$,
where v and X as in (25) and $<_p$ is a probability relation.

Thus, **even** contributes to the meaning that there are alternatives X to the focus β such that $\alpha(\beta)(v)$ is less probable than $\alpha(X)(v)$. In addition, we could try to incorporate that $\alpha(\beta)(v)$ is considered "unlikely" in general; however, the proposed analysis should suffice for our purpose, as we are not concerned with a detailed analysis of the semantics of *even* (see Jacobs 1983, Kay 1990 for that).
Our example can now be derived as follows, given an analysis of **water** as generalized quantifier $\lambda P\exists x[P(x) \,\&\, \textbf{W}(x)]$, where **W** is a predicate applying to water quantities.

(27) Even$_1$ [John]$_{F1}$ drank only$_2$ [water]$_{F2}$.

water ; NP ; **water** ; q
|
S_F *water* ; NP_F ; $<\lambda T.T, \textbf{water}>$; <(q)q, q>
|
| *only* ; FO ; **only** ; fo
| /
S_O *only water* ; NP ; $\textbf{only}(<\lambda T.T, \textbf{water}>)$
$= \lambda P[\textbf{water}(P) \,\&\, \forall T[T\approx\textbf{water} \,\&\, T(P) \rightarrow T=\textbf{water}]]$; q
|
| *drank* ; V'; **drank** ; (e)(e)t
| /
S_2 *drank only water* ; VP ;
$\lambda x[\lambda P[\textbf{water}(P) \,\&\, \forall T[T\approx\textbf{water} \,\&\, T(P) \rightarrow T=\textbf{water}]](\lambda y.\textbf{drank}(x,y))]$
$= \lambda x[\textbf{water}(\lambda y.\textbf{drank}(x,y)) \,\&\, \forall T[T\approx\textbf{water} \,\&\, T(\lambda y.\textbf{drank}(x,y)) \rightarrow T=\textbf{water}]]$
$= \lambda x[\exists y[\textbf{drank}(x,y) \,\&\, \textbf{W}(y)] \,\&\, \forall P[P\approx\textbf{W} \,\&\, \exists y[\textbf{drank}(x,y) \,\&\, P(y)] \rightarrow P=\textbf{W}]]$; (e)t
|
| *John* ; NP ; **John** ; q
| |
| S_F *John* ; NP_F ; $<\lambda T.T, \textbf{John}>$; <(q)q, q>
| |
| | *even* ; FO ; **even** ; fo
| |/
| S_O *even John* ; NP ; $\textbf{even}(<\lambda T.T, \textbf{John}>)$
| $= \lambda P[\textbf{John}(P) \,\&\, \exists T[T\approx\textbf{John} \,\&\, \textbf{John}(P) <_p T(P)]]$
| $= \lambda P[P(\textbf{j}) \,\&\, \exists x[x\approx\textbf{j} \,\&\, P(\textbf{j}) <_p P(x)]]$; q
| /
S_1 *even John drank only water* ; S ;
$\exists y[\textbf{drank}(\textbf{j},y) \,\&\, \textbf{W}(y) \,\&\, \forall P[P\approx\textbf{W} \,\&\, \exists y[\textbf{drank}(\textbf{j},y) \,\&\, P(y)] \rightarrow P=\textbf{W}]] \,\&$
$\exists x[x\approx\textbf{j} \,\&\, \exists y[\textbf{drank}(\textbf{j},y) \,\&\, \textbf{W}(y) \,\&\, \forall P[P\approx\textbf{W} \,\&\, \exists y[\textbf{drank}(\textbf{j},y) \,\&\, P(y)] \rightarrow P=\textbf{W}]] <_p$
$\exists y[\textbf{drank}(x,y) \,\&\, \textbf{W}(y) \,\&\, \forall P[P\approx\textbf{W} \,\&\, \exists y[\textbf{drank}(x,y) \,\&\, P(y)] \rightarrow P=\textbf{W}]]]$

This says (a) that John drank water, and no other comparable substance, and (b) that there are comparable individuals x' for which it is more probable that they drank only water. This is a correct interpretation of our example. We assumed here that indefinite quantifiers like $\lambda P[P(x) \,\&\, \textbf{W}(x)]$ are compatible only to other indefinite quantifiers, hence we can reduce the condition $T\approx\textbf{water}$ to $P\approx\textbf{W}$.
To obtain this reading, it is crucial that **even** gets scope over **only**. This scope relationship is a consequence of the fact that the NP to which *even* is adjoined has *only* in its scope (or syntactically, *only* is c-commanded by that NP). The syntactic rules guarantee the right scoping.

We have seen how cases are handled in which one operator is in the scope of another. Our next example concerns a case in which one operator is not only in the scope, but also in the focus, of another, namely (19c).

(28) John even$_1$ [only$_2$ [drank water]$_{F2}$]$_{F1}$.

drank water ; VP ; $\lambda x\exists y[\mathbf{drank}(x,y) \,\&\, \mathbf{W}(y)]$;(e)t
|
S$_F$ *drank water* ; VP$_F$; $\langle \lambda P.P, \lambda x\exists y[\mathbf{drank}(x,y) \,\&\, \mathbf{W}(y)]\rangle$; $\langle ((e)t)(e)t, (e)t\rangle$
|
| *only* ; FO ; **only** ; fo
| /
S$_O$ *only drank water* ; VP ;
$\mathbf{only}(\langle \lambda P.P, \lambda x\exists y[\mathbf{drank}(x,y) \,\&\, \mathbf{W}(y)]\rangle)$
$= \lambda x[\exists y[\mathbf{drank}(x,y) \,\&\, \mathbf{W}(y)] \,\&\, \forall P[P \approx \lambda x\exists y[\mathbf{drank}(x,y) \,\&\, \mathbf{W}(y)] \,\&\, P(x) \rightarrow P = \lambda x\exists y[\mathbf{drank}(x,y) \,\&\, \mathbf{W}(y)]]]$ (= [1], for short) ; (e)t
|
S$_F$ *only drank water* ; VP$_F$; $\langle \lambda P.P, [1]\rangle$; $\langle ((e)t)(e)t, (e)t\rangle$
|
| *even* ; FO ; **even** ; fo
| /
S$_O$ *even only drank water* ; VP ; $\lambda x[[1](x) \,\&\, \exists P[P \approx [1] \,\&\, [1](x) <_p P(x)]]$;(e)t
|
| *John* ; NP ; **John** ; e
| /
S$_1$ *John even only drank water* ; S ; $[1](\mathbf{j}) \,\&\, \exists P[P \approx [1] \,\&\, [1](\mathbf{j}) <_p P(\mathbf{j})]$; t

This says that John drank water, that he did nothing comparable, and that there are properties comparable to the property of drinking water and doing nothing else such that it would have been more likely that John had them. This is a correct representation of the reading of our example.
Let us now look at the treatment of (19d), where two operators seem to share one focus. In our reconstruction, a focus operator can be associated with only one focus. But we may apply the focusation rule to one constituent twice, one time for each operator, and get an adequate interpretation:

(29) John even$_1$ only$_2$ drank [[water]$_{F1}$]$_{F2}$

water ; NP ; **water** ; q
|
S$_F$ *water* ; NP$_F$; $\langle \lambda T.T, \mathbf{water}\rangle$; $\langle (q)q, q\rangle$
|
S$_F$ *water* ; NP$_{FF}$; $\langle \lambda T.T, \langle \lambda T.T, \mathbf{water}\rangle\rangle$; $\langle (q)q, \langle (q)q, q\rangle\rangle$
| *drank* ; V' ; **drank** ; (e)(e)t
| /
S$_2$ *drank water* ; VP ;
$\lambda R\lambda T\lambda x.T(\lambda y R(x,y))(\mathbf{drank})(\langle \lambda T.T, \langle \lambda T.T, \mathbf{water}\rangle\rangle)$
c $= \langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), \langle \lambda T.T, \mathbf{water}\rangle\rangle$; $\langle (q)(e)t, \langle (q)q, q\rangle\rangle$
|
| *only* ; FO ; **only** ; fo
| /
S$_O$ *only drank water* ; VP ;
$\lambda\langle X,Y\rangle\lambda O[\lambda Z.O(\langle X,Z\rangle)(Y)](\langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), \langle \lambda T.T, \mathbf{water}\rangle\rangle)$ (**only**)
a $= \lambda Z.\mathbf{only}(\langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), Z\rangle)(\langle \lambda T.T, \mathbf{water}\rangle)$
c $= \langle \lambda T.\mathbf{only}(\langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), T\rangle), \mathbf{water}\rangle$; $\langle (q)(e)t, q\rangle$
|
| *even* ; FO ; **even** ; fo
| /
S$_O$ *even only drank water* ; VP ;
$\lambda\langle X,Y\rangle\lambda O[\lambda Z.O(\langle X,Z\rangle)(Y)](\langle \lambda T.\mathbf{only}(\langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), T\rangle), \mathbf{water}\rangle)(\mathbf{even})$
$= \mathbf{even}(\langle \lambda T.\mathbf{only}(\langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), T\rangle), \mathbf{water}\rangle)$

Spelling out **even** yields
$\lambda x[\mathbf{only}(\langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), \mathbf{water}\rangle)(x) \,\&\, \exists T[T \approx \mathbf{water} \,\&\, \mathbf{only}(\langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), \mathbf{water}\rangle)(x) <_p \mathbf{only}(\langle \lambda T\lambda x.T(\lambda y.\mathbf{drank}(x,y)), T\rangle)(x)]]$

Spelling out **only** yields
$\lambda x[\mathbf{water}(\lambda y.\mathbf{drank}(x,y)) \,\&\, \forall T[T \approx \mathbf{water} \,\&\, T(\lambda y.\mathbf{drank}(x,y)) \rightarrow T = \mathbf{water}] \,\&\, \exists T'[T' \approx \mathbf{water} \,\&\, [\mathbf{water}(\lambda y.\mathbf{drank}(x,y)) \,\&\, \forall T[T \approx \mathbf{water} \,\&\, T(\lambda y.\mathbf{drank}(x,y)) \rightarrow T = \mathbf{water}]] <_p [T'(\lambda y.\mathbf{drank}(x,y)) \,\&\, \forall T[T \approx T' \,\&\, T(\lambda y.\mathbf{drank}(x,y)) \rightarrow T = T']]]]$

Spelling out **water** and binding the subject argument by **j** (via rule S$_1$) yields as representation of *John even only drank water*:
$\exists y[\mathbf{drank}(\mathbf{j},y) \,\&\, \mathbf{W}(y)] \,\&\, \forall P[P \approx \mathbf{W} \,\&\, \exists y[\mathbf{drank}(\mathbf{j},y) \,\&\, P(y)] \rightarrow P = \mathbf{W}] \,\&\, \exists P'[P' \approx \mathbf{W} \,\&\, \exists y[\mathbf{drank}(\mathbf{j},y) \,\&\, \mathbf{W}(y) \,\&\, \forall P[P \approx \mathbf{W} \,\&\, \exists y[\mathbf{drank}(\mathbf{j},y) \,\&\, P(y)] \rightarrow P = \mathbf{W}]] <_p \exists y[\mathbf{drank}(\mathbf{j},y) \,\&\, P'(y) \,\&\, \forall P[P \approx P' \,\&\, \exists y[\mathbf{drank}(\mathbf{j},y) \,\&\, P(y)] \rightarrow P = \mathbf{W}]]]$

This says (a) that John drank water and no other comparable substance, and (b) that there is a substance P comparable to water such that it would have been more probable that John drank only that substance. This renders the reading of our example adequately. It is crucial for this derivation that the first focus operator, *only*, is associated with the last focus feature of the NP, leaving additional focus features to other operators. This is accomplished by the semantic rule for the combination of a focus operator with a constituent (23, S_O). This rule expects a focus-background structure, but allows for the focus to consist itself of a focus-background structure, which would then be passed to the complex semantic representation, such that it can be submitted to higher operators. Also, with this example it becomes obvious why the semantic part of rule S_F was formulated in that complicated way ("X is of the type from which the type of [C] is derived that is not a focus-background type").

Finally, let us look at a case in which one operator is the focus of another, (19e).

(30) John even$_1$ drank [only$_2$]$_{F1}$ [water]$_{F2}$

water ; NP ; **water** ; q

|

S_F *water* ; NP_F ; $<\lambda T.T, \mathbf{water}>$; $<(q)q, q>$

|

| *only* ; FO ; **only** ; fo

| |

| S_F *only* ; FO_F ; $<\lambda O.O, \mathbf{only}>$; $<(fo)fo, fo>$

| /

S_O *only water* ; NP ;

$\lambda<X,Y>\lambda O[\lambda Z.O(<X,Z>)(Y)](<\lambda T.T, \mathbf{water}>)(<\lambda O.O, \mathbf{only}>)$

$= <\lambda O.O(<\lambda T.T, \mathbf{water}>), \mathbf{only}>$; $<(fo)q, fo>$

|

| *drank* ; V'; **drank** ; (e)(e)t

| /

S_2 *drank only water* ; VP ;

$<\lambda O.O(<\lambda T\lambda x[T(\lambda y.\mathbf{drank}(x,y)), \mathbf{water}>), \mathbf{only}>$; $<(fo)(e)(e)t, fo>$;

abbr. $<\lambda O.O([1]), \mathbf{only}>$

|

| *even* ; FO ; **even** ; fo

| /

S_O *even drank only water* ; NP ; $\mathbf{even}(<\lambda O.O([1]), \mathbf{only}>)$

$= \lambda x[\mathbf{only}([1])(x) \ \& \ \exists O[O{\approx}\mathbf{only} \ \& \ \text{only}([1])(x) <_p O([1])(x)]]$; q ; abbr. [2]

|

| *John* ; NP ; $\lambda P.P(j)$; q

| /

S_1 *John even drank only water* ; S ; [2](j)

$= \mathbf{only}([1])(j) \ \& \ \exists O[O{\approx}\mathbf{only} \ \& \ \mathbf{only}([1])(j) <_p O([1])(j)]$

$= \exists y[\mathbf{drank}(j,y) \ \& \ \mathbf{W}(y) \ \& \ \forall P[P{\approx}\mathbf{W} \ \& \ \exists y[\mathbf{drank}(j,y) \ \& \ P(y)] \rightarrow P{=}\mathbf{W}]] \ \&$

$\exists O[O{\approx}\mathbf{only} \ \&$

$\exists y[\mathbf{drank}(j,y) \ \& \ \mathbf{W}(y) \ \& \ \forall P[P{\approx}\mathbf{W} \ \& \ \exists y[\mathbf{drank}(j,y) \ \& \ P(y)] \rightarrow P{=}\mathbf{W}]] <_p$

$O(<\lambda T.T, \mathbf{W}>)(\lambda y.\mathbf{drank}(j,y))]]$

This says (a) that John drank water, and no other comparable substance, and that the proposition (a) is less probable than another one where **only** is replaced by a focus operator comparable with **only**. Let us assume that the only comparable operator is **also**, and let us specify the meaning of **also** as follows:

(31) $\mathbf{also}(<\alpha, \beta>) :\leftrightarrow \lambda v[\alpha(\beta)(v) \ \& \ \exists X[X{\approx}\beta \ \& \ \neg X{=}\beta \ \& \ \alpha(X)(v)]]$,
where v and X as in (25).

That is, **also** says that the background representation applies to the focus representation, and that in addition there is an entity comparable with, but different from the focus representation to which the background representation applies as well. Then we get the following representation for our example:

(32) $\exists y[\mathbf{drank}(j,y) \ \& \ \mathbf{W}(y) \ \& \ \forall P[P{\approx}\mathbf{W} \ \& \ \exists y[\mathbf{drank}(j,y) \ \& \ P(y)] \rightarrow P{=}\mathbf{W}]] \ \&$
$\exists y[\mathbf{drank}(j,y) \ \& \ \mathbf{W}(y) \ \& \ \forall P[P{\approx}\mathbf{W} \ \& \ \exists y[\mathbf{drank}(j,y) \ \& \ P(y)] \rightarrow P{=}\mathbf{W}]] <_p$
$\exists y[\mathbf{drank}(j,y) \ \& \ \mathbf{W}(y) \ \& \ \exists P[P{\approx}\mathbf{W} \ \& \ \neg P{=}\mathbf{W} \ \& \ \exists y[\mathbf{drank}(j,y) \ \& \ P(y)]]]]$

This says that John drank water, and only water, and that the probability that John drank water and only water is smaller than the probability that John drank water and also some other salient substance comparable with water. This is a correct representation of (19e).

Let us now turn to illocutionary operators. We assume that they get the widest scope, by a rule like the following one that combines a sentence (S) with an illocutionary operator (IO) to an illocutionary complete sentence (S_I):

(33) S_I S_I -> IO S (alternatively, S IO);
$[[_{S_I}$ IO S$]] = [IO]([S])$,

I give one simple example with the illocutionary operator **ASSERT**, represented orthographically by suffixing a fullstop ".", as the only focus operator:

(34) *John [drank water]*$_F$; S ; $<\lambda P.P(j), \lambda x\exists y[\mathbf{drank}(x,y) \ \& \ \mathbf{W}(y)]>$; $<((e)t)t, (e)t>$

|

| . ; IO ; **ASSERT** ; fo

|/

S_I *John drank water.* ; SI ; $\mathbf{ASSERT}(<\lambda P.P(j), \lambda x\exists y[\mathbf{drank}(x,y) \ \& \ \mathbf{W}(y)]>)$; t

Let us assume an analysis of assertion like in (7). We arrive at the following result:

(35) $\mathbf{ASSERT}(<\lambda P(j), \lambda x\exists y[\mathbf{drank}(x,y) \ \& \ \mathbf{W}(y)]>)$ maps a common ground c to a common ground c', where c' is the intersection of c with the set of possible worlds for which $\exists y[\mathbf{drank}(j,y) \ \& \ \mathbf{W}(y)]$ is true.
Felicity conditions: $c \neq c'$, $c \neq \emptyset$, and there are salient P with $P \approx \lambda x\exists y[\mathbf{drank}(x,y) \ \& \ \mathbf{W}(y)]$ and $P \neq \lambda x\exists y[\mathbf{drank}(x,y) \ \& \ \mathbf{W}(y)]$ such that the intersection of c with the set of worlds for which P(j) holds neither equals c, nor $\emptyset$, nor c'.

Thus, the assertion of *John [drank water]*$_F$ changes the common ground to those worlds in which John drank water. The felicity conditions say that this assertion is informative

at the current point of discourse, that it is not excluded already, that there are other, salient properties comparable with the property of drinking water that could have been asserted of John as well, and that they would have made a difference.
If the sentence which is asserted contains a focus operator, then it is necessary to introduce another focus; otherwise the application conditions for **ASSERT** could not be met. One example:

(36) *only* [*drank water*]$_F$; VP ;

$\lambda x[\exists y[\mathbf{drank}(x,y)$ & $\mathbf{W}(y)]$ & $\forall P[P \approx \lambda x \exists y[\mathbf{drank}(x,y)$ & $\mathbf{W}(y)]$ & $P(\mathbf{j}) \rightarrow P = \lambda x \exists y[\mathbf{drank}(x,y)$ & $\mathbf{W}(y)]]]$ (= [1], for short) ; (e)t

|
S_F *only drank water* ; VP_F ; <λP.P, [1]> ; <((e)t)(e)t, (e)t>

|
| *John* ; NP ; **John** ; q
| /
S_1 *John only drank water* ; S ; <λP.P(**j**), [1]> ; <((e)t)t, (e)t>

|
| . ; IO ; **ASSERT** ; fo
| /
S_I *John only drank water.* ; SI ; **ASSERT**(<λP.P(**j**), [1]>) ; t

We get the following representation:

(37) (36) maps a common ground c to a common ground c', where c' is the intersection of c with the set of possible worlds for which [1](**j**) is true.
Felicity conditions: c≠c', c≠∅, and there are salient P' with P'≠[1] such that the intersection of c with the set of worlds for which P'(**j**) neither equals c, nor ∅, nor c'.

The assertion of (36) changes the common ground to those worlds in which John drank only water, under the felicity conditions that this proposition is possible at the current point of discourse and is informative, and that there are salient properties comparable with the property of drinking only water such that it would have been possible to assert them of John, and they would have made a difference.
In concluding this section, I want to point out that we did not use any coindexing between focus operators and their focus. We could do without that because the function of indexing is inherent in the syntactic-semantic rules. They guarantee that each focus (which might be complex) is related to exactly one focus operator. If there were more focus operators than foci, then some operators could not be applied to a focus-background structure, thus yielding an illformed semantic representation. On the other hand, if there were more foci than focus operators to bind them, the final representation would consist of uninterpreted focus-background structures, which again is illformed. The rules guarantee, furthermore, that a focus operator has scope over its focus. We can conclude that the proposed syntactic coindexing is both motivated and made redundant by the syntactic-semantic rules.

4 Further Adaptations

In this section, I will discuss some constructions that are problematic for the representation format developed above, and I will propose possible solutions.

4.1 Discontinuous Constituents

We have assumed that non-complex focus applies to syntactic constituents. There are, however, examples that show that this is not always the case.
First, certain constructions suggest that focus may apply to discontinuous constituents. I give three examples, two from German and one from English:

(38) a) Er hat [sich]$_{F1}$ nur$_1$ [RASIERT]$_{F1}$.
He has only shaved himself.
b) Diese Tat [forderte]$_{F1}$ seinen Ehrgeiz geradezu$_1$ [HERAUS]$_{F1}$.
This act really challenged his ambition.
c) John only$_1$ [turned]$_{F1}$ it [OFF]$_{F1}$.

In (38a), a variation of an example in Jacobs (1983), the particle *nur* clearly can focus on *sich rasiert*, but note that this forms a discontinous constituent on surface structure. Also, in (38b) the particle *geradezu* focusses on the verb *herausforderte*, which is discontinuous. Similarly, in (38c) *only* may focus on *turn off*, which again does not form a constituent on surface structure.
One way to cope with such cases is to assume that certain transformations may follow focus assignment, that is, focus assignment does happen at a representation level prior to surface structure (cf. 39a for the case of 38b).

(39) a) e e diese Tat seinen Ehrgeiz geradezu$_1$ [HERAUS [forderte]]$_{F1}$
b) [diese Tat]$_i$ [forderte]$_j$ t_i seinen Ehrgeiz geradezu$_1$ [HERAUS [t_j]]$_{F1}$

Another indication that focus marking may apply to some level of deep structure is that in some cases the operator does not seem to c-command its focus. One example mentioned by Jackendoff (1972) is that *even* (but not, e.g., *only*) might be associated with the subject as focus in (40):

(40a) JOHN (even) will (even) have given his daughter a new bicycle.

According to Jackendoff, *even* c-commands the subject in both positions, as he assumed a "flat" structure [$_S$ NP (*even*) [$_{AUX}$*will*)(*even*) VP]. Alternatively, we might assume that the c-command condition is checked at an underlying level of syntactic representation, or at a surface structure that contains traces, where it suffices that an operator c-commands the TRACE of its focus. The latter option was preposed by Jacobs (1968) for similar constructions in German. (We will come back to *even* in the next section). In any case, the syntactic and semantic rules specified in section (3) are strictly surface-oriented and hence cannot treat the phenomena discussed here as they stand.

Changes along the lines suggested here are possible (that is, semantic rules that apply to non-surface structures or to enriched surface structures), but I will not carry out these modifications.

4.2 Focus and Illocutionary Operators

We have assumed above that illocutionary operators always are associated with a focus of their own. This assumption probably must be qualified in several respects. For one thing, it is often difficult to determine, in a running text, where the foci should be. We might take this as an indication that illocutionary operators do not need to be associated with a focus (cf. Kefer 1989: 223, 317 f.). There are other cases of operators that apparently can or cannot be associated with a focus, for example negation (sentence negation vs. constituent negation). Another reason to assume illocutionary operators that are not focussing is that it sometimes seems artificial to propose for a sentence that already has an overt focus operator an additional illocutionary focus.
In some cases, we can argue that operators that seem to have their own focus actually modify or specify the illocutionary operator, so that their apparent focus is the focus of that operator. This was proposed by Jacobs (1988) for sentence mood particles in German. A case which might be explained along the same lines is English *even* (deviating from the analysis given in the previous section). *Even* has several properties which distinguishes it from apparent counterparts like *only*. First, *even* always must have wide scope over other focus operators, like *only* (cf. 41). Second, adverbial *even* might be related to subject focus, in contrast to adverbial *only* (cf. Jackendoff 1972: 42). Third, focus on *even* seems to be barred, except in correction contexts (43). Finally, sentences with multiple *even* are considerably more difficult to get than sentences with multiple *only*; they have even been considered ungrammatical (cf. Kay 1990: 44).

(41) a) John even only drank water.
b) *John only even drank water.

(42) a) JOHN (even) will (even) have given his daughter a new bicycle.
b) *JOHN (only) will (only) have given his daughter a new bicycle.

(43) a) John ONLY drank water.
b) ??John EVEN drank water.

(44) a) Only JOHN drank only water.
b) ??Even JOHN drank even water.

One possible explanation for this behaviour of *even* might be along the lines in which Jacobs (1983) explained the possible scope relations between German *sogar* and *nur*, which are parallel to *even* and *only*. He showed that *sogar* is an affirmative polarity item, and that *nur* does not license these items. However, English *even* may be (part of) a negative polarity item; cf. *if this costs even so much as a dime, I would not buy it* (note that German would use *auch nur* instead of *sogar* in these contexts).

The observations given above fall in their place if we assume that *even* actually modifies the illocutionary operator. Then it must have wide scope over other overt operators (we have assumed this for illocutionary operators in general), it may focus on the subject (because the illocutionary operator has the subject in its scope), it could never receive focus from the illocutionary operator (in a sense, it is part of that operator), and we should not expect multiple *even*, as the illocutionary operator is associated with only one focus. Concerning this latter point, it is interesting to note that the examples with multiple *even* are generally such that we have to put equal stress on both foci; such as the following one, going back to Fraser 1970 (cf. Kay 1990):

(45) Even WORDS give trouble to even LINGUISTS.

But this would mean that the foci of *words* and *linguists* are not ordered with respect to each other; hence they should be described as one, complex, focus of the illocutionary operator modified by *even*.

4.3 Focus and Movement

The theory of focus developed here does not imply any movement of the focus constituent. Jackendoff (1972), and later Rooth (1985), argued against a movement analysis, as association with focus does not obey island constraints (cf. 18). Not obeying syntactic constraints, focus should preferably be treated in the semantic representation language. The reason why Chomsky (1977) proposed an analysis of focus that involves LF-movement is that coreference between a pronoun and an NP in focus seems to obey the same restrictions as coreference between a pronoun and a quantified NP. Quantified NPs, it is argued, have to move at LF, and preceding pronouns cannot be bound by them as this leads to crossover constellations. The relevant data are as follows; (46a) shows that binding is o.k. with (non-moving) names, (b) shows that a focused NP cannot bind the pronoun, and (c) shows that quantified NPs behave similarly:

(46) a) After he_i came home, $John_i$ went to bed.
b) *After he_i came home, $JOHN_i$ went to bed.
$John_i$ [after he_i went home, t_i went to bed]
c) *After he_i came home, $someone_i$ went to bed.
$Someone_i$ [after he_i went home, t_i went to bed]

An alternative explanation for the unavailability of (46b), which does not recur to movement, is that expressions with a focus feature cannot refer to something that is given in the immediate context (47a), except when used contrastively (47b).

(47) a) *John and Mary came in. JOHN kissed Mary.
b) John kissed Mary, and then MARY kissed JOHN.

One observation that supports this reinterpretation of (46b) is that these sentences get much better in the case of contrastive focus (cf. also Lujan 1986 for related data):

(48) After he_i had kissed her_j, $MARY_j$ kissed $JOHN_i$

Another phenomenon that prima facie calls for a movement analysis was presented by Kratzer (1989) with examples like the following:

(49) (What a copycat you are! You visit all the nice places I have visited.)
No, I $only_1$ went to $TANGLEWOOD_{F1}$ because you did.

Kratzer shows that in Rooth's original approach, the VP anapher would be spelled out as in: *I only went to TANGLEWOOD because you went to TANGLEWOOD*. This implies two foci that are, in principle, independent of each other, or a complex focus. However, example (49) involves only one simple focus; its reading can be rendered as: Only for x=Tanglewood it holds that I went to x because you went to x. Kratzer develops a theory, based on a version of alternative semantics mentioned in Rooth (1985), that generates this reading without assuming LF-movement, but with the help of a separate process of variable binding.
The current framework allows for other solutions within structured meanings, assuming certain conditions for comparability. First, look at the following derivation, where we assume that the antecedent VP replaces the anaphor.

(50) *went to* [*Tanglewood*]$_F$; VP ; $\langle \lambda y \lambda x.\mathbf{went\text{-}to}(x,y), \mathbf{t}\rangle$
|
| *you did* (= *went to* [*Tanglewood*]$_F$); S
| $\langle \lambda y \lambda x.\mathbf{went\text{-}to}(x,y), \mathbf{t}\rangle(\mathbf{you})$, = $\langle \lambda y.\mathbf{went\text{-}to}(\mathbf{you},y), \mathbf{t}\rangle$
| |
| | *because* ; $\lambda p \lambda P \lambda x.\mathbf{because}(P(x), p)$
| |/
| *because you did* ; $\langle \lambda y \lambda P \lambda x.\mathbf{because}(P(x), \mathbf{went\text{-}to}(\mathbf{you},y)), \mathbf{t}\rangle$
|/
went to Tanglewood because you did ; VP
$\langle \lambda y \bullet y' \lambda x.\mathbf{because}(\mathbf{went\text{-}to}(x,y), \mathbf{went\text{-}to}(\mathbf{you},y'))\rangle$
|
| *only* ; FO ; **only**
|/
only went to Tanglewood because you did ; VP ;
$\lambda x[\mathbf{because}(\mathbf{went\text{-}to}(x,\mathbf{t}), \mathbf{went\text{-}to}(\mathbf{you},\mathbf{t}))\ \&\ \forall y \bullet y'[y \bullet y' \approx \mathbf{t} \bullet \mathbf{t}\ \&\mathbf{because}(\mathbf{went\text{-}to}(x,y), \mathbf{went\text{-}to}(you,y')) \rightarrow y \bullet y' \approx \mathbf{t} \bullet \mathbf{t}]]$
|
| *I* ; NP; **I**
|/
I only went to Tanglewood because you did ; S ;
$\mathbf{because}(\mathbf{went\text{-}to}(\mathbf{I},\mathbf{t}), \mathbf{went\text{-}to}(\mathbf{you},\mathbf{t}))$
$\&\ \forall y \bullet y'[y \bullet y' \approx \mathbf{t} \bullet \mathbf{t}\ \&\mathbf{because}(\mathbf{went\text{-}to}(x,y), \mathbf{went\text{-}to}(\mathbf{you},y')) \rightarrow y \bullet y' \approx \mathbf{t} \bullet \mathbf{t}]$

Let us assume that the interpretation of conditions like $y \bullet y' \approx \mathbf{t} \bullet \mathbf{t}$ implies not only that $y \approx \mathbf{t}$ and $y' \approx \mathbf{t}$, but also that $y = y'$, as the elements of the right-hand side are equal. In

general, we require that whenever $X_1 \bullet X_2 \bullet \ldots \bullet X_n \approx Y \bullet Y \bullet \ldots \bullet Y$, then $X_1 = X_2 = \ldots = X_n$. Given that, we can reduce the second part of the final representation as: $\forall y[y \approx_t \&\ \mathbf{because}(\mathbf{went\text{-}to}(\mathbf{I},y), \mathbf{went\text{-}to}(\mathbf{you},y)) \rightarrow y \approx \mathbf{t}]$. The reading we get, then, can be paraphrased as: I went to Tanglewood because you went to Tanglewood, and there is no alternative y to Tanglewood such that I went to y because you went to y.
An objection against this analysis is that it would treat cases like (50) similar to cases where the anaphor is fully spelled out, as in

(51) I only went to TANGLEWOOD because you went to TANGLEWOOD.

The only plausible interpretation of (51) is one in which the first occurrence of *Tanglewood* is, or is contained in, the focus of *only*, and the second one is the focus of the illocutionary operator, which can be paraphrased by: The reason why I only went to Tanglewood is because you went to Tanglewood. This suggests a principle saying that a complex focus (whose parts are associated with the same operator) cannot contain identical focused parts. Hence the only way to get semantic representations that restrict their alternatives by formulas like $x \bullet x' = y \bullet y$ is by ellipsis.

4.4 The Scope of Focus Operators

In section (3), we didn't assume any particular scoping rules for focus operators. Although they are essentially propositional operators, we claimed that it is sufficient that the representations they operate on have a type that ends in t.
This guarantees that a focus operator always has the most narrow possible scope. To see this, consider at a case where a focus operator has an AP in scope. As such constructions are marginal in English (except with comparatives, e.g. *an even bigger car*), I will discuss a German example:

(52) Peter kaufte ein nur_1 [MITTELMÄSSIGES]$_{F1}$ Auto
Peter bought an only average car

The crucial thing is that *nur* has scope over the adjective and has to be prevented from taking wide scope, over the whole NP, the VP, or the sentence. This is done naturally when we assume that adnominal APs are nominal modifiers of the type ((e)t)(e)t. Given an obvious rule for the combination of AP's with N's, we get the following interpretation, where M is a variable of type ((e)t)(e)t and semantic combination is by functional application:

(53) *mittelmäßiges* ; AP_F ; $\langle \lambda M.M, \textbf{average}\rangle$

|
| *nur* ; FO ; **only**
|/
nur mittelmäßiges ; AP ; $\textbf{only}(\langle \lambda M.M, \textbf{average}\rangle)$
$= \lambda P \lambda x[\textbf{average}(P)(x) \;\&\; \forall M[M{\approx}\textbf{average} \;\&\; M(P)(x) \rightarrow M{=}\textbf{average}]]$
|
| *Auto* ; N ; **car**
|/
nur mittelmäßiges Auto ; N
$\lambda x[\textbf{average}(\textbf{car})(x) \;\&\; \forall M[M{\approx}\textbf{average} \;\&\; M(\textbf{car})(x) \rightarrow M{=}\textbf{average}]]$
|
| *ein* ; Det ; $\lambda P' \lambda P \exists x[P(x) \;\&\; P'(x)]$
|/
ein nur mittelmäßiges Auto ; NP ;
$\lambda P \exists x[P(x) \;\&\; \textbf{average}(\textbf{car})(x) \;\&\; \forall M[M{\approx}\textbf{average} \;\&\; M(\textbf{car})(x) \rightarrow M{=}\text{average}]]$

Thus, the focus operator nur is applied directly to the AP. We get a predicate that applies to average cars, but not to cars that have another property comparable to **average**. Given a more refined analysis of **only** that takes its scalar properties into account (cf. e.g. Jacobs 1983), this means that the predicate applies to cars that are maximally of average quality, but not of a higher quality.
One observation that might be a counterexample to the claim that focus operators have the most narrow scope possible was reported by Taglicht (1984). According to him, the following sentence has two readings:

(54) We are required to study only syntax.
a) It is required that we study syntax and no other subject.
b) Only for syntax and for no other subject it is required that we study it.

In the latter reading, the expression *only syntax* gets wide scope over *required*. Note that the wide scope interpretation of *only* is not possible when it is an adverbial modifier, as in *we are required to only study syntax*. A plausible explanation of this phenomenon was put forward by Rooth (1985): NPs in general can have wide-scope reading (witness the specific interpretation of *a book in we are required to read a book*), and NPs with focus operators take part in that. That is, focus operators do not get wide scope on their own, but only when carried "piggy-back" by an expression that can get wide scope. However we will implement wide-scope readings of NPs - LF-movement, quantifying in, or operator storage -, this should carry over to cases like (54).

4.5 Focus on Reflexives and Reciprocals

Interesting problems arise in cases like the following, where a focus operator is associated with reflexive or reciprocal pronoun:

(55) a) $John_i$ loves only $himself_i$.
b) [John and $Mary]_i$ love only each $other_i$.

The analysis of (55a) is relatively straightforward if we assume that reflexives are terms $\lambda P.P(xi)$, where the variable xi has to be bound by its antecedent (in the case at hand, the subject). Without going deeper into the modelling of this binding, let us assume that the subject in (55a) is represented by a term $\lambda P \exists x_i[P(x_i) \;\&\; x_i{=}\textbf{j}]$ that binds the variable x_i (where a free variable x_i in the argument doesn't get replaced during application). Then we get the following interpretation, which says that John loves John, and John loves no alternative to John.

(56) *himself* ; NP_i ; $\lambda P.P(x_i)$
|
himself ; NP_{iF} ; $\langle \lambda T.T, \lambda P.P(x_i)\rangle$
|
| *only* ; FO ; **only**
|/
only himself ; NP ; $\lambda P[P(x_i) \;\&\; \forall y[y{\approx}x_i \;\&\; P(y) \rightarrow y{=}x_i]]$
|
| *loves* ; V'; **love**
|/
loves only himself ; VP ; $\lambda x[\textbf{love}(x,x_i) \;\&\; \forall y[y{\approx}x_i \;\&\; \textbf{love}(x,y) \rightarrow y{=}x_i]]$
|
| *John* ; NP_i ; $\lambda P \exists x_i[P(x_i) \;\&\; x_i{=}\textbf{j}]$
|/
John loves only himself ; S ;
$\exists x_i[\textbf{love}(x_i,x_i) \;\&\; \forall y[y{\approx}x_i \;\&\; \textbf{love}(x_i,y) \rightarrow y{=}x_i] \;\&\; xi{=}\textbf{j}]$
$= \textbf{love}(\textbf{j},\textbf{j}) \;\&\; \forall y[y{\approx}\textbf{j} \;\&\; \textbf{love}(\textbf{j},y) \rightarrow y{=}\textbf{j}]$

The treatment of reciprocals requires some more effort. I will sketch one way how it can be done. Let us assume that we have a sum formation on individuals, $\oplus$, such that whenever x, y are individuals, so is $x \oplus y$; $\oplus$ should be the join operation of a join semi-lattice (cf. Link 1983). In particular, $\oplus$ is a symmetric operation, that is, $x \oplus y = y \oplus x$. We also assume a list operation $\bullet$ that is asymmetric. Verbal predicates and relations in natural language typically are cumulative with respect to $\oplus$ in the sense that whenever P(x) and P(y), then $P(x \oplus y)$, and whenever R(x,x') and R(y,y'), then $R(x \oplus x', y \oplus y')$. Furthermore, we assume that natural-language predicates and relations in general are cumulative and distributive with respect to list formation; that is, $P(x) \;\&\; P(y) \leftrightarrow P(x \bullet y)$ and $R(x,x') \;\&\; R(y,y') \leftrightarrow R(x \bullet x', y \bullet y')$. All this can be imposed by suitable meaning postulates.
The reciprocal anaphor *each other*, just like the reflexive, is bound by an antecedent. It requires that this antecedent is a list l, and it imposes that the verbal predicate applies to the RECIPROCAL VARIANT of that list. Before I give a general definition of this notion, let us look at two examples: The reciprocal variant of the list $\textbf{j} \bullet \textbf{b}$ is $\textbf{b} \bullet \textbf{j}$, and the reciprocal variant of $\textbf{j} \bullet \textbf{b} \bullet \textbf{s}$ is $\textbf{b} \oplus \textbf{s} \bullet \textbf{j} \oplus \textbf{s} \bullet \textbf{j} \oplus \textbf{b}$. In general, l' is the reciprocal variant of l iff l and l' have the same length, and the n-th element of l' is the sum individual

of all elements of l with the exception of l's n-th element. Let us assume a function **rec** that maps lists to their reciprocal variants. Then the meaning of *each other*$_i$ is the term $\lambda P.P(\mathbf{rec}(x_i))$. Let us assume that coordination can be interpreted as list formation. I give an example that shows the treatment of sentences with the reciprocal in focus:

(57) *each other* ; NP_i ; $\lambda P.P(\mathbf{rec}(x_i))$
|
each other ; NP_F ; $\langle \lambda T.T, \lambda P.P(\mathbf{rec}(x_i))\rangle$
|
| *only* ; FO ; **only**
|/
only each other ; NP ; $\lambda P[P(\mathbf{rec}(x_i))\ \&\ \forall y[y{\approx}\mathbf{rec}(x_i)\ \&\ P(y) \rightarrow y{=}\mathbf{rec}(x_i)]]$
|
| *love* ; V', **love**
|/
love only each other ; $\lambda x[\mathbf{love}(x,\mathbf{rec}(x_i))\ \&\ \forall y[y{\approx}\mathbf{rec}(x_i)\ \&\ love(x,y) \rightarrow y{=}\mathbf{rec}(x_i)]]$
|
| *John, Bill and Sue* ; NP ; $\lambda P\exists x_i[P(x_i)\ \&\ x_i{=}\mathbf{j{\bullet}b{\bullet}s}]$
|/
John, Bill and Sue love only each other ;
$\exists x_i[\mathbf{love}(x_i,\mathbf{rec}(x_i))\ \&\ \forall y[y{\approx}\mathbf{rec}(x_i)\ \&\ \mathbf{love}(x_i,y) \rightarrow y{=}\mathbf{rec}(x_i)]\ \&\ x_i{=}\mathbf{j{\bullet}b{\bullet}s}]$
$= \mathbf{love(j{\bullet}b{\bullet}s,\ b{\oplus}s{\bullet}j{\oplus}s{\bullet}j{\oplus}b)}\ \&\ \forall y[y{\approx}\mathbf{b{\oplus}s{\bullet}j{\oplus}s{\bullet}j{\oplus}b}\ \&\ \mathbf{love(j{\bullet}b{\bullet}s},y) \rightarrow y{=}\mathbf{b{\oplus}s{\bullet}j{\oplus}s{\bullet}j{\oplus}b}]$

Under the assumption that only lists with the same number of elements are comparable, that **love** is divisive for both lists and sums, and that all atomic individuals are comparable to each other, this amounts to the following:

$$\mathbf{love(j,b)}\ \&\ \mathbf{love(j,s)}\ \&\ \forall y[\mathbf{love(j},y) \rightarrow y{=}\mathbf{b} \lor y{=}\mathbf{s}]\ \&$$
$$\mathbf{love(b,j)}\ \&\ \mathbf{love(b,s)}\ \&\ \forall y[\mathbf{love(b},y) \rightarrow y{=}\mathbf{j} \lor y{=}\mathbf{s}]\ \&$$
$$\mathbf{love(s,j)}\ \&\ \mathbf{love(s,b)}\ \&\ \forall y[\mathbf{love(s},y) \rightarrow y{=}\mathbf{j} \lor y{=}\mathbf{b}]$$

This gives the reading of our example. However, the treatment of reciprocals is still incomplete in several respects: I have showed only how the "strict" interpretation of reciprocals can be modelled, leaving aside the more liberal interpretation which is predominant in cases like *John, Bill and Mary took each other by the hand*; I did not say anything about the formation of coordinated NPs; and I did not talk about cases with plural subjects, such as *The children love only each other*. However, it should have become clear that a treatment of reciprocals with the help of list individuals is feasible, and can be combined with a semantics for focus operators like only in a straightforward way.

4.6 Do We Need Coindexing?

In the framework developed above, we did without coindexing between focus operators and focus. The rules that restrict the association between focus operator and focus are such that they narrow down possible choices. There are two potential problems with this approach: First, the principles may not be restrictive enough for some cases, and second, they might be too restrictive.
As for the first case, note that we can generate examples like the following (I use coindexing here simply as a convenient description device):

(58) John even$_1$ [$_{VP}$ only$_2$ [$_{V_{to}}$ introduced [Bill]$_{F2}$] [to Sue]$_{F1}$]

We arrive at this interpretation by focusing on *Bill*, combining *only* with the V_{to}-expression, focusing on *Sue*, and combining *even* with the VP. The resulting meaning can be described as follows: John introduced Bill to Sue, he did nothing else to Sue, and there are persons x besides Sue for which it is more likely that John introduced Bill to x and did nothing else to x. Does the sentence have this reading? It seems to me that it has it, especially if stressed on *Sue*, and uttered without pause in *only introduced Bill*.
As for the second case, the most serious objection may be raised against the assumption that a focus operator is associated with the most comprehensive focus in its scope (cf. 17). We haven't seen evidence that supports that claim, so let us look at relevant cases. It is not easy to come up with convincing examples, but perhaps the following will do. The adverb *preferably* is focus-sensitive, which can be seen with examples like *John preferably drinks WINE*, which means that of all the drinks, John prefers to drink wine. Now look at the following example:

(59) [Bill preferably$_1$ drinks [Australian WINE]$_{F1}$, and]
John even$_0$ preferably$_1$ drinks [[TASMANIAN]$_{F0}$ wine]$_{F1}$.

Here, it is said that John prefers Tasmanian wine to other drinks, and that there are modifiers X such that it would be more likely that John prefers X wine to other drinks. This seems to be a valid reading of our example, especially in the given context. - Now let us look at the opposite case:

(60) [Bill preferably$_1$ drinks [TASMANIAN]$_{F1}$ beer, and]
? John even$_0$ preferably$_1$ drinks [[Tasmanian]$_{F1}$ wine]$_{F0}$

Here we would expect the interpretation: John prefers Tasmanian wine to other wines, and it is more likely that there is some drink X such that John prefers Tasmanian X to other X. It is at least questionable whether there is such a reading. Of course, we get a reading for *John even$_0$ preferably$_1$ drinks* [*Tasmanian* [*WINE*]$_{F0}$]$_{F1}$, as predicted: John prefers Tasmanian wine to other drinks, and there are drink types X (e.g. beer) such that it would be more likely that John prefers Tasmanian X to other drinks.
There is, however, one class of examples that sheds doubt on our assumption (Hubert Truckenbrodt, personal communication). It is known that gapping is a focus-sensitive process, in the sense that the gap in one coordination part corresponds to the background

in the other coordination part (cf. Sag 1977, Truckenbrodt 1988). Assuming that coordination expresses two assertions (alternatively, coordination itself can be analyzed as focus-sensitive), we can analyze gapping as in the following example:

(61) JOHN met MARY and BILL, SUE.
ASSERT$_0$ [JOHN]$_{F0}$ met [MARY]$_{F0}$ and ASSERT$_0$[BILL$_{F0}$] gap [SUE]$_{F0}$
ASSERT(<λx•y.**met**(x,y),**j•m**>) & ASSERT(< [copy] , **b•s**>)

Now let us look at an example that contains, in addition, an overt focusing operator:

(62) JOHN drank only TASMANIAN wine, and BILL, AUSTRALIAN BEER.
ASSERT$_0$ [JOHN]$_{F0}$ drank only$_1$ [[TASMANIAN]$_{F1}$ wine]$_{F0}$ and
ASSERT$_0$ [BILL]$_{F0}$ gap [[AUSTRALIAN]$_{F1}$ BEER]$_{F0}$

We are interested in an interpretation where the second conjunct has to be spelled out as: *Bill drank only AUSTRALIAN beer*. If this interpretation exists, then we have a counterexample to our assumption, as *only* does not focus not on the most comprehensive focus in its scope. It is not entirely clear, however, whether examples like (62) are grammatical, with the intended interpretation.
In this section, I could give only limited evidence for our assumption that a focus operator is associated with the most comprehensive focus in its domain. If further data shows that this is not the case, then the focus rule S_F has to be formulated in an indeterministic way. If, on the other hand, cases of embedded foci that neither contain intervening focus operators, such as (19c), nor focus on one and the same constituent, such as (19d), are considered to be in general bad, than S_F has to be reformulated in such a way that it can never apply to a focus-background representation to begin with, but may apply to one constituent and generate a multiple focus on that constituent at once (to cover indisputable cases like 19d).

4.7 Assertional Meaning and Presuppositions

The analysis of focus-sensitive operators like *only* and *even* we have given so far neglects one well-known aspect of their semantics, namely that we have to distinguish between the ASSERTIONAL meaning on the one hand and the PRESUPPOSITION or conventional implicature on the other (cf. Horn 1969). Taking constancy under negation as a test for presuppositions, we can observe that a sentence like *John drank only water* asserts that John didn't drink anything but water, and presupposes that John drank water. And we observe that a sentence like *John drank even water* asserts that John drank water, and presupposes that it would have been more likely for John *to drink something else*.

(63) a) - John drank only water.
- No. (i.e., John drank something besides water, too; not: John didn't drink water.)
b) - John drank even water.
- No. (i.e., John didn't drink water; not: it was likely for John to drink water).

We might ask whether it is possible to extend the framework developed above so that it incorporates the distinction between assertion and presupposition, something that was done by Lyons & Hirst (1990) for Alternative Semantics. Cases with complex foci will naturally be of particular interest. For example, consider (12), here repeated as (64):

(65) - John even$_1$ [only$_2$ [drank WATER]$_{F2}$]$_{F1}$.
- No. (i.e., John did other, comparable things as well).

As the negation test shows, this sentence asserts that John did not do other things comparable to drinking water. Its other meaning components listed under (12), then, must be its presuppositions - viz., that John drank water (coming from *only*), and that there are activities comparable to drinking water and doing nothing else for which it is more probable that John performed them (coming from *even*). Note that we have to refer to both the assertional meaning and the presupposition coming from *only* to express this second presupposition.
How can we spell out the semantics of focusing operators like *only*, taking into account the assertional part and the presuppositional part? Perhaps the most explicit theory that was designed to treat assertional meaning and presuppositional meaning in a compositional way is Karttunen & Peters (1979). In particular, they include a treatment of *even*, although they disregard the influence of focus-background structures. Here I want to show how their theory can be combined with the framework of structured meanings.
Karttunen & Peters represent (assertional) meanings and presuppositions on two separate levels, which contain what the sentence EXPRESSES and what it IMPLICATES. (i.e., presupposes). This is rendered formally as a pair <E, I>, where E and I are of the same type. Karttunen & Peters show how meanings and presuppositions of complex expressions can be computed from the meanings and presuppositions of their parts, using a special "heritage function".
How are meaning-presupposition structures and focus-background structures related to each other? Here I will not introduce a formal semantic framework for meaning-presupposition structures, as this would lead us too far astray. I will restrict the discussion to one illustrative example that shows how cases with several focusing operators can be treated in principle.
Let us assume that basic semantic interpretations always consist of an assertion part and a presupposition part of the same semantic type that are constructed in tandem. That is, the semantics of a focus-background structure will be a pair of semantic representations that are pairs themselves. In the following example, I assume, for the sake of exposition, that *drink* presupposes that the agent of the drinking is animate, and that the substance that is drunk is fluid. These presuppositions are projected to the complex expression, *drank water*, with a mechanism like the one given by Karttunen & Peters, this is left implicit here. The alternatives of focus-sensitive operators, like *even*, then may be determined by the conjunction of the meaning and the presupposition

of the focus element; note that we have to assume a conjunction generalized for all types based on t, as the focus often will not be of a sentential type.

(66) *drank water*; V ; $\langle \lambda x \exists y[\mathbf{drank}(x,y) \;\&\; \mathbf{W}(y)], \lambda x[\mathbf{anim}(x) \;\&\; \mathbf{fluid}(\mathbf{W})]\rangle$, abbr. $\langle[1], [2]\rangle$

|

S_F *drank water* ; VP_F ; $\langle\langle\lambda P.P, \lambda P.P\rangle \langle[1], [2]\rangle\rangle$

|

| *only* ; FO ; **only**

| /

S_O *only drank water* ; VP ; $\mathbf{only}(\langle\langle\lambda P.P, \lambda P.P\rangle \langle[1], [2]\rangle\rangle)$
$= \langle\lambda x\forall P[P\approx[1] \;\&\; [2]\; P(x) \rightarrow P = [1]], [1]\&[2]\rangle$, abbr. $\langle[3], [4]\rangle$

|

S_F *only drank water* ; VP_F ; $\langle\langle\lambda P.P, \lambda P.P\rangle \langle[3], [4]\rangle\rangle$

|

| *even* ; FO ; **even**

| /

S_O *even only drank water* ; VP ; $\mathbf{even}(\langle\langle\lambda P.P, \lambda P.P\rangle \langle[3], [4]\rangle\rangle)$
$= \langle[3], \lambda x\exists P[P\approx[3]\&[4] \;\&\; [3]\&[4](x) <_p P(x)]\rangle$

|

| *John* ; NP ; $\lambda P.P(j)$

| /

John even only drank water ; S ; $\langle[3](j), \exists P[P\approx[3]\&[4] \;\&\; [3]\&[4](j) <_p P(j)]\rangle$

The meaning part of this pair, [3](j), expresses that everything that John did was drinking water, or more correctly, that no property P comparable, but not identical to the property of drinking water applies to John. Note that this is also the meaning of the simpler sentence *John only drank water*, which shows that *even* does not change the meaning of an expression.
The presupposition part of that pair says that there is a property P comparable to the property of only drinking water such that this property would more likely apply to John. More precisely, it claims this of a property P that applies to entities that didn't do anything comparable, but not identical to drinking water, that drank water, that are animate, and for which it holds that water is a fluid.
Of course, the meaning postulates for *only* and *even* have to be revised in order to get the intended results. In the example above, I have worked with the following postulates:

(25') $\mathbf{only}(\langle\langle\alpha,\beta\rangle, \langle\gamma,\delta\rangle\rangle) := \langle\lambda v\forall X[X\approx \gamma\&\delta \;\&\; \alpha(X)(v) \rightarrow X= \gamma\&\delta], \alpha(\gamma)\&\beta(\delta)\rangle$

(26') $\mathbf{even}(\langle\langle\alpha,\beta\rangle \langle\gamma,\delta\rangle\rangle := \langle\alpha(\gamma), \lambda v\exists X[X\approx\gamma\&\delta \;\&\; \alpha(\gamma\&\delta)(v) <_p \alpha(X)(v)]\&\beta(\delta)\rangle$

Here, (25') says that a sentence containing *only* asserts that the proposition does not hold for any alternatives to the meaning of the focus constituent, γ. It presupposes the basic assertion, $\alpha(\gamma)$, in addition with the presupposition generated by the presuppositions of the focus and the presuppositions of the background, $\beta(\delta)$. (26') says that the basic assertion, $\alpha(\gamma)$, is asserted, and that it is presupposed that there are alternatives to γ, together with its presuppositions δ, for which it is less likely that α holds. Also, the presuppositions of the background and the focus are projected to the resulting expression. Note that it is crucial that the determination of the alternatives may refer to both the meaning and the presuppositions of the semantic representation of its focus, at least for *even*.

4.8 Topic-Comment Structures

Let us finally turn to a particularly vexing problem. It was pointed out by Jacobs (1988, to appear) with examples like the following one:

(67) SUE KISSED John.

There is a reading involving a complex focus on Sue and kissed, as an answer to a question like *Who did what to John?*, which can be derived in a standard way (cf. 67'a). In addition, there is also a reading where *Sue* and *kissed* seem to form a simple focus, at least semantically: (67) may be an answer to *What happened to John?*, where the focus is equivalent to *was kissed by Sue*. For this case, we would be inclined to assume the representation (67'b):

(67') a) $\mathbf{ASSERT}(\langle\lambda x{\bullet}R.R(j,x), \mathbf{s.kissed}\rangle)$
b) $\mathbf{ASSERT}(\langle\lambda P.P(j), \lambda x.\mathbf{kissed}(s,x)\rangle)$

The problem here is how to arrive at representation (b) in a compositional way, given that the parts of the sentence that correspond to the focus do not form a syntactic constituent at any level, according to standard analyses of these sentences.
One way to do overcome this problem is to assume that the sentences in question indeed have an analysis in which the parts in focus form a syntactic constituent. This could be expressed quite naturally in a syntactic framework like categorial grammar with liberal rules of category composition. Advocates of categorial grammar may welcome these facts as another argument for flexible combination rules, in addition to coordination data like right node raising, as in *Sue kissed and Mary teased John* (cf. Steedman 1985, Dowty 1987).
Another way is to analyze these cases not as involving peculiar focus-background structures, but as rather regular TOPIC-COMMENT structures. The relevant examples of purported non-constituent focus all have a purported background that IS a constituent, and they are examples that answer questions like *What happened to x?* So we might analyze them as cases where the purported background is, in fact, the topic of the sentence, and the purported focus is the comment.
Topic-comment structures can be captured with the same technique as focus-background structures, namely structured meanings. Actually, Dahl (1974) proposed both a separate treatment of focus-background structures and topic-comment structures, and a way to model them that can be seen as a precursor of structured meanings.

One crucial question at this point is how topic-comment structures and focus-background structures interact. It seems that we should allow for both the comment and the topic to consist of focus-background structures (cf. Jacobs 1984); witness the following examples:

(68) a) - Who(m) did Sue kiss?
- $[\text{Sue}]_T$ [kissed $[\text{John}]_F]_C$

b) - What did Bill's sisters do?
- [Bill's $[\text{youngest}]_F$ sister$]_T$ [kissed John$]_C$.

In (68a), *kissed John* arguably is the comment, and it contains a focus, *John*. And in (68b), *Bill's youngest sister* arguably is the topic, and it contains a focus, *youngest*. We also might analyze *kissed John* as a focus of the comment in this case; alternatively, we might skip assignment of focus, given a rule that whenever the comment does not contain any focus feature, it should be considered as focus itself.

This suggests the following framework for topic-comment structures: Topic-comment structures are labelled pairs $\langle_T\alpha,\beta\rangle$, where α is the comment and β is the topic. Both α and β may be simple, or they may contain focus-background structures. Illocutionary operators, like assertion, may take topic-comment structures as their argument. We have the following rule for assertions applying to simple topic-comment structures, where I use $[\Phi]$ for the set of possible words where a formula Φ is true.

(69) If α, β are not focus-background structures, then:
ASSERT($\langle_T\lambda X.\alpha, \beta\rangle$) maps a common ground c to a common ground c', where c' is the intersection of c with the set of possible worlds for which $\lambda X.\alpha(\beta)$ is true, i.e. $c'=c\cap[\lambda x.\alpha(\beta)]$
Felicity conditions:
- $c'\neq c$, $c'\neq\emptyset$, and there are salient Y, $Y\approx\lambda X.\alpha$, $Y\neq\lambda X.\alpha$, such that Y could have been asserted of β. That is, it would have changed c, $c\cap[Y(\beta)]\neq c$, it would not be excluded by c, $c\cap[Y(\alpha)]\neq\emptyset$, and would have yielded a different output context, $c\cap[Y(\beta)]\neq c\cap[\lambda X.\alpha(\beta)]$;
- β is a possible topic in c, that is, β, or something closely related to β, was mentioned in the immediately preceding discourse, or is part of the environment of speaker and hearer, or is something the speaker and hearer talk regularly about.

The first set of felicity conditions covers the conditions specified in (7); the only difference is that now the first member of the pair $\langle_T\alpha,\beta\rangle$ counts as "focus". The second set of felicity conditions is concerned with the topic; it leaves much to be explained, but should give an idea of a possible way to spell out the semantic impact of topics.

We have to change (69) slightly for complex topic-comment structures. I propose the following:

(70) a) **ASSERT**($\langle_T\lambda X.\langle\alpha,\beta\rangle,\gamma\rangle$) maps a common ground c to a common ground c', where $c' = c\cap[\lambda X[\alpha(\beta)](\gamma)]$. Felicity conditions:
- $c'\neq c$, $c'\neq\emptyset$, and there are salient Y, $Y\approx\beta$, $Y\neq\beta$ such that $\lambda X[\alpha(Y)]$ could have been asserted of γ;
- γ is a possible topic in c.

b) **ASSERT**($\langle_T\lambda X.\alpha, \langle\beta,\gamma\rangle\rangle$) maps a common ground c to a common ground c', where $c' = c\cap[\lambda X.\alpha(\beta(\gamma))]$. Felicity conditions:
- $c'\neq c$, $c'\neq\emptyset$
- $\beta(\gamma)$ is a possible topic in c, and there are salient Y, $Y\approx\gamma$, $Y\neq\gamma$ such that $\beta(Y)$ is a possible topic in c as well.

c) **ASSERT**($\langle_T\lambda X.\langle\alpha,\beta\rangle, \langle\gamma,\delta\rangle\rangle$) maps a common ground c to a common ground c', where $c' = c\cap[\lambda X[\alpha(\beta)](\gamma\delta))]$. Felicity conditions:
- $c'\neq c$, $c'\neq\emptyset$, and there are salient Y, $Y\approx\beta$, $Y\neq\beta$ such that $\lambda X[\alpha(Y)]$ could have been asserted of $\gamma(\delta)$;
- $\gamma(\delta)$ is a possible topic in c, and there are salient Y, $Y\approx\delta$, $Y\neq\delta$ such that $\gamma(Y)$ is a possible topic in c as well.

So the focus-background structure in the comment determines alternative comments that could have been made about the topic, and the focus-background structure in the topic determines alternative topics that could have been "commented" upon. We should also account for the possibility of topicless sentences (so-called thetic sentences); in this case, we may assume our old assertion rule (7).

Topic-comment structures and focus-background structures do interact in the derivation of a complex semantic representation. The basic principle is that topic-comment structures take precedence over focus-background structures. Furthermore, topic-comment structures are not recursive; we should allow, however, for the possibility of complex topics, as attested e.g. in Hungarian (Kiss 1986). This leads to the following rules of functional application, in addition to the rules given in (21):

(71) a) $\langle_T\alpha,\beta,(\gamma) = \langle_T\lambda X.\alpha(X)(\gamma), \beta\rangle$
b) $\delta(\langle_T\alpha,\beta\rangle) = \langle_T\lambda X.\delta(\alpha(X)), \beta\rangle$ (if δ is simple)
c) $\langle_T\alpha,\beta\rangle(\langle\gamma,\delta\rangle) = \langle_T\lambda X[\alpha(X)(\langle\gamma,\delta\rangle)], \beta\rangle$
d) $\langle\gamma,\delta\rangle(\langle_T\alpha,\beta\rangle) = \langle_T\lambda X[\langle\gamma,\delta\rangle(\alpha(X))], \beta\rangle$
e) $\langle_T\alpha,\beta\rangle(\langle_T\gamma,\delta\rangle) = \langle_T\lambda X{\bullet}X'[\alpha(X)(\gamma(X'))], \beta{\bullet}\delta\rangle$
(where X, X' are variables of the types of β, δ)

I assume the rule S_T for topicalization of a constituent of category C:

(72) S_T C -> C_T (indexing of arbitrary category Y by topic feature T)
$[C_F] = \langle_T\lambda X.X, [C]\rangle$, where X is a variable of the type of [C].

The topic feature can be spelled out in various ways, for example in the *as for NP*-construction, or in languages like Japanese and Korean by affixation of particles. As for accentual markings, the basic rule seems to be that topical constituents are de-accented as a whole; they may contain accents in case they contain a focus constituent, as in

68b). This implies that the non-topical constituents get accent (or "neutral stress", in the theory of Jacobs 1988, to appear).
It is time to look at an example. Let's take one with a simple topic, *John*, and a comment, *drank water*, that contains a focus, *water*:

(73) - What did John drink?
- John_T drank WATER_F

drank $[\textit{water}]_F$; VP ; $\langle \lambda T \lambda x.T(\lambda y.\mathbf{drank}(x,y)), \mathbf{water}\rangle$
|
| *John* ; NP ; **John**
| |
| S_T *John* ; NP_T ; $\langle_T \lambda T.T, \mathbf{John}\rangle$
| /
S_1 *John drank water* ; $\langle_T \lambda T.T, \mathbf{John}\rangle(\langle \lambda T \lambda x.T(\lambda y.\mathbf{drank}(x,y)), \mathbf{water}\rangle)$
$= \langle_T \lambda T[\lambda T.T(T)(\langle \lambda T \lambda x.T(\lambda y.\mathbf{drank}(x,y)), \mathbf{water}\rangle)], \mathbf{John}\rangle$
$= \langle_T \lambda T.T(\langle \lambda T \lambda x.T(\lambda y.\mathbf{drank}(x,y)), \mathbf{water}\rangle), \mathbf{John}\rangle$
$= \langle_T \lambda T.\langle \lambda T'.T(\lambda x.T'(\lambda y.\mathbf{drank}(x,y))), \mathbf{water}\rangle, \mathbf{John}\rangle$
|
S_I | . ; IO ; **ASSERT**
|/
$\mathbf{ASSERT}(\langle_T \lambda T.\langle \lambda T'.T(\lambda x.T'(\lambda y.\mathbf{drank}(x,y))), \mathbf{water}\rangle, \mathbf{John}\rangle)$

Spelling out **ASSERT**:
(69) maps a common ground c to a common ground c', where c' is the intersection of c with the worlds in which $\lambda T[\lambda T'.T(\lambda x.T'(\lambda y.\mathbf{drank}(x,y)))(\mathbf{water})](\mathbf{John})$ is true, that is, in which $\mathbf{John}(\lambda x.\mathbf{water}(\lambda y.\mathbf{drank}(x,y)))$ is true, that is, in which $\exists y[\mathbf{drank}(j,y) \;\&\; \mathbf{W}(y)]$ is true.

Felicity conditions:
- $c' \neq c$, $c' \neq \emptyset$, and there are salient Y, $Y \approx \mathbf{water}$, $Y \neq \mathbf{water}$ such that **John** $(\lambda x.Y(\lambda y.\mathbf{drank}(x,y)))$ could have been asserted;
- **John** is a possible topic in c.

Now let us come back to our original example, (67). The two analyses can be given as follows. Note that in both cases, *John* is supposed to be the topic.

(74) *kissed* ; V'; **kiss**
|
| *John* ; NP_T ; $\langle_T \lambda T T, \mathbf{John}\rangle$
|/
S_2 *kissed John* ; VP ; $\langle_T \lambda T \lambda x.T(\lambda y.\mathbf{kiss}(x,y)), \mathbf{John}\rangle$
|
| *Sue* ; NP ; **Sue**
|/
S_1 *Sue kissed John* ; S ; $\langle_T \lambda T.\mathbf{Sue}(\lambda x.T(\lambda y.\mathbf{kiss}(x,y))), \mathbf{John}\rangle$

Application of the assertion operator yields the following result: It is asserted that Sue kissed John, with the felicity condition that other salient properties Y that are comparable to $\lambda T.\mathbf{Sue}(\lambda x.T(\lambda y.\mathbf{kiss}(x,y)))$ (that is, be kissed by Sue) could have applied to John at the current point in discourse. In addition, John must be a possible topic at the current point in discourse.

(75) *kissed* ; V'_F ; $\langle \lambda R R, \mathbf{kiss}\rangle$
|
| *John* ; NP_T ; $\langle_T \lambda T T, \mathbf{John}\rangle$
|/
S_2 *kissed John* ; VP ; $\langle_T \lambda T\langle \lambda R \lambda x.T(\lambda y.R(x,y), \mathbf{kiss}\rangle), \mathbf{John}\rangle$
|
| *Sue* ; NP_F ; $\langle \lambda T T, \mathbf{Sue}\rangle$
|/
S_1 *Sue kissed John* ; S ;
$\langle_T \lambda T\langle \lambda T' \bullet R.T'(\lambda x.T(\lambda y.R(x,y))), \mathbf{Sue}\bullet\mathbf{kiss}\rangle, \mathbf{John}\rangle$

Now the application operator yields the following result: It is asserted that Sue kissed John, with the felicity condition that there are salient pairs of representations T'•R that are comparable to **Sue•kiss** such that $\lambda T \bullet T'(\lambda x.T(\lambda y.\ R(x,y)))$ (roughly, T' did R to him) could have been asserted of John as well at the current point in discourse. Again, John must be a possible topic at the current point in discourse.

Conclusion

In this article, I have tried to develop a coherent semantic framework that can ...ture sentences with multiple focus, both free focus and focus bound by overt operators. ...uctured meanings turned out to be a suitable representation format, and I have shown ...w a compositional semantics can be developed for those sentences within that format. In doing this, we have seen that much of the burden that was assigned to syntax in ...ndexing approaches such as Jacobs (1984, 1988, to appear) can in fact be taken over ... well-formedness principles in the semantic component.
...re are several directions into which this approach can be extended. One is to see ...ther we indeed need the full expressibility of structured meanings, or whether the

more parsimonious framework of alternative semantics (cf. Rooth 1985) can be worked out to cover multiple focus constructions as well. Secondly, we should address the various shortcomings mentioned in section (4) above, such as focus assignment to expressions that are not surface constituents, focus assignment to expressions that are not in the scope of their operator on surface structure, and a combination of the structured meaning framework with a way to express different scopings of NPs. Also, the propose interaction between topic-comment structures and focus-background structures needs much more work; it might turn out that insights of the theory of communicative dynamism, as developed in the Czech school by Firbas, Hajicova, Sgall and others are expressible in this framework. Finally, it is necessary to extend the framework such that it can cover the impact of focus on the interpretation of quantifiers, such as *always* (cf. Rooth 1985, 1988) or the genericity operator (cf. Krifka, to appear). To do this with the required generality, we must provide for a mechanism to express anaphoric bindings, which requires a dynamic semantic framework, such as discourse representation theory or one of its alternatives.

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