Focus without variables: A multi-modal analysis

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1. Introduction

It is an issue of ongoing controversy whether the information present at surface structure is sufficient for semantic interpretation or not. In the generative tradition the dominant position is that it is inevitable to enrich this structure with traces, indices etc. — devices that are to be interpreted like variables in logic — and that surface structure has to undergo certain syntactic transformations to get a suitable input for compositional interpretation.[1]

On the other hand, semanticists working in the tradition of Richard Montague (cf. Montague (1974)) usually assume that surface structure contains all information necessary for semantic interpretation. The Categorial tradition has strengthened this constraint by insisting that meaning composition can be done without essential reference to variable names as a kind of information that is not present at surface structure.[2]

Under the perspective of Occam's razor a surface compositional and variable free approach to semantics is certainly preferable, but the ultimate decision has to be made by comparing the empirical coverage of such theories with its competitors.

[1] See for instance von Stechow (1991) for a defense of this view.

[2] For the Combinatory branch of CG cf. Ades and Steedman (1982), Szabolcsi (1989), Jacobson (1997) among many others. Under the type logical perspective, the natural connection to a variable free semantics has been brought to attention by van Benthem (1983).

In this paper I will explore a certain phenomenon concerning the interaction between ellipsis and focus that has been used as an argument (by Kratzer (1991), see also Pulman (1997)) that both the use of variables and of an intermediate level of representation are indispensable. I will present a surface compositional and variable free analysis. The techniques used are not new (the most important sources are Krifka (1992) and Jacobson (1997)), but the paper aims to show that integrating these concepts into multi-modal categorial grammar (cf. Carpenter (1997), Moortgat (1997), Morrill (1994)) results in a system that is more than just the sum of its parts.

Section 2 discusses the problem to be explored and Kratzer's proposal for it's solution. In section 3 the basic concepts of multi-modal categorial grammar are introduced. Section 4 and 5 are concerned with the treatment of ellipsis and of focus in this approach to grammar. Section 6 explicates the interaction of these modules.

2. The interaction of focus and ellipsis

Kratzer (1991) argues that the interpretation of focus requires semantic devices that make reference to names of variables. In a nutshell, the argument is the following. Rooth (1985) gives clear evidence that the non-local character of focus interpretation cannot be modeled by means of LF movement, even if we assume that this operation exists. This is illustrated by his example (1):

(1) They only investigated the question whether you know the woman who chaired [the Zoning Board]$_F$

Only gets interpreted as an operator that takes the interpretation of *the Zoning Board* as one of its arguments. However, the focused constituent cannot become a syntactic sister of *only* at LF, since this would result in an island violation. Kratzer follows Rooth's conclusion that focus has to be interpreted *in situ*. Now consider Kratzer's (1991:830) example (2):

(2) I only went to [Tanglewood]$_F$ because you did.

From the considerations above it follows that *went to [Tanglewood]*$_F$ is a constituent at the level which serves as input for interpretation. So no matter whether we adopt a theory of ellipsis interpretation that assumes copying of syntactic material or an identity of meaning approach, (2) should come out as synonymous with (3), but it doesn't.

(3) I only went to [Tanglewood]$_F$ because you went to [Tanglewood]$_F$.

The sentence (2) can be paraphrased as "The only place x such that I went to x because you went to x is Tanglewood". On the other hand, (3) can mean "The only pair of places $\langle x, y\rangle$ such that I went to x because you went to y is $\langle$Tanglewood, Tanglewood$\rangle$", which has different truth conditions.[3] Kratzer's proposal rests on the intuition that this is a difference between binding of two occurrences of the same variable versus simultaneous binding of two different variables. Technically, she assumes that each sign s has two interpretations, its ordinary meaning $\|s\|$ and its presupposition skeleton $\|s\|^p$. Each focus feature at S-structure comes with an index, and at this level, no two focus features share their index (the "novelty condition for F-indexing"). The presupposition skeleton of a constituent is obtained by interpreting the result of replacing all focused sub-constituents by the variable which bears the index of the respective focus feature. Both the ordinary meaning and the presupposition skeleton of a constituent *only VP* is obtained by applying the interpretation of *only* to both meaning components of its argument ($\|$only VP$\| = \|$only VP$\|^p =$ *only'*$(\|$VP$\|)(\|$VP$\|^p)$. Crucially, the syncategorematic expression *only'* acts as an unselective operator that binds all free variables in its scope. Now due to the novelty condition, *only* binds two different variables in (3). In (2), ellipsis resolution preserves the focus index/variable name, and *only* binds two occurrences of the same variable.

While I agree with the basic intuition behind this approach — the focus sensitive operator in (2) discharges an assumption introduced by the overt focus, and it simultaneously discharges two assumptions in (3) corresponding to the two overt foci — I think that the implementation in terms of variables and a copy theory of ellipsis is not optimal. For one thing, the usage of variables requires abstract devices for managing variable names, since the latter do not correspond to observable phenomena. Kratzer employs the novelty condition for F-indexing here. However, it is crucial for her proposal that this constraint apply at S-structure, while the novelty condition for indefinites that was introduced in Heim (1982) is a constraint on the relation between a linguistic expression and its context of interpretation. So the theoretical status of Kratzer's condition is somewhat unclear.

More seriously, this approach predicts that every focused constituent is as-

[3] According to Krifka (1992), (3) cannot have this reading. I think it can; take the following parallel example:

(i) A You always make your electoral decision with a side-glance on me, either because you want to copy or because you want to defy me. 1992 you voted for Bush because I voted for Bush, and 1996 you voted for Dole because I voted for Clinton. Don't you have your own opinion?

B You are wrong. I didn't vote for Dole because you voted for Clinton. I only voted for BUSH because you voted for BUSH.

sociated with at most one operator. Krifka (1992:22) shows this to be wrong. His crucial example is:

(4) [At yesterday's party, people stayed with their first choice of drink. Bill only drank WINE, Sue only drank BEER, and]
John even only drank WATER$_F$

Here *water* is associated with *only* and *even* simultaneously. With the proviso that one constituent can bear more than one focus feature, this construction can be handled in Krifka's, but not in Kratzer's approach. On the other hand, Krifka's theory in its original formulation cannot account for the ellipsis examples. So the two theories have a different coverage, but they make identical predictions in constructions where both can be applied. Hence any extension of Krifka's theory to the ellipsis constructions would be preferable to either of the to approaches. In the next sections I will develop a compositional and variable free theory of ellipsis resolution which — in combination with Krifka's theory of focus — covers constructions like (2).

3. Multi-modal Categorial Grammar

3.1 The Lambek Calculus

Compositionality of Interpretation requires that each syntactic operation is accompanied by a corresponding operation on meanings. Categorial Grammar strengthens this idea by assuming that not only syntactic and semantic objects, but also syntactic and semantic operations form algebras, and that there is also a homomorphism from syntactic to semantic operations. In the type logical version of Categorial Grammar, the syntactic operations are taken to be theorems (valid sequents) of a logical calculus generated from a single axiom scheme by application of a small set of inference rules. Correspondingly, semantic operations are generated from a single combinatorial scheme by closure under certain operations.

Syntactic categories, i.e. formulas of the syntax logic in question, are recursively built from a finite set of atomic categories by means of the connectives "/" (rightward looking implication), "$\backslash$" (leftward looking implication) and "$\bullet$" (product). A *sequent* is a derivation $X \Rightarrow A$, where X is a string of formulas, and A is a formula. To transform such a logic into a full-blown grammar, two further ingredients have to be added, namely a set of designated categories (usually simply $\{S\}$), and an assignment of at least one category to each lexical item. A sequence of lexical items is recognized as a sentence by this grammar iff one of the designated categories can be derived from a sequent of corresponding categories. The simplest logic fitting into this framework is the associative Lambek Calculus **L** (Lambek (1958)). On the semantic side, there is a set of types which is the closure of a finite set of atomic types under the operations "$\rightarrow$" (function space) and "$\circ$" (Cartesian product). The homomorphism leading from categories to types is a straightforward generalization from the one in Montague's PTQ system, requiring that "$\backslash$" and "/" be sent to "$\rightarrow$" and"$\bullet$" to "$\circ$". The only basic semantic operations are the identity maps on the domain of each type. The meta-operations on semantic operations are most transparently defined as manipulations of polynomials in the simply typed λ-calculus (with product and projections). There is a one-one correspondence between inference rules and semantic meta-operations. Hence syntax and semantics can be presented simultaneously by augmenting the premises of the sequents in the Gentzen-style presentation with variables and the conclusions with polynomials over these variables. The axioms and rules of **L** are presented below.

(5)

$$\frac{}{x : A \Rightarrow x : A}[\mathrm{id}] \qquad \frac{X \Rightarrow t : A \qquad Y, x : A, Z \Rightarrow r : B}{Y, X, A \Rightarrow r_{[t/x]}}[\mathrm{Cut}]$$

$$\frac{X, x : A, y : B, Y \Rightarrow t : C}{X, z : A \bullet B, Y \Rightarrow t_{[(z)_0/x,(z)_1/y]} : C}[\bullet\mathrm{L}] \qquad \frac{X \Rightarrow t : A \qquad Y \Rightarrow r : B}{X, Y \Rightarrow \langle t, r\rangle : A \bullet B}[\bullet\mathrm{R}]$$

$$\frac{X \Rightarrow t : A \qquad Y, x : B, Z \Rightarrow r : C}{Y, y : B/A, X, Z \Rightarrow r_{[(yt)/x]} : C}[/\mathrm{L}] \qquad \frac{X, x : A \Rightarrow t : B}{X \Rightarrow \lambda x.t : B/A}[/\mathrm{R}]$$

$$\frac{X \Rightarrow t : A \qquad Y, x : B, Z \Rightarrow r : C}{Y, X, y : A \backslash B, Z \Rightarrow r_{[(yt)/x]} : C}[\backslash\mathrm{L}] \qquad \frac{x : A, X \Rightarrow t : B}{X \Rightarrow \lambda x.t : A \backslash B}[\backslash\mathrm{R}]$$

3.2 Multi-modality

The Lambek calculus is characterized by a very rigid resource management. In particular, it strongly depends on the linear order of premises, and every resource must be used exactly once. Natural language is more flexible in several respects. So we encounter word order variation, non-local crossing dependencies, the simultaneous use of the same resource in different local environments (for instance in parasitic gap constructions) and many more phenomena that cannot adequately be captured by the basic system. Yet relaxing the resource consciousness of **L** globally results in systems that are too coarse grained for linguistic purposes. These limitation can be overcome if a more flexible management can be made available locally. To this end, multi-modal Categorial Grammar extends the inventory of type forming connectives with a family of modal operators $\diamond_i$ which are characterized by the logical rules below.[4] Premises are now bracketed sequences, i.e. labeled trees

[4]It is more in line with the properties of the basic connective of **L** to pair each $\diamond_i$ with

of formulas. I assume that modalities don't have semantic impact, so the type corresponding to $\Diamond_i A$ is identical with the type corresponding to A.

(6) $$\frac{X \Rightarrow t : A}{(X)^i \Rightarrow t : \Diamond_i A}[\Diamond_i \mathrm{L}] \qquad \frac{X, x : (A)^i, Y \Rightarrow t : B}{X, x : \Diamond_i A, Y \Rightarrow t : B}[\Diamond_i \mathrm{R}]$$

Now while we would lose important distinctions if we introduced additional axioms or rules like permutation as such to the calculus, we can relativize these non-standard operations to modal formulas. This move preserves the overall resource conscious and order sensitive character of **L** while allowing more flexibility in local domains.

4. Ellipsis and Contraction

One instance of the resource consciousness of **L** is the fact that in the meaning representation of a sentence, the meanings of the lexical items involved can each occur only once. This seems to be too restrictive if we turn our attention to anaphora and ellipsis. Consider a simple elliptic sentence like

(7) a. John walked, and Bill did too

b. $and'(walk'b)(walk'j)$

In its semantic representation, the meaning of the VP in the first conjunct occurs twice. There are several ways to deal with this fact. The source of this meaning duplication could be located in the lexical entry of *did*. For pronouns, such a strategy has been proposed in Szabolcsi (1989). However, this treatment only captures bound pronouns in the sense of Reinhart (1983). Since we want to maintain the option for a unified treatment of intra- and inter-sentential ellipses, this seems to be too narrow. Hence we are left with the need to allow duplicating meanings during syntactic composition. In a Lambek-style grammar, this amounts to enriching **L** with the structural rule of Contraction:

(8) $$\frac{X, x : A, y : A, Y \Rightarrow t : B}{X, x : A, Y \Rightarrow t_{[x/y]} : B}[\mathrm{C}]$$

However, the unrestricted usage of Contraction would lead to a heavy overgeneration. For instance, *John shows Mary* would be predicted to be a grammatical sentence with the meaning of *John shows Mary herself*. Therefore we have to impose constraints on the applicability of these rules to avoid such a

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its dual $\Box_i^{\downarrow}$. For the sake of simplicity, I leave this out here. For a thorough discussion of the logical aspects of multi-modality see Moortgat (1997).

collapse. This can be done by employing multi-modality. Let us start with the intuition that anaphors are semantically incomplete expressions. To become complete, they have to be supplemented with an index (or pick up a discourse marker, whatever metaphor you prefer). To formalize this intuition in a categorial framework, we introduce a modal operator $\diamond$, where $\diamond A$ is intended to be the category of an index/discourse marker that was introduced by a sign of category A. An anaphoric pronoun hence should be assign the category $\diamond N \setminus N$, since it behaves like a name if supplied with an nominal index. Since its meaning in a given context is just the meaning of the index, its lexical meaning is the identity function on individuals (ignoring matters of number and gender). Coindexing now amounts to identifying a "freely floating" index of category $\diamond A$ with a sign of category A. This is captured by the following modally restricted version of Contraction:

$$(9)\quad \frac{X, x : A, y : \diamond A, Y \Rightarrow t : B}{X, x : A, Y \Rightarrow t_{[x/y]} : B}\text{[C]}$$

The fact that a pronoun and its antecedent need not be adjacent can be captured by a restricted version of Permutation:

$$(10)\quad \frac{X, x : \diamond A, y : B, Y \Rightarrow t : C}{X, y : B, x : \diamond A, Y \Rightarrow t : C}\text{[P}\diamond\text{]}$$

This proposal is very similar to the one made in Jacobson (1997), though there are important differences. According to her view, anaphors introduce an argument place of a special kind into the derivation. The category of a constituent that is of category A except that it has such an anaphoric argument place is A^N (corresponding to $\diamond N \setminus A$ in the present account). The core of her proposal is the assumption that such a superscript can percolate up to larger constituents in a derivation, and that it can be discharged by merging it with a regular argument place.

Both assumptions are also captured in the present proposal. Percolation amounts to the fact that the following inference rule is derivable (A^B is to be read as an abbreviation for $\diamond B \setminus A$):

$$(11)\quad \frac{x : A, y : B \Rightarrow t : C}{x : A, z : B^D \Rightarrow \lambda w.t_{[(zw)/y]} : C^D}\text{[Perc]}$$

In plain English: If an A and a B can be combined to a C, then an A and a B with a missing D can be combined to a C with a missing D. Merging of argument places is covered by the fact the the following sequent is derivable:

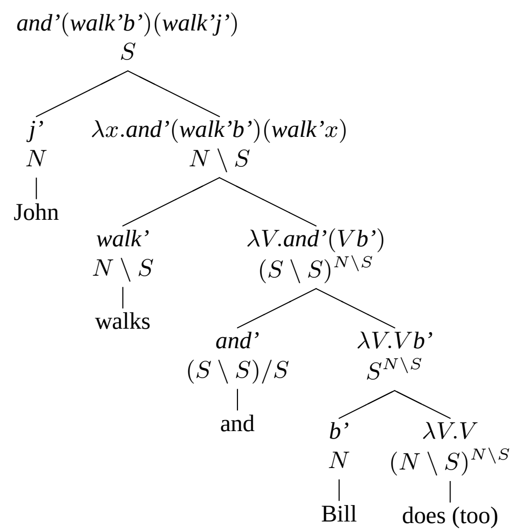
(12) $x : (A \setminus B)^A \Rightarrow \lambda y.xyy : A \setminus B$

Besides merging of argument places, the present proposal also admits another binding device that is not generally available in Jacobson's system. It says that if an A and a B can combine, then an A and a B with a missing A can also combine, by making a copy of the A and using it to fill the argument place indicated by the superscript. More precisely, the following inference rule is derivable too:

(13) $$\frac{x : A, y : B \Rightarrow t : C}{x : A, z : B^A \Rightarrow t_{[(zx)/y]} : C}\text{[Bind]}$$

The system is illustrated by the following sample derivation for (7). Note that function composition is derivable in the Lambek calculus; this together with Bind licenses the combination of *walks* with *and Bill does*.

(14)



For a more thorough discussion of this approach to anaphors and ellipsis, the reader is referred to Jäger (to appear).

5. Krifka's theory of focus interpretation in a multi-modal setting

Krifka (1992) gives a compositional and variable free account of focus interpretation that is based on the concept of *structured meaning*. Constituents containing a focused sub-constituent have structured meanings, i.e. their meaning is an ordered pair consisting of a background part and a focus part (that can be structured meanings themselves). The focus part is just the "ordinary" meaning of the focused sub-constituent, while the background is a function from possible focus meanings to corresponding meanings of the whole constituent. The function of a focus morpheme is to put the meaning of its argument on a stack and to replace it by the identity function. It is worth noting that more than one focus morpheme can be attached to one and the same constituent. The motivation for this assumption comes from constructions such as (4). Both the focus part and the argument slot in the background part are passed on to larger constituents in the course of meaning composition. Crucially for the treatment of multiple foci, if both functor and argument in a local configuration contain a focus, they can be merged.

In what follows I will intermingle the illustration of this proposal with its incorporation into a type logical framework. Let us take a simple example like

(15) John only met SUE$_F$

The "ordinary" meaning of *Sue* is the individual Sue, represented by the constant *s'*.[5] Combining *Sue* with the focus morpheme gives us a structured meaning where the focus part is *s'* and the background part the identity function on individuals, i.e. the meaning of *Sue*$_F$ is $\langle \lambda x.x, \textit{s'} \rangle$.

The semantic type of this object is $(e \to e) \circ e$. Due to the strict category-to-type correspondence in Categorial Grammar, the category of *Sue*$_F$ has to display the same structure. Which category would be adequate here? To answer this question, let us chose another perspective. The focus morpheme has two functions: it moves the meaning of the focused constituent to a store, and it replaces it with a hypothetical assumption. To bring this home in the present framework, we assume that both the store content and the hypothetical assumption(s) are marked by modalities. More concretely, we extend the system with two more modalities, $\triangle$ and ∇, where moving a sign of category A to the focus store results in a sign of category $\triangle A$, and a hypothetical assumption which replaces an A has category ∇A. Since the semantic type corresponding to a product type is always a structured meaning, we can employ the product connective to connect the background part and the focus part. So the syntactic category of *Sue*$_F$ is $(N/\nabla N) \bullet \triangle N$. For simplicity's sake, I will treat the focus morpheme as a proclitic here. In the example, it then takes an N-argument from the right and returns an $(N/\nabla N) \bullet \triangle N$, so it should be assigned the category $((N/\nabla N) \bullet \triangle N)/N$ and the meaning $\lambda x.\langle \lambda y.y, x\rangle$ (the category of the focus morpheme in general is polymorphic

[5] Since Krifka uses a phrase structure grammar, he is forced to assign the type quantifier to proper nouns, which in turn complicates the definition of comparability of alternatives. Due to the flexibility of Categorial Grammar, we can avoid this "generalization to the worst case".

since not only names can be focused). More generally, a constituent of category A that contains a focused name will have the category $(A/\nabla N) \bullet \triangle N$. I will abbreviate this with A_N.

To combine *Sue*$_F$ with *meet*, we function compose the meaning of the verb with the background part of its object and pass the content of the focus store unchanged. The result is $\langle \lambda y.\textit{meet'}y, s' \rangle$. More generally, both ingredients introduced by focus can percolate up to larger constituents in a derivation. In other words, the following inference rule "Focus Percolation" should be valid:

(16) $$\frac{X, x : A, Y \Rightarrow t : B}{X, y : A_C, Y \Rightarrow \langle \lambda z.t_{[((y)_0 z)/x]}, (y)_1 \rangle : B_C}\,[\mathrm{FP}]$$

This rule becomes derivable if we assume that both modalities have restricted access to permutation,which is captured by the following two structural rules:

(17) a. $$\frac{X, x : A, y : \triangle B, Y \Rightarrow t : C}{X, y : \triangle B, x : A, Y \Rightarrow t : C}\,[\mathrm{P}\triangle]$$

b. $$\frac{X, x : \nabla A, y : B, Y \Rightarrow t : C}{X, y : B, x : \nabla B, Y \Rightarrow t : C}\,[\mathrm{P}\nabla]$$

Since a transitive verb (category $N \setminus S/N$) and a name can combine to form a VP (category $N \setminus S$) via function application, in the presence of the above rule, *met* and *Sue*$_F$ can combine to a sign of category $(N \setminus S)_N$ with the meaning given above.

Focus sensitive operators like *only* take a structured meaning as an argument and return an un-structured meaning. In our example, *only met Sue*$_F$ is a VP and accordingly denotes a property which — since the lexical semantics of *only* is not at issue here — I will simply represent with *only'*$\langle \lambda y.\textit{meet'}y, s' \rangle$. So the category of *only* is $(N \setminus S)/(N \setminus S)_N$ (again, lexical assignment is polymorphic since *only* can be associated with foci of different categories). This VP can finally be combined with the subject via function application, yielding finally the sentence meaning *only'*$\langle \lambda y.\textit{meet'}y, s' \rangle$*j'*.

To deal with cases of multiple focus as in

(18) John only introduced BILL to SUE

Krifka assumes that two foci originating from different constituents can be merged. The corresponding inference rule is

(19)

$$\frac{x : A, y : B \Rightarrow t : B}{z : A_D, w : B_E \Rightarrow \langle \lambda v.t_{[((z)_0 v_0)/x, ((w)_0 (v)_1)/y]}, \langle (z)_1, (w)_1 \rangle \rangle : B_{(D \bullet E)}}\,[\mathrm{M}]$$

For reasons of space, I refer the reader to Krifka's paper for discussion. In our multi-modal setting, this rule becomes derivable if we extend the grammar logic with the following two axioms:

(20) a. $\triangle A \bullet \triangle B \Rightarrow \triangle(A \bullet B)$
b. $\nabla(A \bullet B) \Rightarrow \nabla A \bullet \nabla B$

Finally it deserves to be stressed that the same constituent can be focused more than once, and that the result will be a recursively structured meaning. This is important for the analysis of (4). Here two focus morphemes are attached to the object *water*. This gives rise to the category $(N_N)_N$ and the doubly structured meaning $\langle \lambda x.\langle \lambda y.y, x\rangle, \textit{wt'}\rangle$. *Only* decreases the embedding depth by one; so the meaning of *only drank water* here is a simply structured meaning, which serves as argument for *even*, and this returns the un-structured *even'*$\langle \lambda x.$*only'*$\langle$*drink'*$, x\rangle, \textit{wt'}\rangle$.

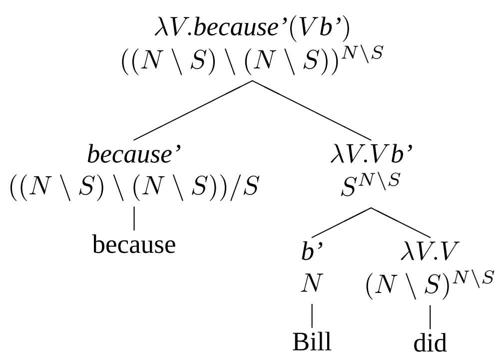
6. The interaction of the modules

Now let us return to our original example (2), repeated here in slightly modified form in (21).

(21) John only went to Tanglewood$_F$ because Bill did.

By employing Percolation (11) together with function application, we can derive the embedded clause to be a VP modifier which looks for a VP antecedent:

(22) a. because Bill did.
b.



By means of the mechanisms described in the last section, we get the following derivation for the embedded VP:

(23) a. went to Tanglewood$_F$

b. $\langle \lambda y.\textit{went'}y, \textit{t'} \rangle$
$(N \setminus S)_N$

$\textit{went'}$ $N \setminus S/PP$ — went

$\langle \lambda y.y, \textit{t'} \rangle$ PP_N

$\lambda x.x$ PP/N — to

$\langle \lambda y.y, \textit{t'} \rangle$ N_N

$\lambda x.\langle \lambda y.y, x \rangle$ N_N/N — $+F$

$\textit{t'}$ N — Tanglewood

Every VP (category $N \setminus S$) can combine with a VP modifier (category $(N \setminus S) \setminus (N \setminus S)$) to a VP via function application. According to the "Bind" rule (13), we get the following local derivation with an arbitrary hypothetical VP:

(24) a. VP because Bill did

b. $\textit{because'}(V\textit{b'})V$
$N \setminus S$

V $N \setminus S$

$\lambda P.\textit{because'}(P\textit{b'})$ $((N \setminus S) \setminus (N \setminus S))^{N \setminus S}$ — because Bill did

From this and the rule of "Focus Percolation" it follows that *went to Tanglewood*$_F$ and *because Bill did* can combine in the following way:

(25) $\langle \lambda y.\textit{because'}(\textit{went'}y\textit{b'})(\textit{went'}y), \textit{t'} \rangle$
$(N \setminus S)_N$

$\langle \lambda y.\textit{went'}y, \textit{t'} \rangle$ $(N \setminus S)_N$ — went to Tanglewood$_F$

$\lambda V.\textit{because'}(V\textit{b'})$ $((N \setminus S) \setminus (N \setminus S))^{N \setminus S}$ — because Bill did

The result can be combined with *only* and with *John* via functional application and yields the correct reading:

(26) *only'*$\langle\lambda y.$*because'*$($*went'*y*b'*$)($*went'*$y), $*t'*$\rangle$*j'*

Informally, this derivation can be described in the following way: focusing has the effect of putting the content of *Tanglewood* on a stack and replacing it with a hypothetical assumption. The ellipsis resolution module operates on the background meaning of the antecedent VP *went to Tanglewood*, which contains this hypothesis. Ellipsis resolution hence has the effect of duplicating the background of the antecedent VP, including the assumption. This gives the effect of having two occurrences of the same variable. The focus sensitive operator *only* discharges the hypothetical assumption and simultaneously empties the focus stack. In sum, the effect of binding of multiple occurrences of a variable has been achieved by the interplay of the structured meaning approach to focus with the modeling of ellipsis resolution by means of Contraction.

This depends crucially on the fact that focusing is done prior to ellipsis resolution, and so it might be expected that reversing this order would result in the (impossible) multiple-focus reading. This derivation is blocked in the present analysis, however. To see why, observe that the category assignment $(N \setminus S)^{N \setminus S}$ to the VP anaphor *does* puts constraints on what may serve as an antecedent. Only a constituent from which category $N \setminus S$ can be derived can serve for this purpose.[6] This means that a VP containing a nominal focus like *went to Tanglewood*$_F$ cannot antecede *does*, since it has category $(N \setminus S)_N$, and

(27) $(N \setminus S)_N \Rightarrow N \setminus S$

is not a valid sequent. Hence the derivation given above is — up to spurious ambiguities — the only one possible (provided the ellipsis has a sentence internal antecedent).

7. Conclusion and further research

This paper was intended mainly to illustrate two methodological points. First, it aimed to show that a surface compositional and variable free interpretation of ellipsis is possible also in non-trivial constructions like the interaction between VP ellipsis and focus. Second, it tried to demonstrate that the deductive

[6]The antecedent need not have this category itself. A prime example is

(i) John washed his car, and Bill did too

Here the constituent *washed his car* has category $(N \setminus S)^N$, i.e. a VP containing an unresolved pronoun. Since

(ii) $x : (N \setminus S)^N \Rightarrow \lambda y.xyy : N \setminus S$

is valid, this constituent can serve as antecedent of *did*, resulting in the sloppy reading of the sentence.

account to grammar that Type Logical Grammar is based on provides an adequate framework for integrating several proposals for a variable free semantics. The *tertium comparationis* is the fact that phenomena which motivate the use of variables — movement, anaphora, focus etc. — are uniformly formalized as involving hypothetical assumptions, while variable binding is re-analyzed as discharging of hypotheses. Modal operators serve to distinguish different instances of this general pattern.

Let me conclude with mentioning two features of the present proposal that deserve attention in further research. Although I remained as close as possible to Krifka's original proposal in the treatment of focus, the transfer from a phrase structure grammar to a categorial grammar has empirical impact. In the latter framework, the notion of a constituent is much more flexible, and accordingly, not only constituents in the traditional sense can be subject to focus assignment. This is certainly desirable — in fact, Steedman (1991) uses examples similar to the following as a major argument against the standard notion of constituency.

(28) I only claim that [MANY PEOPLE BELIEVE]$_F$ that Smith can solve the problem. I don't say that he really can.

On the other hand, since in the standard Lambek Grammar any substring of a sentence can be a constituent, this certainly leads to over-generation. This observation is in line with the current trend in Type Logical Grammar to explore calculi that re-impose hierarchical structure without assuming rigid tree structures. Motivation for this move comes from syntactic island constraints (cf. Morrill (1994)) and intonation structure (cf. Morrill (1994), Hendriks (1997)). It remains to be seen whether the different arguments in favor of cautious constituency will eventually coincide.

Finally it has to be mentioned that it is certainly an oversimplification to treat ellipsis and focus as two independent modules that only interact in quite marginal constructions. Quite the contrary, it is almost a commonplace wisdom that focus structure, intonation and ellipsis are intimately connected. Future research has to show how exactly this connection can be spelled out in a type logical perspective.

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