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Focus and Presupposition in Dynamic Interpretation

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Abstract

Structured meanings have evolved as a well-suited tool to describe the semantics of focus constructions (cf. von Stechow 1990; Jacobs 1991; Krifka 1992). In this paper, I will show how structured meanings can be combined with a framework of dynamic interpretation that allows for a cogent expression of anaphoric relations and presuppositions. I will concentrate in particular on the semantics of the focusing particle *only* and discuss several phenomena that have gone unnoticed or unsolved so far, for example the introduction of discourse markers in the scope of *only* and alternatives that are anaphorically related to quantifiers. In particular, I will show that the proposed representation format can handle sentences with multiple occurrences of focusing particles. The paper also includes a discussion of the behavior of negation with respect to presuppositions, and of principles that govern the interpretation of focus on quantified NPs.

1 INTRODUCTION

This paper is a sequel to Krifka (1992a), where a semantic framework was developed to handle expressions with focusing operators, including complex cases with multiple focusing operators. There I elaborated on a representation format developed independently by von Stechow and Jacobs—structured meanings—and showed how the construction in question can have a compositional treatment. However, I suppressed the fact that focusing operators typically introduce presuppositions, and treated all semantic contributions of an operator as assertional. In this paper I show that structured meanings can be combined with a representation format that can express the distinction between assertions and presuppositions as well as anaphoric relations.[1]

2 FOCUS-BACKGROUND STRUCTURES

One of the basic assumptions of formal semantics for natural language is that interpretation is compositional, that is, the meaning of a complex expression $[\![\phi\psi]\!]$ is given in terms of the meanings of its immediate syntactic parts, $[\![\phi]\!]$ and

$[\![\psi]\!]$. There is an interesting set of constructions that potentially challenge this assumption, namely, focus-sensitive operators. Take *only* in the following examples, where capitalization symbolizes phonological stress.

(1) a. John only kissed MARY.
b. John only KISSED Mary.

In both cases the phrase structure is arguably the same; *only* forms a constituent with the verb phrase *kissed Mary*. However, the meaning of the sentences, and hence the meanings of the complex verb phrases containing *only*, clearly differ: (a) has a reading (i) saying that the only person John kissed was Mary, and a reading (ii) saying that the only thing John did was kiss Mary. (b), in contrast, has a reading saying that the only thing John did to Mary was that he kissed her. Obviously, the stress location plays a role in these different readings. When we adhere to the principle of compositionality, and furthermore agree that the syntactic structures of (a) and (b) are essentially the same, then we must accept that the meanings of *kissed MARY* and *KISSED Mary* are different.

There are several ways to express this meaning difference. Here, I will assume that stress marks that certain constituents are in focus, and that this focus marking induces a partition of semantic material into a 'focus' part and a 'background' part. This analysis, which has its roots in Jackendoff (1972: chapter 6) and Dahl (1974), was developed by Jacobs (1983, 1991) and von Stechow (1982). See von Stechow (1990) for a comparison with an alternative approach, Rooth (1985, 1992).

Stress on *Mary* in our example either means that the object NP is in focus or that the whole VP, *kissed Mary*, is in focus (see von Stechow & Uhmann 1986 and Jacobs 1991 for the ambiguities of stress marking). Stress on *kissed* means that the verb is in focus (or, alternatively, just the past tense morpheme, a possibility that is not dealt with here). We can see focus as a feature that marks a constituent and we can assume that the different readings of (1) are due to the position in which that feature appears. The semantic effect of the focus feature is that it introduces a split of the semantic representation into a background part and a focus part. As this split is different for the interpretations of (1a, b), the meanings of the verb phrases will differ. Many expressions will disregard the focus-background split, but operators like *only* are sensitive to it and will produce different results when combined with expressions that differ in their background-focus articulation.

In Krifka (1992a) I developed a framework in which the creation, propagation and utilization of background-focus structures are formally captured. Background-focus structures are represented as pairs of semantic representations $\langle B, F\rangle$, where B can be applied to F, yielding the standard representation B(F). The semantic contribution of focus is to create such structures by putting the semantic representation of the constituent with focus feature into the focus position and an identity function for entities that are of the type of the focus into the background position. If a background-focus structure $\langle B, F\rangle$ is combined with a semantic representation A that would normally be combined with the standard meaning B(F), then the background-focus structure is propagated. More specifically, if the semantic combination rule calls for a functional application of A to $\langle B, F\rangle$, then the result will be $\langle \lambda X[A(B(X))], F\rangle$, and if it calls for a functional application of $\langle B, F\rangle$ to A, then the result will be $\langle \lambda X[B(X)(A)], F\rangle$. This ensures that the focus constituent remains identifiable even in larger semantic representations. A focus-sensitive operator then takes background-focus structures as arguments and, using the additional structure they provide, yields a standard expression.

To see how things work let us have a look at the treatment of one reading of example (1a). Here, I use x and y as variables standing for individuals, s as a variable for situations (which are considered to be a special sort of individuals), and t as a variable for tuples of individuals of arbitrary length, including length 0 (this simplifies certain semantic rules). P is a predicate over tuples of individuals, T is a second-order predicate variable, and S is a variable over structured meanings. I specify both the syntactic structure and the incremental semantic representation in one tree. Capital letters in brackets, like [A], will be used as abbreviations. Subscript F stands for a focus feature.

(2) Mary, $\lambda P \lambda t.P(t\mathbf{m})$, = [A]

$[\text{Mary}]_F$, $\langle \lambda T.T, [A]\rangle$

kiss, $\lambda sxy.\mathbf{kiss}(sxy)$, = [B]

kiss $[\text{Mary}]_F$, $\langle \lambda T.T, [A]\rangle([B])$, = $\langle \lambda T.T([B]), [A]\rangle$

Past, $\lambda P \lambda t \exists s[\mathbf{Past}(s) \wedge P(st)]$, = [C]

kissed $[\text{Mary}]_F$, $[C](\langle \lambda T.T([B]), [A]\rangle)$, = $\langle \lambda T.[C](T([B])), [A]\rangle$

only, $\lambda S.\mathbf{only}(S)$

only kissed $[\text{Mary}]_F$, $\mathbf{only}(\langle \lambda T.[C](T([B])), [A]\rangle)$

Let us assume that **only**, applied to a background-focus structure, indicates that the background applies to the focus, and that there is no alternative to the focus such that the background applies to it. Let ALT be a function that maps a representation F to the set of its alternatives, ALT(F). The alternative set contains representations of the same type as F and typically is contextually restricted, and the focus content F itself is an element of ALT(F). The alternatives are context-dependent; in the case at hand, we may be talking about a specific set of persons. Furthermore, the alternatives depend on the background (cf. Jacobs 1983); this is suppressed in the current notation. The elements of the alternative set are partially ordered, and **only** excludes just those alternatives that do not rank lower than the focus itself. For example, a predicate like *only kissed* [*Mary and Sue*]$_F$ does not exclude that Mary was kissed. I will write $ALT_{\npreceq}$ (F) for the set of alternatives to F that do not rank lower than F itself. Then the following meaning rule holds for **only** as an operator on verbal predicates:

(3) $\mathbf{only}(\langle B, F\rangle) = \lambda t[B(F)(t) \wedge \neg\exists T[T \in ALT_{\npreceq}(F) \wedge B(T)(t)]]$

When we spell out **only** in (2) along these lines, we obtain the following result:

(4) $\mathbf{only}\ (\langle \lambda T.[C](T([B])), [A]\rangle)$
$= \lambda t[[C]([A]([B]))(t) \wedge \neg\exists T[T \in ALT_{\npreceq}([A]) \wedge [C](T([B]))(t)]]$
$= \lambda t[[C](\lambda P\lambda tP(\mathbf{tm})(\lambda sxy.\mathbf{kiss}(sxy)))(t) \wedge \ldots]$
$= \lambda t[[C](\lambda sx.\mathbf{kiss}(sx\mathbf{m}))(t) \wedge \ldots]$
$= \lambda t[\lambda P\lambda t\,\exists\, s[\mathbf{Past}(s) \wedge P(st)](\lambda sx.\mathbf{kiss}(sx\mathbf{m}))(t) \wedge \ldots]$
$= \lambda t[\lambda x\,\exists\, s[\mathbf{Past}(s) \wedge \mathbf{kiss}(sx\mathbf{m})](t) \wedge \ldots]$
$= \lambda x[\exists s[\mathbf{Past}(s) \wedge \mathbf{kiss}(sx\mathbf{m}) \wedge \neg\exists T[T \in ALT_{\npreceq}([A]) \wedge [C](T([B]))(x)]]$

This predicate applies to entities x such that there was a past event s in which x kissed Mary, and there is no proper alternative T to [A], the quantifier that corresponds to Mary, such that there was an event s in which x kissed T.

This representation expresses the intended meaning only if the alternative set contains the right kind of objects. In particular, it cannot contain just any quantifier, as a predicate like *only kiss* [*Mary*]$_F$ does not exclude that a predicate like *kiss a woman* yields a true sentence as well. Here I will assume that the set of alternatives of a quantifier that is generated by an individual (a so-called 'maximal ultrafilter') are again quantifiers that are generated by an individual. That is, whenever we have it that $T \in ALT(\lambda P\lambda t.P(tx))$, for some x, then T can be given by $\lambda P\lambda t.P(ty)$, where y denotes some individual. This allows us to reduce the above description as follows:

$= \lambda x[\exists s[\mathbf{Past}(s) \wedge \mathbf{kiss}(sx\mathbf{m})] \wedge$
$\qquad \neg\exists y[y \in ALT_{\npreceq}(\mathbf{m}) \wedge \exists s[\mathbf{Past}(s) \wedge \mathbf{kiss}(sxy)]]], = [D]$

When we apply this predicate to an argument, like j (for John), we arrive at a semantic representation which states that there was a situation s in the past such that John kissed Mary in s, and there is no proper alternative y to Mary such that there is a situation s in the past where John kissed y in s.

With focus on *kissed*, we would have arrived at the following result:

(5) John only [kissed]$_F$ Mary
$\mathbf{only}(\langle\lambda R\,\exists s[\mathbf{Past}(s) \wedge R(sjm)], \mathbf{kiss}\rangle)$
$\exists s[\mathbf{Past}(s) \wedge \mathbf{kiss}(s\mathbf{jm})] \wedge$
$\neg\exists R[R \in ALT_{\npreceq}(\mathbf{kiss}) \wedge \exists s[\mathbf{Past}(s) \wedge R(s\mathbf{jm})]]$

That is, there was a situation s in the past such that John kissed Mary in s, and there is no alternative R to kissing such that there is a situation in the past where John R'ed Mary. Note that R has to be suitable restricted by ALT(**kiss**), for example to predicates denoting types of amiable bodily contact. And again the ranking may play a role; for example, as every kissing involves touching, the predicate **touch** should not be considered an element of $ALT_{\npreceq}$ (**kiss**).

Finally, with focus on *kissed Mary* we would get the following interpretation, assuming that focusation takes place before the binding of the situation variable:

(6) John only [kissed Mary]$_F$
$\mathbf{only}(\langle\lambda P\exists s[\mathbf{Past}(s) \wedge P(sj)], \lambda sx[\mathbf{kiss}(sx\mathbf{m})]\rangle)$
$= \exists s[\mathbf{Past}(s) \wedge \mathbf{kiss}(s\mathbf{jm})] \wedge$
$\neg\exists P[P \in ALT_{\npreceq}(\lambda sx[\mathbf{kiss}(sx\mathbf{m})]) \wedge \exists s[\mathbf{Past}(s) \wedge P(sj)]]$

That is, John kissed Mary, and there is no alternative P to kissing Mary such that John performed it. Again, P has to be suitably restricted, for example to social activities of a certain kind.

The representation is flexible enough to treat sentences with multiple focus, like the following ones where the relation between focusing operators and focus is indicated:

(7) a. Even [John]$_F$ only kissed [Mary]$_F$

b. John even [only kissed [Mary]$_F$]$_F$

c. John even [only]$_F$ kissed [Mary]$_F$

See Krifka (1992a) and below, section 9, for details concerning these analyses.

3 FOCUS ON NOUN PHRASES

So far we have looked only at one type of NPs in focus, namely names. They are particularly simple, as they can be analyzed as being of type e. However, we also may focus on indefinite NPs and certain quantified NPs, which have to be analyzed as being of a higher type:

(8) a. John only ate [an apple]$_F$.
b. John only ate [every apple]$_F$.

The issue of focus on NPs, including quantificational NPs, has not been addressed in sufficient detail so far. Above, as well as in Krifka (1992a), I have assumed that NPs of the type of second-order predicates, type ⟨⟨e, t⟩, t⟩, can be focused, and that the function ALT would reduce things to type e in case of names. It is unclear, however, how the alternative sets of indefinite NPs or quantified NPs should be construed.

Let us first discuss indefinite NPs. It seems that sentences like (8a) can be interpreted in two ways:

(8) a′. What John ate was only an apple and nothing more substantial.
a″. There is an apple x which John ate, and John didn't eat anything but x.

Reading (a′) can be generated by focusing on the quantifier *an apple*. We have to retrieve the generating predicate, *apple*, from this quantifier, and take as alternatives those existential quantifiers that are generated by predicates that rank higher than *apple* on some order, e.g. because they denote entities that are more nutritious, more expensive, more damaging to one's health, etc. Note that we cannot simply assume that the noun *apple* is focused in this reading, as the number indicated by the definite article may play a role in determining the alternatives: for example, the properties 'two apples', or 'one apple and one pear', may count as alternatives.

For reading (a″), on the other hand, we are concerned just with the alternatives of x itself; x is treated as if it were a name. One plausible analysis of this case is that the indefinite NP is analyzed as having wide scope, and that the focus is on the trace left behind:[2]

(8′) a′. John only $_1$ ate [an apple]$_F$
a″. an apple$_i$ [John only ate [e$_i$]$_F$]

What about the readings of (8b)? There are two candidates to consider:

(8) b′. John ate every apple, and John didn't eat anything else.
c. John ate every apple, and there is no P other than 'apple' such that John ate every P.

I think that (8b′) is the prominent reading of (8b), with focus on the NP *every apple*, and that (8c) results from a narrow focus on the noun *apple*. Note that focus on *every apple* and focus on *apple* itself are phonologically indistinguishable, as in both cases the main noun will receive focal stress. Reading (8b′) is captured by the structure (8′b′), whereas reading (8c) is due to a different focus assignment, (8′c):

(8′) b′. John only ate [every apple]$_F$.
c. John only ate every [apple]$_F$.

We may ask whether we also should assume a structure in which the quantifier has wide scope, similar to the indefinite NP in (8a″). The underlying structure would be as follows:

(8′) b′. every apple$_i$ [John only ate [e$_i$]$_F$]

I would like to argue that this reading indeed exists, but that it is contradictory as soon as there is more than one apple in our model, and hence is irrelevant. It says that if e$_i$ is instantiated by some apple, then we arrive at the fact that *John only ate* [*e*$_i$] is true, that is, John ate this apple and nothing else. This reading excludes that John ate other apples, and in particular that he ate every apple if there were more than one apple in the domain.

Now the task is to provide a general rule as to how alternatives of focused NPs can be constructed. To illustrate the problem, let us look at the following three sentences:

(9) a. John only kissed [Mary]$_F$.
b. John only ate [an apple]$_F$.
c. John only ate [every apple]$_F$.

Sentence (9a) could not be denied by pointing out that John also kissed *a woman* (namely, Mary). Similarly, (9b) cannot be denied by saying that John also ate *a fruit*, or *a green apple*, and (9c) cannot be denied by saying that John also ate *an apple*, or *every green apple*. These NP meanings obviously should not count as proper alternatives to *Mary*, *an apple* and *every apple*, respectively.

We have to find rules that allow us to construct the right alternatives for NP meanings. The following principles will give us the intuitively adequate results:

(a) If a term T denotes a filter, that is, a set of sets $\{X | P \subseteq X\}$, then the elements in the set of alternatives ALT(T) denote filters, too. The filter-terms include names and universal quantifiers; for example, *Mary* is represented by $\{X | \{\mathbf{m}\} \subseteq X\}$, and *every apple* as $\{X | \mathbf{apple} \subseteq \mathbf{X}\}$. Note that this rule is a generalization of the rule for names given in the previous section.

(b) If a term T is indefinite, that is, denotes a set of sets $\{X | P \cap X \neq \emptyset\}$, then the elements in the set of alternatives ALT(T) are indefinites as well.

Note that we can determine whether a determiner T belongs to the filters or to the indefinites: if $\cap[\![T]\!] = P$, where $P \neq \emptyset$, and for all X with $P \subseteq X$, $X \in [\![T]\!]$, then T is a filter. If T is not a filter, but there is a minimal set P, where $P \neq \emptyset$, such that for all $X \in [\![T]\!]$, $X \cap P \neq \emptyset$, then T is indefinite. The condition that T is not a filter excludes names, and the condition that $X \cap P \neq \emptyset$ excludes negative terms, such as *no apple*.

(c) The set of proper alternatives $ALT_{\nsubseteq}(T)$ is defined as $\{T' \in ALT(T) | T \nsubseteq T'\}$. That is, if a term T includes in its meaning the term T′, then T′ cannot be a proper alternative of T.

The following examples should illustrate how principles (a), (b) and (c) work:

(10) a. $ALT_{\preccurlyeq}$ [[*John*]]
includes [[*Mary*]], [[*every boy*]], excludes [[*a boy*]], [[*no girl*]] (a).
b. $ALT_{\preccurlyeq}$ [[*a boy*]]
includes [[*a girl*]],
excludes [[*John*]], [[*every boy*]], [[*no girl*]] (b), [[*a person*]] (c).
c. $ALT_{\preccurlyeq}$ [[*every boy*]]
includes [[*Mary*]], [[*every girl*]], [[*every person*]],
excludes [[*a boy*]], [[*no girl*]] (a), [[*every tall boy*]] (c).

With these principles we will get the readings discussed above. For the case of indefinites one should keep in mind that for the more prominent reading (8′a″), where the focus is on a variable, we should expect a filter behavior, as focus is on the maximal filter related to the variable.

The rules given above give similar results as the theory of Lerner & Zimmermann (1983), which is based on German data. However, I do not follow their assumption that focus on quantificational NPs is impossible, and that the relevant cases have to be analyzed as focus on the head noun of a quantified NP. Sentences like the following one are perfectly possible and preclude an analysis in terms of noun focus:

(11) John even ate [everything]$_F$

Summarizing this section, it seems possible that quantificational NPs are focused. I have specified the principles that help to determine the alternative sets in two important cases, namely focus on NPs with the filter property, and focus on indefinite NPs. It seems that focus on other NPs is impossible, like focus on negative quantifiers.[3]

4 PROBLEMS WITH ANAPHORIC RELATIONS AND PRESUPPOSITIONS

The representations I have developed here so far are deficient in certain respects: they do not allow expression of anaphoric relations, and they do not make any distinction between presuppositional and assertional material.

As for anaphoric relations, we should be able to take care of examples like the following ones:

(12) Every girl$_i$ only liked [her$_i$ own painting]$_F$
(13) – Did every gentleman talk to his left partner and to his right partner?
– Every gentleman$_i$ only talked to [his$_i$ left partner]$_F$.

In (12), the focus contains an possessive pronoun, *her*, that is anaphorically related to a quantifier, *every girl*. In (13), the alternatives are dependent on the preceding quantifier; for different choices i for a gentleman, we will get i's left partner and i's right partner as alternatives.

Of course there are theories around that do a good job in treating anaphoric relationships—Discourse Representation Theory (Kamp 1981), File Change Semantics (Heim 1982), or some other model of Dynamic Interpretation (e.g. Groenendijk & Stokhof 1990, 1991). However, we will have to check whether we can combine them with the background-focus structures that I have assumed for the treatment of focus information.

As for the presupposition/assertion distinction, it is well known since the work of Horn (1969) that this distinction is crucial for the adequate semantic analysis of particles like *even* and *only*. We have the following situation, illustrated with simple examples:

(14) a. John only kissed [Mary]$_F$
Assertion: John didn't kiss anyone else.
Presupposition: John kissed Mary.
b. John even kissed [Mary]$_F$
Assertion: John kissed Mary.
Presupposition: It was more likely that John kissed someone else.

The known tests for presuppositions (cf. e.g. van der Sandt 1988) verify this analysis. For example, a text where the assertion is followed by the presupposition is pragmatically deviant, in contrast to a text where the presupposition precedes the assertion:

(15) a. John kissed Mary, and he only kissed HER.
b. *John only kissed MARY, and he kissed her.
(16) a. *John even kissed MARY, although it was unlikely that he would have kissed her, out of all people.
b. It was unlikely that John would have kissed Mary out of all people, but he even kissed HER.

Furthermore, the presupposition survives under negation and the possibility operator:

(17) a. It is not the case that John only kissed Mary.
It is possible that John only kissed Mary.
(entails that John kissed Mary)
b. It is not the case that John even kissed Mary.
It is possible that John even kissed Mary.
(entails that Mary was an unlikely person for John to kiss).

Anaphoric reference and presuppositions interact in interesting ways. We find cases where discourse referents seem to be introduced within the presupposition of a sentence:

(18) John only met [a woman]$_{i,F}$. She$_i$ was pretty.

If the first sentence has the presupposition that John met a woman, and asserts that John didn't meet anyone else, then it seems that the presupposition part is responsible for creating a discourse entity for that woman that can be referred to later pronouns.

In Krifka (1992b) I have proposed a way to combine background-focus structures with dynamic interpretation. In this article I will in addition deal with the distinction between presuppositions and assertions. We will see that dynamic interpretation is an appropriate setting for a theory of presupposition, which has been argued for by Stalnaker (1974), Karttunen (1974), Heim (1983a) and most recently Beaver (1992).

For example, certain problems with a static representation of presuppositions are eliminated as soon as we change to a dynamic framework. One such problem is that we must allow for variable bindings across presuppositions and assertion. Any theory that treats these two meaning components as independent, like Karttunen & Peters (1979), faces problems with sentences like the following one:

(19) A man only kissed [Mary]$_F$
Presupposition: $\exists x[\mathbf{man}(x) \wedge \mathbf{kissed}(x, \mathbf{m})]$
Assertion: $\exists x[\mathbf{man}(x) \wedge \neg\exists y[y \in \mathrm{ALT}_{\leqslant}(\mathbf{m}) \wedge \mathbf{kissed}(x, y)]]$

In a two-level representation, we would arrive at the indicated analysis. But this certainly doesn't capture the meaning of (19): it presupposes that some man kissed Mary, and it asserts that some man (possibly another one) kissed no other person than Mary. Karttunen & Peters (1979) acknowledged this as a serious problem, and Beaver (1992) showed how it can be eliminated within dynamic interpretation.

5 DYNAMIC INTERPRETATION AND PRESUPPOSITIONS

In this section I will introduce a framework for dynamic interpretation and show that it allows for a straightforward treatment of presuppositions. The framework is most closely related to Heim (1982: chapter III), Heim (1983b), and Rooth (1987). The treatment of presuppositions follows Beaver (1992) in certain respects.

Let us assume that A is a universe of discourse, W is a set of possible worlds, D is a countable set of discourse markers (I take D to be the set of natural numbers), and G is the set of discourse marker assignments, that is, the set of partial functions from D to A. If α is a constant of the semantic representation language, then α_w should denote the extension of α with respect to world w. I will use w, u, v as variables over possible worlds, and g, h, k, f as variables over assignments.

I will use the following notations to talk about assignments. If $g \in G$ and $d \in \mathrm{Dom}(g)$, I will write g_d for g(d). If g, $h \in G$, then I will write $g \leqslant h$ iff $\mathrm{Dom}(g) \subseteq \mathrm{Dom}(h)$ and g = h restricted to g; that is, g and h are identical for their shared domain, and h is an extension of g. If $x \in A$, $d \in D$, we will write $g \leqslant_{d/x} h$ for $h = g \cup \{\langle d, x\rangle\}$, provided that $d \notin \mathrm{Dom}(g)$; that is, h extends g in so far as it maps d to x. I will write $g \leqslant_d h$ iff there is an $x \in A$ such that $g \leqslant_{d/x} h$. This notation is recursive; for example, I will write $g \leqslant_{d,d'} h$ iff there are x, $y \in A$ and a k such that $g \leqslant_{d/x} k$ and $k \leqslant_{d'/y} h$.

An information state σ is a set of world-assignment pairs {wg|. . .}. The world component w captures the factual information, whereas the assignment component g captures the accessible discourse markers. Sentences, and in general texts, are interpreted as functions from information states to information states, or from 'input states' to 'output states'. In this paper, such functions are rendered by expressions of the form $\lambda\sigma.\{wg|\ldots\}$, where σ is used as state variable.

Instead of giving a fragment with explicit interpretation rules, I will work through an example that illustrates the intended semantic rules.

(20) a man arrived.

arrive, $\lambda sx\lambda\sigma.\{wg \in \sigma | \mathbf{arrive}_w(sx)\}$, = [A]

a$_1$, $\lambda Q\lambda P\lambda t\lambda\sigma.\{wg | \exists x[wg \in P(tx)(Q(x)\{uh | \exists k[uk \in \sigma \wedge k \leqslant_{1/x} h]\})]\}$, = [B]

man, $\lambda x\lambda\sigma.\{wg \in \sigma | \mathbf{man}_w(x)\}$, = [C]

a$_1$ man, [B]([C]),
$\lambda P\lambda t\lambda\sigma.\{wg | \exists x[wg \in P(tx)(\{uh | \exists k[uk \in \sigma \wedge k \leqslant_{1/x} h \wedge \mathbf{man}_u(x)]\})]\}$, = [D]

a$_1$ man arrive, [D]([A])
$\lambda t\lambda\sigma.\{wg | \exists x[wg \in [A](tx)(\{uh | \exists k[uk \in \sigma \wedge k \leqslant_{1/x} h \wedge \mathbf{man}_u(x)]\})]\}$
$= \lambda s\lambda\sigma.\{wg | \exists h[wh \in \sigma \wedge h \leqslant_1 g \wedge \mathbf{man}_w(g_1) \wedge \mathbf{arrive}_w(sg_1)]\}$, = [E]

Past$_2$,
$\lambda P\lambda t\lambda\sigma.\{wg | \exists s[wg \in P(st)(\{uh | \exists k[uk \in \sigma \wedge k \leqslant_{2/s} h \wedge \mathbf{Past}_u(s)]\})]\}$. = [F]

a$_1$ man arrived$_2$, [F]([E])
$= \lambda\sigma.\{wg | \exists h[wh \in \sigma \wedge h \leqslant_{1,2} g \wedge \mathbf{man}_w(g_1) \wedge \mathbf{arrive}_w(g_2 g_1) \wedge \mathbf{Past}_w(g_2)]\}$. = [G]

This example illustrates that indefinite NPs introduce new discourse markers. Episodic predicates behave similar to indefinite NPs in so far as they also introduce a new discourse marker, which is anchored to a situation. This discourse marker is related to the tense operator, and may be identified with the category I^0 of extended X-bar theory. Note that in both cases I assume that the information as to which discourse marker is introduced is derived from some syntactic index. However, we could set up things in such a way that indefinites and episodic verbs take the next available discourse marker that is not in the domain of the input state; note that this rule will pick out a uniquely determined discourse marker, as the set of discourse markers is countable.

The next example illustrates the treatment of anaphoric expressions and presuppositions. Anaphoric expressions, like pronouns or temporal anaphora, pick up a discourse marker that is already in the domain of the input state. Normal pronouns simply refer to such an accessible discourse marker; possessive pronouns and episodic verbs that are temporally related to preceding expressions relate a new discourse marker to an existing one. For simplicity's sake, I assume that possessive pronouns are based on a relation **own**, and that the temporal relationship between two situations is expressed by a relation **TRel** (see Partee 1984 for a more detailed treatment of the temporal relationship).

Presuppositions are formulas that have to be true throughout the input state. This reconstruction of speaker's presuppositions is inspired by the work of Karttunen (1974) and Stalnaker (1974) and has been implemented by Heim (1983a) and Beaver (1992). Here I assume that presuppositions either do not change the input state at all (if they are satisfied), or they reduce it to the empty state (in case they are not satisfied). Let us have a look at one presupposition-carrying example:

(21) He_1 $\text{was}_{2,3}$ pushing $\text{his}_{1,4}$ bike.

$\text{his}_{1,4}$ bike,
$\lambda P \lambda t.\{wg \mid$
$\forall uh[uh \in \sigma \rightarrow \exists! y[\mathbf{bike}_u(y) \wedge \mathbf{own}_u(h_1 y)]] \wedge$ (Presupposition, $[H](\sigma)$)
$\exists k[wk \in \sigma \wedge k \leqslant_4 g \wedge \mathbf{bike}_w(g_4) \wedge \mathbf{own}_w(g_1 g_4) \wedge$ (Introduction DM)
$\wedge\ wg \in P(tg_4)(\sigma)]\}$ (Assertion)

push, $\lambda sxy \lambda\sigma.\{wg \in \sigma \mid \mathbf{push}_w(sxy)\}$

push $\text{his}_{1,4}$ bike, $\lambda sx \lambda\sigma.\{wg \in \sigma \mid [H](\sigma) \wedge$
$\exists k[wk \in \sigma \wedge k \leqslant_4 g \wedge \mathbf{bike}_w(g_4) \wedge \mathbf{own}_w(g_1 g_4) \wedge \mathbf{push}_w(sxg_4)]\}, = [I]$

$\text{Past}_{2,3}$ $\lambda P \lambda t\sigma.\{wg \mid \exists s[wg \in P(st)(\{vh \mid \exists k[kv \in \sigma \wedge k \leqslant_{3/s} h \wedge$
$\mathbf{Past}_v(s) \wedge \mathbf{TRel}_v(k_2 s)]\})]\}, = [J]$

$\text{was}_{2,3}$ pushing $\text{his}_{1,4}$ bike, $[J]([I])$
$\lambda t \lambda\sigma.\{wg \mid \exists s[wg \in [I](st)(\{vh \mid \exists k[kv \in \sigma \wedge k \leqslant_{3/s} h \wedge \mathbf{Past}_w(s) \wedge$
$\mathbf{TRel}_w(k_2 s)]\})]\}$
$\lambda x \lambda\sigma.\{wg \mid [H](\sigma) \wedge \exists k[wk \in \sigma \wedge k \leqslant_{3,4} g) \wedge \mathbf{Past}_w(g_3 \wedge \mathbf{TRel}_w(g_2 g_3) \wedge$
$\mathbf{bike}_w(g_4) \wedge \mathbf{own}_w(g_1 g_4) \wedge \mathbf{push}_w(g_3 x g_4)]\}$
$[K]$

he_1, $\lambda P \lambda t \lambda\sigma.\{wg \in \sigma \mid P(tg_1)(\sigma)\}$, $[L]$

he_1 $\text{was}_{2,3}$ pushing $\text{his}_{1,4}$ bike, $[L]([K])$
$\lambda\sigma.\{wg \mid [H](\sigma) \wedge \exists k[wk \in \sigma \wedge k \leqslant_{3,4} g \wedge \mathbf{Past}_w(g_3) \wedge \mathbf{TRel}_w(g_2 g_3) \wedge$
$\mathbf{bike}_w(g_4)$
$\wedge\ \mathbf{own}_w(g_1 g_4) \wedge \mathbf{push}_w(g_3 g_1 g_4)]\}$
$[M]$

The representation [M] imposes certain requirements on the input state. First, the assertional part requires that the input assignment k is defined for the indices 1 and 2, and undefined for the indices 3 and 4. Second, the presuppositional part $[H](\sigma)$ requires that for all world-assignment pairs uh in the input state σ, h_1 is defined, and there is a unique y such that $\mathbf{bike}_u(y)$ and $\mathbf{own}_u(h_1 y)$ hold. The requirements concerning the indices 1 and 2 are satisfied when we interpret [M] with respect to an output state of the representation [G] (given that its assignments are undefined for 3 and 4), as [G] explicitly introduces the indices 1 and 2 into the output assignment. To be more specific, we can combine [G] and [M] to form a text, using functional composition.

(22) A_1 man arrived_2, [G]
He_1 $\text{was}_{2,3}$ pushing $\text{his}_{1,4}$ bike
A_1 man arrived_2. He_1 $\text{was}_{2,3}$ pushing $\text{his}_{1,4}$ bike
$\lambda\sigma.[M]([G](\sigma))$,
$\lambda\sigma.\{wg \mid [H]([G](\sigma)) \wedge \exists k[wk \in [G](\sigma) \wedge k \leqslant_{3,4} g \wedge \mathbf{Past}_w(g_3) \wedge$
$\mathbf{TRel}_w(g_2 g_3) \wedge \mathbf{bike}_w(g_4) \wedge \mathbf{own}_w(g_1 g_4) \wedge \mathbf{push}_w(g_3 g_1 g_4)]\}, = [N]$

Note that for every σ for which $[G](\sigma)$ is defined, the assignments of $[G](\sigma)$ will be defined for the indices 1 and 2. Furthermore, the requirement $[H]([G](\sigma))$ ensures that [N] is defined only for those input states for which it holds that there is a unique bike that g_1 has. Note that in order to satisfy this condition, the input state σ (the input state for the whole text) must already meet certain requirements. This captures the fact that the presupposition that the man chosen by the first sentence owns a bike is projected from the second sentence to the whole text. Also, due to the universal condition on the input state introduced by *$\text{his}_{1,4}$ bike*, g_4 in [N] will pick out the bike of g_1.[4]

6 ACCOMMODATION AND NEGATION

What happens if a state σ does not satisfy the presuppositions of a sentence ϕ? Then the output state $[\![\phi]\!](\sigma)$ should be the empty set.[5] But we can understand a text like (22), even without being acquainted with the man the speaker is talking about, or his bike.

This well-known phenomenon of accommodation (cf. Stalnaker 1974; Karttunen 1974; Lewis 1979) is treated in a novel way by Beaver (1992). Instead of seeing accommodation as a revision of the input states, that is, as an essentially non-monotonic repair strategy, Beaver analyzes it as a filter on a set of input states, the 'epistemic alternatives'. This set of epistemic alternatives represents the set of information states that are compatible with the text (and perhaps the shared background information of speaker and hearer). Let us assume that a text ϕ is interpreted with respect to a set of epistemic alternatives Σ, for which we write $\Sigma[\![\phi]\!]$; then we can claim that those states in Σ that do not satisfy the presupposition of ϕ are simply filtered out. This is accomplished by the following rule for updating epistemic states:

(23) $\Sigma[\![\phi]\!] = \{[\![\phi]\!](\sigma) \mid \sigma \in \Sigma\} - \{\varnothing\}$

That is, updating a set of epistemic alternatives Σ involves updating every element in Σ, and eliminating the empty set. If a particular state σ does not satisfy the presuppositions in $[\![\phi]\!]$, then $[\![\phi]\!](\sigma)$ will be the empty set, and hence the state σ does not survive in the resulting set of epistemic alternatives. Presupposition and assertion are treated in a complementary fashion: presuppositions filter out certain states in a set of epistemic alternatives Σ, whereas assertions add information to the individual information states in Σ. Thus, accommodation of presuppositions appear as another way of conveying information, and in particular is a monotonic, restrictive operation.

Let us put this theory of accommodation to the test and see how we can treat negation as a presupposition-preserving operator in this setting. I will write NEG(ϕ) for the negation of the sentence ϕ, which will be interpreted compositionally as $[\![\mathrm{NEG}]\!]([\![\phi]\!])$. We expect the following properties of this representation. First, the presuppositions of ϕ must become presuppositions of NEG(ϕ). That is, if an input state σ does not satisfy the presupposition of ϕ then it is mapped to the empty set by NEG(ϕ). Second, if the presuppositions are satisfied then the input state σ is reduced to the set of those world-assignment pairs wg that cannot be extended to pairs wh that are in $[\![\phi]\!]$ when applied to σ. This suggests the following interpretation rule:

(24) $[\![\mathrm{NEG}]\!]([\![\phi]\!]) = \lambda\sigma\{wg \in \sigma \mid [\![\phi]\!](\sigma) \neq \varnothing \wedge \neg\exists h[wh \in [\![\phi]\!](\{wg\})]\}$

The presupposition part $[\![\phi]\!](\sigma) \neq \varnothing$ can be seen as pragmatically motivated: it must be possible to interpret ϕ with respect to σ, otherwise NEG(ϕ) would not be informative.[6] The following example illustrates our analysis:

(25) He$_1$ did$_2$ not see his$_{1,3}$ bike.

did$_2$ see his$_{1,3}$ bike.
$\lambda x\lambda\sigma.\{wg \mid$
$\quad \forall uh[uh \in \sigma \rightarrow \exists! y[\mathbf{bike}_u(y) \wedge \mathbf{own}_u(h_1 y)]$ $\qquad (=[O](\sigma))$
$\quad \wedge\, \exists k[wk \in \sigma \wedge k \leqslant_{2,3} g \wedge \mathbf{bike}_w(g_3) \wedge \mathbf{own}_w(g_1 g_3) \wedge \mathbf{see}_w(g_2 x g_3)]\}$
$\qquad [P]$

$\quad$ NEG, $\lambda P\lambda t\lambda\sigma\{wg \in \sigma \mid P(t)(\sigma) \neq \varnothing \wedge \neg\exists h[wh \in P(t)(\{wg\})]\}$, $= [Q]$

did$_2$ not see his$_{1,3}$ bike, $[Q]([P])$
$= \lambda x\lambda\sigma\{wg \in \sigma \mid [P](x)(\sigma) \neq \varnothing \wedge \neg\exists h[wh \in [P](x)(\{wg\})]\}$, $= [R]$

$\quad$ he$_1$ $\lambda P\lambda t\lambda\sigma.\{wg \in \sigma \mid P(tg_1)(\sigma)\}$, $= [S]$

He$_1$ did$_2$ not see his$_{1,3}$ bike, $[S]([R])$
$\lambda t\lambda\sigma.\{wg \in \sigma \mid [R](tg_1)(\sigma)\}$
$= \lambda\sigma\{wg \in \sigma \mid [P](g_1)(\sigma) \neq \varnothing \wedge \neg\exists h[wh \in [P](g_1)(\{wg\})]\}$
$= \lambda\sigma\{wg \in \sigma \mid$
$\quad [O](\sigma) \wedge \exists k\exists l[wk \in \sigma \wedge k \leqslant_{2,3} l \wedge \mathbf{bike}_w(l_3) \wedge \mathbf{own}_w(l_1 l_3) \wedge \mathbf{see}_w(l_2 x l_3)] \wedge$
$\quad [O](\{wg\}) \wedge \neg\exists h[g \leqslant_{2,3} h \wedge \mathbf{bike}_w(h_3) \wedge \mathbf{own}_w(h_1 h_3) \wedge \mathbf{see}_w(h_2 x h_3)]\}$

Here I have used [O] as an abbreviation for the presupposition. Assume first that the presupposition is not satisfied in σ. That is, the entity referred to by the discourse marker 1 does not own a unique bike throughout σ, which means that $[O](\sigma)$ is false. Then the set $\{wg \mid ..[O](\sigma)..\}$ will be empty and the sentence meaning will result in the empty state when applied to σ. Assume now that the presupposition is satisfied in σ, that is, $[O](\sigma)$ is true. When we apply the sentence meaning to σ, we will get that subset of σ for which it does not hold that entity 1 saw his bike. More formally, we subtract from σ those world-assignment pairs wg that would satisfy $\exists h[\mathbf{g} \leqslant_{2,3} h \wedge \mathbf{bike}_w(h_3) \wedge \mathbf{own}_w(h_1 h_3) \wedge \mathbf{see}_w(h_2 x h_3)]$. Thus, the interpretation of (25) with respect to a state σ will either reduce σ to the empty set, if the presuppositions are not satisfied, or will reduce it to the set of worlds and assignments for which the corresponding non-negated sentence does not hold. In this way the presupposition of the object NP is projected through the negation to the whole sentence.[7]

We have seen that in our reconstruction presuppositions are indeed preserved under negation. However, it is well known that negated sentences do not always preserve presuppositions (cf. Seuren 1988):

(26) It is not the case that John saw his bike. (He doesn't have one in the first place!)

Examples like (26) are typical for a situation where the speaker protests against certain presuppositions of other participants of the conversation. How should such cases be treated? We may assume two distinct types of negation. However, this is problematic, as there is hardly any evidence for that; for example, no language seems to distinguish lexically between a presupposition-preserving and a presupposition-rejecting negation.

Van der Sandt (1991) has proposed a theory of 'denial' that seems to give us what we want. The crucial part of this theory can be rephrased in our framework as follows.

Assume that at a given point in conversation, Σ is the set of epistemic alternatives shared by speaker and hearer. Now speaker A utters a statement ϕ. That is, A proposes to restrict Σ to $\Sigma[\![\phi]\!]$. At this point, speaker B has a choice: if he doesn't give any sign of protest and utters some sentence ψ, where $\Sigma[\![\phi]\!][\![\psi]\!] \neq \emptyset$, then he proposes to make $\Sigma[\![\phi]\!][\![\psi]\!]$ the new set of epistemic alternatives. On the other hand, B can reject ϕ by uttering some sentence ψ, where $\Sigma[\![\phi]\!][\![\psi]\!] = \emptyset$, and B has reasons to believe that this will be immediately obvious to A. A good candidate for ψ is the negation of ϕ, as $\Sigma[\![\phi]\!][\![\text{NEG}(\phi)]\!]$ obviously reduces to $\emptyset$. Often, ψ is followed by another sentence γ that indicates why B does not accept ϕ. In particular, B proposes to A to make $\Sigma[\![\gamma]\!]$ the new common ground.

To see how things work, let us look at the following text:

(27) A: John arrived on his bike. (ϕ)
B: John didn't arrive on his bike; (ψ, = NEG(ϕ))
John doesn't have a bike. (γ)

With sentence ϕ, speaker A proposes to B to add to the common ground that John arrived on his bike. With sentence ψ, B rejects A's proposal, as accepting ψ after ϕ has been accepted would yield an empty set of alternatives. Instead, B proposes to add γ to the common ground, which explains why he rejected ϕ: accepting γ would violate the presuppositions of ϕ.

This explains why negation sometimes seems to affect presuppositions. Note that it is not the semantics of a special type of negation that does that, but the peculiar discourse setting in which the negated sentence is used—namely, a setting in which accepting the sentence would yield an empty set of epistemic alternatives. This explains why presupposition-affecting negations occur only as reactions to previous utterances by another speaker. Furthermore, it explains why we find only one semantic type of negation.

The proposed treatment differs from van der Sandt (1991), who analyzed presupposition-affecting negation as slightly different from normal negation in

so far as presupposition-affecting negation applies to the 'echo' of a previous sentence, where the echo of a sentence is a conjunction of its assertional meaning, its presuppositional meaning, and its implicatures, with respect to the context at which it is evaluated. van der Sandt follows Horn's (1985) theory of metalinguistic negation in this point, assuming that there is no distinction between presupposition-affecting negation and implicature-affecting negation. However, it is doubtful that these types of negation can be identified. Metalinguistic negation clearly identifies a certain expression whose applicability is denied by focal stress (cf. 28a, b), and this feature is lacking in presupposition-affecting negation (29a,b):

(28) a. It is not *possible*, it is *necessary* that the church is right.
b. Grandma did not *kick the bucket*—she *passed away*.

(29) a. The king of France is not bald—France does not have a king.
b. John did not regret that the Longhorns lost—the Longhorns didn't lose.

Hence the position I am taking is that there are two types of negation, normal and metalinguistic, but that both presupposition-preserving and presupposition-affecting negations are instances of normal negation, and that these two cases differ only in so far as presupposition-affecting negation results from the special denial pattern discussed above.

7 FOCUS-BACKGROUND STRUCTURES AND DYNAMIC INTERPRETATION COMBINED

After having introduced structured meanings to cover the relevance of focus and dynamic interpretation to express anaphoric relation and presupposition, a natural way to proceed is to combine both representation frameworks. This was done in Krifka (1992b) with the objective of capturing the focus-sensitivity of sentences containing adverbial quantifiers, like in the following cases:

(30) a. Usually, a frog catches [a FLY]$_F$
(If frogs catch something, it is usually a fly)
b. Usually, a FROG catches a fly.
(If something catches a fly, it is usually a frog)

(31) a. If a painter [lives in a VILLAGE]$_F$, it is usually nice.
(= Most painters who live in a village live in a nice one.)
b. If [a PAINTER]$_F$ lives in a village, it is usually nice.
(= Most villages in which there lives a painter are nice.)

In this paper, I will focus on the semantics of particles like *only*. We have seen that they typically induce presuppositions, and that there are interesting phenomena relating to anaphoric reference. This calls for a dynamic interpretation like the one we developed above.

We have seen in section 4 above that in a sentence with *only* the sentence in which *only* is omitted is presupposed, but it can introduce new discourse markers (cf. (18)). This suggests the following analysis of *only* as a VP-operator in a dynamic setting:

(32) $\mathbf{only}(\langle B, F\rangle)$

$= \lambda t\lambda\sigma\{wg \mid$

$\forall uk \in \sigma\exists h[uh \in B(F)(t)(\{uk\})] \wedge$ (Presupposition)

$wg \in B(F)(t)(\sigma) \wedge$ (Introduction of DM)

$\neg\exists X\exists k[X \in \mathrm{ALT}_{\preccurlyeq}(F) \wedge wk \in B(X)(t)(\sigma)]\}$ (Assertion)

In this formula, the first conjunct expresses the presupposition. The second conjunct introduces the indices of the expression in the scope of **only** into the output state, making it possible to refer to them later. The third conjunct is the assertion in the narrow sense; it excludes alternatives of the item in focus.

Let us work through a few examples. We start with one that has the whole VP in focus:

(33) only $[\mathrm{ate}_2\ \mathrm{an}_3\ \mathrm{apple}]_F$

$\mathrm{ate}_2\ \mathrm{an}_3\ \mathrm{apple}$;
$\lambda x\lambda\sigma\{wg \mid \exists k[wk \in \sigma \wedge k \leqslant_{2,3} g \wedge \mathbf{eat}_w(g_2xg_3) \wedge \mathbf{apple}_w(g_3) \wedge \mathbf{Past}_w(g_2)]\}, = [A]$

$[\mathrm{ate}_2\ \mathrm{an}_3\ \mathrm{apple}]_F$; $\langle\lambda P.P, [A]\rangle$

only, $\lambda S.\mathbf{only}(S)$

only $[\mathrm{ate}_2\ \mathrm{an}_3\ \mathrm{apple}]_F$, $\mathbf{only}(\langle\lambda P.P, [A]\rangle)$

$= \lambda t\lambda\sigma\{wg \mid \forall uh \in \sigma\exists k[uk \in [A](t)(\{uh\})] \wedge wg \in [A](t)(\sigma) \wedge$
$\neg\exists X\exists k[x \in \mathrm{ALT}_{\preccurlyeq}([A]) \wedge wk \in [A](t)(\sigma)]\}$

$= \lambda x\lambda\sigma\{wg \mid$
$\forall uh \in \sigma\exists k[h \leqslant_{2,3} k \wedge \mathbf{eat}_u(k_2xk_3) \wedge \mathbf{apple}_u(k_3) \wedge \mathbf{Past}_u(k_2)] \wedge$
$\exists l[wk \in \sigma \wedge k \leqslant_{2,3} g \wedge \mathbf{eat}_w(g_2xg_3) \wedge \mathbf{apple}_w(g_3) \wedge \mathbf{Past}_w(g_2)] \wedge$
$\neg\exists X\exists k[X \in \mathrm{ALT}_{\preccurlyeq}([A]) \wedge wk \in X(x)(\sigma)]\}$

The resulting predicate maps individuals x to functions from input states σ to output states that satisfy the following requirements: the first conjunct, expressing the presupposition, ensures that in every world u in σ, x ate an apple. The second conjunct updates the assignment k in every pair wk of the input state to a g such that g_2 is an event where x ate an apple g_3 in w. This just introduces the event g_2 and the apple g_3 into the assignments of the output state, but does not restrict its set of possible worlds, given the propositional

information of the first conjunct. The third conjunct, expressing the assertion, says that there is no alternative X to the focus meaning [A] such that X is true of x. This restricts the possible worlds of the output state, but does not change the assignments, which reflects the fact that alternatives do not introduce their own binding possibilities.

In the following expression, *only* focuses on the transitive verb:

(34) only $[\mathrm{ate}_2]_F\ \mathrm{an}_3$ apple

an_3 apple,
$\lambda P\lambda t\lambda\sigma.\{wg \mid \exists x[wg \in P(tx)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{3/x} \wedge \mathbf{apple}_u(x)]\})]\}, = [B]$

eat, $\lambda sxy\lambda\sigma.\{wg \in \sigma \mid \mathbf{eat}_w(sxy)\}, = [C]$

$[\mathrm{eat}]_F$, $\langle\lambda P.P, [C]\rangle$

$[\mathrm{eat}]_F\ \mathrm{an}_3$ apple, $[B](\langle\lambda P.P, [C]\rangle), = \langle\lambda P[B](P), [C]\rangle$

Past_2, $\lambda P\lambda t\lambda\sigma.\{wg \mid \exists s[wg \in P(st)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{2/s} h \wedge$
$\mathbf{Past}_u(s)]\})]\}, = [D]$

$[\mathrm{ate}_2]_F\ \mathrm{an}_3$ apple, $[C](\langle\lambda P[B](P), [C]\rangle), = \langle\lambda P[D]([B](P)), [C]\rangle$

only, $\lambda S.\mathbf{only}(S)$

only $[\mathrm{ate}_2]_F\ \mathrm{an}_3$ apple, $\mathrm{only}(\langle\lambda P[D]([B](P)), [C]\rangle)$
$= \lambda t\lambda\sigma\{wg \mid \forall uh \in \sigma\exists k[uk \in [D]([B]([C]))(t)(\{uh\})] \wedge$
$wg \in [D]([B]([C]))(t)(\sigma) \wedge$
$\neg\exists X\exists k[X \in \mathrm{ALT}_{\preccurlyeq}([C]) \wedge wk \in [D]([B](X))(t)(\sigma)]\}$
$= \lambda x\lambda\sigma\{wg \mid$
$\forall uh \in \sigma\exists k[h \leqslant_{2,3} k \wedge \mathbf{eat}_u(k_2xk_3) \wedge \mathbf{apple}_u(k_3) \wedge \mathbf{Past}_u(k_2)] \wedge$
$\exists k[wk \in \sigma \wedge k \leqslant_{2,3} g \wedge \mathbf{eat}_w(g_2xg_3) \wedge \mathbf{apple}_w(g_3) \wedge \mathbf{Past}_w(g_2)] \wedge$
$\neg\exists X\exists k[X \in \mathrm{ALT}_{\preccurlyeq}([C]) \wedge \exists s\exists y[wk \in X(sxy)(\{uh \mid \exists f[uf \in \sigma \wedge f \leqslant_{2/s,3/y} u \wedge$
$\mathbf{Past}_u(s) \wedge \mathbf{apple}_u(y)]\})]]\}$

We get a predicate that maps entities x to a function from input states σ to output states such that it holds throughout σ that x ate an apple, the assignments of the output state map 3 to an apple and 2 to a situation in which x ate an apple (these two conditions are identical to the first conditions of (33)), and for the worlds of the output state there is no alternative X to eating such that x 'Xed' an apple.

The next example shows a case in which the item in focus is a NP.

(35) only ate_2 $[\text{an}_3\ \text{apple}]_F$

an_3 apple,
$\lambda P \lambda t \lambda \sigma.\{wg \mid \exists x[wg \in P(tx)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{3/x} h \wedge \mathbf{apple}_u(x)]\})]\}$,
$= [E]$

$[\text{an}_3\ \text{apple}]_F$, $\langle \lambda T.T, [E] \rangle$

eat, $\lambda sxy \lambda \sigma.\{wg \in \sigma \mid \mathbf{eat}_w(sxy)\}$, $= [F]$

eat $[\text{an}_3\ \text{apple}]_F$, $\langle \lambda T.T([F]), [E] \rangle$

Past_2 $\lambda P \lambda t \lambda \sigma.\{wg \mid \exists s[wg \in P(st)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{2/s} h \wedge$
$\mathbf{Past}_u(s)]\})]\}$, $= [G]$

ate_2 $[\text{an}_3\ \text{apple}]_F$, $\langle \lambda T.[G](T([F])), [E] \rangle$

only, $\lambda S.\mathbf{only}(S)$

only ate_2 $[\text{an}_3\ \text{apple}]_F$, $\mathbf{only}(\langle \lambda T.[G](T([F])), [E] \rangle)$

$$
\begin{aligned}
= \lambda x \lambda \sigma\{wg \mid\ & \\
& \forall uh \in \sigma \exists k[h \leqslant_{2,3} k \wedge \mathbf{eat}_u(k_2 x k_3) \wedge \mathbf{apple}_u(k_3) \wedge \mathbf{Past}_u(k_2)] \wedge \\
& \exists k[wk \in \sigma \wedge k \leqslant_{2,3} g \wedge \mathbf{eat}_w(g_2 x g_3) \wedge \mathbf{apple}_w(g_3) \wedge \mathbf{Past}_w(g_2)] \wedge \\
& \neg \exists X \exists k[X \in \text{ALT}_{\ntrianglelefteq}([E]) \wedge \exists s[wk \in X(\lambda sxy \lambda \sigma.\{wg \in \sigma \mid \mathbf{eat}_w(sxy)\}) \\
& \quad (sx)(\{uh \mid \exists k[ui \bullet \sigma \wedge i \leqslant_{2/s} h \wedge \mathbf{Past}_u(s)]\})]]\}
\end{aligned}
$$

The first two conjuncts of that formula are the same as in the two preceding examples. The third conjunct says that for the worlds of the output state there is no proper alternative X to the meaning of the item in focus, *an apple*, such that there was an event s in the past and x ate an X. Assuming that the proper alternatives to the meaning of *an apple* are those term meanings T that are generated by predicates that denote something more substantial than the predicate *apple* (see section 3), this says that x didn't eat anything more substantial than an apple.

In section 3 we argued that although this may be one meaning of the example at hand, a more plausible meaning is that there was an apple y, and x ate y and nothing else. This reading can be generated by assuming that *an apple* is quantified in. There are various ways to implement this idea, e.g. assumption of a representation level of logical form, or operator storage. The crucial properties of this reading are given in the following derivation:

(36) $[\text{an}_3\ \text{apple}]$ only ate_2 $[e_3]$

e_3, $\lambda P \lambda t \lambda \sigma.\{wg \in \sigma \mid P(tg_3)(\sigma)\}$, $[H]$

$[e_3]_F$, $\langle \lambda T.T, [H] \rangle$

eat, $\lambda sxy \lambda \sigma.\{wg \in \sigma \mid \mathbf{eat}_w(sxy)\}$, $= [I]$

eat $[e_3]_F$, $\langle \lambda T.T([I]), [H] \rangle$

Past_2,
$\lambda P \lambda t \lambda \sigma.\{wg \mid \exists s[wg \in P(st)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{2/s} h \wedge \mathbf{Past}_u(s)]\})]\}$, $= [K]$

$\text{ate}_2[e_3]_F$, $\langle \lambda T.[K](T([I])), [H] \rangle$

only, $\lambda S.\mathbf{only}(S)$

only ate_2 $[e_3]_F$, $\mathbf{only}(\langle \lambda T.[K](T(\lambda sx \lambda \sigma.\{wg \in \sigma \mid \mathbf{eat}_w(sxy)\})), [H] \rangle)$

$$
\begin{aligned}
& \lambda x \lambda \sigma\{wg \mid \forall uk \in \sigma \exists h[uh \in [K]([H]([I]))(x)(\{uk\})] \wedge wg \in [K]([H]([I]))(x)(\sigma) \wedge \\
& \quad \neg \exists X \exists k[X \in \text{ALT}_{\ntrianglelefteq}([H]) \wedge wk \in [K](X([I]))(x)(\sigma)]\} \\
& = [L]
\end{aligned}
$$

an_3 apple,
$\lambda P \lambda t \lambda \sigma.\{wg \mid \exists y[wg \in P(t)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{3/y} \wedge \mathbf{apple}_u(y)]\})]\}$, $= [M]$

an_3 apple $[\text{only}\ \text{ate}_2\ [e_3]]$, $= \lambda t \lambda \sigma[[M]([L])(t)(\sigma)]$

The wide scope reading of *an_3 apple* is achieved by first specifying the argument place with an empty element e_3 that is semantically interpreted as a pronoun related to the object denoted by g_3. Then the indefinite term *an_3 apple* is quantified in. Contrary to earlier representations of this term, its representation does not fill any argument place of the predicate, but fixes the referent of g_3 as referring to a particular apple. This shows up formally in so far as the description of the term contains an application P(t) instead of P(ty). This dual role of a quantificational NP should follow from slightly different derivations for argument-filling terms and terms that are quantified in.

Let us now compute the result we have gotten so far:

$$
\begin{aligned}
& \lambda t \lambda \sigma[[M]([L])(t)(\sigma)] \\
& = \lambda x \lambda \sigma.\{wg \mid \exists y[wg \in [L](x)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{3/y} \wedge \mathbf{apple}_u(y)]\})]\} \\
& = \lambda x \lambda \sigma.\{wg \mid \exists y[\\
& \quad \forall uk[\exists l[ul \in \sigma \wedge l \leqslant_{3/y} k \wedge \mathbf{apple}_u(y)] \rightarrow \exists h[k \leqslant_2 h \wedge \mathbf{Past}_w(h_2) \wedge \mathbf{eat}_w(h_2 x h_3)]] \\
& \quad \wedge \exists l[wl \in \sigma \wedge l \leqslant_{3/y,2} k \wedge \mathbf{apple}_w(y) \wedge \mathbf{Past}_w(g_2) \wedge \mathbf{eat}_w(g_2 x g_3)]
\end{aligned}
$$

$$\wedge \neg\exists T\exists k[T \in ALT_{\nleq}([H]) \wedge \exists s[wk \in T(\lambda sxy\lambda\sigma.\{wg \in \sigma | \mathbf{eat}_w(sxy)\})(sx)$$
$$(\{uh | \exists l[ul \in \sigma \wedge l \leq_{3/y,2} h \wedge \mathbf{apple}_u(y) \wedge \mathbf{Past}_u(h_2)]\})]]]]\}$$

Let us assume again that the alternatives to terms like [H] that are generated by an individual are terms that are generated by an individual. That is, the alternatives to [H] have the form $\lambda P\lambda t\lambda\sigma.\{wg \in \sigma | P(tz)(\sigma)\}$, where z ranges over individuals. Then the last part of the formula above can be reduced as follows:

$$\neg\exists z\exists k[z \in ALT_{\nleq}(g_3) \wedge$$
$$\exists l[wl \in \sigma \wedge l \leq_{3/y,2} k \wedge \mathbf{apple}_w(y) \wedge \mathbf{Past}_w(k_2) \wedge \mathbf{eat}_w(k_2xz)]]$$

We end up with a predicate that applies to entities x and changes input states σ in the following way. There is some object y, and the following three conditions hold: (i) it is presupposed throughout σ that if σ is extended in such a way that index 3 is mapped to y and y is an apple, then x ate y; (ii) the input state σ is extended in such a way that index 3 is mapped to y, y is an apple, and index 2 is mapped to a past event in which x ate y; (iii) a final condition for the output state is that there is no alternative z to g_3 (= y) such that x ate z. Hence we get the interpretation that x ate a particular object y, which is an apple and nothing else.

In the examples analyzed so far the focus particle occurred as a VP operator. But it may also be an operator on other categories, for example an NP. In this case we have to assume a slightly different meaning rule for *only* in order to adjust to the different type of the scope. I propose the following rule:

(37) $\mathbf{only}(\langle B, F\rangle)$
$$= \lambda Q\lambda t\lambda\sigma\{wg | \forall uh \in \sigma\exists k[uk \in B(F)(Q)(t)(\{uh\})] \wedge$$
$$wg \in B(F)(Q)(t)(\sigma) \wedge$$
$$\neg\exists X\exists k[X \in ALT_{\nleq}(F) \wedge wk \in B(X)(Q)(t)(\sigma)]\}$$

The only difference to definition (32) consists in the introduction of a predicate variable Q which stands for the argument of the term in the scope of only. Hence (37) can be seen as a generalization of (32) to a different type.

Let us see how things work out with an example. In the following, I derive the reading of *eat only* [*an apple*]$_F$:

(38)

an_3 apple,
$\lambda P\lambda t\lambda\sigma.\{wg | \exists x[wg \in P(tx)(\{uh | \exists k[uk \in \sigma \wedge k \leq_{3/x} h \wedge \mathbf{apple}_u(x)]\})]\}$,
= [N]

$[an_3\ apple]_F$, $\langle\lambda T.T, [N]\rangle$

only, $\lambda S.\mathbf{only}(S)$

only $[an_3\ apple]_F$, $\mathbf{only}(\langle\lambda T.T, [N]\rangle)$,
$$= \lambda Q\lambda t\lambda\sigma\{wg | \forall uh \in \sigma\exists k[uk \in [M](Q)(t)(\{uh\})] \wedge wg \in [M](Q)(t)(\sigma) \wedge$$
$$\neg\exists X\exists k[X \in ALT_{\nleq}([M]) \wedge wk \in X(Q)(t)(\sigma)]\}, = [O]$$

eat_2, $\lambda sxy\lambda\sigma.\{wg \in \sigma | \mathbf{eat}_w(sxy)\}$, = [P]

eat_2 only $[an_3\ apple]_F$, $[O]([P])$,
$$\lambda t\lambda\sigma\{wg | \forall uh \in \sigma\exists k[uk \in [N]([P])(t)(\{uh\})] \wedge wg \in [N]([P])(t)(\sigma) \wedge$$
$$\neg\exists X\exists k[X \in ALT_{\nleq}([N]) \wedge wk \in X([P])(t)(\sigma)]\}$$
$$= \lambda sx\lambda\sigma\{wg | \forall uh \in \sigma\exists k[h \leq_3 k \wedge \mathbf{apple}_u(k_3) \wedge \mathbf{eat}_u(sxk_3)] \wedge$$
$$\exists k[wk \in \sigma \wedge k \leq_3 g \wedge \mathbf{apple}_w(g_3) \wedge \mathbf{eat}_w(sxk_3)] \wedge$$
$$\neg\exists X\exists k[X \in ALT_{\nleq}([N]) \wedge wk \in X([P])(t)(\sigma)]\}$$

This is a relation between situations s and entities x that maps input states σ to output states with assignments g that presuppose that throughout σ, x ate an apple in s, furthermore introduce a new index 3 such that g_3 is an apple that is eaten by x in s, and finally exclude that any alternative X to an apple was eaten.

Note that another way to derive the same expression is by quantifying in *an*$_3$ *apple* into *eat only* [e_3]. The result is then a relation between entities x and situations s that map input states σ to output states with assignment g such that there is an object y, where it is presupposed that x ate y in s, a new index 3 is introduced that is mapped to y, and it is excluded that x ate any alternative to y.

In the derivation I have given in (38) for *eat only* [*an apple*]$_F$, *only* has narrow scope with respect to a past operator that binds the situation argument. This differs from the derivation given in (35) for *only ate* [*an apple*]$_F$. Note that for this latter case we also have an alternative derivation where the Past operator has scope over *only*, which yields the same reading as the one given in (38). On the other hand, there is evidence that NPs like *only an apple* can get a wide-scope interpretation (cf. Taglicht 1984, who discusses examples like *We must study only physics*), which would yield an interpretation similar to (35) for sentence (38). That such reading differences indeed exist can be shown with examples like the following. Imagine a lottery with three draws each day, and that John participates in each draw.

(39) a. Yesterday, John (only) won (only) a rose.
b. In the first draw, John won a teddy bear. Then he won a bottle of champagne. Finally, he (only) won (only) a rose.

In (a), *yesterday* arguably specifies the reference time, and the sentence has to be interpreted as implying that within the reference time there was no event of John winning something other than a rose. In (b), the temporal adverbials arguably refer to the draw events. But then the last sentence has to be interpreted as: there was an event in which John didn't win anything but a rose.

It seems that such scope differences indeed exist, but that the position of *only* does not predetermine the availability of possible readings.

8 FOCUS AND ANAPHORIC REFERENCE

We have seen with cases like (13) that focus items can contain anaphoric elements, and that the set of alternatives can vary with the input assignments. Let us check how such cases work out in our formalism. The question of (13) constructs the following alternatives:

(40) Did_2 every_1 gentleman talk to $\text{his}_{1,3}$ left partner and $\text{his}_{1,4}$ right partner?

Set of alternatives:

$\{\lambda P\lambda t\lambda\sigma.\{wg \mid \forall uh[uh \in \sigma \rightarrow \exists! y[\mathbf{left\text{-}partner}_u(yh_1)] \wedge$
$\exists k[wk \in \sigma \wedge k \leqslant_3 g \wedge \mathbf{left\text{-}partner}_w(g_3 g_1) \wedge wg \in P(g_3 t)(\sigma)]\},$
$\lambda P\lambda t\lambda\sigma.\{wg \mid \forall uh[uh \in \sigma \rightarrow \exists! y\mathbf{right\text{-}partner}_u(yh_1)] \wedge$
$\exists k[wk \in \sigma \wedge k \leqslant_4 g \wedge \mathbf{right\text{-}partner}_w(g_4 g_1) \wedge wg \in P(g_4 t)(\sigma)]\}\},$
$= \{[A_1], [A_2]\}$

Here I am assuming that **left-partner** and **right-partner** are relations that map a person to his or her left partner and right partner, respectively. As with other definite descriptions, it is presupposed that there is a unique element that satisfies descriptive content, and a new index for this element is introduced. The answer to the question can be analyzed as follows. I assume that the answer uses the same index for *every gentleman* as the question, and that it takes the set of alternatives indicated above.

(41) Every_1 gentleman only talked_2 to $[\text{his}_{1,3}$ left $\text{partner}]_F$.

$[\text{his}_{1,3}$ left $\text{partner}]_F$, $\langle\lambda T.T,[A_1]\rangle$

talk to, $\lambda sxy\lambda\sigma\{wg \in \sigma \mid \mathbf{talk\text{-}to}_w(sxy)\}$, $= [B]$

talk to $[\text{his}_{1,3}$ left $\text{partner}]_F$, $= \langle\lambda T.T([B]), [A_1]\rangle$

Past_2, $\lambda P\lambda t\lambda\sigma.\{wg \mid \exists s[wg \in P(st)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{2,s} h \wedge$
$\mathbf{Past}_u(s)]\})]\}$, $= [C]$

talked_2 to $[\text{his}_{1,3}$ left $\text{partner}]_F$, $\langle\lambda T.[C](T([B])), [A_1]\rangle$

only, $\lambda S.\mathbf{only}(S)$

only talked_2 to $[\text{his}_{1,3}$ left $\text{partner}]_F$, $\mathbf{only}(\langle\lambda T.[C](T([B])), [A_1]\rangle)$
$= \lambda t\lambda\sigma\{wg \mid \forall uh \in \sigma\exists k[uk \in [C]([A_1]([B]))(t)(\{uh\})] \wedge$
$wg \in [C]([A_1]([B]))(t)(\sigma) \wedge$
$\neg\exists X\exists f[X \in \text{ALT}_{\preccurlyeq}([A_1]) \wedge wf \in [C](X([B]))(t)(\sigma)]\}$

With $X = [A_2]$ as the only alternative of $[A_1]$, this reduces to the following, slightly abbreviated formula:

$= \lambda x\lambda\sigma\{wg \mid$
$\forall uh \in \sigma[\exists! y[\mathbf{left\text{-}partner}_u(yh_1)] \wedge \exists k[uk \in \sigma \wedge h \leqslant_{2,3} k \wedge \mathbf{left\text{-}partner}_u(g_3 g_1) \wedge$
$\mathbf{talk\text{-}to}_u(k_2 x k_3) \wedge \mathbf{Past}_u(k_2] \wedge$
$\exists k[wk \in \sigma \wedge k \leqslant_{2,3} g \wedge \mathbf{talk\text{-}to}_w(g_2 x g_3) \wedge \mathbf{Past}_w(g_2)] \wedge$
$\neg\exists f\exists k[wk \in \sigma \wedge k \leqslant_{2,4} f \wedge \forall uh \in \sigma\exists! y[\mathbf{right\text{-}partner}_u(yh_1)] \wedge \mathbf{right\text{-}}$
$\mathbf{partner}_w(f_4 f_1)\, \mathbf{talk\text{-}to}_w(f_2 x f_4) \wedge \mathbf{Past}_w(f_2)]\}$
$= [D]$

We arrive at a function that maps objects x to functions from input states σ with assignment k to output states such that (i) it is presupposed throughout σ that k_1 (x) has a unique left partner and that x talked to this person, (ii) an index for the left partner of k_1 and an index 2 for the talking event are introduced, and (iii) it is expressed that x didn't talk to any alternative. In particular, as the only alternative is k_1's right partner, it is expressed that x did not talk to k_1's right partner, where again it is presupposed that k_1 has a unique right partner. The sentence is completed as follows:

(41′)

every_1 gentleman, $\lambda P\lambda t\lambda\sigma.\{wg \in \sigma \mid \forall k[g \leqslant_1 k \wedge \mathbf{gentleman}_w(k_1) \rightarrow$
$\exists h[wh \in P(tk_1)(\{wk\})]\}$, $= [E]$

every_1 gentleman only talked to $[\text{his}_{1,3}$ left $\text{partner}]_F$,
$[E]([D])$
$\lambda\sigma.\{wg \in \sigma \mid \forall k[g \leqslant_1 k \wedge \mathbf{gentleman}_w(k_1) \rightarrow \exists h[wh \in [D](k_1)(\{wk\})]]\}$

We arrive at a function that restricts input states σ to output states for which every extension k of an input assignment g to an index 1 such that k_1 is a gentleman can be extended to an assignment h that satisfies [D] applied to k_1. According to our previous calculations, this means that it is presupposed throughout σ that for every k, k_1 talked to k_1's left partner; furthermore, we introduce a situation g_2 such that k_1 talked to k_1's left partner, and didn't talk to k_1's right partner.[8]

9 CASES WITH MULTIPLE FOCUS

In this section, I will discuss cases where more than one focusing operator must be assumed. In particular, I will have a look at the derivations of examples like (7). In the examples we are going to consider, the second focus operator is the particle *even*. For our discussion the following meaning rule for **even** is sufficient.[9]

(42) $\mathbf{even}(\langle B, F\rangle)$

$= \lambda t\lambda\sigma\{wg \mid wg \in B(F)(t)(\sigma) \wedge$ (assertion)

$\forall X \in ALT_{\nleq}(F)[B(F)(t)(\sigma) <_p B(X)(t)(\sigma)]\}$ (presupposition)

The first conjunct simply asserts B(F) with respect to the input state σ. The second conjunct says that for each alternative X to F, it is less probable in σ that B(F) holds than that B(X) holds. This probability measure holds throughout σ, making it a presupposition.

The rule just given covers *even* as a VP-operator. If it is an NP operator we have to adapt the translation of *even* to the new type, where the variable Q takes care of the VP argument:

(43) $\mathbf{even}(\langle B, F\rangle)$

$= \lambda Q\lambda t\lambda\sigma\{wg \mid wg \in B(F)(Q)(t)(\sigma) \wedge$

$\forall X \in ALT_{\nleq}(F)[B(F)(Q)(t)(\sigma) <_p B(X)(Q)(t)(\sigma)]\}$

Let us first have a look at an example with disjoint foci. I assume that [G], [F] and [E] stand for the same objects as in (35) above.

(44)

only ate$_2$ [an$_3$ apple]$_F$, $\mathbf{only}(\langle\lambda T.[G](T([F])), [E]\rangle)$, = [A]

John$_1$, $\lambda P\lambda t\lambda\sigma.\{wg \mid wg \bullet P(tx)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_1 h \wedge h_1 = j_w]\})\}$,
= [B]

[John$_1$]$_F$, $\langle\lambda T.T, [B]\rangle$

even, $\lambda S.\mathbf{even}(S)$

even [John$_1$]$_F$, $\mathbf{even}(\langle\lambda T.T, [B]\rangle)$

even [John$_1$]$_F$ only ate$_2$ [an$_3$ apple]$_F$, $\mathbf{even}(\langle\lambda T.T, [B]\rangle)([A])$

Spelling out the meaning rules of **even** and **only** and performing lambda-reductions, we get the following result:

$\lambda Q\lambda t\lambda\sigma\{wg \mid wg \in [B](Q)(t)(\sigma) \wedge$

$\forall X \in ALT_{\nleq}([B])[[B](Q)((t)(\sigma) <_p X(Q)(t)(\sigma)]\}([A])$

$= \lambda\sigma\{wg \mid wg \in [B]([A])(\sigma) \wedge \forall X \in ALT_{\nleq}([B])[[B]([A])(\sigma) <_p X([A])(\sigma)]\}$

The first conjunct reduces to the representation of *John only ate [an apple]*$_F$. Here it is presupposed that John ate an apple, the indices for this event, the apple, and John are introduced, and it is asserted that John didn't eat any alternative to an apple (see above (35)):

$\forall uh \in \sigma\exists k[h \leqslant_{1,2,3} k \wedge \mathbf{eat}_u(k_2k_1k_3) \wedge k_1 = j_w \wedge \mathbf{apple}_u(k_3) \wedge \mathbf{Past}_u(k_2)]$

$\wedge \exists k[wk \bullet \sigma \wedge k \leqslant_{1,2,3} g \wedge \mathbf{eat}_w(g_2g_1g_3) \wedge g_1 = j_w \wedge \mathbf{apple}_w(g_3) \wedge \mathbf{Past}_w(g_2)]$

$\wedge \neg\exists X\exists k[X \in ALT_{\nleq}([E]) \wedge$

$\exists s[wk \in X(\lambda sxy\lambda\sigma.\{wg \bullet \sigma \mid \mathbf{eat}_w(sxy)\})(sx)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{1,2/s} h \wedge$

$\mathbf{Past}_u(s) \wedge h_1 = j_w]\})]]$

The second conjunct expresses that for every alternative X to John it holds throughout the input state σ that it is less probable that John only ate an apple than that X only ate an apple.

$\forall X \in ALT_{\nleq}([B])[$

$\{uk \in \sigma \mid \exists h[k \leqslant_{1,2,3} h \wedge \mathbf{eat}_w(h_2h_1h_3) \wedge h_1 = j_w \wedge \mathbf{apple}_w(h_3) \wedge \mathbf{Past}_w(h_2)] \wedge$

$\neg\exists X\exists k[X \in ALT_{\nleq}([E]) \wedge$

$\exists s[wk \bullet X(\lambda sxy\lambda\sigma.\{wg \in \sigma \mid \mathbf{eat}_w(sxy)\})(sx)(\{uh \mid \exists k[uk \in \sigma \wedge k \leqslant_{1,2/s} h \wedge$

$\mathbf{Past}_u(s) \wedge h_1 = j_w]\})]]\}$

$<_p X([A])(\sigma)]$

In summary, (44) has the following meaning: it is asserted that John didn't eat any alternative to an apple. It is presupposed that John ate an apple, and that it is less likely for John that he didn't eat any alternative to an apple than it would be for an alternative to John. Furthermore, discourse entities for John, an eating event by John and an apple that is eaten in the event are introduced. This seems to be the correct representation for a sentence like (44). For example, when the sentence is negated by *it is not the case that*, or dialogically by *no*, only the assertion part will be negated, but not the presuppositions.

Other cases with multiple focusing operators can be analyzed in a similar way. Let us have a look at a derivation with overlapping foci:

(45) even [only ate$_2$ [an**1,2** apple]$_F$]$_F$

only ate$_2$ [an$_3$ apple]$_F$, $\mathbf{only}(\langle\lambda T.[G](T([F])), [E]\rangle)$, = [A]

[only ate$_2$ [an$_3$ apple]$_F$]$_F$, $\langle\lambda P.P, [A]\rangle$

even, $\lambda S.\mathbf{even}(S)$

even [only ate$_2$ [an$_3$ apple]$_F$]$_F$, $\mathbf{even}(\langle\lambda P.P, [A]\rangle)$
$= \lambda x\lambda\sigma\{wg \mid wg \bullet [P](x)(\sigma) \wedge \forall X \bullet ALT_{\preccurlyeq}([A])[[A](x)(\sigma) <_p X(x)(\sigma)]\}$

The first conjunct reduces to the following formula, which says that it is presupposed in σ that the individual x ate an apple in σ, which asserts that x didn't eat any alternative to an apple, and which introduces discourse entities for an apple and an eating event:

$\forall uh \in \sigma\exists k[h\leqslant_{2,3}k \wedge \mathbf{eat}_u(k_2xk_3) \wedge \mathbf{apple}_u(k_3) \wedge \mathbf{Past}_u(k_2)] \wedge$
$\exists k[wk \in \sigma \wedge k\leqslant_{2,3}g \wedge \mathbf{eat}_w(g_2xg_3) \wedge \mathbf{apple}_w(g_3) \wedge \mathbf{Past}_w(g_2)] \wedge$
$\neg\exists X\exists k[X \in ALT_{\preccurlyeq}([E]) \wedge$
$\quad\exists s[wk \in X(\lambda sxy\sigma.\{wg \in s \mid \mathbf{eat}_w(sxy)\})(sx)(\{uh \mid \exists k[uk \in \sigma \wedge k\leqslant_{2/s}h \wedge$
$\quad\mathbf{Past}_u(s)]\})]]$

The second conjunct expresses that it is presupposed in σ that it is less likely that x only ate an apple than that x did some alternative to only eating an apple.

Finally, let us analyze a case in which one focusing operator is in the focus of another operator:

(46)

ate$_2$ [an$_3$ apple]$_F$, $\langle\lambda T.[G](T([F])), [E]\rangle$

only, $\lambda S.\mathbf{only}(S)$

[only]$_F$, $\langle\lambda R.R, \lambda S.\mathbf{only}(S)\rangle$

[only]$_F$ ate$_2$ [an$_3$ apple]$_F$,
$\langle\lambda R.R, \lambda S.\mathbf{only}(S)\rangle(\langle\lambda T.[G](T([F])), [E]\rangle)$
$= \langle\lambda R.R(\langle\lambda T.[G](T([F])), [E]\rangle), \lambda S.\mathbf{only}(S)\rangle$

even, $\lambda S.\mathbf{even}(S)$

even [only]$_F$ ate$_2$ [an$_3$ apple]$_F$,
$\mathbf{even}(\langle\lambda R.R(\langle\lambda T.[G](T([F])), [E]\rangle), \lambda S.\mathbf{only}(S)\rangle)$
$= \lambda x\lambda\sigma\{wg \mid wg \in \mathbf{only}(\langle\lambda T.[G](T([F])), [E]\rangle)(x)(\sigma) \wedge$
$\qquad\forall X \in ALT_{\preccurlyeq}(\mathbf{only})[\mathbf{only}(\langle\lambda T.[G](T([F])), [E]\rangle)(x)(\sigma) <_p$
$\qquad\qquad X(\mathbf{only}(\langle\lambda T.[G](T([F])), [E]\rangle))(x)(\sigma)]\}$

The first conjunct reduces to the same formula as the first conjunct in the preceding derivation: it presupposes that x ate an apple, and asserts that x didn't eat any alternative to an apple. As for the second conjunct, we have to know what the possible alternatives to **only** are. In Krifka (1992a) I suggested that the only alternative to **only** is the meaning of the focusing operator *also*. One piece of evidence for this is the common locution *not only X, but also Y*. Let us assume the following meaning for *also* as a VP operator:

(47) $\mathbf{also}(\langle B, F\rangle) =$
$\lambda t\lambda\sigma\{wg \mid wg \in B(F)(t)(\sigma) \wedge$ (assertion)
$\qquad\forall uk \bullet \sigma\exists X\exists h[X \bullet ALT_{\preccurlyeq}(F) \wedge uh \in B(X)(t)(\{uk\})]\}$ (presupp.)

That is, it is asserted that B(F) holds, and it is presupposed that for some alternative X to F, B(X) holds. If **also** is the only element in $ALT_{\preccurlyeq}$ (**only**), then we get the following interpretation of the second conjunct of (46):

$\{uk \in \sigma \mid \exists h[uh \in \mathbf{only}(\langle\lambda T.[G](T([F])), [E]\rangle)(x)(\sigma)]\} <_p$
$\{uk \in \sigma \mid \exists h[uh \in \mathbf{also}(\langle\lambda T.[G](T([F])), [E]\rangle)(x)(\sigma)]\}$

After the meaning postulates for **only** and **also** are spelled out, we get the presupposition that throughout the input state σ it is less likely that x ate an apple and no alternative to an apple, than that x ate an apple and some alternative to an apple. This captures the meaning of expressions like (46) correctly.

10 CONCLUSION

In this article I have shown that structured meanings can be incorporated in a dynamic setting, and that the resulting framework allows for a sophisticated treatment of focusing operators. In particular, we have seen that we can distinguish between presuppositional content and assertional content, and that we can deal with discourse markers that are introduced within the scope of such operators.

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NOTES

1 I thank two anonymous reviewers for helpful comments and criticism. The paper is a substantially revised version of a talk I gave at the Fourth Symposium on Logic and Language, Budapest, 1992. A preliminary version was published in the proceedings of this conference, Krifka (1993). I thank the organizers and participants of this conference for the opportunity to present this paper and discuss its issues.

2 This analysis was suggested to me by Arnim von Stechow.

3 There is one interesting difference

between German and English: Contrary to English, focus on negative terms is possible in German:

(1) a. Nur kein Mädchen hat geweint.
[only no girl cried]
'Everybody who is not a girl cried but no girl cried.'
a. Wir haben nur keine Giraffen gesehen.
[we have only no giraffes seen]
'We saw everything except giraffes.'

This difference is due to the fact that the German negative quantifier has to be decomposed into a negation part and an indefinite part (cf. also Jacobs 1983). This was shown by Jacobs (1980) with examples like the following:

(2) Jeder Arzt fährt kein Auto.
[every doctor drives no car]
One reading: 'Not every doctor drives a car.'

If *kein*(*e*) has to be decomposed in this fashion, then the above examples would obtain the following interpretations:

(3) a. ... nur [Mädchen]$_F$ NEG geweint hat.
[... only girls didn't cry.]
a. ... wir nur NEG [Giraffen]$_F$ gesehen haben.
[... we only didn't see [(any) giraffes]$_F$.]

4 The present analysis differs from the one given in Krifka (1993), where I assumed that it is presupposed throughout the input state that g_4 is defined and refers to g_1's bike. A problem with that analysis is that it cannot handle quantified sentences as the following one, as the dicourse marker 4 cannot be fixed to a particular object:

Every boy$_1$ who likes his$_{1,4}$ bike keeps it$_4$ clean.

Noun phrases like *his bike* are analyzed as 'weakly familiar' in the terminology of Condoravdi (1992). That is, although their index is not present in the input state yet, their descriptive content is presupposed.

5 This differs from the treatment in Beaver (1992), for whom $[\![\phi]\!](\sigma)$ would be undefined in such a case. Consequently, Beaver has to employ a semantic metalanguage that allows for truth-value gaps. This complication is unnecessary, I think. As the empty information state does not serve any essential function, we might make use of it to express presupposition failure.

6 This analysis of negation differs from the one given in Heim (1983a) and Beaver (1992). According to their analysis, a negated sentence $\neg\phi$ restricts an input state σ to those world-assignment pairs whose assignments cannot be extended to satisfy ϕ:

$$[\![\neg\phi]\!](\sigma) = \sigma - \{wf \in \sigma \mid \exists g \geq f[wg \in [\![\phi]\!](\sigma)]\}$$

The problem with this representation is that if ϕ expresses a presupposition that is not satisfied throughout σ, then the substracted set will be reduced to $\emptyset$, and $\sigma - \emptyset$ is σ again. So we would predict that a negated sentence containing a presupposition that is not satisfied simply does not change the input state but otherwise does no harm. Note that the result is different in Beaver's theory, where in such a case $[\![\phi]\!](\sigma)$ will be undefined, and consequently $[\![\neg\phi]\!](\sigma)$ will be undefined.

7 There is one problem of the proposed analysis, illustrated by the following sentence:

He$_1$ did not see [his$_{1,3}$ bike]$_i$. He$_1$ suspected that it$_i$ was stolen.

Note that *it* can be anaphorically related to *his bike*, even though this NP occurs within the scope of a negation, and hence its index should be inaccessible. A way out is the following. Note that the negation does not affect the presupposition that 1 has a unique bike. Assuming that *it* picks up the description *his bike*, it follows that *it* refers to the same entity as its antecedent. In Krifka (1993) I assumed that the index 3 itself is presupposed; however, this creates problems in quantificational cases, as indicated in note 4.

8 This treatment of foci containing anaphoric elements differs from the one given in Krifka (1992b), where I assume that the alternatives directly refer to the partners, and as those entities differ for different gentlemen under consideration, the set of alternatives is dependent on input assignments. The present treatment, where the alternatives are something like Skolem functions (for each gentleman x, they give x's left partner and x's right partner), allows us to give considerably simplified semantic rules for *only*.

9 But see Jacobs (1983), who points out problems with an analysis of *even* in terms of probability.

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