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ONLY: ASSOCIATION WITH FOCUS IN EVENT SEMANTICS*

> . . . *For a child knows that logic and meaning are only nothing nothing screening* . . .
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> — F. Pessoa

We propose an analysis of *only* in terms of event semantics. This approach allows a unified treatment of a wide range of cases in which *only* is associated with focused expressions of different categories. Section 1 is devoted to a preliminary discussion of some problems that a good analysis of *only* should solve. In section 2 we concentrate on sentences in which the focused expression is a NP. In section 3 we show how our analysis can be extended to other categories. Finally, section 4 contains some remarks on related topics, such as scalarity and exhaustiveness.

1. INTRODUCTION

Only is a typical example of a word requiring association with a focus. The interpretation of a sentence containing *only* cannot be determined unless *only* has been associated with a focused expression, and in general, different choices of the focused expression correspond to different interpretations of the sentence. Consider sentence (1):

(1) John only kissed Mary.

Here the focused expression can be *Mary, kissed Mary*, or *kissed.* These three possibilities can be represented as follows:

(2) John only kissed [Mary]$_F$.

(3) John only [kissed Mary]$_F$.

(4) John only [kissed]$_F$ Mary.[1]

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[1] There is a sharp difference in the way (2) and (3) on the one hand and (4) on the other are pronounced: in (2) and (3) the main stress is on *Mary*, whereas in (4) it is on *kissed.*

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(2), (3), and (4) correspond to interpretations (5), (6), and (7) respectively:

(5) John kissed Mary and nobody else.

(6) John did nothing but kiss Mary.

(7) John did nothing to Mary but kiss her.

The nonequivalence of these three interpretations is obvious.

Notice that the truth conditions expressed by (5), (6), and (7) can have little plausibility if certain restrictions determined by the context are not taken into account. For instance, when we use (1) in the sense of (5), what we are likely to mean is not that Mary is the only person *ever* kissed by John, but rather that John did not kiss anybody else in a certain situation, or in a certain restricted range of situations, specified by the context. As to (6) and (7), it is clear that, literally taken, they are always false. Consider (6): even assuming that we are confining our attention to what John did on a given occasion, it is clear that he must have done something else besides kissing Mary. Nevertheless, if John did nothing *relevant* besides kissing Mary, the use of (1) is perfectly appropriate. Of course, what counts as relevant depends on the context. Similar remarks apply to (7).

We have nothing interesting to say here on the role played by the context in the interpretation of the sentences containing *only*. Our aim is simply to explain how paraphrases such as (5), (6), and (7) can be systematically correlated with structures such as (2), (3), and (4).

In the next sections we shall present an analysis of *only* in terms of event semantics. We find this analysis simple and natural, and it seems to us that, without events, no equally good analysis would be possible. Some motivation for the use of events is provided in this introduction.[2]

The first thing to be emphasized is that the class of expressions with which *only* can be associated is quite large: it includes not only proper names, transitive verbs, and verbal phrases (as is shown by (2)–(4)), but also complex noun phrases, determiners, common nouns, adverbs, etc. Now, some of these expressions raise serious difficulties for the analyses of *only* proposed so far. The most blatant case perhaps is that of NPs: as far as we know, a fully adequate treatment of the association of *only* with focused NPs has never appeared in the literature. So we shall proceed as follows. We shall discuss the topic of NPs at some length, trying to make the difficulties explicit and examining different possible lines of approach. It will turn out that if we restrict our attention to expressions of the form

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[2] To a large extent, the discussion contained in the present section was prompted by some penetrating remarks of Irene Heim and Angelika Kratzer.

'*only* $[\alpha]_F$', where α is a NP, then the difficulties can be overcome (at least to a large extent) without any recourse to events. But obviously expressions of this form cannot be treated independently of other kinds of occurrence of *only*, and we shall try to convince the reader that the need for events arises at this point.

To introduce the problem concerning NPs, let us consider the analysis of *only* developed by Rooth (1985) in the framework of his well-known theory of focus (but most of what we are going to say also applies to the analysis in terms of structured meanings proposed by von Stechow (1988, 1991) and Krifka (1991); see also Kratzer (1991) and Rooth (1992)). Rooth's analysis works nicely when the focused expression is a proper name, but its extension to other NPs is not so obvious. Consider a simple sentence like (8):

(8) Only $[\text{John}]_F$ cried.

The analysis proposed by Rooth is more or less the following:

(9) For every a belonging to the set of alternatives determined by $[\textit{John}]_F$, a satisfies '*cried*(x)' if and only if $a = [\![\text{John}]\!]$ (where $[\![\text{John}]\!]$ is the denotation of *John*).

The set of alternatives determined by $[\textit{John}]_F$ is the set of objects whose type is the type of $[\![\textit{John}]\!]$. Thus, if proper names are taken to denote individuals, (9) amounts to saying that an individual a satisfies '*cried*(x)' if and only if a is John, which is an obviously correct way of expressing the truth conditions of (8). So far so good. But now consider (10):

(10) Only $[\text{two boys}]_F$ cried.

An analysis of (10) similar to (9) would be:

(11) For every Q belonging to the set of alternatives determined by $[\textit{two boys}]_F$, Q satisfies 'X(*cried*)' if and only if $Q = [\![\textit{two boys}]\!]$.

Here the set of alternatives determined by $[\textit{two boys}]_F$ is the set of objects whose type is the type of $[\![\textit{two boys}]\!]$, i.e. (assuming that we are treating *two boys* as a generalized quantifier) the set of sets of sets of individuals. But such an analysis of (10) would be unacceptable: the condition stated in (11), far from capturing the content of (10), can never be fulfilled.[3] So the

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[3] Suppose $[\![\textit{two boys}]\!]$ satisfies 'X(*cried*)', i.e. *Two boys cried* is true. Then *One or more boys cried* is true as well, which means that 'X(*cried*)' is also satisfied by $[\![\textit{one or more boys}]\!]$. Since $[\![\textit{one or more boys}]\!]$ is a set of sets of individuals distinct from $[\![\textit{two boys}]\!]$, we are forced to conclude that (11) does not hold. (This argument is taken from von Stechow (1988).)

cases in which *only* is associated with complex NPs represent a serious difficulty for Rooth's analysis.[4]

Is there any way out? If we are willing to introduce suitable modifications in Rooth's analysis, can the difficulty be eliminated? Instead of tackling these questions directly, we prefer to consider a slightly different problem: is it possible to define an operator O mapping sets of sets of individuals into sets of sets of individuals such that for every NP α, $[\![only\ [\alpha]_F]\!]$ can be identified with $O([\![\alpha]\!])$? An observation due to Groenendijk and Stokhof (1990) implies a negative answer.[5] The observation is that, at first sight, *only* appears to be "nonfunctional": there are pairs of NPs α and β such that α and β seem to have the same denotation, and nevertheless the denotations of '*only* $[\alpha]_F$' and '*only* $[\beta]_F$' are different. We call this problem the "*nonfunctionality puzzle*." Let us illustrate it for the pair of NPs *a boy* and *one or more boys*. It is commonly assumed that $[\![a\ boy]\!] = [\![one\ or\ more\ boys]\!] = \{X \mid X \text{ is a set of individuals containing at least one boy}\}$. Therefore, no matter how we choose the operator O, we have $O([\![a\ boy]\!]) = O([\![one\ or\ more\ boys]\!])$, and if we use O to specify the denotation of '*only* $[\alpha]_F$' when α is a NP, we are forced to assign the same denotation to *only* $[a\ boy]_F$ and to *only* $[one\ or\ more\ boys]_F$. But this is wrong, as the following examples illustrate:

(12) Only [a boy]$_F$ cried.

(13) Only [one or more boys]$_F$ cried.

These sentences clearly have different meanings: (12) entails that the boy who cried is unique, whereas (13) does not. A similar difficulty arises with pairs of NPs such as *two boys* and *two or more boys, three boys* and *three or more boys*, etc.

As a natural reaction to the nonfunctionality puzzle, one can question

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[4] It is perhaps worth pointing out that to eliminate the difficulty, it is not enough to say that the set of alternatives must always be regarded as suitably restricted by the context. Take the following example: *Mary doesn't like reading. She has read only* [*two detective stories*]$_F$. Suppose the context in which this is said makes it clear that we are interested only in the *books* read by Mary. This means that the set of relevant alternatives does not contain the quantifiers denoted by NPs such as *John's address in the telephone directory* or *the opening instructions on a can of beans*. But the quantifiers denoted, say, by *two or three detective stories, a few detective stories*, or *two novels by Agatha Christie* are certainly not ruled out, and this suffices to raise the difficulty illustrated in the text.

[5] Actually, the problem discussed by Groenendijk and Stokhof is not that of *only*, but that of the exhaustiveness condition expressed by some answers (see section 4 below). The two problems are closely related, however; so we take the liberty, here and in the following, of reconstructing their line of reasoning as referring to *only*.

the assumption that the two NPs of each problematic pair have the same denotation. The trouble is that to assign them denotations which are distinct yet reasonable is not so easy. For instance, we could distinguish between *a boy* and *one or more boys* by treating the former as if it were synonymous with *exactly one boy*, but this would clearly be a mistake. According to Groenendijk and Stokhof, the puzzle can be solved if we assume (as many people have done) that a proper semantic treatment of NPs requires *groups*.[6] The idea is roughly the following. We extend the universe of discourse by including in it not only ordinary individuals but also every group of individuals. A group consisting of exactly one individual is identified with the individual in question. A predicate denotes a subset of the universe of discourse closed under union of groups. A NP denotes a set of sets of groups. For example, as the denotations of *a boy* and *one or more boys* we can now take $\{X \mid X$ contains a (group consisting of exactly one) boy$\}$ and $\{X \mid X$ contains a group consisting of one or more boys$\}$, respectively. This choice can be justified as follows. *A boy* and *one or more boys* are interchangeable when the predicate is distributive, not when it is collective. (*A boy cried* has the same truth conditions as *One or more boys cried*, but *A boy lifted the stone* can be false even when *One or more boys lifted the stone* is true.) Now, if quantifiers are conceived of as sets of sets of individuals, no account of collectivity is possible: all we can do is restrict ourselves to distributive contexts, take note that in those contexts *a boy* and *one or more boys* are interchangeable, and assign them the same denotation. With groups things are different. Let us suppose that *a boy* and *one or more boys* denote the sets of sets of groups specified above; then the fact that the denotation of a distributive predicate such as *cried* cannot contain a group unless it also contains its individual members explains why *A boy cried* and *One or more boys cried* are equivalent, and the fact that the denotation of a collective predicate such as *lifted the stone* can in fact contain a group without containing all its individual members explains why *A boy lifted a stone* and *One or more boys lifted the stone* are *not* equivalent.

So now we have different denotations for *a boy* on the one hand and for *one or more boys* on the other. Is this sufficient to account for the

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[6] This is the central idea of Link's algebraic semantics (see Link 1983). The reader should bear in mind that in this paper, we use the term 'group' in the sense in which Link uses 'plural individual' or 'sum'. The word 'group' has been employed by other authors to mean something else (see, for instance, Landman 1989 and Schwarzschild 1992). The distinction between 'sums' and 'groups' (in the more specialized sense of the word) is also relevant to the analysis of *only*, but discussion of this point would lead us too far.

difference between *only* [*a boy*]$_F$ and *only* [*one or more boys*]$_F$? Can we find an operator O from sets of sets of *groups* into sets of sets of *groups* such that ⟦*only* [*a boy*]$_F$⟧ = O(⟦*a boy*⟧) and ⟦*only* [*one or more boys*]$_F$⟧ = O(⟦*one or more boys*⟧)? Groenendijk and Stokhof's suggestion is that we take O = EXH, where EXH(Q) = $\{X \mid X \in Q$ and there is no proper subset Y of X such that $Y \in Q\}$ for every quantifier Q. At first sight, this suggestion is correct. EXH(⟦*a boy*⟧) only contains singletons of boys; therefore, if (12) means that the denotation of *cried* belongs to EXH(⟦*a boy*⟧), (12) cannot be true unless the boy who cried is unique. At the same time, if (13) means that the denotation of *cried* belongs to EXH(⟦*one or more boys*⟧), (13) can be true even if the boys who cried are more than one, for EXH(⟦*one or more boys*⟧) contains singletons of *groups* of boys. The fact that EXH(⟦*a boy*⟧) is properly included in EXH(⟦*one ore more boys*⟧) seems to explain why (12) entails (13) but not conversely.

A moment's reflection shows, however, that this solution to the non-functionality puzzle does not work. The reason is that the truth conditions assigned to sentences like (13) are not the right ones. Let us imagine a situation in which two boys – say, John and Peter – cried, and nobody else did. In such a situation (13) is intuitively true, but Groenendijk and Stokhof's analysis in terms of EXH makes it false. The analysis says that (13) is to be counted true if and only if ⟦*cried*⟧ is the singleton of a group of one or more boys, but in the situation we are imagining, ⟦*cried*⟧ contains three different elements: John, Peter, and the group made up of John and Peter. So EXH is not what we need.

A better choice would be an operator O defined as follows. For every set of sets of groups Q, let $Q^+ = \{g \mid \{g\} \in Q\}$ and

(14) $O(Q) = \{X \mid$ there is an $h \in Q^+$ such that $h \in X$ and g is a subgroup of h for every $g \in X\}$

If we now take ⟦*only* [*a boy*]$_F$⟧ = O(⟦*a boy*⟧) and ⟦*only* [*one or more boys*]$_F$⟧ = O(⟦*one or more boys*⟧), the difficulty faced by Groenendijk and Stokhof's proposal is avoided. Let us check that this is so. O(⟦*a boy*⟧) is easily seen to coincide with EXH(⟦*a boy*⟧), for O(⟦*a boy*⟧) = {X | there is a (group consisting of exactly one) boy h such that $h \in X$ and g is a subgroup of h for every $g \in X\}$ = {{h} | h is (a group consisting of exactly one) boy}. On the other hand, we have O(⟦one or more boys⟧) = {X | there is a group h of one or more boys such that $h \in X$ and g is a subgroup of h for every $g \in X\}$. Now, what happens in the situation described above, i.e. in the situation in which John and Peter cried and nobody else did? As we have already said, in such a circumstance ⟦*cried*⟧ contains John, Peter, and the group whose members are John and Peter. Let h be the group of John and Peter. We have that (i) h is a group of two boys; (ii) $h \in$ ⟦*cried*⟧; (iii) g is a subgroup of h for every $g \in$ ⟦*cried*⟧ (since the only elements of ⟦*cried*⟧ other than h are (the groups consisting of) John and Peter). It follows that ⟦*cried*⟧ is contained in O(⟦*one or more boys*⟧), and if O(⟦*one or more boys*⟧) is identified with ⟦*only* [*one or more boys*]$_{\mathrm{F}}$⟧, (13) turns out to be true, as required.

It is easy to see that the use of O also provides a satisfactory treatment of the other problematic pairs mentioned in the formulation of the nonfunctionality puzzle: for example, if we let ⟦*two boys*⟧ = {X | X contains a group of exactly two boys} and ⟦*two or more boys*⟧ = {X | X contains a group of two or more boys}, we are then entitled to identify ⟦*only* [*two boys*]$_{\mathrm{F}}$⟧ and ⟦*only* [*two or more boys*]$_{\mathrm{F}}$⟧ with O(⟦*two boys*⟧) and O(⟦*one or more boys*⟧), respectively. Does an analysis of '*only* $[\alpha]_{\mathrm{F}}$' in terms of O work for every NP α? The reader can check by herself that for many NPs, such as analysis is indeed appropriate. There are two difficulties, however; as we shall see, the first can easily be overcome, whereas the second is slightly more embarrassing.

The first difficulty arises with NPs such as *every boy*. As the denotation of *every boy* we can take {X | X contains every boy} (this is obviously different from {X | X contains the group of all boys}, which can be taken as the denotation of *the boys*; one of the advantages of the approach in terms of groups is that it enables us to distinguish between *every boy* and *the boys* and to explain why the former is compatible only with distributive predicates). Now, what about *only* [*every boy*]$_{\mathrm{F}}$? Some speakers find sentences such as *Only* [*every boy*]$_{\mathrm{F}}$ *cried* a little unnatural, but whatever the explanation of this fact might be, there is no doubt that *only* can be associated with NPs whose determiner is *every*, and we must account for this case, too.[7] Unfortunately, since ⟦*every boy*⟧ = {X | X contains every

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[7] Obviously, *only* [*every boy*]$_{\mathrm{F}}$ must not be confused with *only* [*every*]$_{\mathrm{F}}$ *boy*: the latter is indeed unacceptable. The naturalness of the association of *only* with a focused NP of the form '*every* α' seems to vary with the context: for instance, even the speakers who do not like sentences such as *Only* [*every boy*]$_{\mathrm{F}}$ *cried* find (i) perfectly all right.

(i) John only introduced [every priest]$_{\mathrm{F}}$ to [a nun]$_{\mathrm{F}}$.

The only NPs of the form '*every* α' incompatible with *only* are *everything, everybody*, and the like. Why *only* cannot be associated with certain NPs (and, more generally, with certain expressions of other categories) is an interesting problem on which we have little to say. We think that there is no uniform explanation. Presumably, we cannot say *Only* [*everybody*]$_{\mathrm{F}}$ *jumped* because an event in which everybody jumped is a top element (relative to event inclusion) in the class of events in which somebody jumped, and we cannot say *Only* [*every*]$_{\mathrm{F}}$ *boy jumped* because an event in which every boy jumped is a top element in the class of events in which boys jumped; *only* can never be used in sentences describing boy}, we have $\mathrm{O}([\![\textit{every boy}]\!]) = \{\mathrm{X} \mid$ there is an h such that $\{\mathrm{h}\}$ contains every boy, $\mathrm{h} \in \mathrm{X}$, and g is a subgroup of h for every $\mathrm{g} \in \mathrm{X}\} = \{\mathrm{X} \mid$ there exists exactly one boy h, and $\mathrm{X} = \{\mathrm{h}\}\}$, which means, of course, that we cannot identify $[\![\textit{only } [\textit{every boy}]_{\mathrm{F}}]\!]$ with $\mathrm{O}([\![\textit{every boy}]\!])$. This is the difficulty. We can overcome it, however, by slightly modifying the definition of O. For every set of sets of groups Q, let $\mathrm{Q}^{\#} = \{\sup(\mathrm{X}) \mid \mathrm{X} \in \mathrm{Q}$ and there is no proper subset Y of X such that $\mathrm{Y} \in \mathrm{Q}\}$ (where sup(X) is the supremum of X, i.e. the union of the groups in X; the supremum of the empty set is the empty group). We can now redefine O as follows: for every set of sets of groups Q,

(15) $\mathrm{O}(\mathrm{Q}) = \{\mathrm{X} \mid$ either $\mathrm{Q}^{\#}$ contains the empty group and X is the empty set, or $\mathrm{Q}^{\#}$ does not contain the empty group, $\mathrm{X} \in \mathrm{Q}$, and there is an $\mathrm{h} \in \mathrm{Q}^{\#}$ such that g is a subgroup of h for every $\mathrm{g} \in \mathrm{X}\}$

Let us compute $\mathrm{O}([\![\textit{every boy}]\!])$ according to this definition of O. To begin with, we have $[\![\textit{every boy}]\!]^{\#} = \{\mathrm{h} \mid$ either there are no boys and h is the empty group, or there are boys and h is the group of all boys}. Therefore, $\mathrm{O}([\![\textit{every boy}]\!]) = \{\mathrm{X} \mid$ either there are no boys and X is the empty set, or there are boys, X contains every boy, and every group in X is a group of boys}. The identification of $[\![\textit{only } [\textit{every boy}]_{\mathrm{F}}]\!]$ with $\mathrm{O}([\![\textit{every boy}]\!])$ is now possible. (It is also easy to see that (15) works for all those cases for which (14) was already adequate: notice that if Q contains singletons, $\mathrm{Q}^{\#} = \mathrm{Q}^{+}$).

The second – and perhaps more serious – of the two difficulties mentioned above concerns expressions of the form '*only* $[\alpha]_{\mathrm{F}}$' where α is a NP such as *less than ten boys* or *ten boys at most.* Let us consider, for example, *only* $[\textit{less than ten boys}]_{\mathrm{F}}$. If *less than ten boys* has to denote a set of sets of groups, the most natural choice seems to be $\{\mathrm{X} \mid$ for every g, if g is a group of boys and $\mathrm{g} \in \mathrm{X}$, then g has less than ten members}. The problem is that the denotation of *only* $[\textit{less than ten boys}]_{\mathrm{F}}$ is something completely different from the set of sets of groups we obtain by applying O to $\{\mathrm{X} \mid$ for every g, if g is a group of boys and $\mathrm{g} \in \mathrm{X}$, then g has less than ten members}, whether we define O as in (14) or as in (15). Should we try a third definition? Unfortunately, *no* definition would be appropriate. Here is why. Consider the NPs *less than seventy Miss World's* and

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events which turn out to be such top elements. *Only* is also banned from sentences describing events that are bottom elements in classes of events of the kind just mentioned. This explains the unacceptability of *only* $[\textit{nothing}]_{\mathrm{F}}$, *only* $[\textit{nobody}]_{\mathrm{F}}$, etc. But other cases cannot be accounted for along the same lines. For instance, why is *only* $[\textit{at least two boys}]_{\mathrm{F}}$ so bad, whereas *only* $[\textit{two or more boys}]_{\mathrm{F}}$ is acceptable? (Maybe the explanation has to do with the fact that *at least* is itself a focus operator.)

less than seventy Fields medals. Since the Miss World's and the winners of the Fields medal are actually less than seventy, we have $\{X \mid$ for every g, if g is a group of Miss World's and g $\in$ X, then g has less than seventy members$\}$ = $\{X \mid X$ is a set of groups$\}$ = $\{X \mid$ for every g, if g is a group of winners of the Fields medal and g $\in$ X, then g has less than seventy members$\}$. So the denotation of the two NPs is the same. It follows that no matter how O is defined, the application of O to the denotation of *less than seventy Miss World's* gives the same result as the application of O to the denotation of *less than seventy Fields medals.* Therefore, no matter how O is defined, O cannot provide a suitable denotation for *only* [*less than seventy Miss World's*]$_F$ and *only* [*less than seventy Fields medals*]$_F$, since *only* [*less than seventy Miss World's*]$_F$ and *only* [*less than seventy Fields medals*]$_F$ are clearly not interchangeable. (The meaning of *Only* [*less than seventy Miss World's*]$_F$ *have such an exceptional IQ* is clearly distinct from that of *Only* [*less than seventy Fields medals*]$_F$ *have such an exceptional IQ*.) This is, of course, a new instance of the nonfunctionality puzzle. Is there any solution? We could decide that the NPs in question are not really monotonic decreasing, and that *less than n* entails *at least one*. Then the denotations assigned to *less than seventy Miss World's* and to *less than seventy Fields medals* would be distinct, and the difficulty would no longer arise. But we are not sure that such a move would not be ad hoc.

Let us take stock. We have seen that if NPs are conceived of as expressions denoting sets of sets of individuals, it is impossible to find an operator O such that for every NP α, $[\![$*only* $[\alpha]_F]\!] = O([\![\alpha]\!])$. On the other hand, if we follow Groenendijk and Stokhof's suggestion and exploit the fact that the semantic treatment of NPs can involve groups, we can come close to a positive solution of the problem. If O is defined as in (15), O provides a satisfactory analysis of '*only* $[\alpha]_F$' for a large class of NPs α. The only remaining difficulty is that concerning NPs like *less than ten boys* or *ten boys at most.*

We can now turn to the question: why do we think that a good analysis of *only* requires events? We have said that one of the inadequacies of the analyses proposed so far is their inability to account for all the cases in which *only* is associated with a focused NP. But the preceding discussion shows that a reasonable treatment of expressions of the form '*only* $[\alpha]_F$', where α is a NP, can be achieved simply by adding groups to the universe of discourse. So far at least, events seem unnecessary. Why should we draw them into the picture, then? (It will be shown in the next section that events enable us to deal with NPs like *less than ten boys* without renouncing the assumption that they are monotonically decreasing; but this could be considered too modest an advantage to justify the use of events.) The answer is that the analysis of '*only* $[\alpha]_F$', where α is a NP, is not an end in itself. What we want is a *uniform* explanation of how *only* can be associated with expressions of different categories (including NPs, of course), but as far as we can see, without the resources of event semantics such a uniform explanation would be very difficult to attain: we would be forced to treat different categories in different ways, and this would be highly unsatisfactory. To make this point clearer, let us go back to Rooth's theory. The analysis of '*only* $[\alpha]_F$', where α is a NP, in terms of the operator O defined in (15) can be translated quite easily into a clause à la Rooth. For example, one can assume that the set of alternatives determined by a focused NP consists of those sets of sets of groups Q such that for some group g, $Q = \{X \mid X \text{ contains } g\}$. Then one can say that a sentence of the form '*Only* $[\alpha]_F$ β', where α is a NP and β is a VP, is true if and only if

(16) Either $[\![\alpha]\!]^{\#}$ contains the empty group and $[\![\beta]\!]$ is the empty set, or $[\![\alpha]\!]^{\#}$ does not contain the empty group, $[\![\beta]\!] \in [\![\alpha]\!]$, and there is an $h \in [\![\alpha]\!]^{\#}$ such that for every Q belonging to the set of alternatives determined by $[\alpha]_F$, if $[\![\beta]\!] \in Q$ and $g \in Q^{\#}$, then g is a subgroup of h.

((16) is "à la Rooth" in the sense that the truth conditions of '*Only* $[\alpha]_F$ β' are specified in terms of $[\![\alpha]\!]$, $[\![\beta]\!]$ and the set of alternatives determined by $[\alpha]_F$.) So it might seem that to remedy the inadequacy of Rooth's analysis concerning the association of *only* with NPs, all we have to do is admit groups into the universe of discourse and add (16) (plus something else, perhaps) to the clauses already formulated by Rooth. Such a move would indeed enable us to assign correct truth conditions to sentences not covered by Rooth's original analysis (for an important qualification, see below). The trouble is, however, that (16) and the clauses provided by Rooth have very little in common; it is impossible to see them as different instances of the same general schema (unless, of course, the schema is formulated in a completely ad hoc way). And, if we are unwilling to enrich our ontology any further, the difficulty is insurmountable: no matter how many adjustments we make, we shall always end up with a list of heterogeneous and partially unrelated clauses that certainly could not be regarded as giving us *the* meaning of *only*. (The approach in terms of structured meanings raises exactly the same problem.) On the other hand, if we employ event semantics – or, more exactly, a version of event semantics making use of groups – a uniform representation of the truth conditions of all sentences containing *only* becomes possible. As will be shown, a sentence with *only* can always be interpreted, irrespective of the category of the focus with which *only* is associated, as stating that every event of a certain kind is included in an event of another kind. (Such a representation in terms of events could also be a first step toward a unified account of the "nonscalar" and "scalar" readings of *only*. The issue of scalarity is beyond the scope of the present paper, but see the remarks in section 4.)

One last observation about Rooth's theory. What has been said so far might give the impression that if we are not interested in conceptual coherence and perspicuity – if we are just looking for a formal machinery assigning correct truth conditions to sentences – then the extension of Rooth's approach to cases in which *only* is associated with NPs other than proper names only requires the inclusion of groups into the universe of discourse. But this is not true. In the preceding discussion, we have confined our attention to expressions of the form '*only* $[\alpha]_F$' where α is a NP, and the occurrence of *only* in such expressions can indeed be treated by means of clauses like (16). We should bear in mind, however, that *only* is not always contiguous to the focused NP with which it is associated. For example, instead of saying *John kissed only* $[\textit{Mary}]_F$, we can say *John only kissed* $[\textit{Mary}]_F$ (this was sentence (2)). Or, instead of saying *Mary kissed only* $[\textit{the boy scouts}]_F$, we can say (17):

(17) Mary only kissed [the boy scouts]$_F$.

Now, it can be proved that there is absolutely no way of accounting for a sentence like (17) in the framework of Rooth's theory. Groups are of no help here. Let us see why. For an analysis of (17) in the style of Rooth to be possible, we should be able to define the extension of *only kissed* $[\textit{the boy scouts}]_F$ in terms of the intension of *kissed the boy scouts* and of the set of alternatives determined by *kissed* $[\textit{the boy scouts}]_F$. But it turns out that such a definition does not exist. The actual proof is a bit tedious, but the idea behind it is extremely simple. Let us suppose we are working with models which are like the usual ones except that the domain of individuals is replaced by a domain of groups. What is the set of alternatives determined by *kissed* $[\textit{the boy scouts}]_F$? The answer depends on what one has chosen as the set of alternatives determined by $[\textit{the boy scouts}]_F$. If the latter is specified as in (16), then the former will be the set whose elements are the intensions of expressions of the type '*kissed* A', where A denotes in every possible world the set of sets of groups containing a certain group g. (There are other possible options, but they only require slight changes in the argument.) Now, let us consider a model containing in particular two worlds v and w with the following properties: (i) the only difference between v and w is that in v the boy scouts are John and David, whereas in w the boy scouts are John, David, and Peter; (ii) in both worlds, the individuals kissed by Mary are John, David, and Peter. It follows that Mary belongs to the extension of *only kissed* [*the boy scouts*]$_F$ in w but not in v. On the other hand, no condition expressed in terms of the intension of *kissed the boy scouts* and of the relevant set of alternatives can discriminate between v and w. The reason is that the intension of *kissed the boy scouts* and the set of alternatives are the same in v and in w, and that the information about the worlds contained in these two objects does not make any difference between v and w (on the one hand, the extension of *kissed the boy scouts* is the same in v and w, and on the other, for every x and y, x kissed y in v if and only if x kissed y in w).

The rest of the present paper is organized as follows. In the next section we present our analysis in terms of events for a fragment of language in which *only* occurs only in expressions of the form '*only* $[\alpha]_F$' where α is a NP. In doing so, of course, we do not disavow what we have been saying about the need for a unified and systematic treatment of all contexts in which *only* can occur. We just think that by starting off with this special case, we can make it easier for the reader to grasp certain basic aspects of our approach. The extension of our analysis to a wider range of situations is performed in section 3, which is the core of our work. Finally, in section 4 we sketch some possible developments. Our exposition will be as neutral as possible, in the sense that we will not discuss the possibility of integrating our analysis of *only* in terms of events into current theories of focus; this could be the topic of another paper.

2. NPs IN FOCUS

Let us begin by sketching the main principles of our event semantics, which is similar to the "algebraic" version of event semantics of Krifka (1989).[8] We use models whose domain contains two sorts of elements: events[9] and objects. The set of events and the set of objects are structured as complete Boolean algebras.[10] By $\cup_E$ and $\cap_E$ we denote the join and

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[8] The idea of extending to events the algebraic approach to the semantics of NPs proposed in Link (1981) goes back to Bach (1986). For further developments see Link (1987) and Krifka (1989).

[9] Like Link (1987) and Krifka (1989), we use the word 'event' in a very wide sense, ignoring finer classifications (such as the distinction among events proper, processes, and states).

[10] Recall that a Boolean algebra is complete if every set of elements of the algebra has a supremum.

the meet of the algebra of events, by $\cup_O$ and $\cap_O$ the join and the meet of the algebra of objects. $\subseteq_E$ and $\subseteq_O$ are the "natural" partial orderings of the two structures, $\mathbf{0}_E$ and $\mathbf{0}_O$ their bottom elements (the null event and the null object). The assumption that any set of events has a supremum means that given any set of events, the events in the set can be seen as the constituent parts of a larger event. (So our events are very abstract constructs; for instance, no spatio-temporal unity is presupposed.) The set of objects is conceived of as containing not only ordinary individuals, which correspond to atoms of the Boolean algebra,[11] but also groups of individuals. Given two groups x and y, their join $x \cup_O y$ is nothing else but their "union" or "sum", i.e. the group whose members are the members of x plus the members of y. More generally, the supremum of a set X of groups is the union or sum of the groups in X, i.e. the group whose members are exactly those contained in some element of X. As in section 1, we ignore the distinction between an individual and the group whose only member is that individual. Events are related to objects by "thematic relations": we shall consider in particular the thematic relations of "agent" and "patient".

We assume that our models satisfy the following conditions:

(I) Thematic relations are partial functions from events to objects; thus, if an event has an agent, the agent is unique, and if an event has a patient, the patient is unique. In those cases in which we might be tempted to say that each of several individuals is an agent of a certain event e, we must say instead that the (unique) agent of e is the group formed by all those individuals. Similarly for patients.

(II) Let X be a nonempty set of events with an agent and let e be the supremum of X. Then the agent of e is the supremum of $\{x \mid x$ is an object and x is the agent of f for some $f \in X\}$. Similarly for patients.

(III) $\mathbf{0}_O$ can be neither the agent nor the patient of an event, unless the event in question is $\mathbf{0}_E$.

Starting from the basic types t (the type of truth values), o (the type of objects), and e (the type of events), we can construct complex types by applying the following rule: if σ and τ are types, then (σ, τ) is a type. The formal language we shall make use of contains expressions of every type. We shall employ x, y, . . . as variables of type o, and e, f, . . . as variables of type e.

We can now illustrate the analysis of *only* to be developed in the

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[11] Recall that an element x of a Boolean algebra is an atom if x is not the bottom element and, for every element y such that $y \leqslant x$, either y is the bottom element or $y = x$.

following pages. Let us go back to the simplest example introduced so far, i.e. (8): *Only* $[John]_F$ *cried.* Our starting point is the observation that the content of (8) can be paraphrased as follows: John cried, and every event of crying is included in an event of crying whose agent is John. If we translate this paraphrase into the language of event semantics, the result is (18):

(18) $\exists e[\mathbf{cried}'(e) \,\&\, AG(e, \mathbf{John}')] \,\&\, \forall f[\mathbf{cried}'(f) \rightarrow \exists g[\mathbf{cried}'(g) \,\&\, AG(g, \mathbf{John}') \,\&\, f \subseteq_E g]]$

where **cried**′ is a constant of type (e, t) denoting a set of events other than $\mathbf{0}_E$ (intuitively, the events of crying), **John**′ is a constant of type o denoting an atom in the Boolean algebra of objects (intuitively, (the group whose only member is) John), and AG denotes the thematic relation of agent.

If the reader is not yet convinced that (18) is a correct way of representing the content of (8), here is an explicit argument. Everybody would presumably agree[12] that (8) can be reasonably paraphrased as follows: for every x, x cried if and only if x is John; or, to put it in slightly different terms: for every x, x is the agent of an event of crying if and only if x is John. In symbols,

(19) $\forall x[\exists f[\mathbf{cried}'(f) \,\&\, AG(f, x)] \leftrightarrow x = \mathbf{John}']$

Now, (18) and (19) are easily seen to be equivalent. Every event of crying has an agent (this is ensured by a suitable meaning postulate). Therefore, by the conditions (II) and (III) introduced above, an event of crying f is included in an event whose agent is John if and only if the agent of f is John. It follows that the second conjunct of (18) is equivalent to $\forall x[\exists f[\mathbf{cried}'(f) \,\&\, AG(f, x)] \rightarrow x = \mathbf{John}']$. On the other hand, it is obvious that the first conjunct of (18) is equivalent to $\forall x[x = \mathbf{John}' \rightarrow \exists f[\mathbf{cried}'(f) \,\&\, AG(f, x)]]$.

The advantage of (18) over (19) is, as we shall see, that it exemplifies a form of representation which can be extended to every sentence containing *only*, irrespective of the kind of expression with which *only* is associated. (Moreover, we shall argue that this form of representation is a good starting-point for a unified account of the nonscalar and scalar readings of *only*; see section 4.) In this section we try to convince the reader that the form of representation exemplified by (19) is appropriate

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[12] At least, if all the subtleties concerning the presupposition/assertion distinction are left aside. In the present paper, to keep the overall picture as simple as possible, we shall ignore this aspect of the matter.

for any sentence containing an expression of the form '*only* $[\alpha]_F$' where α is a NP.

We shall now sketch a compositional procedure for translating into logical forms the sentences of a small fragment of language. Since for the time being our attention is confined to occurrences of *only* of the sort just described, we can assume that in the fragment the occurrences of *only* are introduced by a syntactic rule which changes a NP α not containing *only* into a new NP '*only* $[\alpha]_F$'. The translation of an I(ntransitive)V(erb) will be an expression of type (o, (e, t)). The translation of a T(ransitive)V(erb) will be an expression of type (o, (o, (e, t))). The translation of a NP will be an expression of type ((o, (e, t)), (e, t)). The translation of a S(entence) will be obtained in two steps (as usual in event semantics): we shall first map the S into an expression of type (e, t), the so-called "intermediate" translation; then we shall take the existential closure of the intermediate translation as the "official" translation of the S.[13] Instead of giving a fully detailed description of the translation algorithm, we shall now illustrate it by means of a series of examples.

To begin with, we want to explain how the translation algorithm can be applied to (8). As a preliminary, let us consider the corresponding sentence without *only.*

EXAMPLE 1

We want to translate (20):

(20) John cried.

Let us suppose we have a syntactic rule S1 which combines a NP and an IV into a S. We can assume that (20) has been obtained by means of S1. The translations of *John* and *cried* are

$$\lambda F \lambda e F(\mathbf{John}')(e)$$

and

$$\lambda x \lambda e[\mathbf{cried}'(e) \,\&\, AG(e, x)]$$

respectively. (F is a variable of type (o, (e, t)), **John**′ is a constant of type o which denotes an individual, i.e. an atom in the Boolean algebra of objects, **cried**′ is a constant of type (e, t).) We now assume that the translation rule

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[13] More precisely: if A is the expression of type (e, t) associated with the S, the official translation of the S will be $\exists eA(e)$ (in the present section we always use the term 'existential closure' in this sense).

corresponding to S1 is a rule which says that we must perform a functional application of the translation of the NP to the translation of the IV. Let us call this rule T1. In the present case the application of T1 gives

$$\lambda F \lambda e[F(\mathbf{John'})(e)]\,(\lambda x \lambda e[\mathbf{cried'}(e) \,\&\, AG(e, x)])$$

which is equivalent, by λ-conversion, to

(21) $\lambda e[\mathbf{cried'}(e) \,\&\, AG(e, \mathbf{John'})]$

(21) is the intermediate translation of (20). As explained above, we obtain the final translation by performing an existential closure. What we get in this way is (equivalent to)

$$\exists e[\mathbf{cried'}(e) \,\&\, AG(e, \mathbf{John'})]$$

In words: there was an event of crying whose agent was John.

EXAMPLE 2

Let us now revert to (8):

(8) Only [John]$_F$ cried.

We assume that (8) is obtained from *only* [*John*]$_F$ and *cried* by means of S1, and that *only* [*John*]$_F$ is obtained from *John* by means of the rule – call it SO – which turns a NP α into the NP *only* [α]$_F$. We now come to the crucial point: the formulation of the translation rule corresponding to SO. We call it TO.

TO: Suppose β is a NP obtained by means of SO from a NP α, and let A be the translation of α. Then the translation of β will be $\mathbf{O}(A)$, where $\mathbf{O}$ is the operator of type (((o, (e, t)), (e, t)), ((o, (e, t)), (e, t))) defined as follows:

$$\mathbf{O} =_{df} \lambda Q \lambda F \lambda e[Q(F)(e) \,\&\, \forall f[\exists x F(x)(f) \rightarrow \exists g[Q(F)(g) \,\&\, f \subseteq_E g]]]$$

Here Q is a variable of type ((o, (e, t)), (e, t)). The translation of *only* [*John*]$_F$ obtained by applying TO is

$$\lambda Q \lambda F \lambda e[Q(F)(e) \,\&\, \forall f[\exists x F(x)(f) \rightarrow \exists g[Q(F)(g) \,\&\, f \subseteq_E g]]]\,(\lambda F \lambda e F(\mathbf{John'})(e))$$

which is equivalent to

$$\lambda F \lambda e[F(\mathbf{John'})(e) \,\&\, \forall f[\exists x F(x)(f) \rightarrow \exists g[F(\mathbf{John'})(g) \,\&\, f \subseteq_E g]]]$$

We can now apply T1 and obtain the intermediate translation of (8), which turns out to be equivalent to

$$\lambda e[[\mathbf{cried}'(e) \mathbin{\&} AG(e, \mathbf{John}')] \mathbin{\&} \forall f[\exists x[\mathbf{cried}'(f) \mathbin{\&} AG(f, x)] \rightarrow \exists g[\mathbf{cried}'(g) \mathbin{\&} AG(g, \mathbf{John}') \mathbin{\&} f \subseteq_E g]]]$$

So the final translation is (22):

$$\exists e[[\mathbf{cried}'(e) \mathbin{\&} AG(e, \mathbf{John}')] \mathbin{\&} \forall f[\exists x[\mathbf{cried}'(f) \mathbin{\&} AG(f, x)] \rightarrow \exists g[\mathbf{cried}'(g) \mathbin{\&} AG(g, \mathbf{John}') \mathbin{\&} f \subseteq_E g]]] \tag{22}$$

(22) is not quite the same as (18), which we have seen to be a reasonable way of representing the content of (8). But the differences between the two formulas are inessential; notice in particular that, since every event of crying has an agent, $\exists x[\mathbf{cried}'(f) \mathbin{\&} AG(f, x)]$ is equivalent to $\mathbf{cried}'(f)$.

We must now take up NPs other than proper names and show that if the translation of a NP α is chosen in a sensible way, then the translation of '*only* $[\alpha]_F$' provided by our rule TO is always correct. We start from the NPs *a boy* and *one or more boys* (this was one of the pairs of NPs which gave rise to the nonfunctionality puzzle discussed in section 1).

EXAMPLE 3

We want to translate (23):

(23) A boy cried.

This sentence is obtained by means of S1 from *a boy* and *cried.* As the translation of *a boy* we take the following:

$$\lambda F \lambda e \exists x[\text{A-BOY}(x) \mathbin{\&} F(x)(e)]$$

Here A-BOY(x) means that x is a group containing only one individual member, and that member is a boy.[14] It would be easy to derive this translation from the translation of *boy* (a constant of type (o, t)) and the translation of *a* (a suitable expression of type ((o, t), ((o, (e, t)), (e, t)))). But for the moment we are not interested in such a derivation. Let us apply T1: the intermediate translation of (23) turns out to be the following (modulo λ-conversion, of course):

$$\lambda e \exists x[\text{A-BOY}(x) \mathbin{\&} \mathbf{cried}'(e) \mathbin{\&} AG(e, x)] \tag{24}$$

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[14] More precisely, A-BOY(x) stands for the following formula:

$$[\mathbf{boy}'(x) \mathbin{\&} x \neq \mathbf{0}_O \mathbin{\&} \forall y[[y \subseteq_O x \mathbin{\&} y \neq x] \rightarrow y = \mathbf{0}_O]]$$

i.e., x belongs to the set of objects denoted by **boy**′, and x is an atom of the Boolean algebra of objects.

The final translation is obtained from (24) by existential closure:

(25) $\exists e \exists x[\text{A-BOY}(x) \,\&\, \mathbf{cried}'(e) \,\&\, \text{AG}(e, x)]$.

In words: there was a crying whose agent was a boy.

EXAMPLE 4

Let us now consider (26):

(26) One or more boys cried.

Our translation of *one or more boys* is the following:

$$\lambda F \lambda e \exists x[\text{ONE-OR-MORE-BOYS}(x) \,\&\, F(x)\,(e)].$$

Here ONE-OR-MORE-BOYS(x) means that x is a group whose members are boys.[15] So the intermediate translation of (26) we obtain by applying T1 is (27):

(27) $\lambda e \exists x[\text{ONE-OR-MORE-BOYS}(x) \,\&\, \mathbf{cried}'(e) \,\&\, \text{AG}(e, x)]$

Finally, the existential closure of (27) is (28):

(28) $\exists e \exists x[\text{ONE-OR-MORE-BOYS}(x) \,\&\, \mathbf{cried}'(e) \,\&\, \text{AG}(e, x)]$

A point to be emphasized is that in our semantics (28) is equivalent to (25). In other words, the truth conditions we have assigned to (26) coincide with the truth conditions we have assigned to (23). Let us explain *why* (28) and (25) are equivalent. Obviously the set of events denoted by (24) is included in the set of events denoted by (27): this suffices to conclude that the existential closure of (24), i.e. (25), entails the existential closure of (27), i.e. (28). The entailment in the opposite direction is justified as follows. Since *cry* is a distributive verb, we must have a meaning postulate saying that, if x is a group which is the agent of an event of crying and y is an individual member of the group x, then there is an event of crying whose agent is y. Given this meaning postulate, it is easy to see that (28) entails (25), as required. (Obviously, the meaning postulate we have just appealed to is nothing else but a translation into our version of event semantics of the characterization of the distributivity of *cry* in terms of groups: if a group of persons cried, then each individual member of the group cried.)

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[15] Instead of ONE-OR-MORE-BOYS(x), we could simply write **boy**′(x); we write ONE-OR-MORE-BOYS(x) to remind the reader that the formula in question is the result of combining the translation of *one or more* with the translation of *boy*.

EXAMPLE 5

We now want to verify that the treatment of *a boy* and *one or more boys* described in the previous examples together with the translation rule TO provides a solution to the nonfunctionality puzzle. To begin with, let us consider the following sentence:

(29) Only [a boy]$_{\mathrm{F}}$ cried.

(29) is derived from *only* [*a boy*]$_{\mathrm{F}}$ and *cried* by an application of S1; *only* [*a boy*]$_{\mathrm{F}}$ is obtained by applying SO to *a boy*. It is easy to see that the translation of *only* [*a boy*]$_{\mathrm{F}}$ provided by TO is equivalent to

$$\lambda F \lambda e[\exists x[\text{A-BOY}(x) \;\&\; F(x)(e)] \;\&\; \forall f[\exists x F(x)(f) \rightarrow \exists g[\exists x[\text{A-BOY}(x) \;\&\; F(x)(g)] \;\&\; f \subseteq_{E} g]]]$$

If we now apply the translation of *only* [*a boy*]$_{\mathrm{F}}$ to the translation of *cried* and perform the required λ-conversions, we obtain

$$\lambda e[\exists x[\text{A-BOY}(x) \;\&\; \mathbf{cried}'(e) \;\&\; \text{AG}(e, x)] \;\&\; \forall f[\exists x[\mathbf{cried}'(f) \;\&\; \text{AG}(f, x)] \rightarrow \exists g[\exists x[\text{A-BOY}(x) \;\&\; \mathbf{cried}'(g) \;\&\; \text{AG}(g, x)] \;\&\; f \subseteq_{E} g]]]$$

whose existential closure is equivalent to (30):

$$\exists e[\exists x[\text{A-BOY}(x) \;\&\; \mathbf{cried}'(e) \;\&\; \text{AG}(e, x)] \;\&\; \forall f[\exists x[\mathbf{cried}'(f) \;\&\; \text{AG}(f, x)] \rightarrow \exists g[\exists x[\text{A-BOY}(x) \;\&\; \mathbf{cried}'(g) \;\&\; \text{AG}(g, x)] \;\&\; f \subseteq_{E} g]]] \tag{30}$$

To convince the reader of the adequacy of (30), we show that in our models for event semantics (30) is true if and only if (31) is true:

$$\exists y[\text{A-BOY}(y) \;\&\; \forall x[\exists f[\mathbf{cried}'(f) \;\&\; \text{AG}(f, x)] \leftrightarrow x = y]] \tag{31}$$

(31) is an obviously correct way of expressing the content of (29). It can be read as follows: there is a boy y such that, for every x, x is the agent of an event of crying if and only if x = y. It is clear that $\exists e \exists x[\text{A-BOY}(x) \;\&\; \mathbf{cried}'(e) \;\&\; \text{AG}(e, x)]$ is equivalent to $\exists y[\text{A-BOY}(y) \;\&\; \forall x[x = y \rightarrow \exists f[\mathbf{cried}'(f) \;\&\; \text{AG}(f, x)]$; so all we have to do to show that (30) is equivalent to (31) is to prove the equivalence of the subformula of (30) introduced by the universal quantifier and $\exists y[\text{A-BOY}(y) \;\&\; \forall x[\exists f[\mathbf{cried}'(f) \;\&\; \text{AG}(f, x)] \rightarrow x = y]]$. By condition (II) formulated above, to say that every event of crying is included in an event of crying whose agent is a boy is the same as saying that the agent of every event of crying is a boy. To complete the proof, it suffices to verify that the agent of every event of crying is a boy if and only if there is a unique boy y such that the agent of every event of crying is y. The entailment from right to left is trivial. To prove the entailment in the other direction, let us suppose that there are

two events of crying f' and f'' with agents y' and y'' respectively, $y' \neq y''$. By condition (II), the agent of $f = f' \cup_E f''$ is $y = y' \cup_O y''$, and since y is a group of more than one member, A-BOY(y) does not hold. But f is an event of crying, because the sum of two events of crying is again an event of crying; so there is an event of crying whose agent is not a boy.

One last remark. In the preceding argument, we have used the fact that the sum of two events of crying is an event of crying. As a matter of fact, we assume a meaning postulate which says that the set of events E denoted by **cried′** (like any other set of events corresponding to a simple verb) satisfies the following condition: if F is a nonempty set of events other than $\mathbf{0}_E$, then the supremum of F belongs to E if and only if F is a subset of E.[16] This meaning postulate will be exploited again and again in the following pages (usually without being explicitly mentioned).

EXAMPLE 6

Let us now consider (32):

(32) Only [one or more boys]$_F$ cried.

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[16] Some versions of event semantics make use of principles which are (or seem to be) incompatible with this meaning postulate, so a brief comment is in order. The postulate consists of two parts. The first part says that the set of events denoted by a verb is "cumulative", i.e. it contains the supremum of each of its nonempty subsets (this is all we need in the present section). Now, cumulativity is a rather intuitive notion; besides, it has an independent motivation in the role it can play in the explanation of linguistic facts which have nothing to do with those discussed in the present paper (see Krifka 1989). The second part of our meaning postulate says that if the supremum of a set F of events $\neq \mathbf{0}_E$ belongs to the set of events E denoted by a verb, then F is a subset of E. This can be reformulated as follows: if $e \in E$, $f \subseteq_E e$ and $f \neq \mathbf{0}_E$, then $f \in E$. The reader might have the impression that such an assumption is unjustified. Suppose John cleared the table, and one of the several things he did to clear the table was to remove a book. So we have two events: John's clearing the table, and John's removing the book. Call these two events e and f respectively. Since f is, in a sense, "part" of e, one might be tempted to conclude that $f \subseteq_E e$, and since f is not an event of clearing whereas e is, one might claim that this is a counterexample to the second half of our meaning postulate. (Notice that this could also be used as a counterexample to our condition (II): the patient of f is the book and the patient of e is the table, but although f is part of e, the book is not part of the table.) The answer to an objection of this kind is very simple: the relation holding between the two events described above is *not* the same relation as $\subseteq_E$. Instead, it is the relation of "lumping" investigated by Kratzer (1989). Irene Heim and Angelika Kratzer have pointed out to us that this relation too is relevant to the analysis of *only*: if an event e lumps an event f, then e and f cannot both belong to the range of alternatives to be taken into account in evaluating the uniqueness condition expressed by a given occurrence of *only*. For instance, if removing the book was one of the things John did to clear the table, then we cannot say that *John only* [*cleared the table*]$_F$ is false *because* John, besides clearing the table, also removed the book.

Once again the sentence is obtained by means of S1 and the NP is obtained by means of SO. The translation of *only* [*one or more boys*]$_F$ given by TO is equivalent to

$$\lambda F\lambda e[\exists x[\text{ONE-OR-MORE-BOYS}(x)\ \&\ F(x)(e)]\ \&\ \forall f[\exists xF(x)(f) \rightarrow \exists g[\exists x[\text{ONE-OR-MORE-BOYS}(x)\ \&\ F(x)(g)]\ \&\ f \subseteq_E g]]]$$

As a consequence, the intermediate translation of (32) obtained by applying T1 is equivalent to

$$\lambda e[\exists x[\text{ONE-OR-MORE-BOYS}(x)\ \&\ \mathbf{cried}'(e)\ \&\ AG(e,x)]\ \&\ \forall f[\exists x[\mathbf{cried}'(f)\ \&\ AG(f,x)] \rightarrow \exists g[\exists x[\text{ONE-OR-MORE-BOYS}(x)\ \&\ \mathbf{cried}'(g)\ \&\ AG(g,x)]\ \&\ f \subseteq_E g]]]$$

We can now perform the existential closure and obtain (33):

$$\exists e[\exists x[\text{ONE-OR-MORE-BOYS}(x)\ \&\ \mathbf{cried}'(e)\ \&\ AG(e,x)]\ \&\ \forall f[\exists x[\mathbf{cried}'(f)\ \&\ AG(f,x)] \rightarrow \exists g[\exists x[\text{ONE-OR-MORE-BOYS}(x)\ \&\ \mathbf{cried}'(g)\ \&\ AG(g,x)]\ \&\ f \subseteq_E g]]] \tag{33}$$

The reader can verify by herself that (33) is equivalent to (34):

$$\exists y[\text{ONE-OR-MORE-BOYS}(y)\ \&\ \exists f[\mathbf{cried}'(f)\ \&\ AG(f,y)\ \&\ \forall x[\exists f[\mathbf{cried}'(f)\ \&\ AG(f,x)] \rightarrow x \subseteq_O y]]] \tag{34}$$

(In words: there is a group y consisting of one or more boys which is the agent of an event of crying, and every agent of an event of crying is included in y.) Clearly, (34), and therefore (33), correctly represent the content of (32). In particular, (33) is not equivalent to (30) (our translation of *Only* [*a boy*]$_F$ *cried*): the nonfunctionality puzzle for the pair consisting of *a boy* and *one or more boys* has been solved.

It should be clear that this solution to the nonfunctionality puzzle is based on the strategy described in section 1 without any reference to events. The puzzle arises from the fact that *a boy* and *one or more boys* are often treated as having the same denotation. But these two NPs are interchangeable only in distributive contexts; we are entitled to assign them different denotations provided we can show that when the context is distributive, this difference is neutralized. In section 1 we discussed the possibility of distinguishing between *a boy* and *one or more boys* by saying that '*A boy* α' is true if a boy is the extension of the predicate α, whereas '*One or more boys* α' is true if the extension of α contains a group of one or more boys. The idea behind the analysis developed in Examples 3–6 is basically the same; the only novelty is that the relevant groups are now conceived of not as elements of the extensions of the VPs, but as agents of the events specified by the VPs.

It is easy to see that our treatment of expressions of the form '*only* $[\alpha]_F$' for α = *John, a boy,* or *one or more boys* can be extended to many other NPs α; for instance, to NPs such as *John and Mary, John or Mary, boys, some boys, two (three, . . .) boys, two (three, . . .) or more boys, the boys, one half of the boys, many boys, most boys, an odd number of boys, between ten and twenty boys,* etc. The reader can easily guess how these NPs are dealt with in our event semantics, and in each case she can easily verify that the application of TO gives a correct result. We shall not discuss all these examples in detail. Instead we shall examine the two cases which in section 1 were seen to require special care: the case of NPs like *every boy* and that of NPs like *less than ten boys.*

EXAMPLE 7

We know that *every boy* is incompatible with a nondistributive reading of the predicate and that this is one of the main differences between *every boy* and *the boys.* Suppose the team of the boys won a chess tournament against the team of the girls. Then sentence (35) would be true, but (36) could be false:

(35) The boys won.

(36) Every boy won.

For instance, (36) would be false if John (one of the boys) had lost all his games. It follows that

$$\exists e \exists x[\mathrm{SUP_O}(x, \mathbf{boy}') \,\&\, \mathbf{won}'(e) \,\&\, \mathrm{AG}(e, x)]$$

(in words: the supremum of the set of the groups of boys, i.e. the group containing all the boys, is the agent of an event of winning) is acceptable only as a translation of (35), not as a translation of (36). The actual choice of translation for (36) requires a little reflection. One might try something like (37):

(37) $\exists e \forall x[\text{A-BOY}(x) \rightarrow \exists f[f \subseteq_E e \,\&\, \mathrm{AG}(f, x) \,\&\, \mathbf{won}'(f)]]$

To obtain (37) as the translation of (36), it would obviously suffice to translate *every boy* as (38):

(38) $\lambda F \lambda e \forall x[\text{A-BOY}(x) \rightarrow \exists f[f \subseteq_E e \,\&\, F(x)(f)]$

Now, it is unquestionable that (37) expresses the truth conditions of (36) correctly. (37) says that there is an event e such that for every boy x, x is the agent of an event of winning included in e; so (37) cannot be true unless each of the boys has gained his own individual victory. In spite of its prima facie plausibility, however, this way of translating (36) would not be adequate. Consider the expression we obtain when the leftmost existential quantifier of (37) is replaced by a lambda: this expression (which would be the intermediate translation of (36) if (37) were its official translation) denotes the set of events which include, for every boy x, a victory of x. The problem is that an event which includes, for every boy x, a victory of x, can include much else besides. So the treatment of (36) would contrast with the treatment of other sentences, for instance of a sentence like *John won*, because the set denoted by the intermediate translation of *John won* contains only events *consisting* of a victory of John, not events *properly including* such a victory. And it is not hard to see that such lack of conceptual coherence would have immediate repercussions on the question which is our main concern here. Suppose we translate *only* [*every boy*]$_{\mathrm{F}}$ by applying TO to (37). Then the translation of, say, (39)

(39) Only [every boy]$_{\mathrm{F}}$ won.

turns out to be paraphrasable as follows: every boy won, and every event of winning is included in an event g such that for every boy x, there is a victory of x included in g. But this is true if and only if every boy won; so (36) and (39) are assigned the same truth conditions, which is obviously absurd.

To get a correct analysis, (36) must be understood as saying that there is an event e which includes a victory of x for each boy x, *and nothing else.* Here is a way of writing this:

(40) $\exists e \exists \Phi[\forall x[\text{A-BOY}(x) \rightarrow [\mathbf{won}'(\Phi(x)) \,\&\, \text{AG}(\Phi(x), x)]] \,\&\, \text{SUP}_{\mathrm{E}}(e, \lambda f \exists x[\text{A-BOY}(x) \,\&\, f = \Phi(x)])]$

In (40) Φ is a variable of type (o, e), i.e. a variable for functions mapping objects into events. So (40) means the following: there are an event e and a function Φ such that Φ maps every boy x into a victory of x, and e is the sum of all those victories. Clearly, to obtain (40) as the translation of (36), all we have to do is translate *every boy* as (41):

(41) $\lambda F \lambda e \exists \Phi[\forall x[\text{A-BOY}(x) \rightarrow F(x)\ (\Phi(x))] \,\&\, \text{SUP}_{\mathrm{E}}(e, \lambda f \exists x[\text{A-BOY}(x) \,\&\, f = \Phi(x)])]$

EXAMPLE 8

If we take (41) as the translation of *every boy*, TO provides us with a satisfactory translation of *only* [*every boy*]$_F$. The translation in question turns out to be (equivalent to) (42):

(42) $$\lambda F\lambda e[\exists\Phi[\forall x[\text{A-BOY}(x) \rightarrow F(x)(\Phi(x))] \;\&\; \text{SUP}_E(e, \lambda f\exists x[\text{A-BOY}(x) \;\&\; f = \Phi(x)])] \;\&\; \forall f[\exists x F(x)(f) \rightarrow \exists g[\exists\Phi[\forall x[\text{A-BOY}(x) \rightarrow F(x)(\Phi(x))] \;\&\; \text{SUP}_E(g, \lambda f\exists x[\text{A-BOY}(x) \;\&\; f = \Phi(x)])]] \;\&\; f \subseteq_E g]]$$

To verify that (42) is indeed a satisfactory way of translating *only* [*every boy*]$_F$, let us use it to translate (39): *Only* [*every boy*]$_F$ *won.* What we obtain via T1 and existential closure is (equivalent to) (43):

(43) $$\exists e[\exists\Phi[\forall x[\text{A-BOY}(x) \rightarrow [\mathbf{won}'(\Phi(x)) \;\&\; \text{AG}(\Phi(x), x)]] \;\&\; \text{SUP}_E(e, \lambda f\exists x[\text{A-BOY}(x) \;\&\; f = \Phi(x)])] \;\&\; \forall f[\exists x[\mathbf{won}'(f) \;\&\; \text{AG}(f, x)] \rightarrow \exists g[\exists\Phi[\forall x[\text{A-BOY}(x) \rightarrow [\mathbf{won}'(\Phi(x)) \;\&\; \text{AG}(\Phi(x), x)]] \;\&\; \text{SUP}_E(g, \lambda f\exists x[\text{A-BOY}(x) \;\&\; f = \Phi(x)])]] \;\&\; f \subseteq_E g]]$$

In other words, there is at least one event which is the sum of the events associated with boys by a function Φ mapping each boy x into a victory of x, and every event of winning is included in an event of this kind. By now, the reader should be able to see immediately that such a paraphrase is nothing else but a roundabout way of expressing the content of (39); in any case, she can proceed as in the previous examples, and verify that (43) is equivalent to some other formula whose adequacy as a representation of the content of (39) is more evident to her.

EXAMPLE 9

Let us consider the following:

(44) Less than ten boys cried.

What (44) means is that there is no event of crying whose agent is a group of ten or more boys. Now, this is a negative statement, and the treatment of negation in event semantics is a notoriously difficult matter. How can we reduce a statement of the form "there is no event such that . . ." to a statement of the form "there is an event such that . . ."? A solution to this problem is sketched in Krifka (1989). Krifka would translate (44) more or less as follows:

(45) $$\exists e[e = \mathbf{1}_E \;\&\; {\sim}\exists f[f \subseteq_E e \;\&\; \exists x[\text{TEN-BOYS}(x) \;\&\; \mathbf{cried}'(f) \;\&\; \text{AG}(f, x)]]]$$

where $\mathbf{1}_E$ denotes the top element in the Boolean algebra of events, and TEN-BOYS(x) means that x is a group of exactly ten boys. Such a translation is certainly adequate, in the sense that it expresses the truth conditions of (44) correctly. Nevertheless, we cannot adopt it here. To be able to obtain (45) as the translation of (44), we should translate *less than ten boys* as

$$\lambda F \lambda e[e = \mathbf{1}_E \;\&\; \sim\exists f[f \subseteq_E e \;\&\; \exists x[\text{TEN-BOYS}(x) \;\&\; F(x)\,(f)]]]$$

and it is not hard to see that this translation of *less than ten boys* together with rule TO would produce an unacceptable translation of *only* [*less than ten boys*]$_F$. So we need something else. Our translation of (44) will be (46):

(46) $\exists e[[\sim\exists f \exists x[\mathbf{boy}'(x) \;\&\; \mathbf{cried}'(f) \;\&\; AG(f,x)] \;\&\; e = \mathbf{0}_E] \vee [\exists x[<10\text{-BOYS}(x) \;\&\; \mathbf{cried}'(e) \;\&\; AG(e,x)] \;\&\; \forall f[[\exists x[\mathbf{boy}'(x) \;\&\; \mathbf{cried}'(f) \;\&\; AG(f,x)] \;\&\; e \subseteq_E f] \rightarrow e = f]]]$

(where <10-BOYS(x) is an abbreviation of the formula which says that either x is $\mathbf{0}_O$ or x is a group of boys whose cardinality is between one and nine). (46) can be read as follows: there is an event e such that either (i) no boy cried and e = $\mathbf{0}_E$, or (ii) e is an event of crying whose agent is a group of less than ten boys, and e is "maximal" among the events of crying whose agent is a group of boys (i.e. no event of crying whose agent is a group of boys is "larger" or "more comprehensive" than e).

One of the drawbacks of (46) is its length. To shorten it a little, we introduce an abbreviation. Let α be an expression of type e, and let β be an expression of type (e, t): we shall use MAX(α, β) as an abbreviation of $\forall f[\beta(f) \;\&\; \alpha \subseteq_E f] \rightarrow \alpha = f]]]$. So (46) can be rewritten as follows:

(47) $\exists e[[\sim\exists f \exists x[\mathbf{boy}'(x) \;\&\; \mathbf{cried}'(f) \;\&\; AG(f,x)] \;\&\; e = \mathbf{0}_E] \vee [\exists x[<10\text{-BOYS}(x) \;\&\; \mathbf{cried}'(e) \;\&\; AG(e,x)] \;\&\; MAX(e, \lambda f \exists x[\mathbf{boy}'(x) \;\&\; \mathbf{cried}'(f) \;\&\; AG(f,x)])]]$

It goes without saying that to obtain (47) as the translation of (44), the translation of *less than ten boys* must be

(48) $\lambda F \lambda e[[\sim\exists f \exists x[\mathbf{boy}'(x) \;\&\; F(x)\,(f)] \;\&\; e = \mathbf{0}_E] \vee [\exists x[<10\text{-BOYS}(x) \;\&\; F(x)\,(e)] \;\&\; MAX(e, \lambda f \exists x[\mathbf{boy}'(x) \;\&\; F(x)\,(e)])]]$

EXAMPLE 10

If (48) is the translation of *less than ten boys*, then the following is the translation of *only* [*less than ten boys*]$_F$ obtained by applying TO:

$$\lambda F\lambda e[[[\sim\exists f\exists x[\mathbf{boy}'(x)\ \&\ F(x)(f)]\ \&\ e = \mathbf{0}_E]\ \vee\ [\exists x[<10\text{-}BOYS(x)\ \&\ F(x)(e)]\ \&\ MAX(e, \lambda f\exists x[\mathbf{boy}'(x)\ \&\ F(x)(e)])]]\ \&\ \forall g[\exists x F(x)(f) \rightarrow \exists h[[[\sim\exists f\exists x[\mathbf{boy}'(x)\ \&\ F(x)(f)]\ \&\ h = \mathbf{0}_E]\ \vee\ [\exists x[<10\text{-}BOYS(x)\ \&\ F(x)(h)]\ \&\ MAX(h, \lambda f\exists x[\mathbf{boy}'(x)\ \&\ F(x)(e)])]]\ \&\ g \subseteq_E h]]]$$

It follows that the translation of a sentence like (49) is (50):

(49) Only [less than ten boys]$_F$ cried.

(50) $\exists e[[[\sim\exists f\exists x[\mathbf{boy}'(x)\ \&\ \mathbf{cried}'(f)\ \&\ AG(f,x)]\ \&\ e = \mathbf{0}_E]\ \vee\ [\exists x[<10\text{-}BOYS(x)\ \&\ \mathbf{cried}'(e)\ \&\ AG(e,x)]\ \&\ MAX(e, \lambda f\exists x[\mathbf{boy}'(x)\ \&\ \mathbf{cried}'(f)\ \&\ AG(f,x)])]]\ \&\ \forall g[\exists x[\mathbf{cried}'(g)\ \&\ AG(g,x)] \rightarrow \exists h[[[\sim\exists f\exists x[\mathbf{boy}'(x)\ \&\ \mathbf{cried}'(f)\ \&\ AG(f,x)]\ \&\ h = \mathbf{0}_E]\ \vee\ [\exists x[<10\text{-}BOYS(x)\ \&\ \mathbf{cried}'(h)\ \&\ AG(h,x)]\ \&\ MAX(h, \lambda f\exists x[\mathbf{boy}'(x)\ \&\ \mathbf{cried}'(f)\ \&\ AG(f,x)])]]\ \&\ g \subseteq_E h]]]$

This formula is horrible but correct. We can show its correctness by reasoning as follows. To begin with, (50) is easily seen to be equivalent to its universally quantified subformula. So it suffices to prove that the latter has the same truth conditions as (49). Now, (49) is true if either (i) nobody cried, or (ii) somebody cried, every person who cried was a boy, and the boys who cried were less than ten. Therefore, all we have to do to prove that the truth conditions of the universally quantified subformula of (50) coincide with those of (49) is to observe that (i) holds if and only if every event of crying is included in $\mathbf{0}_E$ (this is just a way of saying that there is no such event), and that (ii) holds if and only if every event of crying is included in an event of crying whose agent is a group of less than ten boys (or, equivalently, in an event of crying h such that the agent of h is a group of less than ten boys, and h is maximal among the events of crying whose agent is a group of boys).

Notice that, as promised in section 1, we have given a satisfactory analysis of expressions of the form '*only* [*less than n* α]$_F$' without abandoning the assumption that the NPs of the form '*less than n* α' are monotonically decreasing. (On the other hand, if you believe that such an assumption *should* be abandoned, all you have to do is drop the first disjunct of (48).)

We close this section by showing that our approach also works when a NP of the form '*only* [α]$_F$' is in the scope of another NP. To this end, a few preliminary remarks about the treatment of TVs in event semantics are in order.

EXAMPLE 11

Consider (51):

(51) Three boys kissed two girls.

This sentence is obtained by means of S1 from the NP *three boys* and the IV *kissed two girls*; as to the latter, we assume it is obtained from *kissed* and *two girls* by means of a syntactic rule S2 which combines a TV and a NP into an IV. (51) has at least three different readings: a "cumulative" reading,[17] a reading in which *two girls* is in the scope of *three boys*, and a reading in which *three boys* is in the scope of *two girls*. For the sake of simplicity, we confine our attention to the first two readings.

The representation of the cumulative reading of (51) is a simple task. It suffices to write the following:

(52) $\exists e \exists x[\text{THREE-BOYS}(x) \mathbin{\&} \exists y[\text{TWO-GIRLS}(y) \mathbin{\&} \mathbf{kissed}'(e) \mathbin{\&} \text{AG}(e, x) \mathbin{\&} \text{PT}(e, y)]]$

This means that there is an event of kissing e whose agent is a group of three boys and whose patient is a group of two girls. It is also easy to see how (52) can be obtained compositionally. All we have to do is take $\lambda x \lambda y \lambda e[\mathbf{kissed}'(e) \mathbin{\&} \text{AG}(e, x) \mathbin{\&} \text{PT}(e, y)]$ (where **kissed**′ is a constant of type (e, t)) as the translation of *kissed*, and assume that the translation rule corresponding to S2 is the following rule T2: if $\lambda x \lambda y \lambda e A$ is the translation of a TV α and B is the translation of a NP β, then the translation of the IV $\alpha\beta$ is $\lambda x[B(\lambda y \lambda e A)]$. So the translation of *kissed two girls* provided by T2 is equivalent to (53):

(53) $\lambda x \lambda e \exists y[\text{TWO-GIRLS}(y) \mathbin{\&} \mathbf{kissed}'(e) \mathbin{\&} \text{AG}(e, x) \mathbin{\&} \text{PT}(e, y)]$

Given this translation of *kissed two girls*, (52) can obviously be obtained by an application of T1 and existential closure.

Let us now turn to the reading of (51) which assigns wide scope to *three boys* and narrow scope to *two girls*. If we adopted the approach proposed by Krifka (1989), the intermediate translation of (51) on the reading in question should be more or less the following:

(54) $\lambda e \exists x[\text{THREE-BOYS}(x) \mathbin{\&} \text{AG}(e, x) \mathbin{\&} \forall y \leqslant_{O} x\ \exists f \exists z[f \subseteq_{E} e \mathbin{\&} \mathbf{kissed}'(f) \mathbin{\&} \text{TWO-GIRLS}(z) \mathbin{\&} \text{AG}(f, y) \mathbin{\&} \text{PT}(f, z)]]$

---

[17] This is the reading which can be paraphrased as follows: there are a group of three boys x and a group of two girls y such that every boy in x kissed some girl in y, and every girl in y was kissed by some boy in x. Given the meaning postulate which ensures the distributivity of *kiss*, this reading is correctly captured by (52) below.

(Here $y \leqslant_O x$ means that y is an individual member of the group x, i.e. that $y \subseteq_O x$ and that y is an atom of the Boolean algebra of objects.) It seems to us, however, that (54) cannot be chosen as a translation of (51) for a reason similar to that for which (37) cannot be chosen as the translation of (36) (see Example 7 above). If we accepted (54) as a translation of (51), we should say that the events described by (51) on the reading we are considering are all those events which *include*, for each of three boys, a kissing of two girls by that boy. Now, this is at odds with the usual treatment in event semantics of a sentence like *John kissed Mary.* It is commonly assumed that the events described by *John kissed Mary* are those *consisting of* – not those properly including – a kissing of Mary by John. By analogy, it seems to us reasonable to say that the events described by (51) are those which include, for each member x of a group of three boys, a kissing of two girls by x, *and nothing else.* So, as the intermediate translation of (51), we take (55):

$$(55)\quad \lambda e\exists x[\text{THREE-BOYS}(x)\ \&\ \exists\Phi[\forall y\leqslant_O x\ \exists z[\text{TWO-GIRLS}(z)\ \&\ \mathbf{kissed}'(\Phi(y))\ \&\ \text{AG}(\Phi(y),y)\ \&\ \text{PT}(\Phi(y),z)]\ \&\ \text{SUP}_E(e,\lambda f\ \exists y \leqslant_O x[f=\Phi(y)])]]$$

(where Φ is again a variable of type (o, e)). A more specific reason for believing that this way of treating TVs is the correct one will emerge in the next section: as we shall see, only a treatment of the kind exemplified by (55) (not a treatment of the kind exemplified by (54)) is compatible with a satisfactory analysis of sentences in which the focus contains the verb.

To make it possible to derive translations like (55), we extend our translation algorithm as follows. To begin with, we introduce an operator Δ of type ((o, (e, t)), (o, (e, t))). Here is the definition:

$$\Delta =_{df} \lambda F\lambda x\lambda e\exists\Phi[\forall y\leqslant_O x\ F(y)(\Phi(y))\ \&\ \text{SUP}_E(e,\ \lambda f\ \exists y\leqslant_O x[f=\Phi(y)])]$$

By way of example, let us see what happens when Δ is applied to the translation of *kissed two girls* given in (53). The result of the application is an expression equivalent to the following:

$$(56)\quad \lambda x\lambda e\exists\Phi[\forall y\leqslant_O x\ \exists z[\text{TWO-GIRLS}(z)\ \&\ \mathbf{kissed}'(\Phi(y))\ \&\ \text{AG}(\Phi(y),y)\ \&\ \text{PT}(\Phi(y),z)]\ \&\ \text{SUP}_E(e,\lambda f\exists y\leqslant_O x[f=\Phi(y)])]$$

We now assume that when S1 is applied at the syntactic level, we are allowed to choose between the translation rule T1 and a new translation rule T1* which says: if A is the translation of a NP α and B is the translation of an IV β, then the translation of the sentence $\alpha\beta$ is $A(\Delta(B))$. Since $\Delta(B)$ for B = (53) is (56), the translation of (51) provided by T1* is

(55), as required. Notice that the operator Δ can be thought of as the semantic counterpart of *each* in sentences like *Three boys kissed two girls each.*

EXAMPLE 12

To end this section, we examine the following sentence:

(57) Three boys kissed only [two girls]$_F$.

The translation of (57) we obtain via TO, T2, and T1 is this:

(58) $\exists e \exists x[\text{THREE-BOYS}(x) \;\&\; \exists y[\text{TWO-GIRLS}(y) \;\&\; \mathbf{kissed}'(e) \;\&\; \text{AG}(e, x) \;\&\; \text{PT}(e, y)] \;\&\; \forall f[\exists y[\mathbf{kissed}'(f) \;\&\; \text{AG}(f, x) \;\&\; \text{PT}(f, y)] \rightarrow \exists g[\exists y[\text{TWO-GIRLS}(y) \;\&\; \mathbf{kissed}'(g) \;\&\; \text{AG}(g, x) \;\&\; \text{PT}(g, y)] \;\&\; f \subseteq_E g]]]$

(58) can be read as follows: there is a group x of three boys such that x is the agent of an event of kissing whose patient is a group of two girls, and every event of kissing whose agent is x is included in an event of kissing whose agent is x and whose patient is a group of two girls. It should be clear that (58) corresponds to the "cumulative" reading of (57). Now let us translate (57) by applying TO, T2, and T1*; what we obtain is (59):

(59) $\exists e \exists x[\text{THREE-BOYS}(x) \;\&\; \exists \Phi[\forall y \leqslant_O x \, [\exists z[\text{TWO-GIRLS}(z) \;\&\; \mathbf{kissed}'(\Phi(y)) \;\&\; \text{AG}(\Phi(y), y) \;\&\; \text{PT}(\Phi(y), z)] \;\&\; \forall f[\exists z[\mathbf{kissed}'(f) \;\&\; \text{AG}(f, x) \;\&\; \text{PT}(f, z)] \rightarrow \exists g[\exists z[\text{TWO-GIRLS}(z) \;\&\; \mathbf{kissed}'(g) \;\&\; \text{AG}(g, x) \;\&\; \text{PT}(g, z)] \;\&\; f \subseteq_E g]]] \;\&\; \text{SUP}_E(e, \lambda f \exists y \leqslant_O x[f = \Phi(y)])]$

Is this correct? It is, as the reader can ascertain by checking the equivalence of (57) and the following expression:

$$\exists x[\text{THREE-BOYS}(x) \;\&\; \forall y \leqslant_O x \; \exists v \exists z[\text{A-GIRL}(v) \;\&\; \text{A-GIRL}(z) \;\&\; v \neq z \;\&\; \forall u[\exists f[\mathbf{kiss}'(f) \;\&\; \text{AG}(f, y) \;\&\; \text{PT}(f, u)] \leftrightarrow [u = v \vee u = z]]]]$$

3. EXTENDING THE ANALYSIS

In this section we consider a fragment of language a little richer than the microlanguage studied in section 2. Not only NPs, but also IVs, TVs, C(ommon) N(oun)s, and D(eterminer)s can now be focused. Moreover, in the new fragment *only* need not be contiguous to the focus with which it is associated. (In other words, the fragment contains sentences like (2): *John* *only kissed* [*Mary*]$_F$.) Our aim is to show that the treatment of *only* described in section 2 can be extended to cover this wider range of situations.

The present section is divided into two parts. In the first part we illustrate our analysis by discussing a few simple examples. In the second part we introduce a formal machinery which provides a compositional translation algorithm for the fragment of language we are interested in.

EXAMPLE 13

Let us begin by considering an example in which the focused expression is an IV:

(60) John only [cried]$_F$.

(60) can be paraphrased as follows: the only thing John did was cry; or: John cried, and all the events whose agent was John were events of crying. In symbols:

(61) $\exists e[\mathbf{cried}'(e) \,\&\, AG(e, \mathbf{John}')] \,\&\, \forall f[AG(f, \mathbf{John}') \rightarrow \mathbf{cried}'(f)]$

A slightly different way of expressing the content of (60) is (62):

(62) $\exists e[\mathbf{cried}'(e) \,\&\, AG(e, \mathbf{John}') \,\&\, \forall f[AG(f, \mathbf{John}') \rightarrow \exists g[\mathbf{cried}'(g) \,\&\, AG(g, \mathbf{John}')] \,\&\, f \subseteq_E g]]$

(i.e., John cried, and every event whose agent is John is included in an event of crying whose agent is John). The equivalence of (61) and (62) is easy to verify: all we have to do is show that the universally quantified subformula of (61) is equivalent to the universally quantified subformula of (62). Now, the entailment from $\forall f[AG(f, \mathbf{John}') \rightarrow \mathbf{cried}'(f)]$ to $\forall f[AG(f, \mathbf{John}') \rightarrow \exists g[\mathbf{cried}'(g) \,\&\, AG(g, \mathbf{John}')] \,\&\, f \subseteq_E g]]$ is obvious. The entailment in the opposite direction follows from the meaning postulate which says that every nonnull event included in an event of crying is an event of crying. We choose (62) as our translation of (60).

It should be clear that there is a close analogy between (62) as the translation of (60) and, say, (22) as the translation of (8):

(8) Only [John]$_F$ cried.

(22) $\exists e[[\mathbf{cried}'(e) \,\&\, AG(e, \mathbf{John}')] \,\&\, \forall f[\exists x[\mathbf{cried}'(f) \,\&\, AG(f, x)] \rightarrow \exists g[\mathbf{cried}'(g) \,\&\, AG(g, \mathbf{John}') \,\&\, f \subseteq_E g]]]$

Both translations can be obtained by following, so to speak, the same recipe. Let α be the sentence we want to translate. Let β be the result of removing *only* from α (so that if α is either (8) or (60), β is nothing else but *John cried*). Let B be the intermediate translation of β ($\lambda e[\mathbf{cried}'(e) \ \&\ AG(e, \mathbf{John}')]$ if β is *John cried*). The recipe says that the translation of α is obtained by taking the formula $\exists e[B(e) \ \&\ \forall f[C(f) \rightarrow \exists g[B(g) \ \&\ f \subseteq_E g]]]$, where C is like B except that the part of the formula corresponding to the focus of α is replaced by a suitable variable bound by an existential quantifier: so if α is (8), C is $\lambda e \exists x[\mathbf{cried}'(e) \ \&\ AG(e, x)]$, whereas if α is (60), C will be $\lambda e \exists X[X(e) \ \&\ AG(e, \mathbf{John}')]$, which can be simplified as $\lambda e AG(e, \mathbf{John}')$. In this way, we obtain both (22) and (62). Needless to say, this recipe is not fully accurate, but it conveys the basic idea embodied in the translation algorithm described below.

EXAMPLE 14

Let us recall (4):

(4) John only [kissed]$_F$ Mary.

As the reader can easily imagine, our analysis of this sentence is the following: John kissed Mary, and every event whose agent is John and whose patient is Mary is included in an event of kissing whose agent is John and whose patient is Mary. So, as the translation of (4) we choose the following formula:

(63) $\exists e[\mathbf{kissed}'(e) \ \&\ AG(e, \mathbf{John}') \ \&\ PT(e, \mathbf{Mary}') \ \&$
$\forall f[[AG(f, \mathbf{John}') \ \&\ PT(f, \mathbf{Mary}')] \rightarrow \exists g[\mathbf{kissed}'(g) \ \&$
$AG(g, \mathbf{John}') \ \&\ PT(g, \mathbf{Mary}')] \ \&\ f \subseteq_E g]]$

To check the adequacy of (63), the reader can verify the equivalence of (63) and (64):

(64) $\exists f[\mathbf{kissed}'(f) \ \&\ AG(f, \mathbf{John}') \ \&\ PT(f, \mathbf{Mary}')] \ \&\ \forall f[[AG(f, \mathbf{John}')$
$\&\ PT(f, \mathbf{Mary}')] \rightarrow \mathbf{kissed}'(f)]$

(64) means: John kissed Mary, and every event whose agent was John and whose patient was Mary was an event of kissing (which is, of course, nothing else but a roundabout way of saying that the only thing John did to Mary was kiss her). The equivalence of (63) and (64) follows of course from the fact that every nonnull event included in an event of kissing is itself an event of kissing.

EXAMPLE 15

Let us now consider a sentence in which the focused expression is a CN:

(65) Only every $[\text{boy}]_F$ cried.

If (65) means anything, it means that the set of boys is the unique set X such that every individual element of X cried (obviously, this makes sense only if the class of the relevant sets is suitably restricted). So we can express the content of (65) as follows:

$$\forall X[\forall x[\mathrm{AT}(x, X) \rightarrow \exists e[\mathbf{cried}'(e) \,\&\, \mathrm{AG}(e, x)] \leftrightarrow X = \mathbf{boy}']] \tag{66}$$

where AT(x, X) means that x is an atom and an element of X. A formula equivalent to (66) can be obtained by applying our general recipe for the paraphrase of sentences containing *only*:

$$\begin{aligned}&\exists e[\exists \Phi[\forall x[\text{A-BOY}(x) \rightarrow [\mathbf{cried}'(\Phi(x)) \,\&\, \mathrm{AG}(\Phi(x), x)]] \,\&\, \mathrm{SUP}_E(e, \\ &\lambda f \exists x[\text{A-BOY}(x) \,\&\, f = \Phi(x)])] \,\&\, \forall g[\exists X \exists \Phi[\forall x[\mathrm{AT}(x, X) \rightarrow \\ &[\mathbf{cried}'(\Phi(x)) \,\&\, \mathrm{AG}(\Phi(x), x)]] \,\&\, \mathrm{SUP}_E(g, \lambda f \exists x[X(x) \,\&\, f = \\ &\Phi(x)])] \rightarrow \exists h \exists \Phi[\forall x[\text{A-BOY}(x) \rightarrow [\mathbf{cried}'(\Phi(x)) \,\&\, \\ &\mathrm{AG}(\Phi(x), x)]] \,\&\, \mathrm{SUP}_E(e, \lambda f \exists x[\text{A-BOY}(x) \,\&\, f = \Phi(x)])] \,\&\, \\ &g \subseteq_E h]]\end{aligned} \tag{67}$$

Bearing in mind the treatment of *every* described in Example 7, we can read (67) as follows: every boy cried, and every event in which every member of some set X cried is included in an event in which every boy cried. It is important to notice that (66) and (67) are equivalent no matter how we restrict the range of the variable X.

EXAMPLE 16

Finally, let us consider the case of a focused D. Take for instance (68):

(68) Only $[\text{two}]_F$ boys cried.

Our translation of this sentence will be (69):

$$\begin{aligned}&\exists e[\exists x[\text{TWO-BOYS}(x) \,\&\, \mathbf{cried}'(e) \,\&\, \mathrm{AG}(e, x)] \,\&\, \forall f[\exists x[\mathbf{boy}'(x) \\ &\&\, \mathbf{cried}'(f) \,\&\, \mathrm{AG}(f, x)] \rightarrow \exists g[\exists x[\text{TWO-BOYS}(x) \,\&\, \mathbf{cried}'(g) \,\&\, \\ &\mathrm{AG}(g, x)] \,\&\, f \subseteq_E g]]]\end{aligned} \tag{69}$$

(I.e., two boys cried, and every event of crying whose agent is a group of boys is included in an event of crying whose agent is a group of two boys.) The analogy of (69) with the formal translations considered in the preceding examples should be evident. Readers who do not yet feel completely at ease with the kinds of paraphrase we are proposing can check the correctness of (69) by verifying that (69) is equivalent to the following:

$$\begin{aligned}&\exists x \exists y[\text{A-BOY}(x) \,\&\, \text{A-BOY}(y) \,\&\, x \neq y \,\&\, \forall z[\text{A-BOY}(z) \rightarrow \\ &[\exists e[\mathbf{cried}'(e) \,\&\, \mathrm{AG}(e, z)] \leftrightarrow [z = x \lor z = y]]]]\end{aligned}$$

(In words: there are a boy x and a boy y, $x \neq y$, such that for every boy z, z cried if and only if z is either x or y.)

We now explain how translations of the kind we have been considering so far can be obtained in a systematic way. We consider a fragment of natural language characterized by the following syntactic rules: a rule S1 which combines a NP and an IV into a S; a rule S2 which combines a TV and a NP into an IV; a rule S3 which combines a D and a CN into a NP; a rule SF which changes an expression α belonging to one of the categories NP, IV, TV, CN, D and not containing any free focus into a focused expression $[\alpha]_F$ of the same category; a rule SO which changes any expression α belonging to one of the categories NP, IV, TV, D and containing a free focus into an expression '*only* α' belonging to the same category and no longer containing any free focus. We omit a precise formulation of these rules.

The translation algorithm we are going to describe works as follows. With every expression α of the fragment of natural language which we are taking into account the algorithm associates a pair $\langle A, B\rangle$ of expressions of our formal language (if α is a sentence, we call $\langle A, B\rangle$ the "provisional" translation of α). If α does not contain any free focus, then $A = B$, and A can be regarded as the real translation of α (more precisely, if α is a sentence, A corresponds to the "intermediate" translation of α in the sense of the preceding section). If α contains a free focus, then $A \neq B$, but A and B are always expressions of the same type.

Let us now describe the translation algorithm in detail. The provisional translation of a simple expression α is a pair $\langle A, A\rangle$ such that the type of A is $((o, (e, t)), (e, t))$ if α is a NP, $(o, (e, t))$ if α is an IV, $(o, (o, (e, t)))$ if α is a TV, (o, t) if α is a CN, and $((o, t), ((o, (e, t)), (e, t)))$ if α is a D. In practice, if α is a simple expression of one of the categories NP, IV, TV, CN, the provisional translation of α is the pair $\langle A, A\rangle$ where A is the translation of α considered in section 2. If α is a D, then the provisional translation of α is the pair $\langle A, A\rangle$ where A is, so to speak, the "natural" translation of α. Suppose, for example, that α is *every*; then the provisional translation of α is the pair whose members are both equal to (70):

$$(70) \quad \lambda X \lambda F \lambda e \exists \Phi[\forall x[AT(x, X) \rightarrow F(x)(\Phi(x))] \mathbin{\&} SUP_E(e, \lambda f \exists x[AT(x, X) \mathbin{\&} f = \Phi(x)])]$$

where X is, of course, a variable of type (o, t). (70) is the "natural" translation of *every* in the sense that if we apply it to the translation of a CN β, what we obtain is equivalent to the translation of '*every* β' considered in the preceding section (for instance, if we apply (70) to **boy**′, we obtain the translation of *every boy* given in (41)).

Let us turn to the translation rules corresponding to the syntactic rules listed above. First, we have three rules T1, T2, T1* which are nothing else but the "doubling" of the rules with the same name introduced in section 2. For example, the new rule T1* says that if $\langle A, A' \rangle$ is the translation of a NP α and $\langle B, B' \rangle$ is the translation of an IV β, then the translation of the S $\alpha\beta$ is $\langle A(\Delta(B)), A'(\Delta(B')) \rangle$. Next we have a rule T3 corresponding to S3; T3 prescribes (like the new rules T1 and T2) a double functional application: it says that if $\langle A, A' \rangle$ is the translation of a D α and $\langle B, B' \rangle$ is the translation of a CN β, then the translation of the NP $\alpha\beta$ is $\langle A(B), A'(B') \rangle$. Finally, we have two rules TF and TO corresponding to SF and SO respectively. Their formulation requires a few preliminaries.

To begin with, let us introduce the notion of "skeleton of category C" for each of the categories NP, IV, TV, CN, D:

- the skeleton of category NP is $\lambda F \lambda e F(v)(e)$;
- the skeleton of category IV is $\lambda x \lambda e AG(e, x)$;
- the skeleton of category TV is $\lambda x \lambda y \lambda e[AG(e, x) \& PT(e, y)]$;
- the skeleton of category CN is V (a variable of type (o, t));
- the skeleton of category D is $\lambda X \lambda F \lambda e[X(v) \& F(v)(e)]$.

Notice that the variable v of type o occurs free in the skeletons of categories NP and D, and that the variable V occurs free in the skeleton of category CN; to avoid confusions, we assume that the variables in question are not used elsewhere. We can now formulate the translation rule TF.

TF: Let α be an expression of category C (= NP, IV, TV, CN, D) not containing any free focus, and let $\langle A, A \rangle$ be the translation of α; then the translation of $[\alpha]_F$ is $\langle \Sigma, A \rangle$, where Σ is the skeleton of category C.

It remains to formulate TO. To this end, we define ONLY($\langle A, B \rangle$) for every pair of expressions A, B of "normal" type, the class of normal types being characterized as follows: (e, t) is normal; if τ is normal, then (σ, τ) is normal. Here is the definition of ONLY($\langle A, B \rangle$):

- If A and B are expressions of type (e, t), then ONLY($\langle A, B \rangle$) = $\lambda e[B(e) \& \forall f[A^*(f) \rightarrow \exists g[B(g) \& f \subseteq_E g]]]$, where A* is the existential closure of A.[18]
- If A and B are expressions of type (σ, τ) where τ is normal, then ONLY($\langle A, B \rangle$) = λXONLY($\langle A(X), B(X) \rangle$), where X is a variable of type σ.

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[18] Here we use "existential closure" in the ordinary sense of the expression (cf. fn. 13 above). If A does not contain any free variable, A* coincides with A.

The rule TO says the following:

> TO: The translation of an expression of the form '*only* α' is $\langle \text{ONLY}(\langle A, B\rangle), \text{ONLY}(\langle A, B\rangle)\rangle$, where $\langle A, B\rangle$ is the translation of α.

This ends the description of our translation algorithm. To show how the algorithm works in practice, we shall now apply it to a couple of simple examples.

EXAMPLE 17

Let us reconsider sentence (8): *Only* [*John*]$_{F}$ *cried.* The new translation of *John* is the pair whose members are both equal to the translation of *John* considered in section 2, i.e. $\langle \lambda F \lambda e F(\mathbf{John}')(e), \lambda F \lambda e F(\mathbf{John}')(e)\rangle$. The translation of '[*John*]$_{F}$' we obtain by applying TF is this:

$$\langle \lambda F \lambda e F(v)(e), \lambda F \lambda e F(\mathbf{John}')(e)\rangle$$

(recall that $\lambda F \lambda e F(v)(e)$ is the skeleton of category NP). By TO, the translation of *only* [*John*]$_{F}$ will be the pair whose members are both equal to $\text{ONLY}(\langle \lambda F \lambda e F(v)(e), \lambda F \lambda e F(\mathbf{John}')(e)\rangle)$. Now, by the second clause in the definition of ONLY, $\text{ONLY}(\langle \lambda F \lambda e F(v)(e), \lambda F \lambda e F(\mathbf{John}')(e)\rangle)$ is equivalent to $\lambda F\ \text{ONLY}(\langle \lambda e F(v)(e), \lambda e F(\mathbf{John}')(e)\rangle)$, which, by the first clause in the definition of ONLY, is equivalent to (71):

$$\lambda F \lambda e[F(\mathbf{John}')(e) \mathbin{\&} \forall f[\exists v F(v)(f) \rightarrow \exists g[F(\mathbf{John}')(g) \mathbin{\&} f \subseteq_E g]]] \tag{71}$$

So our translation of *only* [*John*]$_{F}$ will be the pair whose members are both equal to (71). Since the translation of *cried* is $\langle \lambda x \lambda e[\mathbf{cried}'(e) \mathbin{\&} AG(e, x)], \lambda x \lambda e[\mathbf{cried}'(e) \mathbin{\&} AG(e, x)]\rangle$, we can conclude that the provisional translation of (8) obtained by an application of T1 is the pair whose members are both equal to (72):

$$\lambda e[[\mathbf{cried}'(e) \mathbin{\&} AG(e, \mathbf{John}')] \mathbin{\&} \forall f[\exists v[\mathbf{cried}'(f) \mathbin{\&} AG(f, v)] \rightarrow \exists g[\mathbf{cried}'(g) \mathbin{\&} AG(g, \mathbf{John}') \mathbin{\&} f \subseteq_E g]]] \tag{72}$$

Notice that (71) and (72) coincide with our previous translation of *only* [*John*]$_{F}$ and with our previous intermediate translation of (8), respectively (see Example 2 above). More generally, we can observe that for every expression A of type $((o, (e, t)), (e, t))$, $\text{ONLY}(\langle \lambda F \lambda e F(v)(e), A\rangle)$ coincides with $\mathbf{O}(A)$, where $\mathbf{O}$ is the operator defined and used in the preceding section: this means that the new translation of a NP of the form '*only* [α]$_{F}$' is simply $\langle A, A\rangle$, where A is the translation of the NP in question considered in section 2. As a consequence, for the sentences of the microlanguage studied in section 2, the translations provided by the new algorithm are equivalent to the old ones.

EXAMPLE 18

Let us now see what happens when our new algorithm is applied to a sentence containing a focus which is not a NP. Let us take, for instance, sentence (68): *Only* $[\mathit{two}]_F$ *boys cried.* The translation of *two* is the pair whose members are both equal to $\lambda X \lambda F \lambda e \exists x \exists y[x \neq y \;\&\; AT(x, X) \;\&\; AT(y, X) \;\&\; F(x \cup_o y)(e)]$ (where X is a variable of type (o, t)). By applying TF, we obtain the following translation of $[\mathit{two}]_F$:

$$\langle \lambda X \lambda F \lambda e[X(v) \;\&\; F(v)(e)], \lambda X \lambda F \lambda e \exists x \exists y[x \neq y \;\&\; AT(x, X) \;\&\; AT(y, X) \;\&\; F(x \cup_o y)(e)] \rangle$$

Given this translation of $[\mathit{two}]_F$, and given $\langle \mathbf{boy}', \mathbf{boy}' \rangle$ as the translation of the CN *boy*, the translation of $[\mathit{two}]_F$ *boys* obtained by applying T3 turns out to be as follows:

$$\langle \lambda F \lambda e[\mathbf{boy}'(v) \;\&\; F(v)(e)], \lambda F \lambda e \exists x \exists y[x \neq y \;\&\; AT(x, \mathbf{boy}') \;\&\; AT(y, \mathbf{boy}') \;\&\; F(x \cup_o y)(e)] \rangle$$

This can be abbreviated as

$$\langle \lambda F \lambda e[\mathbf{boy}'(v) \;\&\; F(v)(e)], \lambda F \lambda e \exists x[\text{TWO-BOYS}(x) \;\&\; F(x)(e)] \rangle$$

Let us now apply TO: the translation of *only* $[\mathit{two}]_F$ *boys* provided by this rule is the pair whose members are both equal to the following expression:

$$\lambda F \lambda e[\exists x[\text{TWO-BOYS}(x) \;\&\; F(x)(e)] \;\&\; \forall f[\exists v[\mathbf{boy}'(v) \;\&\; F(v)(f)] \rightarrow \exists g[\exists x[\text{TWO-BOYS}(x) \;\&\; F(x)(g)] \;\&\; f \subseteq_E g]]]$$

Finally, we can combine the translation of *only* $[\mathit{two}]_F$ *boys* and the translation of *cried* (i.e. $\langle \mathbf{cried}', \mathbf{cried}' \rangle$) by an application of T1, so as to obtain the provisional translation of the whole sentence. The result is the pair whose members are both equal to the following:

$$\lambda e[\exists x[\text{TWO-BOYS}(x) \;\&\; \mathbf{cried}'(e) \;\&\; AG(e, x)] \;\&\; \forall f[\exists v[\mathbf{boy}'(v) \;\&\; \mathbf{cried}'(f) \;\&\; AG(f, x)] \rightarrow \exists g[\exists x[\text{TWO-BOYS}(x) \;\&\; \mathbf{cried}'(g) \;\&\; AG(g, x)] \;\&\; f \subseteq_E g]]$$

If we now replace the initial lambda by an existential quantifier, what we get is (69), the translation of (68) proposed in Example 16.

It is an easy exercise to verify that the translations of (60), (4), and (65) proposed in Examples 13, 14, and 15, respectively, can also be obtained by applying our translation algorithm. There is one point, however, which requires a brief comment. In Example 18 we assumed that the occurrence of *only* in *only* [*two*]$_F$ *boys* is introduced by an application of the syntactic rule SO to the NP [*two*]$_F$ *boys.* But given our formulation of SO, the NP *only* [*two*]$_F$ *boys* can also be analyzed in a different way, i.e. as the result of an application of SO to the focused D [*two*]$_F$, followed by an application of S3. Now, what happens if we apply our translation algorithm to the latter analysis? The answer is simple: we obtain a translation equivalent to the translation illustrated in Example 18. This is a particular instance of a general fact: every NP of the form '*only* [α]$_F$ β', where α is a D and β is a CN, admits two different syntactic analyses, but the analyses in question correspond to equivalent translations. So, from our present point of view, the possibility of applying SO to Ds is actually a redundancy. With focused TVs the situation is more complex. Take sentence (4): *John only* [*kissed*]$_F$ *Mary.* In this case, too, we can choose between two different syntactic analyses, since *only* can be introduced by an application of SO either to the focused TV or to the IV [*kissed*]$_F$ *Mary*; and in this case, too, the translations corresponding to the two syntactic analyses turn out to be equivalent. If we modify the sentence a little, however, the equivalence no longer holds. Let us consider the following variant:

(73) John only [kissed]$_F$ a girl.

Let us suppose that *only* has been introduced in (73) by an application of SO to the focused TV. Since the translation of [*kissed*]$_F$ provided by TF is $\langle \lambda x \lambda y \lambda e[AG(e, x) \ \& \ PT(e, y)], \lambda x \lambda y \lambda e[\mathbf{kissed}'(e) \ \& \ AG(e, x) \ \& \ PT(e, y)] \rangle$, the translation of *only* [*kissed*]$_F$ obtained by applying TO will be the pair whose members are both equal to this expression:

$$\lambda x \lambda y \lambda e[[\mathbf{kissed}'(e) \ \& \ AG(e, x) \ \& \ PT(e, y)] \ \& \ \forall f[[AG(f, x) \ \& \ PT(f, y)] \rightarrow \exists g[\mathbf{kissed}'(g) \ \& \ AG(g, x) \ \& \ PT(g, y) \ \& \ f \subseteq_E g]]]$$

Therefore, the provisional translation of (73) obtained by an application of T2 followed by an application of T1 will be the pair whose members are both equal to the following:

(74) $\lambda e \exists y[A\text{-}GIRL(y) \ \& \ [\mathbf{kissed}'(e) \ \& \ AG(e, \mathbf{John}') \ \& \ PT(e, y)] \ \& \ \forall f[[AG(f, \mathbf{John}') \ \& \ PT(f, y)] \rightarrow \exists g[\mathbf{kissed}'(g) \ \& \ AG(g, \mathbf{John}') \ \& \ PT(g, y) \ \& \ f \subseteq_E g]]]$

Let us now suppose that the occurrence of *only* in (73) has been introduced by an application of SO to the IV [*kissed*]$_F$ *a girl.* The translation of [*kissed*]$_F$ *a girl* we arrive at by applying TF and T2 is this:

$\langle \lambda x \lambda e \exists y[\text{A-GIRL}(y) \ \& \ \text{AG}(e, x) \ \& \ \text{PT}(e, y)], \lambda x \lambda e \exists y[\text{A-GIRL}(y) \ \& \ \mathbf{kissed}'(e) \ \& \ \text{AG}(e, x) \ \& \ \text{PT}(e, y)] \rangle$

As a consequence, the translation of *only* [*kissed*]$_F$ *a girl* provided by an application of SO turns out to be the pair whose members are both equivalent to the following:

$$\lambda x \lambda e[\exists y[\text{A-GIRL}(y) \ \& \ \mathbf{kissed}'(e) \ \& \ \text{AG}(e, x) \ \& \ \text{PT}(e, y)] \ \& \ \forall f[\exists y[\text{A-GIRL}(y) \ \& \ \text{AG}(f, x) \ \& \ \text{PT}(f, y)] \rightarrow \exists g[\exists y[\text{A-GIRL}(y) \ \& \ \mathbf{kissed}'(g) \ \& \ \text{AG}(g, x) \ \& \ \text{PT}(g, y)] \ \& \ f \subseteq_E g]]]$$

Finally, T1 gives us the provisional translation of the whole sentence, which is the pair whose members are both equal to (75):

(75) $\lambda e[\exists y[\text{A-GIRL}(y) \ \& \ \mathbf{kissed}'(e) \ \& \ \text{AG}(e, \mathbf{John}') \ \& \ \text{PT}(e, y)] \ \& \ \forall f[\exists y[\text{A-GIRL}(y) \ \& \ \text{AG}(f, \mathbf{John}') \ \& \ \text{PT}(f, y)] \rightarrow \exists g[\exists y[\text{A-GIRL}(y) \ \& \ \mathbf{kissed}'(g) \ \& \ \text{AG}(g, \mathbf{John}') \ \& \ \text{PT}(g, y)] \ \& \ f \subseteq_E g]]]$

The point to be emphasized is that (74) and (75) are *not* equivalent. Is this reasonable? Is it reasonable to have two different translations of (73)?[19] We think it is. Intuitively, (73) *does* have two distinct meanings: it can mean that there is a girl x such that the only thing John did to x was kiss her; but it can also mean that whenever John had to do with some girl, the only thing he did to her was kiss her. Now, (74) captures the former meaning of (73), while (75) captures the latter.

Our last example concerns a case in which *only* is not contiguous to the focus with which it is associated.

EXAMPLE 19

Intuitively, (2) has the same meaning as (76):

(2) John only kissed [Mary]$_F$.

(76) John kissed only [Mary]$_F$.

Let us check whether this identity of meaning is accounted for by our translation algorithm. Since the translation of *kissed* is the pair whose members are both equal to $\lambda x \lambda y \lambda e[\mathbf{kissed}'(e) \ \& \ \text{AG}(e, x) \ \& \ \text{PT}(e, y)]$, and the translation of [*Mary*]$_F$ is $\langle \lambda F \lambda e F(v)(e), \lambda F \lambda e F(\mathbf{Mary}')(e) \rangle$, the translation of *kissed* [*Mary*]$_F$ will be as follows:

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[19] It is perhaps worth pointing out that if we apply T1*, we end up with the same two translations we obtain by applying T1.

$\langle \lambda x \lambda e[\mathbf{kissed}'(e) \mathbin{\&} AG(e, x) \mathbin{\&} PT(e, v)], \lambda x \lambda e[\mathbf{kissed}'(e) \mathbin{\&} AG(e, x) \mathbin{\&} PT(e, \mathbf{Mary}')] \rangle$

Therefore, the translation of *only kissed* $[\textit{Mary}]_{\mathrm{F}}$ obtained by applying TO will be the pair whose members are both equal to (77):

(77) $\lambda x \lambda e[[\mathbf{kissed}'(e) \mathbin{\&} AG(e, x) \mathbin{\&} PT(e, \mathbf{Mary}')] \mathbin{\&} \forall f[\exists v[\mathbf{kissed}'(f) \mathbin{\&} AG(f, x) \mathbin{\&} PT(f, v)] \rightarrow \exists g[\mathbf{kissed}'(g) \mathbin{\&} AG(g, x) \mathbin{\&} PT(g, \mathbf{Mary}')] \mathbin{\&} f \subseteq_{E} g]]$

Let us now translate *kissed only* $[\textit{Mary}]_{\mathrm{F}}$. We know that the translation of *only* $[\textit{Mary}]_{\mathrm{F}}$ provided by the translation algorithm we are employing is nothing else but the pair whose members are both equal to the translation of *only* $[\textit{Mary}]_{\mathrm{F}}$ considered in section 2, i.e. the pair whose members are both equal to $\lambda F \lambda e[F(\mathbf{Mary}')(e) \mathbin{\&} \forall f[\exists x F(x)(f) \rightarrow \exists g[F(\mathbf{Mary}')(g) \mathbin{\&} f \subseteq_{E} g]]]$. As the reader can easily verify by herself, it follows that the translation of *kissed only* $[\textit{Mary}]_{\mathrm{F}}$ is a pair whose members virtually coincide with (77). Now, since the translations of *only kissed* $[\textit{Mary}]_{\mathrm{F}}$ and *kissed only* $[\textit{Mary}]_{\mathrm{F}}$ are equivalent to each other, the translations of (2) and (76) will also be equivalent, as required.

4. POSSIBLE DEVELOPMENTS

4.1. *Multiple Focus*

A standard example of association with multiple focus is the following:

(78) John only introduced $[\text{Bill}]_{\mathrm{F}}$ to $[\text{Sue}]_{\mathrm{F}}$.

(78) means that the only person introduced by John to somebody else was Bill, and that the only person to whom John introduced somebody was Sue. The extension of our approach to a sentence like this is very easy, for it is clear that the sentence can be paraphrased as follows: John introduced Bill to Sue, and every event in which John introduced somebody to somebody else is included in an event in which John introduced Bill to Sue. Notice that the same kind of paraphrase also works for a sentence such as (79):

(79) John only introduced $[\text{every priest}]_{\mathrm{F}}$ to $[\text{a nun}]_{\mathrm{F}}$.

which is problematic for theories unable to deal with focused NPs other than proper names. We omit a detailed description of the changes in the translation algorithm required to deal with (78), (79), and the like. There is just one point which deserves explicit mention: the translation rules must ensure that if $\langle A, B \rangle$ is the translation of an expression containing several free foci, then the free variables in A which correspond to the foci in question must be distinct.

Krifka (1991) calls the focus of sentences like (78) "complex focus", and uses the term "multiple focus" to refer to cases with more than one focus operator. It can be shown that our approach is appropriate for the treatment of multiple focus in this sense too. However, to account for all the cases examined by Krifka in his paper, we should introduce a lot of new material (in particular, we should develop an analysis in terms of event semantics for focus operators other than *only*). Discussion of this topic must be left for another occasion.

4.2. *'Only When'*

Only is often associated with expressions which do not belong to any of the categories NP, IV, TV, CN, D. By way of example, let us consider the case in which the focused expression is a *when*-clause. A thorough discussion of this case would obviously presuppose a good analysis of *when*-clauses, and a good analysis of *when*-clauses is only possible within a theoretical framework more flexible and more articulate than the one we have chosen to work in here. However, to convince oneself that our treatment of *only* is applicable in this case too, it suffices to examine the matter in a simplified setting. Take the following sentences:

(80) When John comes in Mary goes out.

(81) Only [when John comes in]$_F$ Mary goes out.

The content of these two sentences can be represented by means of (82) and (83), respectively:

(82) $\forall e[\text{JOHN-COMES-IN}(e) \rightarrow \exists f[R(e, f) \ \& \ \text{MARY-GOES-OUT}(f)]]$

(83) $\forall e[\text{JOHN-COMES-IN}(e) \leftrightarrow \exists f[R(e, f) \ \& \ \text{MARY-GOES-OUT}(f)]]$

where JOHN-COMES-IN(e) is an abbreviation of [**comes-in**′(e) & AG(e, **John**′)]; MARY-GOES-OUT(f) is an abbreviation of [**goes-out**′(f) & AG(f, **Mary**′)]; and R denotes a temporal relation between events whose exact nature (temporal overlap, immediate temporal succession, etc.) is specified by the context. (82) and (83) raise a few problems,[20] but as a first approximation they will do.[21]

Can we account for the shift from the truth conditions of (80) to the truth conditions of (81) on the basis of our treatment of *only*? As (82) shows, the *when*-clause in (80) corresponds to a universal quantification over events. So our first move is to replace (82) by a representation of the content of (80) similar to our representation of the content of the sentences expressing a universal quantification over individuals (see Examples 7 and 8 in section 2). The formula we propose is (84):

$$\exists e \exists \Phi [\forall f [\text{JOHN-COMES-IN}(f) \rightarrow [R(f, \Phi(f)) \,\&\, \text{MARY-GOES-OUT}(\Phi(f))]] \,\&\, \text{SUP}_{E}(e, \lambda g \exists f [\text{JOHN-COMES-IN}(f) \,\&\, g = \Phi(f)])] \tag{84}$$

It is easy to see that (84) is equivalent to (82). We can obtain (84) compositionally as the translation of (80) if the translation of the *when*-clause is the pair whose members are both equal to the following expression of type ((e, t), (e, t)):

$$\lambda P \lambda e \exists \Phi [\forall f [\text{JOHN-COMES-IN}(f) \rightarrow [R(f, \Phi(f)) \,\&\, P(\Phi(f))]] \,\&\, \text{SUP}_{E}(e, \lambda g \exists f [\text{JOHN-COMES-IN}(f) \,\&\, g = \Phi(f)])]$$

(here P is a variable of type (e, t)). To combine this translation of *when John comes in* with the translation of *Mary goes out*, all we need is a rule – call it TW – prescribing functional application. Now suppose we

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[20] The main problem is that in our semantics the set of events e satisfying JOHN-COMES-IN(e) and the set of the events f satisfying MARY-GOES-OUT(f) are closed under the supremum operation, whereas intuitively, only *minimal* events of the two kinds are relevant here. This means that the quantifiers occurring in (82) and (83) must be thought of as suitably restricted. The trouble is that it is not so easy to determine exactly *how* they should be restricted (the restriction to minimal events does not always work). We cannot discuss this problem here. Just note that everything we say in the following remains correct for *any* restriction of the quantifiers.

[21] According to Lycan (1984, 1991), the correct representation of the content of (81) is not (83), but rather $\forall e[\text{MARY-GOES-OUT}(e) \rightarrow \exists f[R(f, e) \,\&\, \text{JOHN-COMES-IN}(f)]]$. All we can say is that we do not share Lycan's intuition. We are not sure that (85) cannot have the reading considered by Lycan, but we are sure that the reading corresponding to (83) is by far the more natural to us. The situation is different with a sentence like *John smokes his pipe only when Mary is out.* In this case an interpretation of the kind suggested by Lycan is no doubt plausible: the sentence does not necessarily entail that John smokes his pipe *whenever* Mary is out. But notice that the same is true of the sentence *John smokes his pipe when Mary is out.* So our hypothesis is that the reading of *only-when*-clauses considered by Lycan presupposes a reading of *when*-clauses different from the reading exemplified by (82).

arrange things so that the translation of [*when John comes in*]$_{\mathrm{F}}$ provided by TF is as given in (85):

(85)
$$\langle \lambda PP,\ \lambda P\lambda e\exists\Phi[\forall f[\text{JOHN-COMES-IN}(f) \rightarrow [R(f, \Phi(f)) \mathbin{\&} P(\Phi(f))]] \mathbin{\&} \text{SUP}_{\mathrm{E}}(e, \lambda g\exists f[\text{JOHN-COMES-IN}(f) \mathbin{\&} g = \Phi(f)])] \rangle$$

The translation of *only* [*when John comes in*]$_{\mathrm{F}}$ obtained by an application of TO to (85) is the pair whose members are both equal to (86):

(86)
$$\lambda P\lambda e[\exists\Phi[\forall f[\text{JOHN-COMES-IN}(f) \rightarrow [R(f, \Phi(f)) \mathbin{\&} P(\Phi(f))]] \mathbin{\&} \text{SUP}_{\mathrm{E}}(e, \lambda g\exists f[\text{JOHN-COMES-IN}(f) \mathbin{\&} g = \Phi(f)])] \mathbin{\&} \forall f[P(f) \rightarrow \exists g[\exists\Phi[\forall h[\text{JOHN-COMES-IN}(h) \rightarrow [R(h, \Phi(h)) \mathbin{\&} P(\Phi(h))]] \mathbin{\&} \text{SUP}_{\mathrm{E}}(g, \lambda k\exists h[\text{JOHN-COMES-IN}(h) \mathbin{\&} k = \Phi(h)])] \mathbin{\&} f \subseteq_{\mathrm{E}} g]]]$$

Finally, if we combine (86) and the translation of *Mary goes out* by means of TW, we obtain the translation of (81), which turns out to be the pair whose members are both equal to (87):

(87)
$$\lambda e[\exists\Phi[\forall f[\text{JOHN-COMES-IN}(f) \rightarrow [R(f, \Phi(f)) \mathbin{\&} \text{MARY-GOES-OUT}(\Phi(f))]] \mathbin{\&} \text{SUP}_{\mathrm{E}}(e, \lambda g\exists f[\text{JOHN-COMES-IN}(f) \mathbin{\&} g = \Phi(f)])] \mathbin{\&} \forall f[\text{MARY-GOES-OUT}(f) \rightarrow \exists g[\exists\Phi[\forall h[\text{JOHN-COMES-IN}(h) \rightarrow [R(h, \Phi(h)) \mathbin{\&} \text{MARY-GOES-OUT}(\Phi(h))]] \mathbin{\&} \text{SUP}_{\mathrm{E}}(g, \lambda k\exists h[\text{JOHN-COMES-IN}(h) \mathbin{\&} k = \Phi(h)])] \mathbin{\&} f \subseteq_{\mathrm{E}} g]]]$$

It is not hard to see that the existential closure of (87) is equivalent to (83), as desired.

4.3. *Scalarity*

Our way of translating into formal language the sentences containing *only* can perhaps be the first step toward a unified treatment of the "scalar" and "nonscalar" readings of sentences containing *only.* Suppose Mary asks Peter, "Have you seen the headmaster?" and Peter says:

(88) No, only [the assistant]$_{\mathrm{F}}$ received me.

(88) can be understood in two different ways. It can mean that exactly one person received Peter, and that person was the assistant headmaster. But it can also mean that the assistant headmaster was the most important person who received Peter (or something like that). The latter is a typical "scalar" interpretation. The relevant "scale" is the ordering of the individuals according to their hierarchic status; so in this scale the headmaster is higher up than the assistant headmaster, the assistant headmaster is

higher up than the secretaries, and so on. Given a certain pragmatic context, the scale in question induces, so to speak, a corresponding ordering of events. For instance, since the headmaster is more important than the assistant headmaster, being received by the headmaster can be regarded as more rewarding than being received by the assistant headmaster; since the assistant headmaster is more important than a secretary, being received by him can be regarded as more rewarding than being received by a secretary; and so on. Let us denote by $\leqslant$ the relation 'not more rewarding than'. Then the content of (88) under the scalar interpretation can be represented as follows:

(89) $\exists e[\text{RECEIVED-PETER}(e)\ \&\ \text{AG}(e, \text{THE-ASSISTANT-HEADMASTER})]\ \&\ \forall f[\text{RECEIVED-PETER}(f) \rightarrow \exists g[\text{RECEIVED-PETER}(g)\ \&\ \text{AG}(g, \text{THE-ASSISTANT-HEADMASTER})\ \&\ f \leqslant g]$

where RECEIVED-PETER denotes the set of events consisting in Peter being received by somebody, and THE-ASSISTANT-HEADMASTER denotes the assistant headmaster. (89) can be read more or less as follows: the assistant headmaster received Peter, and every event consisting in Peter being received by somebody is at most as rewarding as an event consisting in Peter being received by the assistant headmaster. Now, what is remarkable is that (89) has exactly the same structure as (18). This suggests that the scalar and the nonscalar interpretations can perhaps in general be represented in the same way, the only difference being that while the ordering of events relevant for the scalar interpretation is determined each time by the context, the ordering relevant for the nonscalar interpretation is just $\subseteq_E$.

4.4. *Exhaustiveness*

Answers to questions are usually interpreted as satisfying an "exhaustiveness" condition: they are supposed not only to convey true information, but also to exhaust all relevant information.[22] Consider the following example:

(90) a. Who cried?
b. $[\text{John}]_F$ cried.

(90b) would not be a fully adequate answer to (90a) if, say, Mary too had

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[22] The operator EXH mentioned in section 1 was introduced by Groenendijk and Stokhof to account for this fact.

cried. (A correct answer would then be [*John and Mary*]$_{\mathrm{F}}$ *cried* or [*Two children*]$_{\mathrm{F}}$ *cried* or something like that.) In other words: when used as an answer to (90a), (90b) is more or less equivalent to (8), *Only* [*John*]$_{\mathrm{F}}$ *cried.* Does this mean that answers should be analyzed as if a hidden occurrence of *only* were associated with each focused expression? We do not think so. Take a slightly more complex example, like (91):

(91) a. Who kissed whom?
b. [Three boys]$_{\mathrm{F}}$ kissed [two girls]$_{\mathrm{F}}$.

A moment's thought shows that (91b) is by no means equivalent to (92):

(92) Only [three boys]$_{\mathrm{F}}$ kissed only [two girls]$_{\mathrm{F}}$.

Compare, for instance, the readings of (91b) and (92) which assign wide scope to the subject NP. On this reading, (91b) means: there is a group x of three boys such that each boy in x kissed two girls and nobody else, x contains every person who kissed somebody, and nobody was kissed except the girls kissed by the boys in x. On the other hand, (92) means: there is a group x of three boys such that each boy in x kissed two girls and nobody else, and x contains every person who kissed two girls and nobody else.

To account for the meaning of (91b), we can proceed as follows. Let us assume that the whole sentence is in the scope of an answerhood operator ANS:

(93) ANS([Three boys]$_{\mathrm{F}}$ kissed [two girls]$_{\mathrm{F}}$).

Let us further assume that the translation of ANS(α) is $\langle \textsc{only}(\langle \mathrm{A}, \mathrm{B}\rangle), \textsc{only}(\langle \mathrm{A}, \mathrm{B}\rangle)\rangle$, where $\langle \mathrm{A}, \mathrm{B}\rangle$ is the translation of α. It is easy to see that under these assumptions, (91b) receives the correct interpretation. (The computation is straightforward; just recall that the variables corresponding to the two foci must be kept distinct, as pointed out in section 4.1 above.)

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