INFORMATION STRUCTURE IN A DYNAMIC THEORY OF MEANING

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1. Introduction

This paper sketches a way of incorporating an account of focus background articulation within a dynamic semantics. More specifically, we will present an extension of Discourse Representation Theory (DRT) in which focus-background divisions can be explicitly represented and then subjected to further processing. The DRT-based representations of focus-and-background I will propose have a (model-theoretic) semantics based on the Alternative Semantics of (Rooth, 1985).

The paper is a shortened version of the first part of a longer one (*A DRT-based Treatment of Focus-Background Articulation and its Presupposiotions*; see my webpage at http://www.ims.uni-stuttgart.de). For reasons of space there is just one use of focus-background structure I am able to discuss in this version, that where it is in the service of interpreting the focus-sensitive particle *only*.

2. A basic case.

We begin with a familiar example from the focus literature.

(1) Mary introduced $[\text{Bill}]_F$ to Sue.

The notation $[\text{Bill}]_F$ around the constituent *Bill* it as focused. I will refer to constituewnts that are marked in this way as *focus-marked*.

The representation of (1) which w make the starting point of our discussion, is the one in (2)[1].

(2) <m,b,s,n: Mary(m), Bill(b), Sue(s), < <**y**: C(**y**)>, <e: e < n, e: intr(m,**y**,s)>, <-: **y** = b>>.

There are quite a few things about this representation which need explanation. This is what will occupy us throughout this section.

A. The representation of the focus and its background in (2) is the triple between the inner angled brackets. We refer to such representations of focus structure as *focus frame focus divisions* (*ff-f divisions* for short). I will often represent them schematically as $<K_0,K_1,K_2>$. The first copmponent K_0 - in (2) this is the DRS <**y**: C(**y**)> - is called the *restrictor* of the given ff-f division; K_1 - in our example <e: e < n, e: intr(m,y,s)> - is referred to as the ff-f division's *focus frame* and K_2 - here <-: **y** = b> as its *focus constituent.*

B. The variable **y**, displayed in bold face, is the *focus variable* of the given ff-f division. It replaces the focus marked constituent *Bill* of the represented sentence (1) in its semantic representation. The replacement of the focus-marked constituent by the focus variable is what produces the separation of focus constituent from focus frame. The logical type of the focus variable is always that of the extracted focus constituent. Thus, given the assumption that the NP *Bill* in (1) has the type of an individual, the focus variable **y** in (2) is an individual variable.

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1 For reasons of space and security of formatting I do not use the box notation of Discourse Representation Structures (DRSs, the representations of DRT), which I normally prefer myself, but the linear format used for instance by Geurts (See e.g. (Geurts, 1999). In this notation the DRS for (1) without focus marking takes the form <m,b,s,n,e: Mary(m), Bill(b), Sue(s), e < n, e: intr(m,b,s)>. Here the members of the first component of the DRS (its so-called *universe*), the discourse referents m,b,s,n,e, are separated from those of the second component, the conditions Mary(m), Bill(b), Sue(s), e < n and e: intr(m,b,s) by a colon. (Not to be confused with the colon after the event discourse referent e, which separates e from its characterisation by the verb and its arguments. Note: In this paper i use the rems "variable" and "discourse referent" interchangeably.
Also for the record: the meaning of this representation is that there are individuals m.b.s, an utterance time n and an event e such that: m is Mary, b is Bill, S is Sue, e is before n and e is an event of m introducing b to s.
As often observed, the difference between this mode of presentation and the "box mode" is purely cosmetic.

C. The focus constituent of an ff-f division expresses that the value for the focus variable is that which is specified by the focus marked constituent. (We will consider later the question whether this value is unique. But for the time being let us assume it is.)

D. In general the possible values of the focus variable are restricted by context. This restriction is represented by the predicate C; the restrictor of the ff-f division serves to express this constraint on the values of the focus variable.

E. The reason that in (2) the discourse referents m,b,s and n and the conditions "Mary(m)", "Bill(b)", "Sue(s)" appear outside the focus frame has to do with the presuppositional status of the sentence consituents which introduce them: the definite NPs *Mary, Bill, Sue* and the tense of the verb (in the case of n). In (2) it has been assumed that the presuppositions these constituents introduce have already been resolved. We return to the issue of presupposition under G.

F. In this paper I give no explicit account of the process by which representations like (2) are constructed from focus-annotated syntactic sentence structures. The following recipy (formulated along the lines of the top-down construction algorithm of (Kamp & Reyle, 1993) is meant as a rough guide line[2]:

(i) Extract the focus constituent from its position in the syntactic tree and replace it by a variable of its type.

(ii) Process the resulting syntactic tree essentially as one would have done if no such substitution had taken place. (To combine the focus variable with the representations of other constituents from the tree will require slight adjustments, but this is straightforward.) The result of this processing is the focus frame component of the representation.

(iii) The focus constituent itself is turned into a (reducible) DRS-condition by adjoining the focus variable as argument to the root node of that constituent and placing the condition into the condition set of the focus constituent of the ff-f division (of which this condition will be the sole constituent). The application to this reducible condition of procedures familiar from the DRT literature will then convert the focus constituent into a DRS. A comparatively trivial example is the focus constituent in (2).

(iv) Familiar DRS.constructin procedures will similarly lead to the focus frame DRS, after the focus variable has been inserted at the position of the focus-marked constituent within the syntactic tree.[3]

(iv) The restrictor is always constructed as the DRS $<\alpha: C(\alpha)>$, where α is the focus variable and where C is a fresh predicate variable. More will be said about C in the next remark.

G. As in other devices found in natural language - quantification, abstraction, wh-question formation, to name some - the focus variable in an ff-f division is open to restrictions that are not made explicit in the sentence itself, but have to be extracted or inferred from the context. As said, the predicate variable C represents this contextual restriction. The resolution of C in context can take either an intensional or an extensional form. Often the value of C is determined as the property of being a member of a given set Y - $C \equiv \lambda\alpha.\ \alpha \varepsilon Y$ - where Y can be recovered from the context. It is common for Y to be quite small. An example is the exchage given in (3), in which (1) is uttered as B's reply to the question asked by speaker A.

(3) A: I know that Carl, Bill and Fred were in the room and I saw
that Mary introduced one of them to Sue. But who was it?

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2 N.B for the remainder of this paper it is not essential to understand the details of this recipy or to be familiar with the top-down construction algorithm which it presuposes. I should add that the recipy is easily adapted to other construction algorithms for DRT, e.g. the bottom-up algoirthms of (Zeevat, 1989), (Asher, 1993), or (Van Genabith et al, 2004).

3 I am ignoring a complication here, which has to do with the scope of a given focus marking. Often the material that goes into the focus frame and the focus constituent of a ff-f division is not all but only part of the material that makes up the sentence. (In (Rooth, 1992) and much of the subsequent literature, scope is marked by a tilda.) Since the scope question is not crucial to any of the points in this paper I will make the simplifying assumption that the scopes of ff-f divisions always include all sentence material. (This does not exclude the possibility that some material lands outside the ff-f division because of presuposition. See G below for discussion.)

B: Mary introduced $[\text{Bill}]_F$ to Sue.

In this case it is A's query which provides the relevant contextual clue. This clue enables the interpreter to associate with the focus frame of (1) a set consisting of just three propositions, the proposition that Mary introduced Carl to Sue, the proposition that she introduced Bill to Sue and the proposition that she introduced Fred to Sue.

Since the value of C has to be determined in context, it is natural to treat this requirement as a presupposition - a presupposition of an "anaphoric" kind that is akin to the anahoric presuppositions which, following (Van Der Sandt, 1992), we associate with third person pronouns and other overtly anaphoric expressions. Seen in this light the representation in (2) is incomplete, as a representation of the presupposition is missing from it.

Before we add a representation of this presupposition to the representation of (1), let me recall one of the central contentions of (Rooth, 1992): Each ff-f division comes with a pair of presuppositional constraints on its alternative set - the set is presupposed (i) to contain the focus value as one of its members; and (ii) to contain at least one other element besides. Within our representational approach this thesis can be cast into the following form:

(4) The value of the predicate variable C has to be determined in such a way that

(i) it contains the value for the focus variable that is determined by the focus constituent; and (ii) it contains at least one other element.

A fully general formulation of these constraints is a somewhat delicate matter. However, for the cases which will be discussed here we can make do with a formulation which is fairly straighforward. We illustrate it by example: In the case of (2), where the focus constituent consists solely of the condition is "$\mathbf{y}$ = b", the two constraints can be formulated as (i) C(b); and (ii) $(\exists\zeta)(C(\zeta)\ \&\ \zeta \# b)$[4].

We incorporate the constraints of (4) into the presupposition on C. In (5), which includes this presupposition, I have also represented the contributions made by the proper names *Mary*, *Bill* and *Susan* and finite tense explicitly as presuppositions. (Presuppositions are represented as in (Kamp, 2001) or (Van Genabith et al., 2004): sets of presupposition representations are adjoined to the DRS as a whole (as in (5) for the presuppositions associated with the proper names and the finite tense of (1)), or to some DRS-constituent (as is the case here for the presupposition on C, which is adjoined to a sub-DRS containing the ff-f division). Justification of the presuppositions connected with the proper names and tense[5] gets us back to the contributions of these constituents shown in (2).

(5)
$$<\{<\underline{m}: \text{Mary}(m)>, <\underline{b}: \text{Bill}(b)>, <\underline{s}: \text{Sue}(s)>, <n: ->\}, <\{<\underline{C},\zeta: C(b), \zeta \# b, C(\zeta)>\},$$
$$<-: <<\mathbf{y}: C(\mathbf{y})>, <e: e < n, e: \text{intr}(m,\mathbf{y},s)>, <-, \mathbf{y} = b>>>>>$$

N.B. the underlining of the discourse referents in the presuppositions of (5) is to indicate that presupposition justification has to identify the denotations represented by the underlined discourse referents.

The semantics of DRS conditions which represent ff-f divisions follows the informal gloss we have given of the meaning of the ff-f division (and which aims to capture the essence of the alternative semantics of (Rooth, 1985). To see what this semantics comes to for the case under discussion it will be easier to look at a representation stage which we reach after the presuppositions of (5) have been resolved. To get to this stage we assume again that resolution of the presuppositions for the proper names and tense of (5) leads to the

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4 I am using the Greek letter ζ in order to leave open whether the value of this variable is an individual (an atomic element of mereological universe of things and pluralities; see Link (83)) or a set of more than one element (a non-atomic element of such a universe). The use of the disjointness symbol # is to allow for a similar flexibility: "a # b" means the same as " a **π** b" in case a and b are both individuals, "a # B" means the same as " a **œ** b" in case a is an individual and B a set, (and analogously for a set A and an individual b), and when both A and B are sets, then "A # B" means that A and B are disjoint. The reason for this more general formulation will become clear as we move to other examples. See (Kamp & Reyle 1993), Ch. 4.

5 Justification either takes the form of accommodation, in which case the presupposition will actually be merged with the DRS to which it is adjoined, or it will be an entailment of the context DRS into which (11.i) gets integrated. In either case the presupposition becomes an entailment of the DRS as a whole.

contributions shown in (2). With regard to the presupposition on C I will asume that we are dealing with an utterance of (1) in the context of (3) and that C is resolved in the way suggested above, i.e. as the predicate λy. y ε {c,b,f}, where c,b,f represent Carl, Bill and Fred, respectively. Under these assumptions (5) gets transformed into (6). (I have included in (6) the representations of Carl and Fred, although these strictly speaking do not belong to the representation of (1). They should be seen as a "spill-over" from the context in which the C-presupposition is resolved.)

(6) <c,b,f,m,s,n: Carl{c), Bill(b), Fred(f), Mary(m), Sue(s),
< <**y**: **y** ε {c,b,f}>, <e: e < n, e: intr(m,**y**,s)>, <-: **y** = b>>.

H. Alternative Semantics suggests as the semantic value of an ff-f division < K_0, K_1, K_2> a pair <Q,p>, where Q is a set of propositions and p is a proposition belonging to Q. More precisely, Q is the set of all those propositions q which are expressed by the focus frame K_1 when the focus variable is assigned a value admitted by the restrictor K_0; and p is the proposition expressed by K_1 when the focus variable is assigned the value selected by the focus constituent K_2. This presupposes, however, that the focus constituent selects, in conjunction with the restrictor, a unique value for the focus variable. From the approach we have taken, this does not follow automatically, and we will see cases below where this assumption can be questioned. All that is guaranteed (by the restrictions imposed on the resolution of the restrictor predicate C) is that restrictor and focus constituent admit *at least* one value.

Since I do not want to take the uniqueness assumption for granted, I will assume that in general the semantic value of < K_0, K_1, K_2> is a pair <Q,P> of sets of propositions, with Q as described above and P the proper subset of Q consisting of those propositions that are expressed by K_1 when the focus variable is assigned a value which satisfies both K_0 and K_2. (That P is a proper subset of Q is also a consequence of the conditions in the C-presuppopsition.) We summarise the definition of the values of ff-f divisions in (7)

(7) (Definition of the semantic value of a ff-f division K_0, K_1, K_2>)

Let < K_0, K_1, K_2> be any ff-f condition and let **a** be its focus variable..

(i) The pair <K_0,K_1> defines a set of propsitions Q, consisting of those propositions q such that for some d which satisfies K_0 (i. e. when assigned to **a**), q is the proposition expressed by K_1 when d is assigned to **a**. We call Q the *focus frame set* Q determined by < K_0, K_1, K_2>.
(ii) P is the subset of Q consisting of those propositions q such that the corresponding d satisfies not only K_0 but also K_2. P is called the *focus selection*
(iii) <Q,P> is the *semantic value of* < K_0, K_1, K_2>.

It is easy to see from (7) that for the ff-f division in (6) the set Q consists of three propositions - the proposition that Mary introduced Carl to Sue, the one that she introduced Bill to Sue and the one that she introduced Fred to Sue. The set P is the singleton set consisting of the proposition that Mary introduced Bill to Sue. (This proposition can thus be identified with the ordinary value of (1) according to Alternative Semantics. See (Rooth,1985)) P is a singleton since the constraint imposed by the focus constituent has the form of the identity condition "**y** = b". Focus constituents are often of this form. However, below we will encounter examples which indicate that it is debatable whether the constraint imposed by the focus constituent always entails uniqueness. This is the theme of Section 3

3. Does focus select single propositions or proposition sets? Focus in the service of intepreting *only*

This section has two aims. The first is to get some purchase on the question raised at the end of the last section - whether the general semantic form of focus-background articulkation is <Q,p> or <Q,P>. To this end we will look at sentences in which the focus-marked constituent is not a singular NP such as *Bill*, but a plural NP such as *Bill and Tom* or *three people*. To appreciate how such focused plural NPs work, however, it is helpful to see what contributions they make to the interpretation of sentences involving a focus-senstitive operator like *only*. This brings us to the second aim - that of exploring the semantics of *only*. We follow (Rooth, 1985) and others in assuming that *only* is a *focus-sensitive operator* . Within the present approach this is most naturally captured by assuming that *only* takes ff-f structures as arguments.[6]

We begin by looking at an *only*-sentence which differs minimally from the sentence (1) which we considered in Section 2, viz. (8).

(8) Mary only introduced [Bill]$_F$ to Sue.

Using the notation we have developed in Section 1, we represent (8) as in (9):

(9) <{<$\underline{m}$: Mary(m)>, <$\underline{b}$: Bill(b)>, <$\underline{s}$: Sue(s)>, <n: ->}, <{<$\underline{C}$,ζ: C(b), ζ # b, C'(ζ)>},
<-: only(<<**y**: C(**y**)>, <e: e < n, e: intr(m,**y**,s)>, <-: **y** = b> >)>>>

(9) represents (8) as involving an application of the focus-sensitive operator *only* to the ff-f triple induced by the focus marking of the NP *Bill*. But what exactly is the semantic contribution which this complex - i.e. the complex condition which is headed by *only* - makes to the meaning (and, thereby, to the truth conditions) of (8)? What, to be more exact, is the contribution made by *only*, as opposed to the one that would have been made by some other possible focus-sensitive operator? According to Rooth and others the lexical semantics of *only*, as applied to the case of (8), is this:

The proposition which is the ordinary semantic value (in our proposal: the second component of the semantic value of the ff-f division to which *only* is being applied, assuming that this value has the form <Q,p>) is the *only true* member of the alternative set Q (in our terminology, the focus frame set):[7][8]

(10) only(<Q,p>) iff (i) $^{\vee}$p and (ii) ("q ε Q)($^{\vee}$q → q = p).

When we combine (9) with (10), we get the intuitively right truth conditions for (8): The conjunction of (i) the (presupposed) proposition expressed by K_1 when **y** is assigned the value represented by b - i.e. the proposition that Mary introduced Bill to Sue - and (ii) the proposition that if **y** is assigned any other value satisfying C, then the proposition expressed by K_1 for that value of **y** is not true. The DRSs in (11) in which it is assumed that the presupositional part of (10) has been justified and thereby turned into a conjunct on a par with the non-presuppositional part, give first order representations of these truth conditions.[9]

(11) <m,b,s,n,e: Mary(m), Bill(b), Sue(s), e < n, e: intr(m,b,s),
(∀y)(<y,e': C(y, e' < n, e': intr(m,y,s)>,<-,y = b>)>

Summary of this section: We have obtained two superficially different ways of arriving at a representation for (8) which captures its truthconditional content. The first way takes (9) as the final representation. (9) gives the desired truth conditions if we (i) compute the proposition set Q and the proposition p from the argument of *only* according to the semantics for ff-f divisions, and (ii) apply (10) to this pair. The second way involves (11) as final representation. This DRS gives the intended truth conditions for (1) on the basis of the familiar modeltheoretic semantics for standard DRT. (see Kamp & Reyle, 1993))

3.1 Focus on plural NPs.

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6 (Beaver & Clark, 2003) show that this assumption, though correct for the case of *only*, is questionable in general. The issue is taken up in the longer version of this paper. Time permitting it will be taken up in the lecture.

7 We use the notation "$^{\vee}$q" from Monatgue Grammar to express that the proposition q is true.

8 In (10) the contribution of *only* has been broken up into two parts. It is held by many that the two parts do not have eaxctly the same status: has the status of a presupposition, while the actual non-presuppositional contribution made by "only(<Q,p>" is given by (ii). However opinions appear to be divided on this point. The issue is not directly relevant to this paper.

9 In keeping with the linear notation used here the "duplex condition which represents the universal quantification over y is here rendered in the form "(∀y)(K_r, K_s)", where K_r is the restrictor DRS ("left hand side box" of the duplex condition) and K_s its nuclear scope (the "right hand side box").

For sentence (8) (10) gives the truth conditions we want: Bill is the only person (in the contextually determined reference set) whom Mary introduced to Sue. But what happens when we replace the focussed phrase *[Bill]$_F$* by *[Bill and Tom]$_F$*, as in (12)?

(12) Mary only introduced [Bill and Tom]$_F$ to Sue.

One way to gloss (12) is as follows: The only two true propositions (from some larger set) are that Mary introduced Bill to Sue and that Mary introduced Tom to Sue.[10] We can capture this reading in the following representation (again with presuppositions for proper names and tense resolved).

(13)
$$\begin{aligned}&\langle m,b,t,s,n,e,W: \mathrm{Mary}(m), \mathrm{Bill}(b), \mathrm{Tom}(t), \mathrm{Sue}(s), W = b \oplus t,\\ &\langle\{\langle \underline{C},\zeta: (\forall w)(\langle w: w \leq W\rangle,\langle -: C(w)\rangle), \zeta \# W, C(\zeta)\rangle\},\\ &\langle -: \mathrm{only}(\langle \langle \mathbf{y}: C(\mathbf{y})\rangle, \langle e: e < n, e: \mathrm{intr}(m,\mathbf{y},s)\rangle, \langle -: \mathbf{y} \leq W\rangle \rangle)\rangle\rangle\rangle\end{aligned}$$

In (13) W is a 'plural discourse referent', standing for the non-atomic individual whose atomic constituents are Bill and Tom.[11]

The crucial difference between (9) and (12) is to be found in the third component K_2 of the argument of *only*. Instead of the earlier condition "**y** = b" in (6), which restricts the possible values of **y** to the single individual represented by b, we now have the condition "**y** ≤ W" which says that the individual represented by **y** is a mereological part of the entity represented by W. (In set-theoretical terms this amounts to **y** being a member (or subset) of the set {Bill,Tom}.) Given that the reference set - i.e. the extension of the contextually determined predicate C - satisfies the C-presupposition of (13), there are two possible atomic values for **y** which satisfy C, viz. Bill and Tom. Thus the second component of the semantic value of the ff-f triple of (13) is the set of the two corresponding propositions. We obtain the intuitively correct truth conditions for (12) if we modify the semantics of *only* in the obvious way. First, *only* now operates on pairs $\langle Q,P\rangle$, were Q and P are both sets of propositions and P is a subset of Q, and, second, the truth conditions of "only($\langle Q,P\rangle$)" are now as stated in (14):

(14) only($\langle Q,P\rangle$) iff (i) $(\forall q\ \varepsilon\ P)\ {}^{\vee}q$ and (ii) $(\forall q\ \varepsilon\ Q)({}^{\vee}q \rightarrow q\ \varepsilon\ P)$

A second difference between (13) and (9) concerns the C-presupposition itself. The presupposition in (13) requires not just that C be satisfied by a single value that is identified by the focus constituent, but by all values which stand to W in the relation ≤. Note, however, that this is the obvious adaptation of the C-presupposition to cases where the focus constituent takes the form that it has in (13): Rather than requiring that C be satisfied by the individual whose assignment to **y** gives the *unique* proposition which constitutes the second component of the semantic value of the ff-f triple in question (i.e. the one we have called its "ordinary value"), it insists that C be satisfied by *every* individual which generates a proposition that belongs to the *focus selection*. (As before, there is the additional requirement that C be satisfied by at least one individual other than those included in the focus value.)

According to the analysis of (12) that is given in (13) the focus constituent does not select a single proposition from the alternative set, but a set of two propositions. But are we really forced to adopt this analysis? An alternative that comes to mind is the following: Assume that the focus variable y doesn't range over individuals in the usual sense of the word - i.e. not only over atomic individuals of the mereologically structured domain of which the referent of W in (13) is a non-atomic member - but over non-atomic as well as atomic individuals of this domain. This makes it possible to represent the focus condition in the preliminary representation of (13) in the form "y = W", with the effect that once again the focus constituent selects from the set of alternative propositions a single proposition. (The proposition which says that the event e mentioned in the focus frame of (13) is of the type "e: intr(m,W,s)".)

One consequence of this alternative proposal is that (10) will no longer do as semantic characterisation of *only*. Assume for instance that there are three people - Bill, Tom and Elliot - in the contextual restriction (i.e.

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[10] This is the "distributive" reading of (12). (12) also has a collective reading according to which the only introduction to Sue which Mary performed involved the pair consisting of Bill and Tom. I ignore non-distributive readings in this paper. Note that as long as it is assumed that introducing a group entails itroducing each of its members (13) assigns roughly the right truth conditions to (12) also on its non-distributive interpretation.

[11] "atomic" is to be understood in the sense of mereology. # is used to denote merological disjointness. In the present case this just amounts to saying that the individual represented by z does not belong to the set represented by W. ⊕ denotes mereological sum. "≤" denotes the'part-whole' relation of mereology. See also fn. 4.

C is resolved to the predicate ly. y e {Bill, Tom, Elliot}. Then, according to the truth conditions of (12), the ordinary value of the ff-f division (viz the proposition that Mary introduced (Bill Å Tom) to Sue) is not the only one within the set of possible alternatives which is true. For instance the proposition that Mary introduced Bill toSue will be true as well. Generally speaking,, once we allow the focus variable **y** to take non-atomic as well as atomic values, the set of its possible values as restricted by the context set of Bill, Tom and Elliot will have to include also the possible mereological sums that can be formed out of these. On the given resolution of C this gives us 7 distinct elements in all, and thus a focus frame set consisting of the 7 propositions corresponding to these. According to (12) three of these are true, not one.

The following revision of Definition (10) of the truth-conditional contribution made by *only* correctly captures the truth conditions of sentences like (12), in which the focus associated with *only* is on a term which denotes a non-atomic individual, as well as those of sentences like (8) where the denotation of the focus constituent is atomic.

(15) only(<Q,p>) iff (i) $^{\vee}p$ and (ii) $(\forall q \; \varepsilon \; Q)(^{\vee} q \rightarrow -$ (q is stronger than p))

Here "q is stronger than p" is to be understood as:
q entails p and p does not entail q

It is easy to see that (15) subsumes (10), provided that we assume that the alternative set Q satsifies the following closure condition[12]:

(16) If q_1, q_2 ε Q and q is the proposition which is the conjunction of q_1 and q_2 ($q = \hat{}(^{\vee}q_1 \; \& \; ^{\vee}q_2)$), then q ε Q.[13]

By way of illustration of how (15) works in conjunction with (16) consider the case of (8). Suppose that the focus frame set Q besides the proposition that Mary introduced Bill to Sue also the one that she intioduced Elliot to Sue. Suppose moreover, that, contrtary to what (8) asserts, both propositions were true. Then their conjunction would be true as well, and according to (16) it would be in Q. So Q would contain a true proposition that is stronger than the focus proposition, which contradicts (15).

(15) is suggestive of a generalisation which not only captures the cases of *only* considered so far, but also those where its interpretation involves some scalar relation between the elements belonging to the extension of C. Typical examples (though by no means the only ones) are those in which the relevant scale is numerical. Consider sentence (17), where we assume that the focus marked constituent associated with *only* is the indefinite NP *three people*.

(17) Mary only introduced [three people]$_F$ to Sue.

The representation principles we have been using suggest for (17) (with its given focus marking) the representation in (18)

(18) <m,s,n,e,W: Mary(m), Sue(s), persons(W), |W| = 3,
<{<<u>C</u>,ζ: (∀w)(<w: w ≤ W>,<-: C(w)>), ζ # W, C(ζ)>},
<-: only(< <**y**: C(**y**)>, <e: e < n, e: intr(m,**y**,s)>, <-: **y** ≤ W>>)>>>

With the semantics for *only* given in (15), (18) represents (after presupposition justification) the proposition that there was a set of three people who were the only ones that Mary introduced to Sue. For (a) (17) requires that there be such a set of three people introduced by Mary to Sue, and (b) if there had Mary introduced to Sue anyone besides these, then a stronger proposition - viz that Mary introduced the three mentioned people to Sue *and* one or more other people besides, which would also have been true, and this would have contradicted (16).

(18) gives us the intuitively right truth conditions when we evaluate its only according to (15). But what happens when the focal stress in (17) is only on *three*? In that case the rules for focus projection tell us that it is just this constituent - the prenominal adjective (or determiner) *three* - which is the focus associated with *only* - see (19).

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12 If we adopt the present analysis of sentences like (12) we should also adopt (16) as a general cosntraint on C-resolution.

13 ^ turns a formula into a term that denotes the proposition which the formula expresses.

(19) Mary only introduced [three]$_F$ people to Sue.

(19) is our first (and in this version of hte paper only) example of a sentence whose interpretation involves a focus variable of higher type. There may be room for some debate over what sort of variable this is (see fn 14), but this is a matter that need not detain us here. For sake of definiteness I will assume (i) that occurences of numerals like that of *three* in (19) are syntactically adjective phrases adjoined to the nouns that follow them, while full NPs like *three people* are to be regarded as indefinites with empty determiner; and (ii) that such numeral occurrences function semantically as cardinality predicates of mereological individuals. (Thus the occurrence of *three* in (19) is the predicate that is true of those and only those non-atomic individuals which are made up of three atoms.) On this analysis the focus variable in the representation of (19) is a variable which ranges over a certain sort of predicates of individuals. For now I will refer to these predicates as "numerals".

The numerals come with a natural order <, viz that of the natural numbers they can be used to denote, and it is this order which is invoked as a default in the interpretation of sentences in which *only* associates with a cardinal.

(20) <m,s,n,e,W: Mary(m), Sue(s), persons(W), |W| = 3,
<{<C,ζ: (∀w)(<w: w ≤ W>,<-: C(w)>), ζ # W, C(ζ)>},
<-: only(< <**P**: C(**P**)>, <e,W: persons(W), **P**(W), e < n, e: intr(m,**P**,s)>, <-: **P** = 3>>)>>>

In order to turn (20) into a final representation we still have to resolve the presuposition on C. In this case - something similar is true for many other cases where the focus variable is of higher type - the natural resolution would seem to be to the class of all predicates of the relevant sort, i.e to the class of all numerals. The resulting representation is shown in (21)

(21) <m,s,n,e,W: Mary(m), Sue(s), persons(W), |W| = 3,
<-: only(< <**P**: numeral(**P**)>, <e,W: persons(W), **P**(W), e < n, e: intr(m,**P**,s)>, <-: **P** = 3>>)>>>

What are the truth conditions that are determined by (21)? That depends on how we evaluate the operator 'only'. If we assume the semantics for 'only' given in (15) and furthermore that *introduce* is distributive in its direct object argument (an assumption we already made earlier), then we get the right truth conditions. In fact, in the present case this is so irrespective of whether we interpret numerals in an "at least" or an "exactly" sense.[14] There are many other cases, however, in which *only* gets a number-related scalar interpretation, and where our analysis will only get us the correct truth conditions when the number specifications are taken in the sense of "at least". An example is (22)

(22) Mary only jumped 1.95 m.

The considerations of this section, starting with our second anaylsis of (12), point towards a unified asccount of the meaning of *only*, which covers the scalar cases as well as those "logical" cases captured by the definitions (10) and (14), which rely solely on the logical notion of propositional identity. The common ground between the logical and scalar interpetation of only is expressed by the following variant (23) of (15)

(23) only(<Q,p>) iff (i) $^{\vee}p$ and (ii) $(\forall q \,\varepsilon\, Q)(^{\vee} q \rightarrow q \leq_p p))$

Here $\leq_p$ is some relation between propositions. What $\leq_p$ is will vary from one occurrence of *only* to the next. In each case $\leq_p$ will be based on some underlying partial order ≤ defined over the extension of the restrictor predicate C of the ff-f division which acts as argument to this occurrence of *only*. The connection between ≤ and $\leq_p$ is given in (24).

[14] Argument: If we take "Mary introduced **n** people to Sue" to be true provided Mary introduced at least n people to Sue, then for n > 3 the proposition that Mary introduced **n** people to Sue is a stronger proposition than the one that Mary introduced **3** people to Sue. So (15) entails that (i) Mary introduced 3 people to Sue and (ii) that for no n > 3, Mary introduced n people to Sue; ergo, she introduced exactly three, and hence only three people to Sue. If on the other hand we take n to be true only of those non-atomic individuals which contain exactly n atoms, then the first part of (15) will already get us the proposition that Mary intoduced exactly, and thus only, three people to Sue. Now the second part, to the effect that there is no stronger proposition of the given form which is also true, is satisfied, since for all n ≠ 3 the proposition that Mary introdued n people to Sue will be contradictory with the proposition that she introduced three people to Sue. In other words, on the 'exactly" interpretation of **n** the second part of (16) is entailed by its first part.

(24) Let <<α: C(α)>,K_1,K_2> be the argument of the given occurrence of *only*. Let q_1, q_2 be propsitions from the focus frame set and let d_1, d_2 satisfiers of C such that q_i is the proposition expressed by K_1 when d_i is assigned to α. (q_i = ^$K_1[\alpha/d_i]$). Then $q_1 \leq_p q_2$ iff $d_1 \leq d_2$.

In order that (23) yields a plausible interpretation for *only*, the relation "$q_1 \leq_p q_2$" ought to be interpretable as meaning that the proposition q_2 is at least as "strong" as q in some intuitively plausible sense of propositional strength. Not every partial order ≤ will induce an order $\leq_p$ on the corresponding proposition set which will satisfy this criterium. (For instance, if a relation ≤ does, then in general its converse ≥ will not.) Thus only certain orderings ≤ are acceptable as bases for $\leq_p$ in (23). So far, however, I have not been able to determine an independent characterisation of orderings which meet this criterium.[15]

Only-sentences with focus-marked plural NPs such as (12) and (17) can be seen to form a link between unequivocally scalar cases like (19) and (22) on the one hand and the "logical" cases like (8) which have been dominant in that part of the literature in which *only* is discussed in the context of focus. In the case of (12) and (17) the underlying partial order is the part-whole relation of the mereological universe of atomic and non-atomic individuals. This is partial order of a special kind, but it is a perfectly good, non-degenerate example of the mathematical class of partial orderings. The case of (8) with which we began our discussion of *only* is the special subcase of the part-whole relation in which all individuals in the extension of C are atomic. This is a sort of degenerate case, in which the part-whole relation reduces to the identity relation on the extension of C. The corresponding relation $\leq_p$ is in that case the identity relation on the focus frame set Q, and (23) reduces to (10).

On the assumption that the second analysis we offered for (12) is tenable, and a fortiori if the unifying analysis based on (23) can be upheld, there is no evidence yet that the general form of the semantics of focus background articulation is <Q,P>, with P a proper subset of Q, rather than the simpler <Q,p>, with p a member of Q. Alternative Semantics only allows for the second possibility. The approach taken in this paper allows for the first. But at this point it remains unclear whether this extra generality is really wanted for the analysis of information structure in natural language

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[15] In fact, I am not convinced there is an independent criterium. If none exists, then it will have to be acknowledged that the propositional strength criterium itself will enter into deciding what are suitable relations ≤ in connection with *only*-interpretations.