

Long Distance Selective Binding: The Case of Focus

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Focus belongs to a class of expressions that are insensitive to syntactic islands. Rooth (1996, 283-84) illustrates this with the sentences in (1).

- (1) a. Dr. Svenson only rejected the proposal that [John]_F submitted.
b. Tell me who rejected the proposal that who submitted.

In (1b), the wh-in-situ *who* in the relative clause must be assigned scope at the position of the first *who* in the Spec of CP. But raising this wh-phrase violates syntactic constraints on movement, inasmuch as the relative clause is an island for extraction:

- (2) *Tell me who you rejected the proposal that t submitted.

Similarly, in (1a), the focus F on *John*_F may associate with the focus sensitive operator *only* across a relative clause island. The link between a focus and a focus sensitive operator can be established over indefinitely long distances and can be shown to be impervious to various further island constraints.

This concern has led Rooth (1985) to develop an in situ theory of focus interpretation, in which a focused constituent such as *John*_F in (1a) need not undergo a movement to the position of the focus sensitive operator. A variant of Kratzer's (1991) version of this in situ account is reviewed in Section 1 of this paper. This analysis makes an incorrect prediction that a focus sensitive operator unselectively binds all the foci in its scope. Section 2 devises a theory which solves this problem by treating focus sensitive operators as selective binders coindexed with the foci with which they are associated. This theory is applied to multiple focus in Section 3. Finally, Section 4 compares the expressive power of the proposed system to that of other accounts of focus interpretation.

1. Focus Sensitive Operators as Unselective Binders

The basic idea underlying the interpretation of focus is that a focused constituent generates a set of alternatives to that constituent. Thus, the focused NP *Sue*_F evokes a set of alternatives to *Sue*, that is, a set of individuals. The semantic interpretation of the sentence "John introduced *Sue*_F to Bill" produces a set of alternative propositions which substitute an alternative individual for the focused element *Sue*_F:

- (3) The set of alternative propositions for
 "John intro Sue_F to Bill" =
 $\{\lambda w' [\text{John intro } x \text{ to Bill in world } w'] : x \in D\}$,
 where D is the set of individuals.

This set of alternatives is employed by a focus sensitive operator such as *only* which associates with the focus. As Rooth (1985) discusses, the semantics of *only* states that "only ϕ " is true only if the proposition expressed by ϕ is the only true proposition in the set of alternatives to ϕ :

- (4) "only ϕ " is true only if given any true proposition in the set of alternatives to ϕ , that proposition equals the proposition expressed by ϕ .¹

Thus, the sentence (5), in which the focus on Sue_F associates with the focus sensitive operator *only*, is true only if for any true proposition $\lambda w' [\text{John intro } x \text{ to Bill in } w']$ in the set in (3), that proposition equals $\lambda w' [\text{John intro Sue to Bill in } w']$. That is, (5) is true only if for any individual x such that John introduces x to Bill, x = Sue.

- (5) John only introduced Sue_F to Bill.

The question arises of how to derive the set of alternatives in (3) compositionally. One method would be to move the focused constituent Sue_F to the position of the focus sensitive operator *only*. This movement would leave behind a trace which could straightforwardly be interpreted as a variable ranging over alternative individuals. But keeping in mind the fact that the focused phrase may be separated from the focus sensitive operator by any number of syntactic islands (cf. Anderson 1972), Rooth (1985) devises a method of producing the set of alternative propositions in (3) without syntactically moving the focused constituent. We will present here a variation on Kratzer's (1991) amendment to Rooth's theory.

Kratzer proposes that each focus feature F bears an index. So the logical form for (5) should be (6), where the unindexed focus F is replaced by the indexed F_i.

- (6) only [John intro Sue_{F_i} to Bill]

Indices are interpreted by assignment functions which map them into various objects. We assume that the semantic value of a logical form α is relativized to an assignment function g: $\llbracket \alpha \rrbracket^g$. One of the roles of g is to assign a value to the index on a pronoun. For example, using the semantic rule in (7a), the function g assigns the pronoun a value from the context in (7b).

- (7) a. $\llbracket he_j \rrbracket^g = g(j)$
 b. $\llbracket he_j \text{ intro Sue to Bill} \rrbracket^g =$
 $\lambda w [g(j) \text{ intro Sue to Bill in } w]$

Alongside the ordinary variable assignment g, Kratzer introduces a second

distinguished assignment h to focus variables. h may be applied only to indices on foci. Relativization of the semantic value of a focused element α_{F_i} to a focus variable assignment h produces an alternative $h(i)$. If α_{F_i} is not relativized to an alternative variable assignment, F_i is semantically inert:

- (8) Semantics of the Focus Feature F_i :
- a. $[[\alpha_{F_i}]^{g,h}]$ defined iff $i \notin \text{Dom}(g)$ & $i \in \text{Dom}(h)$
 $[[\alpha_{F_i}]^{g,h}] = h(i)$
 - b. $[[\alpha_{F_i}]^g]$ defined iff $i \notin \text{Dom}(g)$
 $[[\alpha_{F_i}]^g] = [[\alpha]]^g$

Moreover, this second assignment h is used only in the computation of the set of alternatives:

- (9) The set of alternatives to ϕ is:
 $\{[[\phi]]^{g,h}; h \in H\}$,
 where H is the set of focus variable assignments.

Now the informal statement of the semantics of *only* in (4) can be expressed as (10).

- (10) $[[\text{only } \phi]]^g = \lambda w \forall p \in \{[[\phi]]^{g,h}; h \in H\}$
 $[p(w) = 1 \rightarrow p = [[\phi]]^g]$

Let us apply this semantic system to example (6).

- (11) $[[\text{only } [\text{John intro Sue}_{F_i} \text{ to Bill}]]]^g$
 $= \lambda w \forall p \in \{[[\text{John intro Sue}_{F_i} \text{ to Bill}]]^{g,h}; h \in H\}$
 $[p(w) = 1 \rightarrow p = [[\text{John intro Sue}_{F_i} \text{ to Bill}]]^g]$

Inside the set of alternatives, $[[\text{Sue}_{F_i}]]^{g,h} = h(i)$ and outside the set of alternatives, $[[\text{Sue}_{F_i}]]^g = [[\text{Sue}]]^g = \text{Sue}$, by (8). Therefore, (11) can be simplified to (12).

- (12) $\lambda w \forall p \in \{\lambda w' [J \text{ intro } h(i) \text{ to Bill in } w']; h \in H\}$
 $[p(w) = 1 \rightarrow p = \lambda w'' [J \text{ intro Sue to Bill in } w'']]$
 $= \lambda w \forall x [J \text{ intro } x \text{ to Bill in } w \rightarrow x = \text{Sue}]$

This is the correct result.

Notice that in (11), the semantic value of the sister of *only*, $[[\text{John intro Sue}_{F_i} \text{ to Bill}]]$, is computed twice, once with respect to the double assignment g,h and once with respect to the single ordinary assignment g . Inside the set of alternatives, in the calculation of $[[\text{John intro Sue}_{F_i} \text{ to Bill}]]^{g,h}$, the assignments g,h pass down to the focused constituent by virtue of the semantic composition rules, and we compute $[[\text{Sue}_{F_i}]]^{g,h}$. The focus variable assignment h activates the focus feature F_i , producing an alternative $[[\text{Sue}_{F_i}]]^{g,h} = h(i)$. The generation of the set of alternative propositions is thus accomplished without moving the focused phrase

Sue_{F_i} . Outside the set of alternatives, there is no focus variable assignment h , and so the focus feature F_i is semantically null, yielding no alternative to the focused element: $\llbracket Sue_{F_i} \rrbracket^g = \llbracket Sue \rrbracket^g = Sue$.

This system also correctly predicts the association of more than one focus with a single focus sensitive operator. Consider example (13a) and its logical form (13b).

- (13) a. John only introduced Sue_F to $Bill_F$.
 (He didn't introduce Ann to Fred.)
 b. only [John introduce Sue_{F_i} to $Bill_{F_m}$]

Calculation of the semantic value of (13b) gives the desired truth conditions in (14).

- (14) $\llbracket \text{only [John introduce } Sue_{F_i} \text{ to } Bill_{F_m}] \rrbracket^g$
 $= \lambda w \forall p \in \{ \llbracket \text{John introduce } Sue_{F_i} \text{ to } Bill_{F_m} \rrbracket^{g,h} : h \in H \}$
 $\quad [p(w) = 1 \rightarrow p = \llbracket \text{John introduce } Sue_{F_i} \text{ to } Bill_{F_m} \rrbracket^g]$
 $= \lambda w \forall p \in \{ \lambda w' [\text{John intro } h(i) \text{ to } h(m) \text{ in } w'] : h \in H \}$
 $\quad [p(w) = 1 \rightarrow p = \lambda w'' [\text{J intro Sue to Bill in } w'']]$
 $= \lambda w \forall x,y [\text{J intro } x \text{ to } y \text{ in } w \rightarrow x = Sue \ \& \ y = Bill]$

The set of alternative propositions in (14) introduces a focus variable assignment h which percolates down to the focused elements Sue_{F_i} and $Bill_{F_m}$ and generates alternatives $h(i)$ and $h(m)$ for both of them.

In fact, in situ theories of the type found in Rooth (1985) and Kratzer (1991) predict that each focus is bound by the lowest focus sensitive operator that c-commands it. That is, in these theories, a focus sensitive operator is an unselective binder of the foci in its scope.

- (15) Prediction: Each focus is absorbed by the lowest focus sensitive operator that c-commands it.

However, this prediction is falsified by cases of multiple focus discussed by Jacobs (1983), Krifka (1991), and Rooth (1994).

Consider the multiple focus example (16b) uttered in the context (16a).

- (16) a. John only introduced Sue_F to Fred.
 (He didn't introduce anyone else to Fred.)
 b. John also only introduced Sue_F to $Bill_F$.
 (He didn't introduce anyone else to Bill.)

In (16b), the focus on Sue_F associates with *only* and the focus on $Bill_F$ is supposed to associate with the higher focus sensitive operator *also*. But because *only* is the lowest focus sensitive operator that c-commands $Bill_F$, (15) incorrectly predicts that *only* absorbs the focus on $Bill_F$ and consequently that no focus associates with *also*.

Thus, the in situ theories of Rooth (1985) and Kratzer (1991) do not account for constructions in which one focus sensitive operator binds a focus across another focus sensitive operator. Rooth (1994) notes that a movement analysis could capture (16b) by raising $Bill_F$ outside the scope of *only*, but observes that this movement violates island constraints. For example, in the multiple focus construction (17b), the focus on $John_F$ is supposed to associate with the higher focus sensitive operator *also*, but by (15), it will be absorbed by the lowest operator *only* if $John_F$ remains in situ. But if $John_F$ undergoes movement in order to escape from the scope of *only*, then it will have to raise out of a relative clause island, as seen in (18).

- (17) a. Dr. Svenson only told Sue_F about the proposal that Bill submitted.
 b. Dr. Svenson also only told Sue_F about the proposal that $John_F$ submitted.
 (18) also [$John_F \lambda_2$ [only [Dr. S. told Sue_F about
 the proposal that t_2 submitted]]]

To summarize, the systems of Rooth (1985) and Kratzer (1991) for interpreting focused constituents in situ make the undesirable prediction that each focus is unselectively bound by the lowest focus sensitive operator that takes scope over it. The next section develops an analysis of focus which avoids this prediction.

2. Focus Interpretation as Selective Variable Binding

Let us return to the comparison between (1a) and (1b), repeated here in (19).

- (19) a. Dr. Svenson only rejected the proposal that [$John$] $_F$ submitted.
 b. Tell me who rejected the proposal that who submitted.

In (19b), movement of the lower *wh*-phrase to its scope-taking position should be impeded by the relative clause island. An alternative analysis has been developed in Baker (1970), Pesetsky (1987), and Reinhart (1992). The *wh*-phrase remains in situ and is coindexed with an interrogative Q operator in Comp that specifies its scope:

- (20) Tell me $Q_{j,i}$ who $_j$ [t_j rejected the proposal that who $_i$ submitted]

Similarly, consider the analogy between (21a), the multiple focus example from (16b), and (21b), a multiple *wh* construction.

- (21) a. John also only introduced Sue_F to $Bill_F$.
 b. Which teacher wonders which student read which book?

In (21a), the focus on $Bill_F$ associates with the highest focus sensitive operator *also* across a lower operator *only*. Likewise, (21b) has a reading where *which book* associates with the highest Q operator across a lower Q operator (producing

answers such as "Prof. Jones wonders which student read *War & Peace*". In the Baker/Pesetsky/Reinhart approach, this interpretation is represented by the structure in (22).

(22) $Q_{\langle j,m \rangle}$ which_j teacher t wonders [Q_i which_i student t read which_m book]

Notice that the interrogative Q operator does not unselectively bind all the wh in its scope. *Which book* associates with the highest Q selectively via coindexation.

Suppose we represent the connection between a focus sensitive operator and the focus that it associates with by the same mechanism, namely, coindexation. Then (19a) and (21a) will be assigned the logical forms in (23) and (24).

(23) $only_i$ [Dr. Svenson rejected the proposal that John_{F_i} submitted]

(24) $also_m$ [$only_i$ [John introduce Sue_{F_i} to Bill_{F_m}]]

Now we need a semantics for the indexed focus sensitive operators. The definition of the set of alternatives in the old system with unindexed focus sensitive operators employed relativization of the semantic value to a distinguished focus variable assignment h in addition to the ordinary assignment function g . Let us now abolish this second assignment function h and define the set of alternatives by using only the ordinary assignment g .

(25) Old definition:

The set of alternatives corresponding to $[[Op \phi]]^g$, where Op is an (unindexed) focus sensitive operator such as *only*, *also* is $\{[[\phi]]^{g,h}: h \in H\}$.

(26) New definition:²

The set of alternatives corresponding to $[[Op_i \phi]]^g$, where Op_i is an (indexed) focus sensitive operator such as *only_i*, *also_i* is $\{[[\phi]]^{g \cup \{i,x\}}: x \in D\}$, where D is the set of individuals.

More specifically, the new entry for the indexed focus sensitive operator *only_i* will read:

(27) $[[only_i \phi]]^g$ defined only if $i \notin \text{Dom}(g)$
 $[[only_i \phi]]^g = \lambda w \forall p \in \{[[\phi]]^{g \cup \{i,x\}}: x \in D\}$
 $[p(w) = 1 \rightarrow p = [[\phi]]^g]$

The condition $i \notin \text{Dom}(g)$ in (27) can be thought of as an instantiation of Heim's (1982) general condition that operators quantify over novel indices. This clause will ensure that foci do not act as pronouns, picking out a contextually determined referent. Rather, foci are interpreted through variable binding by an indexed focus sensitive operator.

ϕ in (27) will contain a focus feature F_i coindexed with the variable binder *only_i*. Since we no longer have a distinguished focus variable assignment h , we need to redefine the semantic value of a constituent focused by F_i . Observe that

the semantic value $\llbracket \phi \rrbracket$ is calculated with respect to the assignments g and $g \cup \{\langle i, x \rangle\}$ in (27).

Outside the set of alternatives, we compute $\llbracket \phi \rrbracket^g$. ϕ dominates the focused constituent α_{F_i} , so that the assignment g percolates down by the composition rules to the calculation of $\llbracket \alpha_{F_i} \rrbracket^g$. Since this takes place outside the set of alternatives, we do not want $\llbracket \alpha_{F_i} \rrbracket^g$ to produce an alternative to α . That is, we want $\llbracket \alpha_{F_i} \rrbracket^g = \llbracket \alpha \rrbracket^g$.

Inside the set of alternatives in (27), we calculate $\llbracket \phi \rrbracket^{g \cup \{\langle i, x \rangle\}}$. Once again, the composition rules pass the assignment function down to $\llbracket \alpha_{F_i} \rrbracket^{g \cup \{\langle i, x \rangle\}}$. Because this occurs inside the set of alternatives, we want $\llbracket \alpha_{F_i} \rrbracket^{g \cup \{\langle i, x \rangle\}}$ to generate an alternative individual x , which is equal to $(g \cup \{\langle i, x \rangle\})(i)$. That is, we want $\llbracket \alpha_{F_i} \rrbracket^{g \cup \{\langle i, x \rangle\}} = (g \cup \{\langle i, x \rangle\})(i) = x$.

Now observe that the difference between the assignment g and $g \cup \{\langle i, x \rangle\}$ is that the index i is in the domain of the latter but not of the former. That $i \notin \text{Dom}(g)$ follows from (27). Combining the two desiderata that $\llbracket \alpha_{F_i} \rrbracket^g = \llbracket \alpha \rrbracket^g$ and $\llbracket \alpha_{F_i} \rrbracket^{g \cup \{\langle i, x \rangle\}} = (g \cup \{\langle i, x \rangle\})(i)$, we define the semantics of the focus feature F_i in (28).

(28) New definition of the semantics of F_i :

$$\llbracket \alpha_{F_i} \rrbracket^g = \begin{cases} g(i) & \text{if } i \in \text{Dom}(g) \\ \llbracket \alpha \rrbracket^g & \text{if } i \notin \text{Dom}(g) \end{cases}$$

The focus feature F_i resembles a switch that may be turned on or off by an assignment function. An assignment g whose domain contains the index i of the focus feature activates the focal switch, generating an alternative $g(i)$. Otherwise, if F_i is evaluated with respect to an assignment that cannot apply to its index, the feature remains switched off, that is, semantically inert.

Let us apply the selective binding semantics of (27) and (28) to the simple focus example (5), which now receives the logical form (29).

(29) only _{F_i} [John introduce Sue _{F_i} to Bill]

Application of (27) yields (30).

$$\begin{aligned} (30) \quad & \llbracket \text{only}_i [\text{John introduce Sue}_{F_i} \text{ to Bill}] \rrbracket^g \\ & \text{defined only if } i \notin \text{Dom}(g) \\ & = \lambda w \forall p \in \{ \llbracket \text{John intro Sue}_{F_i} \text{ to Bill} \rrbracket^{g \cup \{\langle i, x \rangle\}} : x \in D \} \\ & \quad [p(w) = 1 \rightarrow p = \llbracket \text{John intro Sue}_{F_i} \text{ to Bill} \rrbracket^g] \end{aligned}$$

$i \in \text{Dom}(g \cup \{\langle i, x \rangle\})$ and $i \notin \text{Dom}(g)$. Therefore, (28) produces $\llbracket \text{Sue}_{F_i} \rrbracket^{g \cup \{\langle i, x \rangle\}} = (g \cup \{\langle i, x \rangle\})(i) = x$ and $\llbracket \text{Sue}_{F_i} \rrbracket^g = \llbracket \text{Sue} \rrbracket^g = \text{Sue}$. (30) then reduces to (31).

$$\begin{aligned} (31) \quad & \lambda w \forall p \in \{ \lambda w' [\text{John intro } x \text{ to Bill in } w'] : x \in D \} \\ & \quad [p(w) = 1 \rightarrow p = \lambda w'' [\text{J intro Sue to Bill in } w'']] \\ & = \lambda w \forall x [\text{John intro } x \text{ to Bill in } w \rightarrow x = \text{Sue}] \end{aligned}$$

So far, this system makes the same predictions for simple focus as the unselective binding semantics in Section 1 (compare (30) and (31) with (11) and (12)). In general, in our new system, if Op_i is a focus sensitive operator such as *only*, *also*, *even*, etc., then in the calculation of $\llbracket Op_i \phi \rrbracket^g$, the semantic value of ϕ is computed with respect to g outside the set of alternatives and with respect to $g \cup \{\langle i, x \rangle\}$ inside that set. By the composition rules and the semantics of F_i , F_i remains semantically vacuous outside the set of alternatives since $i \notin \text{Dom}(g)$. But inside the set, the assignment $g \cup \{\langle i, x \rangle\}$ is introduced, activating F_i and producing an alternative x to the focused constituent.

Now suppose that ϕ dominates not only F_i but also an additional focus feature F_m . The assignments g and $g \cup \{\langle i, x \rangle\}$ will switch F_m on only if the domain of g contains m . This differs from the prediction of the system in Section 1. In that account, the unindexed focus sensitive operator *only* introduces an assignment h in the set of *only*-alternatives that unselectively activates both features F_i and F_m . In the new system, the indexed focus sensitive operator *only* _{i} selectively activates the feature F_i while leaving the other feature F_m in its scope intact. This is the key to solving the puzzle of multiple focus in situ, as the next section will demonstrate.

3. Multiple Focus

3.1. Overlapping Focal Dependencies

Return now to the overlapping focal dependencies in (24), repeated as (32), where *also* _{m} binds F_m across an intervening operator *only* _{i} .

(32) $\text{also}_m [\text{only}_i [\text{John introduce Sue}_{F_i} \text{ to Bill}_{F_m}]]$

First we need a definition of the semantic value of *also* _{m} . *also* _{m} ϕ asserts ϕ and presupposes that there exists a true alternative proposition distinct from the proposition expressed by ϕ :

(33) $\llbracket \text{also}_m \phi \rrbracket^g(w)$ defined only if $m \notin \text{Dom}(g)$ &
 $\exists q \in \{ \llbracket \phi \rrbracket^{g \cup \{\langle m, y \rangle\}} : y \in D \} [q(w) = 1 \ \& \ q \neq \llbracket \phi \rrbracket^g]$
 Where defined, $\llbracket \text{also}_m \phi \rrbracket^g(w) = \llbracket \phi \rrbracket^g(w)$

For $\phi =$ the scope of *also* _{m} in (32), we have

(34) $\llbracket \text{also}_m [\text{only}_i [\text{John introduce Sue}_{F_i} \text{ to Bill}_{F_m}]] \rrbracket^g(w)$
 defined only if $m \notin \text{Dom}(g)$ &
 $\exists q \in \{ \llbracket \text{only}_i [J \text{ intro Sue}_{F_i} \text{ to Bill}_{F_m}] \rrbracket^{g \cup \{\langle m, y \rangle\}} : y \in D \}$
 $[q(w) = 1 \ \& \ q \neq \llbracket \text{only}_i [J \text{ intro Sue}_{F_i} \text{ to Bill}_{F_m}] \rrbracket^g]$
 Where defined, $= \llbracket \text{only}_i [J \text{ intro Sue}_{F_i} \text{ to Bill}_{F_m}] \rrbracket^g(w)$

The semantic value of the c-command domain of $also_m$ is relativized to $g \cup \{ \langle m, y \rangle \}$ inside the set of $also_m$ -alternatives and to g outside the set of $also_m$ -alternatives. Inside the set of $also_m$ -alternatives, the expression "John intro Sue_{F_i} to Bill_{F_m}" is computed both inside and outside the set of $only_i$ -alternatives. Similarly, outside the set of $also_m$ -alternatives, "John intro Sue_{F_i} to Bill_{F_m}" is calculated inside and outside the set of $only_i$ -alternatives. Therefore, "John intro Sue_{F_i} to Bill_{F_m}" is computed four times in the course of expanding (34):

- (35) Inside the set of $also_m$ -alternatives:
 $m \in \text{Dom}(g \cup \{ \langle m, y \rangle \})$
 a. Inside the set of $only_i$ -alternatives:
 $i \in \text{Dom}(g \cup \{ \langle m, y \rangle \} \cup \{ \langle i, x \rangle \})$
 $\llbracket J \text{ intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^{g \cup \{ \langle m, y \rangle \} \cup \{ \langle i, x \rangle \}}$
 $= \lambda w' \llbracket \text{John intro } x \text{ to } y \text{ in } w' \rrbracket$
 b. Outside the set of $only_i$ -alternatives:
 $\forall y \ i \notin \text{Dom}(g \cup \{ \langle m, y \rangle \})$
 $\llbracket J \text{ intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^{g \cup \{ \langle m, y \rangle \}}$
 $= \lambda w'' \llbracket \text{John intro Sue to } y \text{ in } w'' \rrbracket$
- (36) Outside the set of $also_m$ -alternatives:
 $m \notin \text{Dom}(g)$
 a. Inside the set of $only_i$ -alternatives:
 $i \in \text{Dom}(g \cup \{ \langle i, x \rangle \})$
 $\llbracket J \text{ intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^{g \cup \{ \langle i, x \rangle \}}$
 $= \lambda w' \llbracket \text{John intro } x \text{ to Bill in } w' \rrbracket$
 b. Outside the set of $only_i$ -alternatives:
 $i \notin \text{Dom}(g)$
 $\llbracket J \text{ intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^g$
 $= \lambda w'' \llbracket \text{John intro Sue to Bill in } w'' \rrbracket$

(35) and (36) present the four basic stages in the derivation of the multiple focus construction. Applications of the semantics of the focus feature in (28) to F_i and F_m yield the above results.

Notice that in (36a), $only_i$ switches on only the focus feature F_i with which it is coindexed. The other feature F_m remains inactive since $m \notin \text{Dom}(g \cup \{ \langle i, x \rangle \})$. This diverges from the prediction of the old account in Section 1, where $only$ switches on every feature in its scope inside the set of $only$ -alternatives.

To continue the derivation, (37) and (38) use the lemmas in (35) and (36) and the definition of the semantics of $only_i$ in (27) to compute the semantic value of "only_i [John intro Sue_{F_i} to Bill_{F_m}]."

(37) Inside the set of *also_m*-alternatives:

$$\begin{aligned} & \llbracket \text{only}_i [\text{John intro Sue}_{F_i} \text{ to Bill}_{F_m}] \rrbracket^{g \cup \langle m, y \rangle} \\ & = \lambda w'' \forall p \in \{ \llbracket J \text{ intro Sue}_{F_i} \text{ to B}_{F_m} \rrbracket^{g \cup \langle m, y \rangle} \cup \langle i, x \rangle; x \in D \} \\ & \quad [p(w'') = 1 \rightarrow p = \llbracket J \text{ intro Sue}_{F_i} \text{ to B}_{F_m} \rrbracket^{g \cup \langle m, y \rangle}] \\ & = \lambda w'' \forall p \in \{ \lambda w' [\text{John intro } x \text{ to } y \text{ in } w']; x \in D \} \\ & \quad [p(w'') = 1 \rightarrow p = \lambda w'' [J \text{ intro Sue to } y \text{ in } w'']] \\ & = \lambda w'' \forall x [\text{John intro } x \text{ to } y \text{ in } w'' \rightarrow x = \text{Sue}] \end{aligned}$$

(38) Outside the set of *also_m*-alternatives:

$$\begin{aligned} & \llbracket \text{only}_i [\text{John intro Sue}_{F_i} \text{ to Bill}_{F_m}] \rrbracket^g \\ & = \lambda w''' \forall p \in \{ \llbracket J \text{ intro Sue}_{F_i} \text{ to B}_{F_m} \rrbracket^{g \cup \langle i, x \rangle}; x \in D \} \\ & \quad [p(w''') = 1 \rightarrow p = \llbracket J \text{ intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^g] \\ & = \lambda w''' \forall p \in \{ \lambda w' [\text{John intro } x \text{ to Bill in } w']; x \in D \} \\ & \quad [p(w''') = 1 \rightarrow p = \lambda w'' [J \text{ intro Sue to B in } w'']] \\ & = \lambda w''' \forall x [\text{John intro } x \text{ to Bill in } w''' \rightarrow x = \text{Sue}] \end{aligned}$$

In (37), *y* is an *also*-alternative to *Bill*. (37) states that John didn't introduce anyone other than Sue to the alternative to Bill. (38) states that John didn't introduce anyone other than Sue to Bill.

After inserting the results of (37) and (38) into (34) and simplifying, we finally obtain the proper truth conditions for the multiple focus example:

$$\begin{aligned} (39) & \llbracket \text{also}_m [\text{only}_i [\text{John introduce Sue}_{F_i} \text{ to Bill}_{F_m}]] \rrbracket^g(w) \\ & \text{defined only if} \\ & \quad \exists y [y \neq \text{Bill} \ \& \ \forall x [\text{John intr } x \text{ to } y \text{ in } w \rightarrow x = \text{Sue}]] \\ & \quad \text{Where defined,} \\ & = 1 \text{ iff } \forall x [\text{John intro } x \text{ to Bill in } w \rightarrow x = \text{Sue}] \end{aligned}$$

3.2. Embedded Foci

Another kind of multiple focus example is discussed in Krifka (1991). In (40b), uttered in the context (40a), a single phrase seems to bear two distinct foci.

- (40) a. John once only drank [wine]_F.
 b. John also once only drank [[water]_F]_F.

Krifka suggests that *water* in (40b) carries two foci--the constituent *water* is attached to one focus feature which is embedded inside a second focused constituent. In Krifka's analysis, the inner focus associates with the higher focus sensitive operator *also* and the outer focus associates with the lower operator *only*. In our system, this means that (40b) should have a logical form like (41).

$$(41) \text{also}_m [\text{only}_i [\text{John drink } [\text{water}_{F_m}]_{F_i}]]$$

Nothing new needs to be added to the semantic analysis of Section 2 in order to interpret this structure. The calculation of the semantic value of (41) proceeds in the same way as the case of multiple focus we have just discussed:

- (42) $\llbracket \text{also}_m \llbracket \text{only}_i \llbracket \text{John drink } [\text{water}_{F_m}]_{F_i} \rrbracket \rrbracket^g(w)$
 defined only if $m \notin \text{Dom}(g)$ &
 $\exists q \in \{ \llbracket \text{only}_i \llbracket \text{John drink } [\text{water}_{F_m}]_{F_i} \rrbracket \rrbracket^{g \cup \{ \langle m, y \rangle \}}; y \in D \}$
 $\llbracket q(w) = 1 \ \& \ q \neq \llbracket \text{only}_i \llbracket \text{J drink } [\text{water}_{F_m}]_{F_i} \rrbracket \rrbracket^g \}$
 Where defined, $= \llbracket \text{only}_i \llbracket \text{J drink } [\text{water}_{F_m}]_{F_i} \rrbracket \rrbracket^g(w)$

Once again, the computation of "John drink $[\text{water}_{F_m}]_{F_i}$ " takes place four times, in conformity with the four combinations: inside/outside the set of also_m -alternatives and inside/outside the set of only_i -alternatives. Accordingly, we have the lemmas in (43) and (44).

- (43) Inside the set of also_m -alternatives:
 $m \in \text{Dom}(g \cup \{ \langle m, y \rangle \})$
 a. Inside the set of only_i -alternatives:
 $i \in \text{Dom}(g \cup \{ \langle m, y \rangle \} \cup \{ \langle i, x \rangle \})$
 $\llbracket \text{John drink } [\text{water}_{F_m}]_{F_i} \rrbracket^{g \cup \{ \langle m, y \rangle \} \cup \{ \langle i, x \rangle \}}$
 $= \lambda w' \llbracket \text{John drink } x \text{ in } w' \rrbracket$
 b. Outside the set of only_i -alternatives:
 $\forall y \ i \notin \text{Dom}(g \cup \{ \langle m, y \rangle \})$
 $\llbracket \text{John drink } [\text{water}_{F_m}]_{F_i} \rrbracket^{g \cup \{ \langle m, y \rangle \}}$
 $= \lambda w'' \llbracket \text{John drink } y \text{ in } w'' \rrbracket$
- (44) Outside the set of also_m -alternatives:
 $m \notin \text{Dom}(g)$
 a. Inside the set of only_i -alternatives:
 $i \in \text{Dom}(g \cup \{ \langle i, x \rangle \})$
 $\llbracket \text{John drink } [\text{water}_{F_m}]_{F_i} \rrbracket^{g \cup \{ \langle i, x \rangle \}}$
 $= \lambda w' \llbracket \text{John drink } x \text{ in } w' \rrbracket$
 b. Outside the set of only_i -alternatives:
 $i \notin \text{Dom}(g)$
 $\llbracket \text{John drink } [\text{water}_{F_m}]_{F_i} \rrbracket^g$
 $= \lambda w'' \llbracket \text{John drink } \text{water} \text{ in } w'' \rrbracket$

The above equations follow from the semantics of the focus feature in (28). Take (43b), for example.

- (45) Calculation of $\llbracket [\text{water}_{F_m}]_{F_i} \rrbracket^{g \cup \{ \langle m, y \rangle \}}$ in (43b):
 $\llbracket [\text{water}_{F_m}]_{F_i} \rrbracket^{g \cup \{ \langle m, y \rangle \}}$
 $= \llbracket \text{water}_{F_m} \rrbracket^{g \cup \{ \langle m, y \rangle \}}$ since $i \notin \text{Dom}(g \cup \{ \langle m, y \rangle \})$
 $= (g \cup \{ \langle m, y \rangle \})(m)$ since $m \in \text{Dom}(g \cup \{ \langle m, y \rangle \})$
 $= y$

By the semantics of *only_p*, we have

- (46) Inside the set of *also_m*-alternatives:

$$\llbracket \text{only}_i [\text{John drink } [\text{water}_{F_m}]_{F_i}] \rrbracket^{g \cup \langle m, y \rangle}$$

$$= \lambda w'' \forall p \in \{ \llbracket \text{J drink } [\text{water}_{F_m}]_{F_i} \rrbracket^{g \cup \langle m, y \rangle} \cup \langle i, x \rangle; x \in D \}$$

$$[p(w'') = 1 \rightarrow p = \llbracket \text{J drink } [\text{water}_{F_m}]_{F_i} \rrbracket^{g \cup \langle m, y \rangle}]$$

$$= \lambda w'' \forall p \in \{ \lambda w' [\text{John drink } x \text{ in } w']; x \in D \}$$

$$[p(w'') = 1 \rightarrow p = \lambda w'' [\text{J drink } y \text{ in } w'']]$$

$$= \lambda w'' \forall x [\text{John drink } x \text{ in } w'' \rightarrow x = y]$$

(47) Outside the set of *also_m*-alternatives:

$$\llbracket \text{only}_i [\text{John drink } [\text{water}_{F_m}]_{F_i}] \rrbracket^g$$

$$= \lambda w''' \forall p \in \{ \llbracket \text{John drink } [\text{water}_{F_m}]_{F_i} \rrbracket^{g \cup \langle i, x \rangle}; x \in D \}$$

$$[p(w''') = 1 \rightarrow p = \llbracket \text{John drink } [\text{water}_{F_m}]_{F_i} \rrbracket^g]$$

$$= \lambda w''' \forall p \in \{ \lambda w' [\text{John drink } x \text{ in } w']; x \in D \}$$

$$[p(w''') = 1 \rightarrow p = \lambda w'' [\text{John drink } x \text{ in } w'']]$$

$$= \lambda w''' \forall x [\text{John drink } x \text{ in } w''' \rightarrow x = \text{water}]$$

(46) says that John drank nothing other than *y*, where *y* is an *also*-alternative to *water*, and (47) means that John drank nothing other than *water*.

Substitution of these results back into (42) and simplifying produces the desired truth conditions.³

- (48) $\llbracket \text{also}_m [\text{only}_i [\text{John drink } [\text{water}_{F_m}]_{F_i}]] \rrbracket^g(w)$
 defined only if
 $\exists y [y \neq \text{water} \ \& \ \forall x [\text{John drink } x \text{ in } w \rightarrow x = y]]$
 Where defined,
 $= 1 \text{ iff } \forall x [\text{John drink } x \text{ in } w \rightarrow x = \text{water}]$

The semantic system that we have devised accounts for multiple focus by permitting foci to be selectively bound by focus sensitive operators. It is therefore clearly more expressive than the unselective binding semantics of Section 1. The next section offers a few comments about the degree of expressiveness of this new system in relation to other theories that have been proposed in the literature.

4. Comparisons with Other Systems

4.1. The Focus Interpretation Operator ~

Rooth (1992) introduces an operator ~ which encodes the general properties of focus sensitive operators such as *only*, *also*, and *even*. In this theory, each focus feature *F* is found in the scope of a focus interpretation operator ~. In the representation (49), *only* no longer interprets the focus feature directly. *F* is interpreted by the ~ operator which has two arguments, *v_j* and "John intro Sue_{*F*} to Bill." *v_j* is anaphoric to a set of propositions and ~ constrains *v_j* to be a set of alternatives to "John intro Sue_{*F*} to Bill." *Only* associates with *F* by sharing the

common argument v_j with \sim .

(49) $\text{only}(v_j) [\sim(v_j) [\text{John intro Sue}_F \text{ to Bill}]]$

This framework can be integrated with the semantics that we have proposed by allowing \sim to be selectively coindexed with the feature F to which it is linked:

(50) $\text{only}(v_j) [\sim_i(v_j) [\text{John intro Sue}_{F_i} \text{ to Bill}]]$

\sim_i is interpreted roughly as in (51).

(51) $[[\sim_i(v_j) \phi]]^g$
 presupposes that $g(j)$ is the set of alternatives
 $\{[[\phi]]^g \cup \langle i, x \rangle; x \in D\}$
 asserts $[[\phi]]^g$

4.2. Structured Meanings

In the Structured Meanings approach to focus interpretation (see, for example, Jacobs 1983, Krifka 1991, and von Stechow 1991), the scope of the focus sensitive operator *only* in (52) is interpreted as a pair consisting of the characteristic function of a set of alternatives to the focused constituent and the focused constituent itself.

(52) $\text{only} [\text{John introduce Sue}_F \text{ to Bill}]$

(53) "John intro Sue_F to Bill" interpreted as
 $\langle \lambda x \lambda w' [\text{John intro } x \text{ to Bill in } w'], \text{Sue} \rangle$

The operator *only* combines with this pair to produce "Given any x satisfying the first member of the pair, $x =$ the second member of the pair.

Rooth (1996) argues that the Structured Meanings approach is too expressive. He discusses a hypothetical focus sensitive operator *tolf* which has the interpretation "y tolf ϕ " is true iff y tells α that ϕ , where α is the meaning of the focused constituent dominated by ϕ . For instance, (54a) would mean (54b).

(54) a. Fred tolfed that John introduced Sue_F to Bill.

b. Fred told Sue that John introduced Sue to Bill.

Operators like *tolf* apparently do not exist in natural language, and so a theory of focus should be restrictive enough to exclude them. However, the theory of Structured Meanings does not conform to this requirement. The embedded clause in (54a) is interpreted as the structured pair $\langle \lambda x \lambda w' [J \text{ intro } x \text{ to Bill in } w'], \text{Sue} \rangle$. Then it is unproblematic to define "tolf $\langle X, \alpha \rangle$ " as "tell α that $X(\alpha)$." Too much information is recoverable from a structured representation. In particular, the meaning of the focused constituent can be accessed from the structured format and then used to construct an impossible verb *tolf*.

Manfred Krifka (personal communication) has pointed out that the selective in situ binding semantic system of Section 2 is less expressive than Structured Meanings and more expressive than Rooth's (1985) Alternative Semantics. It is more restrictive than Structured Meanings because the meaning of the focused constituent cannot in general be obtained from the representation. Consider a clause ϕ that dominates a focused phrase α_{Fi} . If a focus sensitive operator Op_i applies to this clause relative to an assignment g , Op_i can access the meanings $\llbracket \phi \rrbracket^g$ and $\llbracket \phi \rrbracket^{g \cup \{ \langle i, x \rangle \}}$, but cannot in general recover $\llbracket \alpha_{Fi} \rrbracket^g$.

In addition, structured representations mimic the effects of syntactic movement. In a sense, the structured format is isomorphic to a representation in which the focused constituent has raised, leaving behind a trace. On the other hand, our proposed in situ binding theory does not employ movement of the focused phrase, nor does it mirror syntactic movement in the semantic representation.

4.3. *Alternative Semantics*

The theory of interpreting foci in situ developed in Rooth (1985) is known as Alternative Semantics (von Stechow 1989). To derive the set of alternatives without moving the focused constituent, this theory introduces a distinction between two semantic values, the ordinary semantic value $\llbracket \]$ and the focus semantic value $\llbracket \]^f$. Focus features F are unindexed and are activated by the focus value $\llbracket \]^f$, which produces a set of alternatives. F is semantically vacuous with respect to the ordinary value $\llbracket \]$.

- (55) a. $\llbracket Sue_F \rrbracket^f = \{x: x \in D\}$
 b. $\llbracket Sue_F \rrbracket = Sue$
- (56) a. $\llbracket \text{John introduced Sue}_F \text{ to Bill} \rrbracket^f$
 $= \{\lambda w' [\text{John intro } x \text{ to Bill in } w'] : x \in D\}$
 b. $\llbracket \text{John introduced Sue}_F \text{ to Bill} \rrbracket$
 $= \lambda w'' [\text{John intro Sue to Bill in } w'']$

The focus semantic value gives the set of alternatives that is used by the focus sensitive operators. But because the focus value of a clause activates all the foci dominated by that clause, Alternative Semantics makes the prediction in (15) that a focus is captured by the lowest c -commanding focus sensitive operator. Alternative Semantics cannot account for the binding of a focus by one operator across another intervening operator without moving the focus and is therefore less expressive than the selective in situ binding theory of Section 2.

The question may be asked of exactly how much needs to be added to Alternative Semantics in order for it to reach the degree of expressive power of the proposed selective binding system. Consider a system that we will call Augmented Alternative Semantics, that is, Alternative Semantics augmented by selective variable binding. This system will turn the focus sensitive operators into variable binders--the operator is coindexed with a focus that it associates with, and both the ordinary and focus semantic values are relativized to an assignment function g that mediates variable binding. Augmented Alternative Semantics will

retain the distinction between the two semantic values, but instead of the focus value producing a *set* of alternatives, the focus value will represent the alternative itself. Thus, Augmented Alternative Semantics replaces (55) and (56) with (57) and (58).

- (57) a. $\llbracket \text{Sue}_{F_i} \rrbracket^{f;g} = g(i)$
 b. $\llbracket \text{Sue}_{F_i} \rrbracket^g = \llbracket \text{Sue} \rrbracket^g = \text{Sue}$
 (58) a. $\llbracket \text{John introduced Sue}_{F_i} \text{ to Bill} \rrbracket^{f;g}$
 $= \lambda w' [\text{John intro } g(i) \text{ to Bill in } w']$
 b. $\llbracket \text{John introduced Sue}_{F_i} \text{ to Bill} \rrbracket^g$
 $= \lambda w'' [\text{John intro Sue to Bill in } w'']$

The semantics of *only_i* ϕ employs the focus value to generate the set of alternatives:

- (59) $\llbracket \text{only}_i \phi \rrbracket^g$ defined only if $i \notin \text{Dom}(g)$
 $= \lambda w \forall p \in \{ \llbracket \phi \rrbracket^{f;g \cup \{ \langle i, x \rangle \}} : x \in D \} [p(w) = 1 \rightarrow p = \llbracket \phi \rrbracket^g]$

Is Augmented Alternative Semantics equivalent to the system we devised in Section 2?⁴ The answer is that Augmented Alternative Semantics is still too restrictive. It cannot capture the behavior of multiple foci in situ. To see this, return to the calculation of the semantic value of the multiple focus example (32). Recall that $\llbracket \text{John intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket$ was computed four times, with the results shown in (35) and (36). (35) and (36) exhibit the pattern of desired focal switch settings of the features F_i and F_m that derive the correct truth conditions for multiple focus. Compare this pattern with the one in (60) and (61) generated by Augmented Alternative Semantics.

- (60) Inside the set of *also_m*-alternatives:
 a. Inside the set of *only_i*-alternatives:
 $\llbracket \text{J intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^{f;g \cup \{ \langle m, y \rangle \} \cup \{ \langle i, x \rangle \}}$
 $= \lambda w' [\text{John intro } x \text{ to } y \text{ in } w']$
 b. Outside the set of *only_i*-alternatives:
 $\llbracket \text{J intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^{g \cup \{ \langle m, y \rangle \}}$
 $= \lambda w'' [\text{John intro Sue to Bill in } w'']$
 (61) Outside the set of *also_m*-alternatives:
 a. Inside the set of *only_i*-alternatives:
 $\llbracket \text{J intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^{f;g \cup \{ \langle i, x \rangle \}}$
 $= \lambda w' [\text{J intro } x \text{ to } (g \cup \{ \langle i, x \rangle \}) (m) \text{ in } w']$
 b. Outside the set of *only_i*-alternatives:
 $\llbracket \text{J intro Sue}_{F_i} \text{ to Bill}_{F_m} \rrbracket^g$
 $= \lambda w'' [\text{John intro Sue to Bill in } w'']$

There are two discrepancies between (35)/(36) and (60)/(61). Inside the set of *also*-alternatives and outside the set of *only*-alternatives, (35b) generates an alternative to Bill_{F_m} , but (60b) does not. In fact, Rooth (1994, §7)

tried to devise a version of Augmented Alternative Semantics, but observing the problem posed by (60b), he abandoned this attempt. Similarly, outside the set of *also*-alternatives and inside the set of *only*-alternatives, (36a) produces no *also*-alternative to $Bill_{F_m}$, but (61a) does. In (61a), $(g \cup \{ \langle i, x \rangle \}) (m)$ is not even defined. Even if we make the assignments total functions, this will not prevent (61a) from wrongly assigning an *also*-alternative to $Bill_{F_m}$.

Thus, simply enriching Alternative Semantics by a variable binding mechanism is not enough to derive multiple focus. The source of the inaccurate predictions in (60b) and (61a) is the definition of the semantics of the focus feature in (57). The focus value $\llbracket \]^{f_g}$ always activates the focus feature, whereas the ordinary value $\llbracket \]^g$ never does. Augmented Alternative Semantics cannot handle "mixed" cases, where one focus feature is switched on and another is switched off simultaneously. The semantics of the focus feature is too rigid.

In order to ensure that $\llbracket Bill_{F_m} \rrbracket$ produces a n alternative but $\llbracket Sue_{F_i} \rrbracket$ does not in (60b), we need to change the definition of the ordinary semantic value of the focus feature to (62).

$$(62) \llbracket \alpha_{F_i} \rrbracket^g = \begin{cases} g(i) & \text{if } i \in \text{Dom}(g) \\ \llbracket \alpha \rrbracket^g & \text{if } i \notin \text{Dom}(g) \end{cases}$$

Similarly, altering the definition of the focus semantic value to (63) will ensure that F_m remains semantically null but F_i is activated in (61a).

$$(63) \llbracket \alpha_{F_i} \rrbracket^{f_g} = \begin{cases} g(i) & \text{if } i \in \text{Dom}(g) \\ \llbracket \alpha \rrbracket^{f_g} & \text{if } i \notin \text{Dom}(g) \end{cases}$$

But now notice that the ordinary and focus values of an expression are always identical. The modification that we made to Alternative Semantics in order to correctly capture the semantics of multiple focus constructions turns out to be exactly the change needed to eliminate the distinction between the ordinary and focus semantic values. Augmented Alternative Semantics together with the alterations in (62) and (63) becomes the semantic system in Section 2.

To summarize, for Alternative Semantics to reach the degree of expressiveness of our proposed in situ selective binding theory, it needs to incorporate not only selective variable binding, but also a more flexible semantics of the focus feature which collapses the ordinary/focus semantic value distinction.

This paper has elaborated an approach to the semantics of focus which is intermediate in expressive power between Alternative Semantics and Structured Meanings. Foci are interpreted through a selective variable binding mechanism which can establish a link between a focus and the operator that binds it over long distances--across islands and intervening operators--without moving the focused element. The focus feature behaves like a switch that remains semantically inert until activated by an assignment function introduced by the focus sensitive operator.

Endnotes

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1. This paper ignores the presupposition of "only ϕ " that ϕ is true.
2. This definition makes the simplifying assumption that only elements of individual type may be focused. It can be easily generalized.
3. Technically these truth conditions are inconsistent since we have suppressed the semantics of *once* in (40b) in order to simplify the calculation.
4. Arnim von Stechow (personal communication) has also posed this question for a similar system of Augmented Alternative Semantics.

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