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How to Get even with Domain Selection

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1 The Focus Interaction

The phenomenon which I am concerned with is illustrated in (1). In sentences which include *only*, *even*, *also*, and *just*, changing focus can affect truth conditions and conventional implicatures. Suppose John introduced Bill and Tom to Sue, and performed no other introductions. Then (1a) is false and (1b) is true.

(1)a. John only introduced BILL to Sue
   b. John only introduced Bill to SUE
(2)a. John {even/also} introduced BILL to Sue
   b. John {even/also} introduced Bill to SUE
(3) assertion of (1a):
      John introduced noone who is not Bill to Sue
   implicature: John introduced Bill to Sue

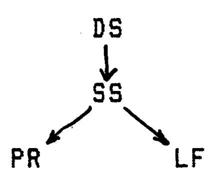
(2) illustrates a similar effect with *even* and *also*. Either version of (2a) implicates that John introduced someone other than Bill to Sue; either version of (2b) implicates that John introduced Bill to someone other than Sue. To simplify things, I will (despite the title) concentrate below on the assertive meaning of *only* indicated in (3) (cf. Horn (1967)).[1] However, I claim that my approach extends to *even* and *also*, and to the analysis of conventional implicatures.

2 Scope Theory

'How to Get Even' (Anderson(1972)) contains an outline of a theory of the phenomenon illustrated above, a phenomenon which I will term the 'focus interaction'.[2] The idea which underlies his approach is that at some semantically significant level, the focused phrase is an argument of only/even/also: "Assume that *even*, like other adverbial elements, is generated in some single position in underlying structure, but is not interpreted at this point. Then allow it to be moved into any of the derived-structure positions where adverbs can appear by a permutation of some sort.... Then, at some level of derived structure (perhaps shallow structure in the sense of Postal (1970)) we can apply an interpretive principle to determine the interpretation of *even* by locating a constituent ... which can serve as the element's scope. The reading of this constituent (or constituents) would then be inserted into the appropriate places in a complex dictionary reading for *even*..."(Anderson(1972), p898). (In Anderson's terminology, the focused phrase entering into the interpretation of *even* is the 'scope' of *even*. Thus in (2a), *BILL* is the scope of *even*. Since this conflicts with other senses of 'scope', and because the terminology does not accord with my ultimate conclusions, I have not adopted it.)

No doubt because his work antedated the development of the logical form level in the extended standard theory, Anderson's remarks, while more extensive than the quoted passage, are programmatic. Nevertheless, the general outlines of an execution of Anderson's idea within the assumtions of the extended standard theory (EST) seem fairly straightforward. Consider the organization of grammar proposed in Chomsky and Lasnik(1977):

(4)



DS = 'deep' structure
SS = S-structure
LF = logical form
PR = phonological representation

We identify SS as a level where *even*, *only* and *also* are in their surface positions. SS is mapped to LF by construal and indexing rules, notably involving the assignment of scope to quantifiers (May (1977)). We identify LF as the level where focused phrases have moved to a position where they can serve as an argument of *even*, *only* or *also*. For concreteness, I will propose a structure for these logical forms, one which facilitates semantic interpretation. Suppose that the S-structure of (1a) is (5), where *only* is Chomsky-adjoined to VP, and the focused phrase is marked with the feature F. A logical form for this sentence is to express the idea that the focused phrase is an argument of *only*. Given that the primary syntactic correlate of the function-argument relation is sisterhood, let us entertain the hypothesis that the focused phrase is a sister of *only* in LF. More specifically, suppose that the focused phrase is adjoined to only in the derivation of LF, so that (6) is a logical form for (5).[3,4]

(5) $[_S$John $[_{VP}$only$[_{VP}$introduced [Bill$]_F$ $[_{PP}$to Sue]]]]
(6) $[_S$John $[_{VP}[$only$[_{NP}$Bill$]_{F,2}][_{VP}$introduced $[_{NP}]_2$ $[_{PP}$to Sue]]]]
(7) $[_S[_{NP}$only[John]]$[_{VP}$swims]]
(8) a. $\forall y[swim'(y) \longrightarrow y = j]$
b. $\lambda x \lambda P\ \forall y[P(y) \longrightarrow y = x]$

This logical form facilitates semantic interpretation in that independently motivated principles, the denotation for only and the semantic rule interpreting structures of quantifier construal, yield the desired model theoretic interpretation for (6). The denotation for only is motivated by sentences like (7) where only is adjacent to the focused phrase. Here there is no reason to postulate a logical form distinct from the surface structure. If we assume in addition that (i) the assertion induced by only is what was indicated above, namely (8a) in the case of (7); (ii) the denotations of John and swims are an individual and a property, respectively; (iii) there is a strict correlation between the syntactic sisterhood relation and the semantic function-argument relation, then it follows that only has the denotation (8b).[6] Semantic rules for structures of quantifier construal are given in Montague(1973). The clause we are interested in is that which interprets a quantified NP adjoined to (or in his terminology quantified into) a VP:

(9) a. Syntactic configuration: $[NP_i[VP]]$
b. Intensional Logic translation: $\lambda z NP'(\lambda x_i[VP'(z)])$, where NP' and VP' are the IL translations of NP and VP.

(10) a. $\lambda P\ \forall y[P(y) \longrightarrow y = b]$
b. $introduce'(x_2,s)$
c. $\lambda z[[\lambda P\ \forall y[P(y) \longrightarrow y = b](\lambda x_2 introduce'(z,x_2,s))]$,
$= \lambda z\ \forall y[introduce'(z,y,s) \longrightarrow y = b]$
d. $\forall y[introduce'(j,y,s) \longrightarrow y = b]$

Given (8b) and (9), the problem of providing an interpretation for the logical form (6) is solved. From (8b) it follows that the phrase [only Bill] has the interpretation (10a). The minimal VP in (6) has the interpretation (10b), where the trace $[_{NP}]_2$ is interpreted as an individual variable. From (9) it follows that the maximal VP has the interpretation (10c). Hence (6) (and derivatively (5)) has the desired assertion (10d).[7]

3 Criticisms

I call the theory outlined above the 'scope theory' of the focus interaction, since it proposes that the focused phrase is assigned scope in the derivation of logical form. Above we saw that it satisfied a criterion of semantic adequacy. There are several additional arguments in its favor (the weak crossover argument and the scope fixing property, described in section 6 and footnote 10). My reasons for pursuing an alternative analysis are the following:

3.1 Interaction with focus is stipulated

My exposition was careless when I stated "suppose that the focused phrase is adjoined to *only* in the derivation of LF". Given the assumptions of EST subsumed under the slogan 'move alpha', the focused phrase could indeed be adjoined to *only* in the derivation of LF, but so could any phrase. If the scope theory is to specify the desired relation between phonological and semantic objects, it must include principles which entail that (11b) (=(6)), but not (11c), is a possible logical form for (11a).

(11)a.(5)[$_S$John [$_{VP}$only[$_{VP}$introduced [Bill]$_F$ [$_{PP}$to Sue]]]]
b. [$_S$John [$_{VP}$[only[$_{NP}$Bill]$_{F,2}$[$_{VP}$introduced [$_{NP}$]$_2$ [$_{PP}$to Sue]]]]
c.[$_S$John [$_{VP}$[only[$_{NP}$Sue]$_3$[$_{VP}$introduced [Bill]$_F$ [$_{PP}$to [$_{NP}$]$_3$]]]]

In the examples, I have adopted the notation of Jackendoff(1972), marking focused phrases with the feature F. Some such device is necessary, given that focus has both phonological and semantic significance, and that phonology and semantics (more specifically, LF) are separate components of the grammar. The scope theory takes the semantic significance of F to be, in part, that some focused phrase must be adjoined to only/even/also in LF. That (11b) is the logical form for (11a) could be enforced by a simple cooccurrence restriction:

(12) In LF, *only* must be the sister of a phrase bearing the feature F.

My objection to a condition like (12) is that it stipulates that *only* interacts with focus. That focus influences the assertions and conventional implicatures of sentences involving *only*, *even*, and a small group of other adverbs seems to be a marginal fact about English, and we should not have to state a separate principle which covers it. Of course, I have not proven that all possible scope theories of the focus interaction are stipulative in the way that the one which I outlined is; it is not possible to prove things like this. I do not see how to eliminate stipulation from the scope theory. Furthermore, it seems that Anderson had an account in mind which was stipulative: "...our principle might simply locate an element on which a stress maximum appears, and select as a possible scope any constituent containing it"[8,9] (Anderson(1972), p898).

3.2 Conditions on bound variables are violated

The representation generated when scope is assigned to a focused phrase has a bound syntactic variable in the position of the focused phrase. A central concern of recent work in syntax has been formulating structural conditions on the occurence of variables in phrase markers. For instance Kayne(1979) and Chomsky (1982) observe that in multiple wh-questions, there seems to be an asymmetry between the subject and object positions of tensed sentences:

(13) (=(15iii), Ch.4 of Chomsky (1981))
  a I know perfectly well who thinks that he is in love with _whom_
  b *I know perfectly well who thinks that _who_ is in love with him

It is proposed that an LF rule assigns scope to wh-phrases which have not been moved in the derivation of S-structure, so that in LF there are bound variables in the underlined positions. The distinction between (13a) and (13b) is attributed to a wellformedness condition applied at LF (and perhaps elsewhere), the empty category principle, which distinguishes the subject and object positions of tensed sentences by means of the notion of government, and disallows (13b) (Chomsky(1981), p250).

Chomsky notes as a puzzle that focused phrases, which according to his analysis are always assigned scope in LF, are acceptable in the subject position of embedded tensed sentences. This is also true of focused phrases semantically associated with _only_ and _even_:

(14)a He even thinks that BILL is in love with him
    b He only claims that SUE likes him

This is problematic because if (14a,b) had a bound variable in the position of the focused phrase in LF, the wellformedness condition which rules out (13b) would be violated. Quantifier scope islands present a similar problem. For me, the tensed sentential complement of an adjective is a scope island; the sentences in (15)have no readings with wide scope for the quantifier. As before, if we assume that some principle of grammar prevents wide scope assignment in (15), it seems that the same principle would apply in (16), (which it shouldn't).[11]

(15) a. It is possible that every candidate will get the job
     b. It is likely that noone will win
(16) a. It is also possible that MARY will get the job
     b. It is even likely that JOHN will pass

3.3 _Types of variables_

Another observation follows from the fact that essentially all syntactic categories can be focused. This has the consequence that we must postulate quantified variables of all types used in translating syntactic phrases. For instance, the logical form

(17b) for (17a) has a trace in the position of the focused transitive verb, and the intensional logic formula (17c) which translates (17b) has a bound relation variable R.[12]

(17)a. John only intends to CRITICISE Bill
b. [$_S$John[VP[only criticise$_{F,a}$][$_{VP}$ intend to [$_{VP}$[$_V$]$_a$ Bill]]]]
c. only′(criticise′, λRintend′(j,R(b)))

The scope theory seems to commit us to employing a semantic metalanguage which, like intensional logic, includes bound variables of various types, including variables over relations. Thus it appears to be an obstacle to limiting the semantic metalanguage.

4 Domain Selection Theory
4.1 Outline of Idea

According to the analysis reviewed above, the focused subphrase of the VP is an an argument of adverbial only. (18) is a special case; here the entire VP is focused.

(18) John only [swims]$_F$
(19) a. only′(swim′, λPP(j)), equivalent to $\forall Q[Q(j) \longrightarrow Q = swim']$
b. definition of only′: $\lambda P \lambda \emptyset\ \forall Q[\emptyset(Q) \longrightarrow Q=P]$
(20) only" = $\lambda P[\lambda x[\forall Q[Q(x) \longrightarrow Q=P]]]$
(21) (John)[[only](swims)]

(19) is a step in the derivation of the denotation of (18); the arguments of only′ are the focused property (swim′) and a property of properties (\PP(j)). (P and Q are property variables; 0 is a propety of properties varible. It is necessary to posit a family of translations for only, since phrases with various semantic types can be focused.) For this simple case, it is not necessary to postulate a variable (P in (19a)) in the position of the focused phrase; at the price of redundancy in the grammar, (19a) could be derived without appealing to an abstract logical form, by assigning only the alternative translation (20). (21) indicates the resulting function-argument relations; the translations of phrases enclosed in parentheses serve as arguments.

I would like to show that the simple denotation (20) provides the basis for an alternative treatment of the focus interaction. Independent of the choice between (19b) and (20) as a denotation for only, a problem with (19a) must be acknowledged. In any model (and any world), j has the properties λx[x=x] and λx[x=j], the properties of self-identity and of being John. In conjunction with (19a), this entails that these properties are identical to swim′, and hence to each other. Since any individual has the property λx[x=x], and since λx[x=j] is a unit property, it follows that any model which satisfies (19a) has exactly one individual. Hence (19a) can be true only in the most trivial of models. (This is true strictly; a similar argument shows that a model which satisfies (19a) has exactly one world.) There is a simple and familiar solution to this problem. Suppose the domain of the quantification over properties in (19a) is a contextually relevant set, say the properties which are exercise activities (swim', run', [play tennis]', ...), rather than the set of all properties. Then the quantification would not impose such strong constraints on the model, since λx[x=x] and λx[x=j], for instance, need not be in this set.

I prefer to write the domain of quantification into the semantics as a free variable in the translation of <u>only</u>:

(22) only" = λP[λx[∀Q[[Q(x) ∧ C(Q)] ⟶ Q=P]]]
(23) translation for (18): ∀Q[[Q(j) ∧ C(Q)] ⟶ Q = swim']

C is the characteristic function of a set of properties, which we think of as the set of relevant properties. (23) says that John has no relevant properties aside from swim'.

Returning now to the focus interaction, consider the translations induced by (22) for (24) and (25), the examples which began this paper.

(24) John only introduced BILL to Mary
(25) John only introduced Bill to MARY
(26) ∀P[[P(j) ∧ C(P)] ⟶ P = introduce'(b,m)]

The translation is the same in the two cases, which does not do justice to our intuitions about the meanings of the sentences. But the right truth conditions can be obtained by supplying different values for C in the two cases. The idea is that in (24), the quantification is restricted to properties of the form 'introduce y to Mary', while in (25) it is restricted to properties of the form 'introduce Bill to y'. The desired value of C for (24) is (27). Substituting this into (26) yields (28), which is similar in truth conditions to the quantification over individuals (29), the translation for (24) produced by the scope theory.[13]

(27) λP ∃y[P = introduce'(y,m)]
(28) ∀P[[P(j) ∧ ∃y[P = introduce'(y,m)]] ⟶ P = introduce'(b,m)]
(29) ∀x[introduce'(j,x,m) --> x=b]

(28) says that if John has a property of the form 'introduce y to Mary' then it is the property 'introduce Bill to Mary'. The desired value for C for (25) is (30). Substituting this into (26) yields (31), which says that if John has a property of the form 'introduce Bill to y' then it is the property 'introduce Bill to

Mary'. (31) is similar in truth conditions to the quantification over individuals (32), the translation for (25) produced by the scope theory.

(30) $\lambda P\ \exists Y[P = introduce'(b,y)]$
(31) $\forall P[[P(j) \wedge \exists y[P = introduce'(b,y)]] \longrightarrow P = introduce'(b,m)]$
(32) $\forall x[introduce'(j,b,x) \dashrightarrow x=m]$

I suggest then that the truth conditional effect of focus in (24) and (25) is a result of a contribution of focus to the selection of domains of quantification. Since the focused phrase is not an argument of only, it is not necessary to structurally distinguish (24) and (25) in LF by assigning scope to focused phrases.

4.2 Formalization

As yet I have provided no mechanism for determining the sets (27) and (30) which serve as domains of quantification. There are several ways of doing this. The formulation presented here is intended to emphasize the point that there need not be a variable in the position of the focused phrase. I begin by reviewing how a logical form like (33) receives its model theoretic interpretation. The interpretations of lexical items are given in the lexicon. The interpretation for a phrase is obtained by combining the denotations of its daughters; usually the mode of combination is function application. In (33), phrases which serve as arguments are delimited by parentheses rather than square brackets.

(33) $[(\text{John})\ [_{VP}\ \text{only}\ (\text{introduced}\ (\text{Bill})_{NP,F}\ (\text{to}\ (\text{Mary})_{NP})_{PP})]]$

In order to make the make my theory of the focus interaction work, I want there to be a separate and focus-sensitive component of the meaning of (33), which will serve as the domain of the quantification over properties induced by only. The following recursive definition associates a 'domain' with each phrase in a logical form.

Let θ be a phrase. Dom(θ) is

(34) (i) The set of objects in the model matching denotation(θ) in type, if θ is a focused phrase
(ii) the unit set of denotation(θ), if θ is a non-focused lexical item
(iii) the image of the domains of its parts under the semantic function for θ (usually function application), if θ is a non-focused complex phrase.

The domains for the subphrases of the VP in (33) are determined in the following way. The lexical items [introduced], [to], and [Mary] are not focused, so (ii) applies, and their domains are the unit sets of their denotations: {introduce'}, {λxx}, and {m}.[14] (λxx is the identity function on the set of individuals; I assume that this is the denotation of this occurence of to). $[\text{Bill}]_F$ is focused, so (i) applies, and the domain for this phrase is D, the individual universe of the model. Suppose f is a function with domain A and range B. There is a corresponding function f′, the image function for f, with domain the power set of A and range the power set of B:

(35) Let $f: A \longrightarrow B$

$$\text{Then } f': \wp(A) \longrightarrow \wp(B)$$
$$C \rightsquigarrow \{y \in B \mid \exists x[x \in C \wedge f(x) = y]\}$$

A subset C of A is mapped to the set of elements y which are the value of f when it is applied to some element of C. More generally, if f is an n-place function with domain $A_1 \times \ldots \times A_n$ and range B, the corresponding image function is defined:

(36) $$f': \wp(A_1) \times \ldots \times \wp(A_n) \longrightarrow B$$
$$C_1 \times \ldots \times C_n \rightsquigarrow \{y \in B \mid \exists x_1 \ldots x_n [x_1 \in C_1 \wedge f(x_1 \ldots x_n) = y]\}$$

[to Mary] is a complex phrase, so (iii) applies. I am assuming that the semantic rule for this PP is function application: apply the translation of the preposition to the translation of the object. To obtain the domain for [to Mary], we are to apply the corresponding image function to $\{\lambda x x\}$ and $\{m\}$:

$$\text{Dom}([\text{to Mary}]) = \{y \in D \mid \exists g, x[g \in \{\lambda x x\} \wedge x \in \{m\} \wedge g(x) = y]\}$$
$$= \{y \in D \mid [\lambda x x](m) = y\}$$
$$= \{m\}$$

There is one choice for g and x, so the domain has one element. The semantic rule for VP is again function application; in this case there are three arguments. To obtain the domain for [introduced $[\text{Bill}]_F$ to Mary], the image function corresponding to this rule is applied to {introduce′}, D, and {m}.

$$\text{Dom}([\text{introduced Bill to Mary}])$$
$$= \{P \mid \exists R, x, z[R \in \text{Dom}([\text{introduce}]) \wedge x \in \text{Dom}([\text{Bill}]_F) \wedge z \in \text{Dom}([\text{to Mary}]) \wedge P = R(x,z)\}$$
$$= \{P \mid \exists R, x, z[R \in \{\text{introduce}'\} \wedge x \in D \wedge z \in \{m\} \wedge P = R(x,z)\}$$
$$= \{P \mid \exists x[x \in D \wedge P = \text{introduce}'(x,m)\}$$

Since there is exactly one choice for R and z, the existential quantifications of these variables can be eliminated, yielding the desired domain expression. The domain of quantification for (25) is derived in a similar way:

$\text{Dom}([\text{introduced}]) = \{\text{introduce}'\}$
$\text{Dom}([\text{Bill}]) = \{b\}$
$\text{Dom}([\text{Mary}]_F = D$
$\text{Dom}([\text{to } [\text{Mary}]_F]) = D$
$\text{Dom}([\text{introduce Bill to } [\text{Mary}]_F]) = \{P \mid \exists x[x \in D \wedge P = \text{introduce}'(b,x)]\}$

4.3 Intensional Logic Version

Since I am using IL expressions to name objects in the model, it is convenient to restate the image construction as an IL schema.

(37) Let f have type $\langle a_1 \ldots a_n\ t\rangle$, $n>0$.
Then the corresponding image function has type $\langle\langle a_1\ t\rangle \ldots \langle a_n\ t\rangle\ \langle b\ t\rangle\rangle$, and is defined
$f' = \lambda f_1 \ldots \lambda f_n[\lambda y\ \exists x_1 \ldots \exists x_n[f_1(x_1) \wedge \ldots \wedge f_n(x_n) \wedge y=f(x_1 \ldots x_n)]]$,
where f_i is a variable of type $\langle a_i\ t\rangle$,
and y is a variable of type b.

I will illustrate this by the semantic rule for a transitive VP:

(38) a. construction: $[_{VP}$ V NP$]$
b. semantic rule: $\lambda R\lambda x[R(x)]$, where R and x are variables of type $\langle e\ \langle e\ t\rangle\rangle$ and e respectively.
c. rule for computing domains:
$\lambda h\lambda g[\lambda P\exists R\exists x[h(R) \wedge g(x) \wedge P = R(x)]$,
where h, g and P are variables of type $\langle\langle e\ \langle e\ t\rangle\rangle\ t\rangle$, $\langle e\ t\rangle$, and $\langle e\ t\rangle$, respectively.

(39) John only [likes [Bill]$_F$]

This yields the following IL derivation (consisting of tuples of syntactic form, category, assertion, and domain) for the sentence (39):

(40) Bill$_F$, NP, b, $\lambda x[x=x]$
likes, V, like', $\lambda R[R=like']$
likes Bill$_F$, VP, like'(b),
$\lambda h\lambda g[\lambda P\exists R\exists x[h(R) \wedge g(x) \wedge P = R(x)]](\lambda R[R=like'])(\lambda x[x=x])$,
equivalent to
$\lambda P\exists R\exists x[\lambda R[R=like'](R) \wedge \lambda x[x=x](x) \wedge P = R(x)]$,
equivalent to $\lambda P\exists x[P = like'(x)]$
only, Adv, $\lambda P\lambda x\forall Q[[Q(x) \wedge C(Q)] \rightarrow Q=P]$
only likes Bill$_F$, VP, $\lambda x[\forall Q[[Q(x) \wedge C(Q)] \rightarrow Q=like'(b)]]$,
equivalent to
$\lambda x[\forall Q[[Q(x) \wedge \exists x[Q = like'(x)]] \rightarrow Q=like'(b)]]$
if $\lambda P\exists x[P = like'(x)]$ is the value of C.
John only likes Bill$_F$, VP, $\forall Q[[Q(j) \wedge \exists x[Q = like'(x)]] \rightarrow Q=like'(b)]$

5 Review of Criticisms
5.1 Variables in LF

Given the interpretive procedure I specified, (14) and (16), which are repeated in (41), can have logical forms identical to their surface structures. Since the logical forms contain no syntactic variables, wellformedness conditions on syntactic variables like the empty category principle are not invoked.

(41)a He even thinks that BILL is in love with him
b He_3 only claims that SUE likes him_3
c It is also possible that MARY will get the job
d It is even likely that JOHN will pass

(42)a $\lambda P \exists y[P = claim'(\ \ like'(y,x_3))]$
b $-Q[[Q(x_3)\ \ C(Q)] \longrightarrow Q = claim'(like'(s,x_3))]$

The VP [claims that SUE likes him_3] in (41b) has the domain (42a); this is taken as the value of C in the denotation (42b) to obtain the desired truth conditions.

5.2 Types of Variables

According to the scope theory, the logical form for (17a), repeated in (43a), was (43b), which is effectively a structure of quantifier construal involving a variable $[_V]_6$ bound by the 'quantified V' [only $criticise_F$].

(43)a John only intends to CRITICISE Bill
b $[_S John[_{VF}[only\ criticise_{F,6}][_{VP}\ intends\ to\ [_{VP}[_V]_6\ Bill]]]]$

I pointed out that $[_V]_6$ is not an individual variable, but a quantified variable over relations, and that this was perhaps problematic for attempts to limit the power of the semantic metalanguage. On the other hand, the intensional logic translation assigned to (43a) by the domain selection theory is (44), which mirrors the surface structure in its constituency, and does not include a variable over relations.

(44) $only'(intend'(criticise'(b)))(j)$
(45) $\lambda P \exists R[P = intend'(R(b))]$

However, the issues are more complex than an inspection of (44) suggests. I claimed that a 'domain' was a significant part of the meaning of a phrase, one which contributed to truth conditions in the context of only. The domain for the VP [intends to CRITICISE Bill] in (43a) is named by (45). This is an IL expression which includes a bound relation variable; it seems that relation variables (and variables of various other types, obtained by focusing phrases of various syntactic categories) have reappeared in another part of the semantics. Whether this is so depends on the the status of (45). The original definition of the rule for computing domains was given in terms of the image construction (36). Unlike its intensional logic counterpart (37), this did not explicitly involve binding variables. Thus we are led to ask whether a logic allowing only individual variables, but including a cross-categorial operator forming image functions, has the expressive power of IL. I leave this question open; that variables can be eliminated in favor of an appropriate set of operators, as shown in combinatory logic, is a perhaps relevant fact.

5.3 Stipulation of Interaction with Focus

The interaction of *only* with focus in (46) was attributed to three principles: (i) The domain of the quantification over properties induced by *only* is a set C of 'relevant' properties; (ii) Part of the meaning of a phrase is a recursively defined 'domain'; (iii) In the configuration [only VP], the value of C in the translation of *only* may be taken to be the domain for VP. (i) is a general property of natural language quantification, and is consequently motivated independently of the interaction with focus construction.

(46) Mary only teased SUE

2 1
(47) Teasing SUE would be amusing

A genuine motivation for (ii) would be found in a theory of the meaning of focus in discourse. In a sentence like (47), focus appears to have no effect on truth conditions or conventional implicatures. Rather, the function of focusing *Sue* in the verb phrase *teasing Sue* seems to be to suggest that properties (or activities) of the form 'teasing y' are relevant or under discussion. If this is correct, the semantic rule (34) which associated the 'domain' {tease'(y)|y D} with this VP provides an adequate basis for rules of pragmatics which organize discourse. Moreover, if this domain is interpreted in pragmatics as a set of relevant properties, (iii) need not be stated as a separate principle; it follows from (i), the fact that the domains of natural language quantifications are sets of relevant objects. This suggests that the semantic interaction of *even*, *only* and *also* with focus might be derivable as a theorem. In other words, it would not be necessary to state a separate rule covering interaction with focus. If this program were carried through, we would have a truly non-stipulatory and explanatory theory of interaction with focus.

6 Crossover Argument

6.1 Apparent Evidence for Scope Theory

The scope theory of the focus interaction is similar to a proposal mooted in Chomsky (1975) according to which focused phrases are uniformly assigned scope in logical form. In the cited paper, the logical form of (48) is informally represented as (49). Taking (49) to be the logical form of (48) requires the postulation of structure building rules deriving logical forms. For simplicity, I will instead assume that the logical form of

(48) is (50) according to this proposal, (49) serving merely to suggest what the interpretation of the logical form (50) is.

(48) Bill likes $[\text{John}]_F$
(49) the x such that Bill likes x - is John
(50) $[_S[\text{John}]_{F,4}[_S\text{Bill likes }[_{NP}]_4]]$

The primary argument favor of this proposal is based on the weak crossover phenomenon illustrated below.

(51) a. Who was betrayed by the woman he loved?
b. Who did the woman he loved betray?
c. for which person x, [the woman x loved betrayed x]
(52) a. Every man was betrayed by the woman he loved.
b. The woman he loved betrayed every man.
c. [for all men x][the woman x loved betrayed x]

In (51) and (52), sentences a., but not sentences b., have the bound variable readings indicated by the paraphrases c. The similarity of (51b) and (52b) is evident in their logical forms (53) and (54), which have identical configurations of traces and indexed pronouns, assuming quantified NPs have scope in LF (May(1977)).

(53) $[_{S'}\text{who}_5[_S[_{NP}\text{the woman he}_5\text{ loved}]\text{ betrayed }[_{NP}]_5]]$
(54) $[_S[_{NP}\text{every man}]_9[_S[_{NP}\text{the woman he}_9\text{ loved}]\text{ betrayed }[_{NP}]_9]]$

The absence of a bound pronoun reading for (51b) and (52b) has been attributed in the literature to various wellformedness conditions which rule out the logical forms (53) and (54). Two examples are the abstract leftness condition of Higginbotham (1980), which rules them out because the trace is to the right, in a technical sense, of the coindexed pronoun, and the bijection principle of Koopman and Sportiche, which requires that an operator be the minimal binder for exactly one variable. In (53), who_5 is the minimal binder for both $[NP]_5$ and he_5, because neither of these phrases c-commands the other. For present purposes, it is sufficient to assume that some LF wellformedness condition, the "weak crossover condition", rules out logical forms such as (53) and (54). Returning now to the proposal that focused phrases are assigned scope in LF, consider the interpretations possible for the sentences (55). Chomsky observes that the bound pronoun reading suggested by the paraphrase c. is possible in a. but not b.

(55) a. JOHN was betrayed by the woman he loved
b. The woman he loved betrayed JOHN
c. the x such that the woman x loved betrayed x - is John
(56) $[_S[_{NP}\text{John}]_{F,9}[_S[_{NP}\text{the woman he}_9\text{ loved}]\text{ betrayed }[_{NP}]_9]]$

If focused phrases are uniformly assigned scope in LF, (55) is assimilated to (51) and (52): (56), the logical form for (55b) which corresponds to the relevant reading, has the same configuration of pronouns and traces as (53) and (54). This argument is of interest here because it can be replicated in the context of the focus-<u>only</u> interaction. In (57), it seems that a. but not b. has the bound pronoun reading suggested by the formula c.

(57)a. We only expect JOHN to be betrayed by the woman he loves
b. We only expect the woman he loves to betray JOHN
c. $\forall x$[we expect the woman x loves to betray x $\longrightarrow$ x = John]

(58)a. We [[only $John_F]_2$
[expect $[[_{NP}]_2$ to be betrayed by the woman he_2 loves]]]
b. We [[only $John_F]_3$ [expect [the woman he_3
loves to betray $[_{NP}]_3$]]]

According to the scope theory of the focus-only interaction, the logical forms associated with the intended bound variable readings of (57) a. and b. are (58) a. and b. respectively. Since (58b) has the configuration of traces and pronouns found in (51b) and (52b), it will violate the weak crossover condition. Thus the scope theory explains in an independently motivated way why (57b) has no bound variable reading. This would appear to confirm the scope theory of the focus interaction, and to disconfirm a theory which does not depend on the assignment of scope to focused phrases. I will show that the conflict between the crossover datum and my analysis is only apparent. Before proceeding, I will simplify the examples in two ways. First, we can sidestep the issue of how to interpret the coindexation of a pronoun with a proper name by restricting our attention to examples with pronouns. These exhibit the phenomenon we are interested in:

(59)a. We only expect HIM_2 to be betrayed by the woman he loves
b. We only expect the woman he loves to betray HIM_2
c. $\forall y$[we expect the woman y loves to betray y --> $y=x_2$]

As before, a. but not b. has the bound variable reading c. Having made this revision, we can simplify the semantics of the examples, and sharpen intuitions, by considering sentences exhibiting 'strong' crossover, in the sense of Wasow(1972):

(60)a. We only expect HIM to claim that he is brilliant
b. We only expect him to claim that HE is brilliant
c. $\forall z$[we expect z to claim z is brilliant $\longrightarrow$ z = x_2]

6.2 <u>Outline of argument</u>

(60a) is associated with logical forms by 'move alpha'. Of the possible logical forms, two are of particular interest: (61a) is identical to the S-structure (60a), and in (61b) the focused phrase has been adjoined to the embedded S.

(61)a We only expect [$_S$ HIM$_2$ to claim he$_2$ is brilliant]
b [We only expect [$_S$[him]$_{F,2}$
[$_S$ [$_{NP}$]$_2$ to claim he$_2$ is brilliant]]]
(62)a $\forall z$[we expect z to claim x_2 is brilliant $\longrightarrow$
z = x_2]
b $\forall z$[we expect z to claim z is brilliant $\longrightarrow$
z = x_2]

Suppose that both of these are admissible logical forms, and that they have the distinct interpretations suggested by the formulas (62). (62b), the interpretation for (61b), is the bound variable reading discussed above. In (62a) x_2 is logically a free variable, the denotation of which we can assume is fixed by an assignment function.

If the above assertions are correct, we can conclude that, while focused phrases can according to my proposal be interpreted without scope assignment, assigning scope to focused phrases in LF is permissible and can affect interpretation. The bound variable reading which figures in the crucial examples is associated with a logical form where the focused NP has been assigned scope. Consider now the logical forms for (60b) corresponding to (61):

(63)a We only expect [him$_3$ to claim that HE$_3$ is brilliant]
b We only expect [$_S$ [he]$_{3,F}$[him3 to claim that
[$_{NP}$]$_3$ is brilliant]]
(64)a $\forall z$[we expect z to claim that x_3 is brilliant $\longrightarrow$ z = x_3]
b $\forall z$[we expect z to claim that z is brilliant $\longrightarrow$ z = x_3]

Suppose that, as before, it is (63b) which has the bound variable interpretation (64b). But (64b) is not a well-formed logical form, since it is a crossover configuration. This explains why the bound variable reading is not available for (61b).

In summary, I have suggested that the crossover phenomenon is consistent with the theory of the focus interaction proposed above. While focused phrases need not be assigned scope in order to interact with <u>only</u>, scope assignment can influence interpretation. In particular, the 'bound variable' reading present in sentences a., but not sentences b., of (55), (57), (59), and (60) requires scope assignment in LF. It is this which triggers the crossover effect, which following Chomsky I take to be a consequence of LF scope assignment.

I will now develop the steps in the above argument.

6.3 Position of NPs in LF

The claim that (61a) and (61b) are both logical forms for (60a) may be in conflict with the a common view of the distribution of NPs, expressed in Higginbotham (1983):

"Elements subject to Scope Assignment will be called operators. I will leave the extension of this concept partially open, but operators certainly include quantificational elements and wh-elements. Not only may operators be assigned scope, but, we may suppose, they must be assigned scope to create a well-formed LF-representation."

This passage suggests that whether a phrase is assigned scope in LF is completely determined by its form. NPs of a certain form are operators, and an NP is assigned scope in the derivation of LF if and only if it is an operator. Since the focused phrase in (60a) either is or is not an operator, (61a) and (61b) can not both be wellformed LF representations.

The motivation for the view expressed in the quoted passage is, I believe, interpretive: it is suggested that operators can not be interpreted in operator positions, and that non-operators (e.g. names) can not be interpreted in non-argument positions. The semantics I have been employing makes a type distinction between individual-denoting NPs such as names and pronouns and quantified NPs, a distinction which might be identified with the non-operator/operator distinction. But it dos not follow that individual-denoting NPs can not be interpreted in non-argument positions. Suppose the semantic rule interpreting an NP adjoined to S is this:

(65) $[_S NP_i S]]$

Semantic rule: combine NP′ and $\lambda x_i S'$ by function application.

(65) does not specify whether NP′ or S′ is to be the function. This will depend on the type of NP′: if NP′ is a generalized quantifier, it will serve as the function. If NP′ is an individual, it will serve as the argument. These possibilities are illustrated in (66) and (67).

(66) a $[[\text{every man}]_4\ [[_{NP}]_4 \text{left}]]$
     b $[\text{every man}]'(\lambda x_4 \text{left}'(x_4))$
(67) a $[[\text{John}]_4\ [[_{NP}]_4 \text{left}]]$
     b $[\lambda x_4 \text{left}'(x_4)](j)$, equivalent to left′(j)

6.4 Some Computations

It would hardly be of interest to simply assert that the bound variable readings of (57a), (59a), and (60a) are associated with logical forms where the focused phrase has been adjoined to the embedded S. Rather, this should follow from independent interpretive principles, such as the domain rule (34) and the semantic rule for structures of quantifier construal (65).

Consider first the logical forms not involving scope assignment, repeated in (68). The assertion in both cases is (69), where the value of C remains to be specified.

(68)a We only expect [S HIM_3 to claim he_3 is brilliant]
b We only expect [him_3 to claim that HE_3 is brilliant]
(69) $\forall P[P(w) \wedge C(P) \dashrightarrow P = expect'(claim'(x_3, brilliant'(x_3)))]$
(70)a $\lambda P \exists y[P = expect'(claim'(y, brilliant'(x_3)))]$
b $\lambda P \exists y[P = expect'(claim'(x_3, brilliant'(y)))]$
(71)a $\forall P[P(w) \wedge \exists y[P = expect'(claim'(y, brilliant'(x_3)))]$
$\longrightarrow P = expect'(claim'(x_3, brilliant'(x_3)))]$
b $\forall P[P(w) \wedge \exists y[P = expect'(claim'(x_3, brilliant'(y)))]$
$\longrightarrow P = expect'(claim'(x_3, brilliant'(x_3)))]$
(72)a $\forall y$[we expect y to claim x_3 is brilliant $\longrightarrow y = x_3$]
b $\forall y$[we expect x_3 to claim y is brilliant $\longrightarrow y = x_3$]

Given the rules introduced in section 4, the domain expressions for the VP in (68a) which is a sister of only is (70a). When this is substituted for C in (69), the result is (71a), which can be paraphrased: if we have a property of the form 'expect y to claim that x_3 is brilliant', for some value of y, then it is the property 'expect x_3 to claim that x_3 is brilliant'. (71a) is similar in truth conditions to the first order formula (72a), which I described as the 'free-variable' reading of (60a). In a parallel way, the logical form (68b) has the denotation (71b), which is similar in truth conditions to (72b), the 'free variable' reading for (60b).

It remains to be verified that (61b), repeated in (73), has the 'bound variable' interpretation.

(73) [We only expect $[_S[him]_{F,2}$
$[_S[_{NP}]_2$ to claim he_2 is brilliant]]]
(74)a. $claim(x_2, brilliant'(x_2))$
b. $\lambda p[p = claim'(x_2, brilliant'(x_2))]$
(75)a. x_2
b. $\lambda y[y = y]$
(76)a. $[\lambda x_2 claim(x_2, brilliant'(x_2))](x_2)$, equivalent to $claim(x_2, brilliant'(x_2))$
b. $\lambda q \exists y[q = [\lambda x_2 claim'(x_2, brilliant'(x_2))](y)]$, equivalent to $\lambda q \exists y[q = claim'(y, brilliant'(y))]$
(77) $\lambda P \exists y[P = expect'(claim'(y, brilliant'(y)))]$
(78) $\forall P[P(w) \wedge \exists y[P = expect'(claim'(y, brilliant'(y)))]$
$\longrightarrow P = expect'(claim'(x_3, brilliant'(x_3)))]$
(79) $\forall y$[we expect y to claim y is brilliant $\longrightarrow y = x_3$]

(74a) is the assertion assigned to the minimal S in (73). I assume that both the empty category $[_{NP}]_2$ and the pronoun he_2 translate as the individual variable x_2. Since this S contains no focused phrases, the domain expression is the unit set of the assertion, namely (74b). The assertion for $[him]_{F,2}$ is likewise x_2; since this phrase is focused, its domain is the set of individuals in the model; this set is named by the IL expression (75b). (76) gives the assertion and domain assigned to the complement of claim, which consists of an NP adjoined to S. The semantic rule which applies is (65); since the adjoined NP is of individual type, the translation of NP will serve as an argument, and the lambda abstract of the translation of the translation of S will be the function. The resulting assertion is (76a); note that assigning scope to the focused NP does not alter the assertion of the complement of claim. The domain is obtained by applying the same semantic rule to elements of the sets (74b) and (75b). Since (74b) is a unit set, the function will always be a lambda abstract of the sole element of this set, namely $\lambda x_2 claim(x_2, brilliant'(x_2))$. The argument can be any element of the set of individuals. The resulting set of propositions is (76b). Notice that this differs from (70a); assigning scope to the focused NP has affected the domain for the complement of claim.

(77) is the domain for the VP in (73) which is the sister of only. The assertion assigned to (73) is the same as that assigned to (68a), i.e. (69), as long as C is regarded as a variable. Substituting (77) for C in (69) yields (78), which can be paraphrased: if we have a property of the form 'expect y to claim that y is brilliant', then it is the property 'expect x_3 to claim x_3 is brilliant'. As desired, this is similar to the first order formula (79), which I described as the 'bound variable' reading of (60a).

6.5 Conclusion

Given the rule for computing domains and the semantic rules for the relevant construction (in particular, the rule for a structure of quantifier construal), a 'bound variable' reading for (57b), (59b), or (60b) would require a logical form where the focused phrase has been adjoined to the embedded S. Since such a logical form would violate the weak crossover condition, the absence of a bound variable reading is explained, or at any rate assimilated to other cases of crossover.

Since this result was obtained in an explicit system of semantic interpretation, it has been demonstrated that the crossover datum is not evidence for the scope theory of the focus-only/even/also interaction. More generally, the crossover datum is not evidence for a scope theory of focus interpretation such as that proposed in Chomsky(1975). This result is not tied to the particular way in which the meaning of focus is represented in this paper; the same result can be obtained with a more familiar system, wherein there is a separate component of meaning, the theme, in which variables drawn from a distinguished set of focus variables have been substituted for focused phrases. As before, the bound variable reading requires scope assignment.

(80) The theme for a phrase θ is
   a. a focus variable matching the denotation of θ in type, if θ is focused
   b. the denotation of θ, if θ is a non-focused lexical item
   c. the semantic function for θ applied to the themes of the parts of θ, if θ is a non-focused complex phrase
   d. [$he_{F,2}$ thinks he_2 is smart]
      theme: think(y,smart'(x_2)), where y is a focus variable.
   e. [$_S he_{F,2}$[$_S$[$_{NP}$]$_2$ thinks he_2 is smart]
      theme: think(y,smart'(y))

7. Summary

I sketched a scope theory of the focus interaction, according to which a focused phrase is inserted as an argument of only/even/also in LF. The resulting quantifier binds a variable in the surface position of the focused phrase. According to the alternative I proposed, the argument of <u>only</u> is the VP which is adjacent to it in surface structure. The focused phrase is (or at least may be) interpreted in its surface position. The semantic interaction of only/even/also with focus is attributed to a contribution of focus to the selection of domains of quantification. Three advantages over the scope theory were claimed:

(i) No syntactic bound variable is postulated; thus it is not predicted that the relation between only/even/also is restricted by scope islands or local conditions on variables like ECP.

(ii) It is not necessary to employ variables of (nearly) arbitrary type in the semantic metalanguage.

(iii) Interaction with focus is derived as a theorem from independently motivated principles.

Point (i) is verified by the rules proposed here. (ii) is clearly desirable, but is speculative for the reason cited in section 5.2. (iii) describes the familiar 'best theory'. While my results strongly suggest that this is true, I have not really demonstrated it, since if intertaction with focus is a theorem, it is a theorem of a pragmatic theory of the meaning of focus and of domain selection which was only partially formulated and motivated here.

To maintain continuity of exposition, I embedded my proposal in an EST grammar employing logical forms. It is perhaps worth noting that the recursive domain rule (34), (likewise the recursive theme rule (80)), fits naturally into a rule by rule grammar in the sense of Bach(1980). In this formalism, a grammar is a recursive definition of phrases, which have various components or attributes, such as phonological form, syntactic features, and semantic interpretation. Suppose that one component is a domain (or theme), and that the phonological reflex of focus is a phrasal rule of pitch accent assignment, as proposed in Selkirk(1984). In a rule by rule system, the focus rule would affect the phonological and domain (or theme) components of a phrase, but not the assertion component.

FOOTNOTES

[1] Accordingly, the terms 'assertion' and 'denotation' are used interchangeably.

[2] I am not employing the term 'association with focus' from Jackendoff(1972) since this is a label for a rule; I will claim that this phenomenon is not to be described by a construction-specific rule.

[3] Possibly there are other logical forms. It might be that individual denoting NPs ([John], [Sue], etc.) can be assigned scope (i.e. adjoined to S or other phrasal nodes). Given the interpretive system employed below, this would not effect semantic interpretation.

[4] Given the semantic rule (9), the entire phrase [only Bill] should bear the index 2 and the category label NP. This might follow from a theory of features; since I am not advocating a scope theory, I will make no proposal in this area.

[5] Logical forms, which are syntactic objects, are model theoretically interpreted by recursive semantic rules; the objects in the model which are the denotations of phrases are named by expressions of intensional logic (Montague(1970)). This translation step can be eliminated, and IL is not a separate level of logical form, save in a trivial sense.

The semantic rules employed here do not constitute a serious attempt to construct a model-theoretic semantics for the logical forms generated by an extended standard theory syntax (in particular, by a government-binding syntax, Chomsky(1981)). The interesting issues, such as the possibly various interpretations of the various empty categories, are ignored.

[6] In a theory where quantifier construal is obligatory (i.e. where quantified NPs can not be interpreted in argument positions), (7) has the logical form $[_S[_{NP}$only John$]_2[_S[_{NP}]_2$ swims]]. This would not effect the denotation required for only, which is essentially a consequence of the view that only John in (7) is a constituent whose semantic type is that of a quantified NP.

HOW TO GET EVEN WITH DOMAIN SELECTION

[7] Some semantic assumptions and abbreviations:

(i) The IL translation of a name is an individual constant, which in my examples will always be the first letter of the name.

(ii) The IL translation of a case-marked trace $[_{NP}]_i$ is the individual constant x_i.

(iii) The preposition to has no semantic effect (or, equivalently, denotes the identity function), so that the IL translation of $[_{PP}$to Sue] is s.

(iv) In the VP [introduce NP_1 $[_{PP}$to NP_2]], the translations of NP_1 and PP are simultaneous arguments of introduce′, the translation of introduce.

(v) introduce′(a,b)(c) is abbreviated introduce′(c,a,b)

[8] Here Anderson alludes to the fact that a right-branching constituent with final nuclear stress is (or at least may be) ambiguous as to its focus structure: any of the right branches may be read as the focused phrase. Following Jackendoff(1972), I assume that there is no ambiguity at S-structure: phrases which are semantically interpreted as focused have the feature F at S-structure. I leave open the question whether S-structures like [John [likes Sue]$_F$] and [John [likes Sue$_F$]] can be phonetically disambiguated (i.e., whether there is a phonetic form which is an image of one but not the other); cf. Jackendoff(1972), page 242.

[9] Moreover, other proposals (or remarks) in the literature with which I am familiar are stipulative, whether they are scope theories or not. Anderson summarizes a standard theory proposal, attributed to Fischer(1968), where the even and the focused phrase are a constituent in deep structure. The cooccurrence restriction between even and the focus feature are stated in a phrase structure rule. Horn(1969) appears to concur with this proposal: "[Muriel on vote for Hubert] is a paraphrase of [Muriel voted {only for/for only} Hubert], and is in fact derived from it, by an optional adverb movement transformation of the kind described in Kuroda (1966)." In their detailed study of the compositional semantics of even, Karttunen and Peters state that sentences where even is not adjacent to the focused phrase are not problematic for their analysis (which is a scope or quantifying in analysis), "except for syntactic complications" (Karttunen and Peters(1979), page 24). This suggests that they would treat (1) and (2) in a way similar to the one I outlined, by binding a variable in the position of the focused phrase. Horn and Karttunen and Peters were primarily concerned with semantic issues.

[10] Chomsky (1981, p238) mentions a possible explanation (attributed to Sportiche) for the absence of an ECP effect with focus. If in the logical form of the sentence 'I don't think that JOHN solved this problem' the focused phrase has scope in the embedded sentence rather than the matrix sentence (i.e if it is adjoined to the embedded S), the ECP will not be violated, since the trace will be bound by a sufficiently local operator (c.f. the formulation of proper government, (Chomsky(1982) p 250). But if we

adopt the scope theory of the focus interaction, this is not a possibility in (14): the scope of the focused phrase is determined by the surface position of only.

In this context, it is of interest to note that the ambiguity of the sentence (i) is resolved if only is placed in front of a VP.

(i) We are required to study only SYNTAX
(ii) We are required to only study SYNTAX
(iii) We are only required to study SYNTAX

Presumably the ambiguity of (i) is a normal quantifier scope ambiguity, [only syntax] being a quantified NP. (ii) has the reading of (i) with narrow scope for [only syntax], and (iii) has the wide scope reading. These facts are reminiscent of the discussion of the French ne-personne construction in Kayne(1979): only appears to be acting as a 'scope marker'. The ne-personne construction exhibits an ECP effect, an effect which is marginal or absent for many quantifiers. It has been suggested that this distinction is to be attributed to the fact that that the scope of personne, unlike that of other quantifiers, is syntactically marked in S-structure (by the position of the scope marker ne). The parallelism with the ne-personne construction leads us to expect an ECP effect for focused phrases associated with even, only, or also. Thus it is the more significant that no such effect is observed.

[11] This does not appear to be an ECP effect, since no subject/object asymmetry is perceived: It is possible that they will hire every candidate also has no wide scope reading. There is extreme variability in the quantifier scope islands people observe; I picked this one merely as a representative example.

[12] In (17c) I assume that the complement of intend denotes a property. The point I am making is unaffected if it denotes a proposition.

[13] Consider the following false claim (in employing intensional expressions, I depart from my practice in the text).

Proposition: the formulas (i) and (ii) are true in the same models.

(i) $\forall P[[P\{j\} \wedge \exists y[P={}^\wedge introduce'(y,m)]] \longrightarrow P={}^\wedge introduce'(b,m)]$
(ii) $\forall x[introduce'(j,x,m) \longrightarrow x=b]$

"Proof": Let M be an intensional model.

(a) Suppose (ii) is true in M. We want to show that (i) is true in M. Let P_1 and a be such that the conditions in the antecedent of (i) is true, i.e. $P_1\{j\}$ and $P_1 = {}^\wedge introduce'(a,m)$. Combining these two statements we have introduce'(j,a,m). It follows from (ii) that a=b. Therefore ${}^\wedge introduce'(a,m) = {}^\wedge introduce'(b,m)$. So $P_1 = {}^\wedge introduce'(b,m)$. This is the consequent in (ii), as required.

(b) Suppose that (ii) is false in M, say introduce'(j,a,m) and a≠ b. We want to show that (i) is false in M.

^introduce′(a,m) satisfies the conditions on P in the antecedent of (i). "But since a≠ b, ^introduce′(a,m) ≠ ^introduce′(b,m)", and the consequent of (i) is false if ^introduce′(a,m) is the value of P. So (i) is false.

The flaw in this argument is the part in scare quotes. There are models in which ^introduce′(a,m) = ^introduce′(b,m), but a≠ b. In a model of this kind, (i) may be true and (ii) false. This would be true, for instance, in a model with one possible world, a world in which the extentions of ^introduce′(a,m) and ^introduce′(b,m) are both {j}, and the extension of ^introduce′(c,m) is the empty set for any c distinct from a and b.

Is it pernicious that (ii) implies (i), but is not equivalent to it? We have an intuition that John introduced only BILL to Sue and John only introduced BILL to Sue mean the same thing. This may be because our intuitions reflect facts about models more 'realistic' than the degenerate one I described. In models where ^introduce′(b,m) and ^introduce′(a,m) arer different properties (for all a≠ b), (i) and (ii) denote the same proposition. Mathematical statements are the thorniest, because their truth does not presumably vary from world to world, even in 'realistic' models.

(iii) Nine is only the square of THREE
(iv) Nine is the square only of THREE
(v) $\forall P[[P\{9\} \wedge \exists y[P = {}^\wedge\lambda x[x=y^2]]] \longrightarrow P = {}^\wedge\lambda x[x = 3^2]]$
(vi) $\forall x[9 = x^2 \dashrightarrow x = 3]$

Since 9 is the square of -3 as well as 3, (vi) (which I am supposing is the translation of (iv)) is false. But since $3^2 = (-3)^2$, $^\wedge\lambda x[x = 3^2]$ and $^\wedge\lambda x[x = (-3)^2]$ are the same property. So (v) (which I am supposing is the translation of (iii)) is true.

Our intuition is that (iii) is false, just like (iv). To do justice to our intuitions, a 'more intensional' semantics, one in which being the square of 3 and being the square of -3 are distinct but cointensional properties, is required. Philosophers have made proposals of this kind, motivated by problems of propositional attitudes. Chierchia (1984) proposes a semantics for English employing Cochiarella's second order logic HST which admits models with the right properties. If my analysis of interaction with focus is correct, these proposals can be motivated outside the realm of propositional attitudes. For other arguments to this effect, see Chierchia(1984).

The upshot of this discussion is that I will describe the IL formulas produced by the domain selection theory as 'similar in truth conditions' to the IL formulas produced by the scope theory, without regarding the absence of logical equivalence as a problem for my analysis.

[14] For clarity, I am temporarily using set notation (e.g. {m}) rather than IL notation (e.g. $\lambda x[x = m]$).

[15] The significance of the distinction between the 'bound' and 'free' readings of sentences like those in (55) is pointed out in Horvath(1981), page 215 and following. Rochemont(1978) had argued that Chomsky's demonstration of a crossover effect for focus was flawed. The underlined occurence of he in (i), Rochemont observes, can be coreferential with John.

(i) A: Sally and the woman John loves are leaving the country today.
B: I thought that the woman he loves had BETRAYED Sally.
A: No-the woman he loves betrayed JOHN; Sally and she are the best of friends.

The reading which Rochemont appears to have in mind is what I described in the text as the free variable reading. At the time of A's second utterance, propositions of the form 'the woman he (John) loved betrayed y' are presupposed to be relevant. This example is irrelevant, as Horvath notes, since it is the bound variable reading which is claimed to be impossible.

According to my analysis, the final sentence in (i) would have a logical form not involving scope assignment; this explains the absence of a weak crossover effect. Horvath represents the distinction between bound and free readings in a different way. In both cases, the focused phrase is assigned scope in LF. The bound reading is obtained by rewriting the pronoun he as a variable: "the condition in question [the weak crossover condition] merely specifies under what circumstances a pronoun can be rewritten as a variable bound by a quantifier" (Horvath (1981), p 217). If we assume that $[_{NP}]_i$ is the (syntactic) variable corresponding to he_i, the two readings would be distinguished in the following way:

(ii) free: $[John_{F,2}$[the woman he_2 loved betrayed $[_{NP}]_2]$

(iii)bound: $[John_{F,2}$[the woman $[_{NP}]_2$ loved betrayed $[_{NP}]_2]$

Both ways of drawing the distinction between bound and free readings seem to work, and to interact as desired with an appropriately formulated weak crossover condition. (ii) raises some interesting interpretive issues. In most Montague grammar treatments, pronouns have been interpreted as variables. In this paper I followed this practice in translating both $[_{NP}]_i$ and he_i as the variable x_i. To further develop Horvath's proposal, we have to decide what the interpretation of he_i is, as opposed to the interpretation of $[_{NP}]_i$. Janssen's distinction between pronouns interpreted as variables and pronouns interpreted as constants is relevant here (Janssen(1980)).

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