Squiggly Issues: Alternative Sets, Complex DPs, and Intensionality

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Abstract. In this paper, we investigate a number of long-standing issues in connection with (i) focus interpretation and its interrelation with complex definite descriptions, and (ii) the intensional properties of sentences with focus constituents. We revitalize the use of Rooth's (1992) $\sim$ operator, clarify its definition as an anaphoric operator, discuss the principles that govern its placement in logical forms and show how it can be succesfully employed to replace the notion of Krifka's (2006) focus phrases. Finally, we argue that a proper view of the intensional dimension of retrieving the antecedent sets required by the operator can account for problems relating to the intensionality of sentences with focus sensitive operators that are discussed by Beaver & Clark (2008).

1 Introduction: Focus Semantic Values and Context Sets

According to Rooth (1985, 1992, 1996) focusing – the semantic reflex of an F feature assigned to some constituent X in logical form – leads to the creation of a focus semantic value $[\![X]\!]^f$ (FSV). The FSV is simply the domain of objects having the same semantic type as the ordinary semantic value $[\![X]\!]^o$ relative to some model. For instance, the FSV of the phrase [THEodore]$_F$ is simply the domain of individuals D_e.

Note that, other than in the case of mathematical models, natural discourse does not enable us to exhaustively list all entities that belong to D_e since we are not omniscient. All we know is that if d is an individual then it is a member of D_e. We shall therefore consider focus semantic values to be (anonymous) *characterizations* rather than extensionally determined sets.

It is well-known since Rooth (1992) that FSVs are not as such suited to function with conventionally focus-sensitive particles[3]; they need to undergo contextual restriction. Consider the sequence in (1).

(1) a. We have invited all siblings of your mom but, I noticed, we have really neglected your father's relatives.
b. So far, we have only invited [uncle THEodore]$_F$.

(2) $\forall x[x \in C \wedge \mathit{invite}(\mathbf{we}, x) \rightarrow x = \mathbf{t}]$

[3] Beaver and Clark (2008) distinguish conventional, free, and quasi-sensitivity.

Using a standard semantics for *only* yields (2) as the reading for (1b). We get the wrong result if the quantificational domain C for *only* is set to D_e since this set also comprises Mom's invited siblings and (2) would falsely rule them out. Therefore, in order to get the proper meaning for (1b), C must be restricted to a contextually available set, in this case "your father's relatives".

For this and a number of other focus-related purposes, Rooth (1992, 1996) defines, in addition to the focus feature F, a *focus interpretation operator* $\sim$, which can in principle attach to arbitrary constituents. If X is some constituent, $[\![X]\!]^o$ is the ordinary meaning of X and $[\![X]\!]^f$ is the FSV, then $\sim$X triggers a presupposition such that a *context set* C containing a contrastive item y must be identified, with the properties given in (3).[4]

(3) (i) $C \subseteq [\![X]\!]^f$ (ii) $y \in C$ (iii) $y \neq [\![X]\!]^o$

In the following we would like to scrutinize the anaphoric nature of $\sim$. For that purpose we provide a translation of the constraints in (3) into DRT, which is geared to the treatment of presuppositions and anaphora in the framework of van der Sandt (1992), Geurts (1999) and Kamp (2001). Definite descriptions like in the second sentence of (4) are represented as in Fig. 1a, where the anaphoric variable $\underline{z}$ is waiting to get bound to the previously mentioned customer x.[5]

(4) A customer entered. Mary greeted the man.

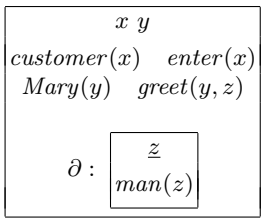

Fig. 1a.
Preliminary DRS for (4)

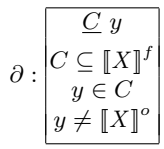

Fig. 1b.
Presupposition triggered by $\sim X$

In this vein, we formulate the $\sim$ conditions from (3) as in Fig. 1b.

[4] We ignore a fourth condition according to which $[\![X]\!]^o \in C$, since we think it is superfluous. While it is unproblematic that the retrieved set C sometimes will contain $[\![X]\!]^o$ there are cases in which imposing this as a constraint is implausible, for instance, cases of overt contrast.

[5] We ignore issues like tense.

2 Squiggle Placement

A representation like the one in Fig. 1b – in particular the treatment of C as an anaphoric variable – clearly shows that the semantic type which these variables adopt is dependent on the attachment site of $\sim$. If $\sim$ attaches to a DP then C must be a set of individuals. If it attaches to a VP then C is a set of properties or, preferably, a set of events or states. Seen in this light, it is surprising that Rooth (1992: 89) chooses to attach the $\sim$ in (5) at VP level.

(5) Mary only $\sim[_{VP}$ introduced BILL_F to Sue].

Rooth assumes that *only* is syntactically adjoined to VP and that it quantifies over the set provided by a variable C which gets instantiated by means of $\sim$. The squiggle operator, in its designated location, triggers the presupposition in Fig. 2a,b.

$$\partial : \boxed{\begin{array}{c}\underline{C}\ P \\ C \subseteq \{\lambda x.\mathit{introd}(x,z,\mathbf{s}) \mid z \in D_e\} \\ P \in C \quad P \neq \lambda x.\mathit{introd}(x,\mathbf{b},\mathbf{s})\end{array}}$$

Fig. 2a
Presupposition triggered by $\sim[_{VP}\ldots]$

$$\partial : \boxed{\begin{array}{c}\underline{C}\ e' \\ C \subseteq \{e \mid \mathit{introd}(e) \wedge \textsc{go}(e,\mathbf{s})\} \\ e' \in C \quad \textsc{th}(e') \neq \mathbf{b}\end{array}}$$

Fig. 2b
Same issue, using event semantics

We provide two variants of this presupposition. Figure 2a is immediately derived from Rooth's original account, Fig. 2b is a reformulation in Neo-Davidsonian semantics, which uses discourse referents for events rather than properties (as it is common practice in DRT).[6] The meaning of (5) is correctly represented as (6a)[7] or (6b).

(6) a. $\forall P[P \in C \wedge P(\mathbf{m}) \rightarrow P = \lambda x.\mathit{introd}(x,\mathbf{b},\mathbf{s})]$
b. $\forall e[e \in C \wedge \textsc{ag}(e,\mathbf{m}) \rightarrow \textsc{th}(e,\mathbf{b})]$

The question is whether it is plausible to assume that the instantiation of C is due to anaphoric retrieval as suggested by the definitions in Fig. 2a,b. Consider the discourse in (7).

(7) a. At the party, there were Alex, Bill, and Carl, none of whom Sue had met before.
b. Mary only introduced BILL_F to Sue.

There are no introduction events in the discourse context given by (7a). It seems therefore wrong to assume that (7b) involves anaphoric retrieval of a set of VP-

[6] See Bonomi and Casalegno (1993), Beaver and Clark (2008) for an elegant treatment of focus in event semantics.
[7] Here, we ignore intensionality.

meanings of the form [introduced z to Sue]. On the other hand, it is highly likely that retrieval is of a set of alternatives to *Bill*. But in that case it is more intuitive for $\sim$ to attach to [BILL$_F$] as shown in (8).

(8) Mary only introduced $\sim$[$_{DP}$ BILL$_F$] to Sue.

The problem is how to bring this insight in line with the semantics in (6a), which was found to be essentially correct. First of all, since C is now the set of individuals $\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}$ rather than a set of predicates, it can no longer be used in formula (6a) as before. What we want instead is (9).

(9) $\forall P[P \in [\![\textit{introd. } \sim[\textit{BILL}_F] \textit{ to Sue}]\!]^A \wedge P(\mathbf{m}) \rightarrow P = \lambda x.\textit{introd}(x, \mathbf{b}, \mathbf{s})]$;
where $[\![\textit{introd. } \sim[\textit{BILL}_F] \textit{ to Sue}]\!]^A = \{\lambda x.\textit{introd}(x, z, \mathbf{s}) \mid z \in C\}$

We call $[\![\cdot]\!]^A$ simply an *alternative set* in order to distinguish it from the previously defined FSV $[\![\cdot]\!]^f$, the difference being that, on our treatment, alternative sets contain elements that can be extensionally listed because they are ultimately grounded via a process of anaphoric identification. Of course, the anaphorically retrieved context set C is itself a basic alternative set, but alternative sets can also derive from semantic composition based on C. In switching from Rooth's (6a) to (9), we are reversing the order of compositional focus semantics and anaphoric retrieval as shown in Table 1. In doing so, we maintain the desired reading but avoid implausible anaphoric processes and, furthermore, establish a clear criterion for $\sim$ placement.

Rooth (1992)		Our Account
$[\![\textit{BILL}_F]\!]^f = D_e$		$[\![\textit{BILL}_F]\!]^f = D_e$
	Foc.int.$\rightarrow$	$[\![\sim[\textit{BILL}_F]]\!]^A = \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}$
$[\![\textit{introd. BILL}_F]\!]^f$ $= \{\lambda y \lambda x.\textit{introd}(x, z, y) \mid z \in D_e\}$		$[\![\textit{introd. } \sim[\textit{BILL}_F]]\!]^A$ $= \{\lambda y \lambda x.\textit{introd}(x, z, y) \mid z \in \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$
$[\![\textit{introd. BILL}_F \textit{ to Sue}]\!]^f$ $= \{\lambda x.\textit{introd}(x, z, \mathbf{s}) \mid z \in D_e\}$		$[\![\textit{introd. } \sim[\textit{BILL}_F] \textit{ to Sue}]\!]^A$ $= \{\lambda x.\textit{introd}(x, z, \mathbf{s}) \mid z \in \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$
$[\![\sim[\textit{introd. BILL}_F \textit{ to Sue}]]\!]^A$ $= \{\lambda x.\textit{introd}(x, z, \mathbf{s}) \mid z \in \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}\}$	$\leftarrow$**Foc.int.**	

Table 1. Alternative Semantics reversed

3 Benefits of our Account

In (8) $\sim$ is adjoined to the focus constituent itself. But we do not propose that this is always so. Our interpretation of the $\sim$ operator allows us, for instance, to handle the issue of *focus phrases* (Drubig, 1994, Krifka, 2006). Sentence (10) demonstrates what Krifka calls "the problem of the only child".

(10) Sam only talked to [BILL's$_F$ mother]$_{FP}$.

Drubig and Krifka noticed the problem that (10) presents for a Structured Meanings account which would analyse the sentence as involving *only*-quantification over *Bill* and the other members of his alternative set. If the set contains a sibling of *Bill* then *Sam* must both have talked to their mother and, at the same time, not have talked to her, and the sentence would come out as a contradiction, although intuitively it isn't. Krifka (2006) solved the problem by postulating that *only* instead associates with *focus phrases (FP)*, cf. (10), which means that quantification is about referentially distinct alternatives to *Bill's mother* rather than alternatives to *Bill*.

By applying our strictly anaphoric definition of the squiggle we automatically get the correct semantics for (10). $\sim$ is attached to [$_{DP}$ BILL's$_F$ mother], giving rise to the presupposition in Fig. 3.

$$\partial : \boxed{\begin{array}{c} \underline{C}\ y \\ \hline C \subseteq [\![BILL's_F\ mother]\!]^f \\ y \in C \quad y \neq [\![BILL's_F\ mother]\!]^o \end{array}}$$

Fig. 3. $\sim$[BILL's$_F$ mother]

(11) a. $[\![BILL's_F\ mother]\!]^o = \iota x.mother\_of(x, \mathbf{b})$
b. $[\![BILL's_F\ mother]\!]^f = \{d \mid \exists x.mother\_of(d, x)\}$

The ordinary value occuring in Fig. 3 is simply Bill's mother – representable as yet another embedded presupposition or the ι-expression in (11a). The focus semantic value is the anonymous set given in (11b), the set of all mothers of individuals in D_e. During the process of anaphoric retrieval this set undergoes restriction, and C is resolved to whatever mothers play a role in a certain context. Compare, for instance, sentence (12).

(12) At the party there were Alex, Bill, Carl and Daniel, and also Bill's mother and Carl's mother. I only knew $\sim$[BILL's$_F$ mother].

The second sentence of (12) is naturally interpreted as saying that the speaker knew Bill's mother but not Carl's mother, leaving it open whether he also knew the unmentioned mothers of Alex and Daniel. This interpretation can be obtained when $\sim$ is attached to [BILL's$_F$ mother], but not when it is attached to [BILL's$_F$]. Note also that the semantics correctly predicts that the other mentioned persons, who are not mothers, do not become elements of C.

As a side remark, Krifka (2006) argues in his article for the use of a "hybrid" system combining insights from Structured Meanings Theory and Alternative Semantics. Our suggestions concerning the use of $\sim$ are very much in the spirit of this proposal. In fact, we might have replaced all bits dealing with focus

semantic values by *background* expressions. Instead of (11b) we could have used (13), which is simply the characteristic function of (11b).

(13) $\lambda x[\exists y.mother\_of(x, y)]$

Backgrounds and FSVs are interchangeable. However, interchangeability ends as soon as the $\sim$ has anaphorically turned the FSV into a true alternative set $[\![BILL's_F\ mother]\!]^A$, for instance $\{e, f\}$ consisting of Bill's mother (Eva) and Carl's mother (Florence). This is where Alternative Semantics takes over from Structured Meanings.

A further benefit of the way we propose to use $\sim$ arises in connection with an example discussed in von Heusinger (2007). He notices a problem with complex definite descriptions like the one occurring in (14a), which involves adjectival modification.[8]

(14) a. John only talked to [the GERman$_F$ professor].
b. $\{[\![the\ German\ professor]\!], [\![the\ French\ professor]\!], [\![the\ English\ professor]\!], \ldots\}$

Something is wrong if (14a) is analyzed under the assumption that determining the truth conditions of the sentence involves computing denotations of expressions of the form [the A professor][9], in other words a set like (14b). For it might well be that on the occasion that (14a) speaks of there were besides the one German professor several French professors and therefore the expression $[\![the\ French\ professor]\!]$ would fail to properly refer. Still, if the only professor that John talked to was the only German professor there, then (14a) is a perfectly good way of saying that John only talked with this one professor.

The solution we offer for this case is as follows. The FSV of the phrase [the GERman$_F$ professor] is determined by a purely mechanical process as the set characterized by (15a), which does not run into the problems that (14b) caused. The set can even be further simplified to (15b).

(15) a. $\{d \mid \exists P[P(d) \wedge professor(d)]\}$ b. $\{d \mid professor(d)\}$

The $\sim$ is then adjoined to $[_{DP}$ the GERman$_F$ professor], which simply defines the task of retrieving from the context a set of professors **a, b, c, d, ...** who are naturally distinct from each other and whose nationality doesn't play any role.

4 Intensionality

Discussions of the intensional aspects of information structure are not very common, but an exception is Beaver and Clark (2008) (in the following: B & C), which contains a detailed discussion of the sentence in (16a) (the F-marking is theirs, a translation to our account is (16b)).

[8] The same point can be made using descriptions with restrictive relative clauses.
[9] A is some alternative to *German*.

(16) a. Sandy only met [the PREsident]$_F$.
b. Sandy only met ∼[the PREsident$_F$].

B & C argue roughly as follows. An extensional evaluation of (16) involves a set A of alternatives for the denotation (= the *extensional value*) of *the president*. A is a set of ordinary individuals (of which the actual president is one) that enters into the determination of the extensional value of the sentence (its actual truth value), like the actual president himself does. If instead we want to obtain the *intensional* value of the sentence (i.e. the proposition it expresses), then we must start with the intensions of its smallest constituents and compute the intensions of the complex constituents from the intensions of their components, in the manner familiar from Montague Grammar, arriving eventually at the intension of the sentence as a whole. In this way we obtain as intension for *the president* an individual concept *pr* (a function from possible worlds to individuals; for each possible world w, $pr(w)$ is the president in w). B & C's next assumption is that if the semantic value of *the president* is an individual concept, then the members of the alternative set invoked by the F-marking of this phrase must consist of individual concepts as well. But if that is what we want to assume about the alternative set A, we have to be a very careful. For one thing we cannot assume A to be the set of all individual concepts. For if there is at least one world w other than the actual world, and there are at least two individuals in w, then there will be different individual concepts that both assign the actual president to the actual world (but differ in what they assign to w). And then the usual semantics for *only* will yield a contradiction for a sentence like (16)[10]. Furthermore, even when we accept that in general the alternative set is contextually restricted, it isn't immediately clear how this kind of conflict can be avoided. B & C discuss a number of options. But as we see it, the problem that these options are trying to deal with need not arise in the first place.

The solution we suggest starts from the observation that all compositional steps in the computation of the truth value of sentences like (17) (in any possible world w) are extensional. In this regard (16) is no different than e.g. (17).

(17) Sandy met the president.

The intension of such a "purely extensional" sentence s can be obtained by simple "abstraction with respect to possible worlds". (In an intensional model $M = \langle \mathrm{W}, \mathrm{M} \rangle$, where W is a set of possible worlds and M a function which assigns each $w \in \mathrm{W}$ an extensional model $\mathrm{M}(w)$, the intension $[\![s]\!]_M$ of s in M can be obtained as $\lambda w.[\![s]\!]_{M,w}$, where $[\![s]\!]_{M,w}$ is the truth value of s in $\mathrm{M}(w)$.)

Our second assumption is that retrieval of alternative sets is in actual fact always retrieval of a set – *description* – or, if you prefers, of a predicate. Intuitively, interpreting the focus of (18b) triggers retrieval of the predicate *(member of) the president's family*.

[10] Note that this rests on the assumption that if two different concepts $c1$ and $c2$ denote the same individual in a world w, then $meet(Sandy, c1)$ holds in w iff $meet(Sandy, c2)$ holds in w.

(18) a. Sandy wanted to meet the members of he presdent's family.
b. But she only met ∼[the PREsident$_F$].

In the preceding sections, in which we were only concerned with the extensional semantics of information structure, only the actual extension of the retrieved predicate would have been relevant and we could have represented the alternative set presupposition triggered by ∼[the PREsident$_F$] in (16) as in Fig. 4.

$$\partial : \boxed{\begin{array}{c} \underline{C} \quad \mathrm{y} \\ C \subseteq [\![\textit{the PREsident}_F]\!]^f \\ y \in C \quad y \neq [\![\textit{the president}]\!] \end{array}}$$

Fig. 4. ∼[the PREsident$_F$]

Here $[\![\textit{the president}]\!]$ stands for the actual president (that is, somewhat simplified, the unique x such that x is president) and $[\![\textit{the president}]\!]^f$ is the set of all individuals D_e).

This is all that the presupposition needs to say when we are interested just in the actual alternative set. Since resolution of the anaphoric (higher order) discourse referent $\underline{C}$ is to a predicate C^0, this predicate will determine extensions not just for the actual world, but for other possible worlds as well. In order to make sure that these extensions C^0_w can serve properly as alternative sets in the evaluations of (16) the constraints on the resolution of C^0 that are given in Fig. 4 need to be generalised. That is, what we need instead of Fig. 4 is a presupposition of the form given in Fig. 5. In order to avoid all possible sources of ambiguity we now treat C as a discourse referent for a predicate. $\Box$, as usual, stands for 'necessity' i.e. for implicit universal quantification over worlds.

$$\partial : \boxed{\begin{array}{c} \underline{C} \\ \Box \quad \boxed{\begin{array}{c} \mathrm{y} \\ \forall x[C(x) \rightarrow x \in [\![\textit{the PREsident}_F]\!]^f] \\ y \in C \quad y \neq [\![\textit{the president}]\!] \end{array}} \end{array}}$$

Fig. 5. Intensional treatment of ∼[the PREsident$_F$]

If $\underline{C}$ is resolved by a predicate C^0 that satisfies the constraints in Fig. 5, then in every w the president will be a member of the extension of C^0 in w and (18b) will evaluate to the proposition that is true in a world w iff the president is the only individual in the extension of C^0 in w that Sandy met in w. Intuitively, this seems pretty much what is wanted.

But pretty much is not quite all. Our presentation of Fig. 5 has been deliberately cagey on one point. From Fig. 4 we took over the abbreviatory notation

⟦*the president*⟧ for the denotation of *the president*. But now that this term is embedded under the necessity operator □ it is no longer clear which denotation is intended: that in the actual world (i.e. the actual president) or the "local" president (i.e. the president in the world w that is quantified over by □). This second option, which may be termed the *de dicto* interpretation of *the president* in Fig. 5, resembles *de dicto* interpretations in the familiar sense of the term, of noun phrases occurring in opaque contexts like *the president* in (19).

(19) Mary believes that Sandy only met the president.

Let us call the *de dicto* interpretation of (19) that according to which the sentence claims that a world w belongs to the set of Mary's belief worlds iff the president in w is the only member of the relevant alternative set in w that Sandy met in w, Here the alternative set is determined in w via the president in w. In other words, the *de dicto* interpretation of (19) involves a "local" interpretation of *the president*, both in the role it plays in determining the different alternative sets and in its contributions to the proposition that is expressed given these alternative sets. Its contribution to the proposition which (19) identifies as one of Mary's beliefs and as part of the presupposition for the alternative set predicate. If as we assumed for (18b), this predicate is resolved to *member of the president's family* (with *the president* interpreted *de dicto*), then the belief ascribed to Mary is the proposition that is true in w iff the president in w is the only member of his family in w that Sandy met in w.

But this is not the only way ⟦*the president*⟧ can be taken in Fig. 5. The interpretation of *the president* in (18b) goes hand in hand with a *de re* interpretation of *the president* in (19) in the familiar sense; that of attributing to Mary, with regard to the actual president, the belief that he is the only member of his family that Sandy met. On this interpretation the belief attributed to Mary is the proposition that is true in w iff the actual president is the only member of the actual president's family in w.

This is surely a different proposition from the one we get on the *de dicto* interpretation. But our description doesn't make fully clear which proposition it is. There are still two ways of understanding which set is meant by "member of the president's family in w". This could either be the set of actual members of the (actual) president or the set of those that are family members of the actual president in w. As far as we can tell, both these interpretations are in principle available once C has been resolved to "member of the president's family".

We believe the three interpretations we have described are the only ones, but we are not sure and leave this as an open question.

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