

Don't Believe in Underspecified Semantics An LRS Account of NegRaising

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Bremen, August 12, 2005

1 Introduction

In neg-raising (NR) a negation in the matrix clause is understood as negating the complement clause. Such readings are only possible with certain matrix predicates such as *believe*, *think*, *want*, so-called *Neg-Raising Predicates* (NRP). For illustration, (1-a) can either mean that it is not the case that I think Peter will come, or it can be seen as expressing the same idea as (1-b).

- (1) a. I don't think Peter will come.
b. I think Peter will not come.

We will argue that in (1-a),

- the negation is syntactically realized in the matrix clause, but that
- it can take scope either in the matrix or in the embedded clause.

Frameworks of *underspecified semantics* (Pinkal, 1996) provide the necessary ingredients to model this as an instance of *scope ambiguity*. Here, we will use *Lexical Resource Semantics* (LRS, Richter and Sailer (2004)).

2 Data on NegRaising

- (2) NR predicates (Horn, 1978, p.187):
- a. opinion: think, believe, suppose, imagine, expect, reckon, % anticipate, %guess
 - a'. perception: seem, appear, look like, sound like, feel like, (see)
 - b. probability: be probable, be likely, figure to
 - c. intention/volition: want, intend, chose, plan, (%wish, %desire)
 - c'. judgment/(weak) obligation: be supposed to, ought, should, be desirable, advise, suggest
- (3) Not NR predicates:
hope, realize, know, be certain/sure, claim, insist on, demand, have to, order

2.1 The Negation is Syntactically in the Matrix Clause

2.1.1 Form of the Matrix Verb

- (4) a. I don't believe that Pat will win.
b. Jan isn't likely to win.

2.1.2 Neg-Incorporation in the Matrix Clause

- (5) a. None of my friends think [that I'll finish until the twenty-first century]. (Horn, 1978, p. 148)
b. $\forall x[\text{my-friend}'(x) \rightarrow \text{think}'(x, \neg[\text{I will finish before the 21st century}])]$
- (6) a. No Belgian believes that the Dutch will lift a finger to help him. (van der Wouden, 1995)
b. $\forall x[\text{belgian}'(x) \rightarrow \text{believe}'(x, \neg[\text{the Dutch will help } x'])]$

Note: Examples of this type require a universal interpretation of the n-word. For this reason, we find them with expressions such as *none of my friends*.

Klooster (nd) suggests that *no-one believes that* (and its Dutch equivalent *niemand gelooft dat*) are idiomatic expressions, having the meaning *it is absolutely implausible that*. As such, they are claimed to behave like negative predicates such as *doubt*.

2.1.3 No Neg-Incorporation in the Embedded Clause

- (7) I don't think that ever before have the media played such a major role in a kidnapping. (Horn, 1978, p. 168)

2.2 The Negation is Semantically in the Embedded Clause

2.2.1 Polarity Item Licensing in the Embedded Clause

Strong Negative Polarity Items (NPIs) occur under a negated NRP, but not under other negated bridge verbs.

- (8) Weak NPI: *ever*
a. Nobody/ *Someone will ever finish this paper.
b. I don't think that Pat will ever finish this paper.
c. I don't claim that Pat will ever finish this paper.
- (9) Strong NPI: *lift a finger*
a. Pat won't/ *will lift a finger to help you.
b. I don't think that Pat will lift a finger to help you.
c. *I don't claim that Pat will lift a finger to help you.
- (10) Strong NPI: *until*
a. Pat won't/ *will finish the paper until Friday.
b. I don't think that Pat will finish the paper until Friday.
c. *I don't claim that Pat will finish the paper until Friday.

2.2.2 No NPI Licensing in the Matrix Clause

There are instances with a matrix clause NPI, but in these sentences, strict NPIs are excluded in the embedded clause:

- (11) a. Nobody would suppose anymore that the war was worth it.
Everyone would suppose now/ %anymore that the war was not worth it. (Horn, 1978, p. 170)
b. *Nobody would suppose anymore that Pat lifted a finger to help her.
- (12) a. I don't believe that Pat will ever finish this book.
b. *I don't believe at all that Pat will ever finish this book.
- (13) a. Well, I think that the standard would have to be very, very, very high. I don't believe at all that it was met in Iraq. (www.campusprogress.org/features/360)
b. Separate negation in the embedded clause:
The pirates are a menace and I don't believe, at all, that the public wouldn't support action to enforce the law. (www.offshoreradio.co.uk/story05.html)

- c. PPI in the embedded clause:
 I don't believe at all that Beane had some big plan in place to make a run in 2005 or that he's making dumb deals at the moment.
 (mb3.scout.com/ftampabaydevilraysfrm1.showMessageRange?topicID=2016.topic&start=141&stop=160)

I encountered one example with a putative NPI in the embedded clause:

- (14) Michael is a very sweet person and I do not believe at all that he could have molested any child.
 (xianlandia.com/te-amo/2002/12/03/catch_michael_jackson_kids.html)

2.3 Analogy to Coherent Constructions

Horn (1978) points out that something similar to neg-raising occurs in infinitival constructions. This is particularly clear for so-called coherent verbs in German: they form a cluster together with their infinitival complement, and a modifier can be interpreted semantically as modifying either the entire cluster or the embedded verb (Bech, 1955). Our analysis will capture this parallelism directly by treating NRPs semantically in the same way as German coherently embedding verbs.

- (15) (dass) Chris das Buch nicht kaufen kann.
 that Chris the book not buy can.
 a. 'It is not the case that C. can buy the book'
 b. 'Chris is able/entitled to [not buy the book]'

2.4 Scope

In English negated auxiliaries have idiosyncratic scope properties. In NR, however, the "raised" negation must have scope over any embedded auxiliary. If this scope is not possible, the NR reading is excluded.

- (16) a. Kim will not call. ($\neg(Fut\dots)$)
 b. I don't believe that Kim will call. ($\neg(Fut\dots)$)
 (17) a. Kim may not have called ($May(\neg\dots)$)
 b. I don't think that Kim may have called.
 \neq I think that Kim may not have called.
 (18) a. The prisoners must not make a second phone call. ($must' > \neg$)
 b. I don't believe that the prisoners must make a second phone call. ($\neg > must'$)

"Raised" negation has always scope over quantifier in the embedded clause. This can lead to the absence of a unambiguous paraphrase for the NR reading.

- (19) a. I don't believe that several senators are communists.
 b. \neq I believe that several senators aren't communists. (Horn (1978), p. 181, quoting unpublished work by Epstein)

3 Previous Approaches

3.1 Syntactic Raising

Assumption: negation is syntactically introduced into the embedded clause and interpreted there. It is, then, raised into a higher clause.

- (20) Example derivation:
 a. I believe [he wants [I think [not [he did it]]]]
 b. \rightarrow I believe [he wants [not [I think [he did it]]]]
 c. \rightarrow I believe [not [he wants [I think [he did it]]]]
 d. \rightarrow not [I believe [he wants [I think [he did it]]]]
 I don't believe that he wants me to think he did it.

Problems:

- It is not clear whether there is evidence for a *syntactic* operation (see Horn (1978)).
- In derivational frameworks: “Deep structure” is no longer considered the level which is relevant for the interpretation of scope relations.
- In constraint-based frameworks: such transformations are alien to the grammar.

3.2 Negative Operator in Comp

Progovac (1994) assumes an empty negative operator in the COMP position of the complement clause of some predicates. It is, however, not clear how her approach would differentiate between NRPs, which license strict NPIs, and negated propositional attitude predicates (*don't claim*) which only license less strict NPIs.

Klooster (nd) proposes an analysis along the lines of Progovac, i.e., he assumes that there is a negation operator in the COMP position of the embedded clause. Klooster faces two problems: (i) why is the matrix negation to interpreted? (ii) why does a negated NR select for such a negative complement clause, but a non-negated NR does not?

- (21) a. I do not think that John will leave until tomorrow.
 b. I *neg* think [[C:*neg*] John will leave until tomorrow]

Klooster makes the following assumptions to address these issues:

- The matrix negation undergoes a process of “neg absorption” (going back to Klima (1964));
- the use of an NRP which embeds a negative complement clause is licensed by a distinct lexical entry, which specifies this NRP as a NPI.

These two assumptions seem rather undesirable so a theory with just one negation and just one lexical entry for the NR predicate is to be preferred.

3.3 Entailment-based Theory

According to the entailment-based theory of NPI licensing (Ladusaw (1980), Zwarts (1997), van der Wouden (1997), among others) an NPI can be used in a context which is *downward entailing* (a strict NPI requires an *anti-additive* context (Zwarts, 1997))

- (22) a. Entailments:

$$\frac{\text{downward entailing context } f: X \subseteq Y \rightarrow f(Y) \subseteq f(X)}{\text{anti-additive context } f: X \subseteq Y \rightarrow f(Y) \subseteq f(X)}$$

$$f(X) \cap f(Y) \subseteq f(X \cup Y)$$

- (23) The scope of *nobody* is an anti-additive context:

- see a sparrow \subseteq see a bird
 Nobody saw a bird. \subseteq Nobody saw a sparrow.
- Nobody saw a sparrow and nobody heard a nightingale. \subseteq Nobody saw a sparrow or heard a nightingale.
 \Rightarrow Nobody lifted a finger to help her.

- (24) The scope of *I don't believe that* is an anti-additive context:

- I don't believe that Kim saw a bird. \subseteq I don't believe that Kim saw a sparrow.
- I don't believe that Kim saw a sparrow and I don't believe that Kim heard a nightingale. \subseteq I don't believe that Kim saw a sparrow or heard a nightingale.
 \Rightarrow I don't believe that Kim lifted a finger to help her.

The predicate *it is not the case/true that* also create an anti-additive context, but is not a NRP:

- (25) a. It is not the case that Kim saw a bird. \subseteq It is not the case that Kim saw a sparrow.

- b. It is not the case that Kim saw a sparrow and it is not the case that Kim heard a nightingale.
 \subseteq It is not the case that Kim saw a sparrow or heard a nightingale.
- (26) It isn't true/the case that he'll get here (*until Sunday). (Horn, 1978, p. 207)

van der Wouden (1995) investigates the question of whether the entailment behavior of a matrix clause can be derived from some *monotonicity calculus*. He concludes that distinct rules might be needed for NR predicates. Furthermore, non-NR predicates will require special marking to. Thus, the entailment-based theory will have to be enriched by idiosyncratic marking of the predicate classes with respect to their behavior in the calculus.

3.4 Pragmatic Approach

Finally, Horn manages to provide a pragmatic characterization of NRPs in terms of scalar implicatures. This approach provides a generalization on which predicates are to be expected to be found among the NRPs and which ones are excluded. But:

- his approach is not connected to an explicit syntax-semantics interface.
- the pragmatic characterization of the class of NRPs cannot capture the language specific idiosyncrasies (such as why *hope* is not a NRP)

4 Lexical Resource Semantics (LRS)

We will provide an analysis within the framework of LRS, (Richter and Sailer, 2004). LRS uses techniques of underspecified semantics.

- In such approaches, the semantic representation of a sentence is not a single term, but a set of expressions, which will ultimately form the overall logical form of a sentence.
- What makes these systems underspecified is that the subterm relation between these terms is constrained by the lexical properties of the words and by the syntactic constellations, but not fully resolved.

This allows for a lean representation of scope ambiguities, which will also turn out to be the main analytical device of the present paper.

For the syntax-semantics interface, it is necessary to identify some expressions from this set of expressions which will play a role in the formulation of constraints on the possible readings. The following have been singled out so far:

1. The *main* contribution. This is the main semantic constant contributed by the lexical head of a phrase (*believe'*, or *come'*). A selector can impose semantic selection requirements on the main contribution of a selected element.
2. The *internal content* (*inc*). This is the subexpression in the semantic representation of a phrase which is necessarily in the scope of all scope-bearing items that belong to this phrase (such as the negation, or quantified arguments). In the case of *come* in (1), this is *come'(e, Peter)*. For the temporal auxiliary *will* and for modal verbs Richter and Sailer (2004) argue that the *inc* is identical to the *inc* of their verbal complement (i.e. *come'(e, Peter)*).
3. Finally, there is the *external content* (*exc*). This is the semantic representation associated with a phrase.

The different semantic attributes are integrated into the architecture of a linguistic sign in the following way (see Richter and Sailer (2004) and Sailer (2004)):

(27) Example lexical entry of the verb *may*:

$$\left[\begin{array}{l} \text{PHON } \langle \text{may} \rangle \\ \text{SYNS LOC } \left[\begin{array}{l} \text{CAT ARG-ST } \langle \text{NP, VP} \rangle \\ \text{CONT } \left[\begin{array}{l} \text{MAIN } \text{may}' \\ \text{INDEX } s \end{array} \right] \end{array} \right] \\ \text{LF } \left[\begin{array}{l} \text{INC } \alpha \\ \text{EXC } \beta \\ \text{PARTS } \langle s, \text{may}', \text{may}'(s, \dots \alpha \dots) \rangle \end{array} \right] \end{array} \right]$$

where α is the INC value of VP.

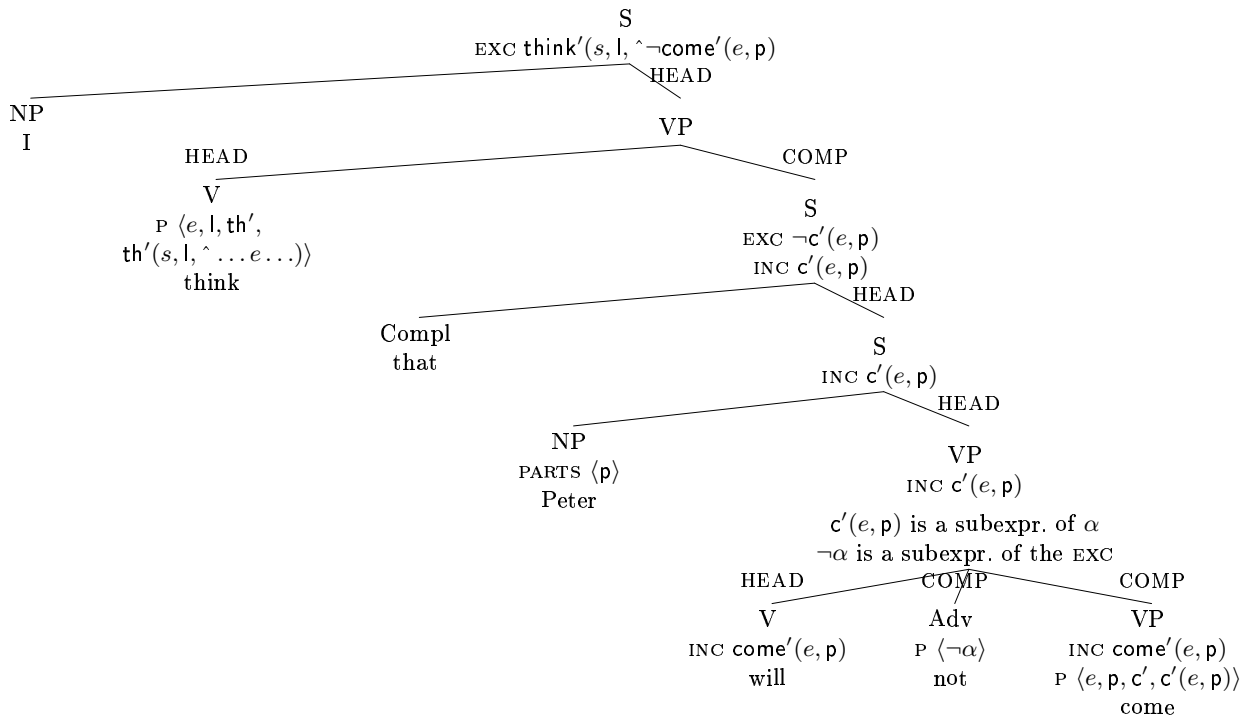
Some remarks about the semantic combinatorics:

1. General well-formedness conditions guarantee that the *exc* of a given utterance will exclusively consist of all semantic items contributed by the words of this utterance.
2. At phrasal nodes in the structure, the syntax-semantics interface may impose additional embedding constraints on how the contributed subexpressions combine:
For example, in a head-adjunct structure, the head's *inc* must be a subexpression of the nonhead's *exc* and the nonhead's *main* must be a subexpression of the phrase's *exc*. This will ensure that a modifier (including negation) cannot take scope outside the clause in which it occurs.
3. Existing LRS analyses showed that the *main*, *inc* and *exc* are necessary to restrict the possible readings of utterances adequately. Applied to sentence (1-b), we get as simplified semantic representation:

(28) a. The semantic representation of (1-b):

believe'(l, ^¬(come'(Peter)))

b. The derivation of the reading in (28-a):



5 Sketch of the Analysis

5.1 Assumption about NPI Licensing

We make the simplifying assumption that a strict NPI is licensed if it(s MAIN value) is in the scope of \neg in the EXC of the smallest S which contains it.

- (29) a. [_S Kim won't finish the paper until midnight.]
 b. *Pat doesn't claim [_S that Kim will finish the paper until midnight]
 c. Pat doesn't believe [_S that Kim will finish the paper until midnight]

5.2 Lexical Properties of NRPs and Modifiers

To account for NR we only have to assume the following two lexical properties:

- NRPs behave like auxiliaries in that their *inc* is identical to that of their verbal complement (i.e. *come'*(Peter) in (1)). For non-NR predicates (such as *claim*), the *inc* is, similar to the case of *come*, the verb's *main*, together with its semantic arguments. This, then, allows a matrix quantifier or adverbial to take either wide or narrow scope with respect to the verb's *main*, as long as it has scope over the *inc*. In fact, both readings of (1-a) satisfy this restriction.

(30) Specifications for some verbs:

$$\text{a. } \textit{come}: \left[\begin{array}{l} \text{SYNS LOC} \left[\begin{array}{l} \text{CAT ARG-ST} \langle \text{NP}_x \rangle \\ \text{CONT} \left[\begin{array}{l} \text{MAIN } \textit{come}' \\ \text{INDEX } e \end{array} \right] \end{array} \right] \\ \text{LF} \left[\begin{array}{l} \text{INC } \textit{come}'(x) \\ \text{PARTS} \langle x, e, \textit{come}', \textit{come}'(e, x) \rangle \end{array} \right] \end{array} \right]$$

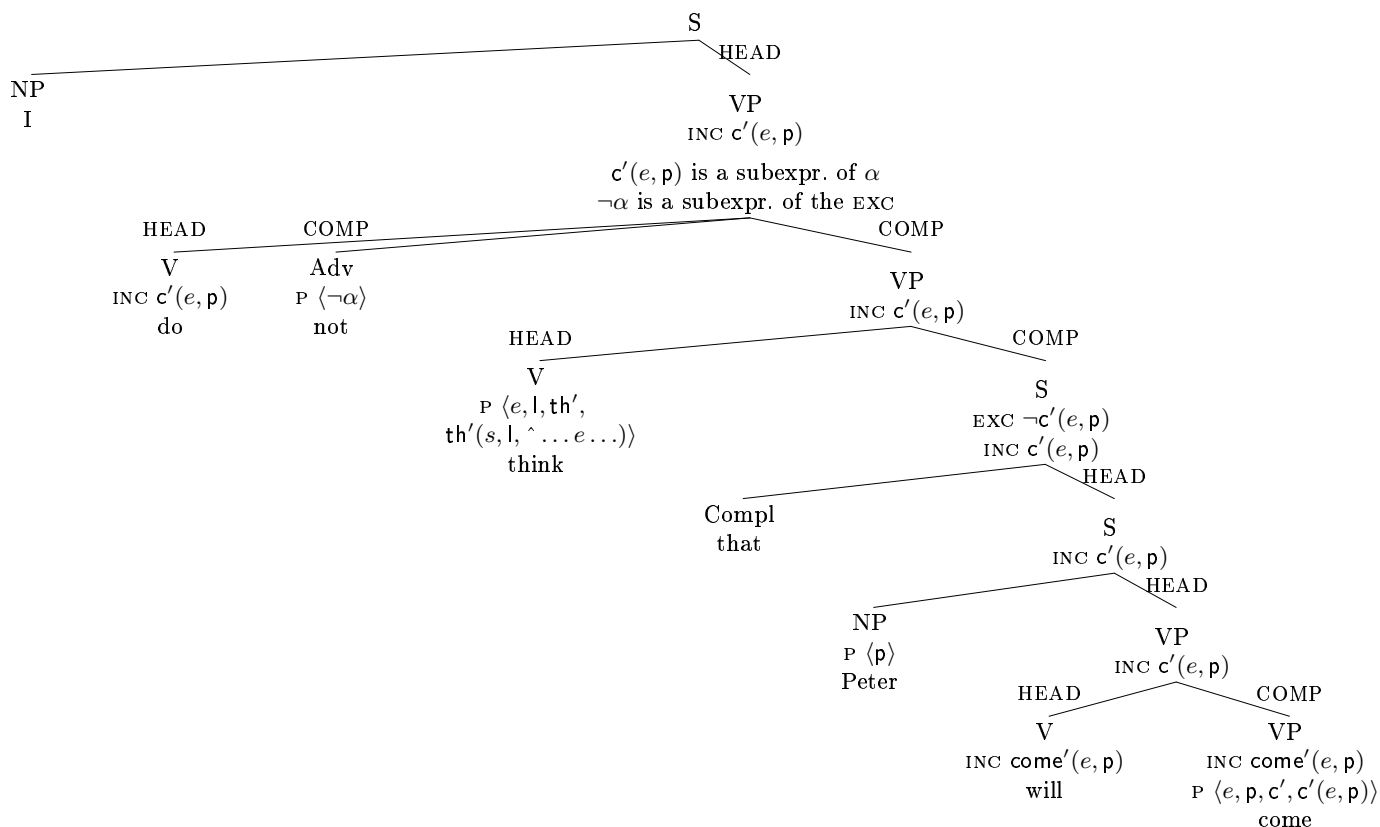
$$\text{b. } \textit{may}: \left[\begin{array}{l} \text{SYNS LOC} \left[\begin{array}{l} \text{CAT ARG-ST} \langle \text{NP}, \text{VP}_e \rangle \\ \text{CONT} \left[\begin{array}{l} \text{MAIN } \textit{may}' \\ \text{INDEX } s \end{array} \right] \end{array} \right] \\ \text{LF} \left[\begin{array}{l} \text{INC } \alpha \\ \text{PARTS} \langle s, \textit{may}', \textit{may}'(s, \dots \alpha \dots) \rangle \end{array} \right] \end{array} \right]$$

where α is the INC value of VP.

$$\text{c. } \textit{believe}: \left[\begin{array}{l} \text{SYNS LOC} \left[\begin{array}{l} \text{CAT ARG-ST} \langle \text{NP}_x, \text{S} \rangle \\ \text{CONT} \left[\begin{array}{l} \text{MAIN } \textit{believe}' \\ \text{INDEX } s \end{array} \right] \end{array} \right] \\ \text{LF} \left[\begin{array}{l} \text{INC } \alpha \\ \text{PARTS} \langle x, s, \textit{believe}', \textit{believe}'(s, x, \dots \alpha \dots) \rangle \end{array} \right] \end{array} \right]$$

where α is the INC value of S.

- (31) a. The semantic representation of the NR reading of (1-a):
 $\textit{believe}'(l, \hat{\neg}(\textit{come}'(\textit{Peter})))$
 b. The derivation of the reading in (31-a):



2. The negation (*not*) does not impose special semantic restrictions on the head it combines with. In particular, the *main* of the head need not be in the scope of the negation. In this respect, negation differs from other modifiers which typically impose this requirement. The fact that negation is less restricted than other modifiers allows the low reading in NR — and blocks it in the case of other modifiers.

(32) Some modifiers:

$$\text{a. } \textit{quickly}: \left[\begin{array}{l} \text{SYNS LOC} \left[\begin{array}{l} \text{CAT HEAD MOD VP} \left[\begin{array}{l} \text{LOC CONT} \left[\begin{array}{l} \text{MAIN } \boxed{1} \\ \text{INDEX } e \end{array} \right] \\ \text{CONT} [\text{MAIN } \textit{quickly}'] \end{array} \right] \\ \text{INC } \textit{quickly}'(e) \\ \text{EXC } (\textit{quickly}'(e) \wedge \alpha) \\ \text{PARTS } \langle \textit{quickly}'(e), (\textit{quickly}'(e) \wedge \alpha) \rangle \end{array} \right] \end{array} \right]$$

where e is an event (not a state) and the MAIN value of the VP ($\boxed{1}$) is a subexpression of α .

$$\text{b. } \textit{not}: \left[\begin{array}{l} \text{SYNS LOC} \left[\begin{array}{l} \text{CAT HEAD} [\text{MOD } \textit{synsem}] \\ \text{INC } \neg(\dots) \\ \text{EXC } \neg(\dots) \\ \text{PARTS } \langle \neg(\dots) \rangle \end{array} \right] \end{array} \right]$$

where α is the INC of $\boxed{1}$.

From these specifications we can derive the possibility of “raising” *not* but not *quickly*: In (33-a) the MAIN value of the matrix verb (*believe*) must be in the scope of the adverbial *quickly*. For the negation in (34-a) no such restriction holds.

- (33) a. ??I quickly believe that Pat runs.
 b. \neq I believe that Pat runs quickly.

- (34) a. I do not believe that Pat runs.
 b. = I believe that Pat doesn't run.

This analysis also accounts for the data in (5-a). The semantic contribution of *none* is a universal quantifier and a negation, where the negation is in the scope of the universal.

- (35) a. Lexical entry of *none* (universal reading):

$$\left[\begin{array}{l} \text{PHON } \langle \textit{noone} \rangle \\ \text{SYNS LOC CONT INDEX } x \\ \text{LF } \left[\begin{array}{l} \text{EXC } \forall x(\alpha \rightarrow \beta) \\ \text{PARTS } \langle x, \neg\beta, (\alpha \rightarrow \neg\beta), \forall x(\alpha \rightarrow \neg\beta) \rangle \end{array} \right] \end{array} \right]$$

- b. Lexical entry of *none* (existential reading):

$$\left[\begin{array}{l} \text{PHON } \langle \textit{noone} \rangle \\ \text{SYNS LOC CONT INDEX } x \\ \text{LF } \left[\begin{array}{l} \text{EXC } \exists x(\alpha \wedge \beta) \\ \text{PARTS } \langle x, (\alpha \wedge \beta), \exists x(\alpha \wedge \beta), \neg(\dots \exists x(\alpha \wedge \beta) \dots) \rangle \end{array} \right] \end{array} \right]$$

The constituent structure imposes the constraint that the verb's *inc* be in the scope of the universal. Since the universal binds a variable (say x) in an argument slot of the verb, the quantifier's scope must include the expression $\text{believe}'(x, \hat{\dots})$. Again, the negation can have either wide or narrow scope with respect to this expression. Thus, the NR reading follows from the interaction of the LRS treatment of negation in Richter and Sailer (2004) and the analogy between NRPs and auxiliary verbs.

6 Conclusion

We could only sketch how intriguing properties of NR follow directly once Horn's observation of the parallelism between coherently combining verbs and NRPs is combined with the LRS analysis of coherently constructing verb.

Our approach accounts for the semantic combinatorics, but it does not provide an explanation for why some predicates allow for NR. If Horn is correct, the class of NRPs can be defined in pragmatic terms. LRS has been proposed as a semantics within *Head-Driven Phrase Structure Grammar* (Pollard and Sag (1994)), a theory which includes pragmatic information in the structure of linguistic signs. Thus, the necessary information is available to relate NRP-hood and pragmatic properties in a principled way. However, this question is beyond the syntax-semantics interface issues which we aimed at in this paper.

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