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Don't Believe in Underspecified Semantics
Neg Raising in Lexical Resource Semantics

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1 Introduction

Neg raising is a construction that has been widely studied from different theoretical perspectives, going back to the classic philosophers (cf. Horn (1989)). Yet even the most central properties have not received a satisfactory integration into a linguistic framework. In this paper I will try to approach the phenomenon from a new angle: that of scope ambiguity.

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* (NR predicates). For illustration, (1-a) can either mean that it is not the case that John thinks Peter will come, or it can be seen as expressing the same idea as (1-b).

(1) a. John doesn't think Peter will come.
b. John thinks Peter will not come.

I 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. In a way this can be seen as the exact opposite of the classic syntactic transformation of *negation raising* (Fillmore, 1963), in which a negation is syntactically moved out of an embedded clause into a higher clause.

I have encoded my proposal within the syntactic framework of *Head-Driven Phrase Structure Grammar* (HPSG, Pollard and Sag (1994)) using techniques of *underspecified semantics* for the syntax-semantics interface. Frameworks of underspecified semantics (Pinkal, 1996) provide the necessary ingredients to model the empirical generalization as an instance of *scope ambiguity*. In this paper, I use *Lexical Resource Semantics* (LRS, Richter and Sailer (2004)), but it should be possible to express the basic idea within other underspecified frameworks as well, such as *Constraint Language for Lambda Structures* (Egg et al., 2001), *Minimal Recursion Semantics* (Copestake et al., 2005), or the semantics proposed for *Lexical Tree Adjoining Grammar* in Kallmeyer and Romero (2006).

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In Section 2 I present data to justify the claim that in a neg raising construction, the negation is syntactically part of the matrix, but semantically part of the embedded clause. The data will mainly stem from English, Dutch and German. Previous approaches and their problems are sketched in Section 3. Section 4 contains a brief introduction to Lexical Resource Semantics, focusing on the aspects needed for the analysis of NR. The analysis is then presented in Section 5. A short summary and directions for future research are given in Section 6.

2 Data on Neg Raising

The most enlightening study of NR to date, and also the primary source of this paper, is Horn (1978). Horn lists a number of NR predicates for English, ordered according to semantic categories. I present Horn's classification together with a subset of the predicates he lists in (2). The "%" symbol indicates that the given predicate is an NR predicate for some speakers, but not for others.

(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,
   b. probability: be probable, be likely, figure to
   c. intention/volition: want, intend, chose, plan
   c′. judgment/(weak) obligation: be supposed to, ought, should, be desirable, advise, suggest

It is important to note that not all predicates that fall within a certain category are really NR predicates. This is already obvious from the "%" marking in (2). The following list is also taken from Horn. Note that close translations of some of the non-NR predicates in English are indeed NR predicates in other languages. For example, German *hoffen* (*hope*) is mentioned as an NR predicate in Horn (1978), but English *hope* appears on the list of non-NR predicates.

(3) Not NR predicates (Horn, 1978):
   hope, realize, know, be certain/sure, claim, insist on, demand, have to, order

In this section I will try to provide empirical support for the major analytical claim of this paper: that the negation in an NR construction is semantically part of the embedded sentence (in Section 2.1), but syntactically part of the matrix sentence (in Section 2.2).

2.1 The Negation is Semantically in the Embedded Clause

To substantiate the claim that the negation in NR constructions is semantically part of the embedded clause, I will first review the classical data which demonstrate that strong negative polarity items can occur in the embedded clause. Then, I will show that the negation does not license negative polarity items in the matrix clause.

2.1.1 Polarity Item Licensing in the Embedded Clause

The strongest argument for an embedded position of the negation in an NR construction clearly comes from their licensing potential for *negative polarity items* (NPI). The data in (4-a) show that the word *ever* is an NPI, i.e., it cannot occur if there is no negation. This NPI is not restricted to a clause-mate negation. A negated NR predicate as in (4-b) can also license the NPI. The same is true for a number of other matrix predicates such as *claim* in (4-c), but not for all, as illustrated in (4-d).[1]

(4) 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.
d. *I don't whisper that Pat will ever finish this paper.

The situation of more restrictive NPIs such as *lift a finger* and *until* is different from that of *ever*. As shown in (5) and (6) these NPIs can occur with a clause-mate negation (a) or in the complement clause of a negated NR predicate (b), but not in the complement clause of a negated occurrence of *claim* (c).

(5) 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.

(6) 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.

The simplest explanation of these facts lies in an analysis which semantically reconstructs the negation in the complement clause of a NR predicate, but not in that of other matrix verbs. The analysis that I present in Section 5 will achieve exactly this.

2.1.2 No NPI Licensing in the Matrix Clause

Let us consider next the NPI licensing potential in the matrix clause. There are instances with a matrix clause NPI, but in these sentences, the strong NPIs from (5) and (6) are excluded in the embedded clause:

(7) 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. Chris wouldn't suppose anymore that the war was worth it.
c. *Chris wouldn't suppose anymore that Pat lifted a finger to help her.
d. *Chris wouldn't suppose anymore that I will finish until the next century.

[1] Throughout this paper I will underline NPIs in the examples.

The NPI *anymore* needs to be in the scope of a negation. Thus, the negation introduced by *nobody* must take scope over the matrix verb. This is possible in (7-a) and (7-b). Sentences (7-c) and (7-d) are excluded because either (i) the negation is interpreted in the matrix clause, and there is no local licenser for the strong NPI in the embedded clause; or (ii) the negation is interpreted in the embedded clause, and there is no licenser for the NPI in the matrix. This is exactly the pattern that we expect if we assume that in NR, the negation is interpreted in the embedded clasue. In (7-a), there is no NR and the NPI *anymore* is licensed because negation is interpreted in the matrix clause.[2]

These data present a problem for a naive interpretation of the c-command condition for NPI licensing, according to which an NPI must be c-commanded by its licenser at surface structure. Hoeksema (2000) discusses a series of other problems. In his cases, NPIs could be licensed even without being c-commanded, because they fall into the scope of an appropriate licenser at the level of interpretation. In the sentences considered here, the syntactic condition is met, but the semantic relation fails to hold, which accounts for the ungrammaticality of a matrix NPI in neg raising.

2.2 The Negation is Syntactically in the Matrix Clause

In this subsection I will present evidence that syntactically, in NR constructions, the negation is part of the matrix clause. I will show that the form in which the negation appears depends on items in the matrix clause.

2.2.1 Form of the Matrix Verb

In an NR constellation the negation particle interacts with an auxiliary the same way it interacts in simple clauses. In particular, we can observe *do*-insertion (8-a), contraction (8-b) and suppletion of the auxiliary (8-c).

(8) a. I don't believe that Pat will win.
b. Jan isn't likely to win.
c. I can't believe Pat will win.

2.2.2 Neg Incorporation in the Matrix Clause

In the following I will consider sentences in which an NR predicate combines with a subject of the form *no N* or *few N*. In such constellations, strong NPIs are still possible in the embedded clause. I will argue that this is due to an independently motivated property of such NPs — their potential to occur as an antecedent to a so-called *complement set anaphor*. I will argue that a quantifier and a sententential negation are lexically fused into the relevant determiners. This fusion only occurs if the negation and the quantifier are syntactically expressed within the same clause. I will also point to a surprising contrast between *no N* and *few N* on one side and *not every/all N* on the

[2]The data in (i) suggests that even a weak NPI such as *ever* is less acceptable in the embedded clause if there is an additional NPI in the matrix clause. I will not have anything to say about this contrast here.

(i) ?* I don't believe at all that Pat will ever finish this book.

other: the latter item does not license NPIs in the complement clause of an NR predicate, whereas the former two do. This will also follow from the analogy to complement set anaphora.

There is some debate as to which matrix clause elements other than *not*/*n't* give rise to NR readings. In particular, expressions such as as *no one*, *nothing*, *no (N)* or *none (of NP)* play an important role in the discussion. I will call these items *n-words* in this paper.[3] Klooster (2003) argues that matrix n-words do not create NR contexts.[4] However, Horn and others provide examples in which the matrix negation is introduced by an n-word. In (9) and (10) I give the example sentence in (a) and sketch the logical form in (b).

(9) a. None of my friends think [that I'll finish until the twenty-first century]. (Horn, 1978, p. 148)
b. $\forall x[\text{my-friend}'(x) \rightarrow \text{think}'(x, \hat{}\neg[\text{I will finish before the 21st century}])]$

(10) a. No Belgian believes that the Dutch will lift a finger to help him. (van der Wouden, 1995)
b. $\forall x[\text{belgian}'(x) \rightarrow \text{believe}'(x, \hat{}\neg[\text{the Dutch will help } x])]$

If we follow the reasoning of Section 2.1 that a strong NPI must be in the scope of a negation in its own clause, this type of examples requires an interpretion of the n-word as a universal quantifier.[5]

The data in (9) and (10) can be put in a broader context. A neg raising reading with an n-word in the matrix clause seems to be possible only under certain conditions — in particular if there is a concrete antecedent set available, such as my friends in (9) and the Belgians in (10). The availability of this kind of antecedent is also relevant for situations in which a so-called *complement anaphor* can be used, i.e. an anaphor which refers to the intersection of the restrictor and complement set of the scope of the subject NP. For example, (9-a) can be continued with (11). In this continuation, the pronoun *they* refers to such a complement set, i.e. to those of *my friends* who *don't believe that I will finish until the 21st century*.

(11) They actually wonder whether I will finish at all.

Complement anaphora occur with a number of quantifiers.[6] In particular, the de-

[3] I am aware of the fact that this terminology differs from that of, for example, Giannakidou (2005). For her, and other authors working on negative concord, the term *n-word* is confined to items which (i) may co-occur with a sentential negation marker and still express a single negation, and (ii) express negation in fragmentary answers. Expressions such as English *no one* and their Dutch and German equivalents are called *negative quantifiers*. This distinction is not relevant for the present paper and, furthermore, my analysis of English "negative quantifiers" will be analogous to the analysis of Polish "n-words" in Richter and Sailer (2004).

[4] Klooster (2003) 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*. This explanation cannot work directly for (9) and (10), since the subject-verb combination is not idiomatic in these examples.

[5] With an existential quantifier the logical form of (9-a) would be as in (i), i.e. the negation would be outside the logical form of the embedded clause and the NPI could not be licensed.

(i) $\neg\exists x[\text{my-friend}'(x) \wedge \text{think}'(x, \hat{}[\text{I will finish before the 21st century}])]$

[6] Sanford et al. (1994) provides psycholinguistic evidence for the existence of such readings, Kibble

terminer *few* can give rise to complement anaphora, whereas its positive dual *many* or negated universal quantifiers (*not all, not every*) cannot. In (12) the judgements are given for an interpretation of the pronouns as "those congressmen who didn't go to the beach"

(12) a. Few congressmen went to the beach. They preferred the swimming pool.
b. Many congressmen went to the beach. * They preferred the swimming pool.
c. Not all congressmen went to the beach. * They preferred the swim. pool.

We can account for this dynamic effect of *few* by assuming a lexical decomposition. For contexts which allow a complement anaphor, the reading in (13-b) can be chosen. Then the dynamic properties of *few* are reduced to those of *many*.[7]

(13) Possible logical forms for *few*:
a. Expected reading: $\neg \mathsf{many} x(\phi)(\psi)$
b. Reading required for complement set anaphora: $\mathsf{many} x(\phi)(\neg\psi)$

Van der Wouden (1995) observes a puzzling behavior of the Dutch NPI *ook maar iets* (*anything at all*): This NPI is licensed by a clause-mate negation or a clause-mate n-word, but not by a weaker licenser such as *nauwelijks* (*hardly*) (see (14)).

(14) a. Niemand heeft ook maar iets gezien.
no one has anything at all seen
'No one has seen anything at all.'
b. *Jan heeft nauwelijks ook maar iets gezien.
Jan has hardly anything at all seen

The situation changes, however, in NR constructions. The NPI *ook maar iets* can appear in the complement clause of an NR predicate even if the matrix clause does not contain an appropriate licenser for *ook maar iets*.

(15) a. U beweert dat niemand gelooft dat er ook maar iets gebeurd is.
you claim that no one believes that there anything happened has
'You claim that no one believes that anything happened at all.'
b. U beweert dat Jan nauwelijks gelooft dat er ook maar iets gebeurd
you claim that Jan hardly believes that there anything at all happened
is.
has
'You claim that Jan hardly believes that anything happened at all.'

While this data seems mysterious at first sight, it patterns precisely with the observations on complement anaphora made above. Van der Wouden (1995) shows that not all downward-entailing operators license *ook maar iets* in the embedded clause. The simply downward entailing quantifier *weinig* (*few*) can license an embedded NPI. The

(1998) and Nouwen (2003) provide formal analyses.

[7] In this paper, I use $\mathsf{many} x(\phi)(\psi)$ as an abreviation for something like *all* ϕ *with a small number of exceptions did* ψ, i.e. $\exists X(\forall x(x \in X \rightarrow (\phi \wedge \psi)) \wedge |X| \geq |\{\lambda x.\phi\}| * \mathsf{n}/100)$, where n is the percentage which must satisfy the condition to count as *many*.

quantifier *niet iedereen* cannot.[8]

(16) a. Weinig mensen herinneren zich [ook maar iets gezien te hebben]
few people remember themselves anything at all seen to have
'Few people remember having seen anything at all.'
b. *U beweert dat niet iedereen gelooft dat er ook maar iets gebeurd
you claim that not everyone believes that there anything at all happened
is.
has

The contrast in (16) is parallel to that in (12). If we assume the expression in (13-b) as a possible translation of *few*, we get the following logical forms for the above sentences.

(17) a. (15-a): $\forall x(\text{human}'(x) \rightarrow \text{believe}'(x, \hat{}\neg\exists y \text{happen}'(y)))$
b. (16-a): $\text{many}x(\text{human}'(x))(\text{remember}'(x, \hat{}\neg\exists y \text{see}'(x, y)))$
c. (16-b): $*\ldots\neg\forall x(\text{human}'(x) \rightarrow \text{believe}'(x, \hat{}\exists y \text{happen}'(y)))\ldots$

These logical forms explain the facts immediately. In (a) and (b) the semantic contribution of the NPI ($\exists y\ldots$) is in the immediate scope of the negation operator. In (17-c), the negation must take scope over the universal quantifier. Thus, the NPI is not licensed because the universal quantifier ($\forall x\ldots$) intervenes between the negation operator and the semantic contribution of the NPI.[9]

For German I can present a set of data which supports the parallelism between NR constellations and complement anaphora. The German NPI *auch nur irgendetwas* (*anything at all*), like its Dutch counterpart *ook maar iets*, is licensed by a clause-mate negation or an n-word, but not by the language-specific equivalents of *few* or *hardly*.

(18) a. Niemand hat auch nur irgendetwas fürs Seminar gelesen.
no one has anything at all for the class read
'No one has read anything at all for the class.'
b. *Wenige Studenten haben auch nur irgendetwas fürs Seminar gelesen.
few students have anything at all for the class
read

The set of sentences in (18) reflects the generally observed pattern for this NPI. We can, however, embed sentence (18-b) in contexts where the subject *wenige Schüler* serves as antecedent to an anaphoric expression. In (19-a), the second sentence contains an anaphor which refers to the set of pupils that have to be notified. The NPI is not licensed in this reading. In (19-b), however, the second sentence contains a complement anaphor, i.e., the pronoun refers to the pupils that don't have to be notified. In such a context, the NPI *auch nur irgendetwas* is considerably better if not perfectly acceptable.[10]

[8]Note that in the hierarchy of negation strength established in Zwarts (1997) *niet iedereen* (*not everyone*) is stronger than *weinig* (*few*) in that it is not only downward-entailing but also anti-multiplicative.

[9]This account generalizes to the licensing by *nauwelijks* (*hardly*) in (15-b) if we follow Kibble (1998) and treat *hardly* as a version of *few*, quantifying over situations ("*in few situations*").

[10]If the personal pronoun precedes the NPI, the contrast between (a) and (b) remains, but (i-b) is

(19) a. *Wenige Studenten haben auch nur irgendetwas fürs Seminar gelesen. Sie sind sehr fleißig.
'Few students read anything at all for the class. They are very dilligent.'
b. Wenige Studenten haben auch nur irgendetwas fürs Seminar gelesen. Sie sind lieber ins Kino.
'...They preferred to go to the cinema.' (complement anaphor)

As expected, we find the NPI *auch nur irgendetwas* in NR constructions with *wenige* (*few*) as the quantifier in the subject position of the matrix clause.

(20) Wenige Studenten glauben, dass sie auch nur irgendetwas fürs Seminar
few students think that they anything at all for the class
lesen sollen.
read should
'Few students think they should read anything at all for the class.'
a. *Sie haben auch schon ein paar Aufsätze durchgearbeitet.
'They have already read a couple of papers.'
b. Sie glauben, es reicht, wenn sie ins Seminar kommen.
'They think it's enough if they attend classes.'

In (20) I offer two continuations. In (20-a), the pronoun *sie* (*they*) is intended to refer to the set of students that think they should do some reading. This continuation is not possible. In (20-b), the pronoun refers to the complement set, which leads to an acceptable continuation. This supports the assumption that the logical form needed for NPI licensing is identical to the logical form that allows for complement anaphora.

I have presented arguments that a negation and a quantifier can be fused into an n-word or into the determiner *few*. The following sentences show that this fusion cannot occur if the negation and the quantifier are not syntactically part of the same clause. I use a non-NR predicate to prevent NR. Then, the sentence with *many* and the negation *not* in different clauses in (21-a) is not synonymous with a sentence with *few* in the matrix clause in (21-b).

(21) a. Many students realized that they wouldn't pass the exam.
b. Few students realized that they would pass the exam.

In the data reported in this section the negation is part of the subject of the matrix clause. I have tried to show that this "incorporation" can take several forms, from an n-word to a quantifier, *few*. In both cases, however, I think that there is interesting parallelism to complement anaphora, which motivates a lexical decomposition as suggested here.

perceived as even better than (19-b) by some speakers (J.-P. Soehn, p.c.):

(i) a. *Da sie sehr fleißig sind, haben wenige Studenten auch nur irgendetwas ...
since they very dilligent are, have few students anything at all ...
b. Da sie lieber ins Kino sind, haben wenige Studenten auch nur irgendetwas ...
since they rather to the cinema are, have few students anything at all ...

2.2.3 Specialized Negators

Another set of evidence for the claim that the negation is part of the matrix clause comes from collocationally specialized negators in German. I have listed some of these expressions in (22).

(22) NP-negatives:

a. einen Dreck
a dirt

b. einen feuchten Kehrricht
a wet dirt

The NP-negatives in (22) can only be used to negate a highly restricted set of verbs, such as those of intellectual concern in (23-a) and (23-b), but not the semantically relatively close verb *reizen* (*attract*).

(23) a. Das interessiert mich einen Dreck/ einen feuchten Kehrricht.
this interests me a dirt/ a wet dirt
'I am not at all interested in this.'

b. Das geht dich einen Dreck/ einen feuchten Kehrricht an.
this concerns you a dirt/ a wet dirt PARTICLE
'This is none of your business.'

c. *Das reizt mich einen Dreck/ einen feuchten Kehrricht.
this attracts me a dirt/ a wet dirt
putative meaning: 'This does not attract me at all.'

There is at least one NPI-verb that can combine with these special NP-negatives, *kümmern* (*care/worry*). Note that the NP-negatives must be considered the NPI-licensers in (24-b) in the absence of any other overt negator.

(24) a. Das kümmert ihn *(nicht).
this worries him not
'He doesn't care about this.'

b. Das kümmert ihn einen Dreck/ einen feuchten Kehrricht.
this worries him a dirt/ a wet dirt

As an NPI, *kümmern* can occur in an NR construction. However, then the matrix clause may not contain any of the NP-negatives.

(25) a. Ich glaube nicht, dass ihn das kümmert.
I believe not that him this worries
'I don't believe he cares about this.'

b. *Ich glaube einen Dreck/ einen feuchten Kehrricht, dass ihn das kümmert
I believe a dirt/ a wet dirt that him this worries

Under an analysis in which the surface matrix negation stems from the embedded clause, the ungrammaticality of (25-b) would be unexpected because the specialized negation is compatible with the verb *kümmern*. If we assume, however, that the negation is part of the matrix clause, the ungrammaticality follows from a violation of the collocational restrictions of the specialized negator.

The data presented in this subsection strongly support the claim that the negation in an NR construction syntactically behaves as a matrix negation. After establishing the contrast between the syntactic and the semantic aspects of the negation in NR constructions, I will review data that address the scopal behavior of the negation in Section 2.2.4.

2.2.4 Scope of the Negation

There is another classical observation about NR which indirectly defeats attempts to analyse NR in terms of a negation which is syntactically part of the embedded sentence. It has been observed that the "NR reading" is not always equivalent to a reading in which there is an overt negation in the embedded clause. Instead, the "raised" negation must have wide scope over quantifiers and operators in the embedded clause.

This leads to a potential difference between an NR sentence and an analogous sentence with a negation in the embedded clause with respect to the set of possible readings. The NR reading of (26-a) is paraphrased as (26-c). The narrow-scope reading of the negation with respect to *several senators*, indicated in (26-d), is not available. The sentence in (26-b), with the negation in the embedded clause, is ambiguous between the readings in (26-c) and (26-d).

(26) (Horn (1978), p. 181, quoting unpublished work by Epstein)
   a. I don't believe that several senators are communists.
   b. I believe that several senators aren't communists.
   c. I believe that [it is not the case that several senators are communists.]
   d. I believe that [for several senators it is true that they are not communists.]

An analogous situation can be observed with the relative scope of other operators. 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. The future auxiliary *will* usually takes narrow scope with respect to a clause-mate negation. Thus, the NR reading is fine, as illustrated in (27).

(27) a. I believe Kim will not call. ($\neg$(Fut…))
   b. = I don't believe Kim will call. ($\neg$(Fut…))

The modals *may* and *must*, on the other hand, take scope over a clause-mate negation, as indicated in the (a)-sentences in (28) and (29). In an NR construction, the negation may not take scope below the modal operator. This leads to a situation in which speakers either reject an NR reading or at least argue that the negation will have scope over the modal, contrary to what we find with clause-mate negation.

(28) a. Kim may not have called (May($\neg$…))
   b. I don't think that Kim may have called.
   $\neq$ I think that Kim may not have called.

(29) 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))

The obligatory wide scope of the matrix negation in NR constructions leads to intervention effects in the embedded clause. In (30-a) it is shown that *most* cannot license an NPI. However, if the sentence is negated, as in (30-b), the NPI *lift a finger* can occur. As indicated, (30-b) only has a reading in which the negation is inside the scope of *most*. If we embed sentence (30-a) in an NR construction, as in (30-c), the NPI is not licensed. This follows directly if we assume that the "raised" negation must take wide scope over quantifiers in the embedded sentence. In this case, the subject quantifier intervenes between the negation and the NPI and, thus, the licensing is not possible.

(30) a. *Most people will lift a finger to protest against it.
b. Most people won't lift a finger to do anything against it.
(Most(...¬...); but not: ¬(...Most...))
c. *I don't think most people will lift a finger to protest against it.

The scope data considered in this section suggest for NR constellations that while the negation is syntactically part of the matrix clause it is semantically part of the embedded sentence. There, however, it takes wide scope.

3 Previous Approaches

In this section I will schematically address a number of previous approaches to NR. I will discuss the classical transformational analysis of *syntactic raising* (Section 3.1), a more recent syntactic approach that assumes a negative operator (Section 3.2), a semantic approach (Section 3.3) and a pragmatic approach (Section 3.4).

3.1 Syntactic Raising

The phenomenon of neg raising received its name from an analysis in which the negation is syntactically introduced in the embedded clause and interpreted there. It is then raised into a higher clause (Fillmore, 1963). This transformation can be iterated as demonstrated in (31), where (31-a) is the underlying structure, (31-b) shows the derivation steps, and (31-c) is the surface realization.

(31) a. I believe [he wants [I think [*not* [he did it]]]]
b. → I believe [he wants [*not* [I think [he did it]]]]
→ I believe [*not* [he wants [I think [he did it]]]]
→ *not* [I believe [he wants [I think [he did it]]]]
c. I don't believe that he wants me to think he did it.

Horn (1978) lists a number of problems for this approach, among which are the observations on the obligatory wide scope of the raised negation referred to in Section 2.2.4.

The traditional neg raising analysis builds on the assumption that the base position of the negation determines the semantic interpretation. This assumption is no longer shared among generative linguists. Instead, a level of *Logical Form* (LF, May (1985), Stechow (1993), Heim and Kratzer (1998) among others) is taken as the interface to semantic interpretation. In such a more up-to-date architecture, a neg raising analysis

would assume that the negation is first raised out of the embedded clause(s) to achieve the right surface representation and then reconstructed into its base position at LF. To my knowledge, no such adaptation of the classical theory has been proposed yet.

3.2 Negative Operator in Comp

Progovac (1994) assumes an empty negative operator in the complementizer position (COMP) of the complement clause of some predicates. It is, however, not clear how her approach would differentiate between NR predicates and negated propositional attitude predicates (*don't claim*) that only license less strict NPIs, as illustrated in (4)–(6).

Klooster (2003, to appear) 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. His structure is sketched in (32).

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

Klooster faces two conceptual problems: (i) Why is the matrix negation not interpreted? (ii) Why does a negated NR predicate select for such a negative complement clause, when a non-negated NR predicate does not? Klooster makes the following assumptions to address these issues: (i) The matrix negation undergoes a process of "neg absorption" (going back to Klima (1964)). (ii) The use of an NR predicate that embeds a negative complement clause is licensed by a distinct lexical entry, which specifies this predicate as an NPI itself.

The data on the NPI *ook maar iets* (*anything at all*) presented in Section 2.2.2 seem to provide the right kind of empirical evidence for this rather complex analysis. Klooster's analysis predicts the data in (15) correctly: in the matrix clause the (weak) NPI "*geloven* + CP[neg]" is licensed by *nauwelijks*. The neg feature in the embedded COMP can, subsequently, license the strong NPI *ook maar iets*. However, the ungrammaticality of (16-b) shows that this explanation is insufficient, since it would predict that if *few* can license an NPI then *niet iedereen* (*not everyone*) should be capable of licensing the same NPI.

Thus, Klooster's analysis of NR predicates as NPIs leads to incorrect empirical predictions. Furthermore, his two assumptions seem rather undesirable conceptually: Concerning the first, it is surprising that neg absorption would require a lowering of the matrix negation. As far as the second assumption is concerned, the ambiguity of NR predicates seems ad hoc if no further support of this assumption is being offered.

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* (DE). A strict NPI requires an *anti-additive* (AA) context (Zwarts, 1997). The logical characterizations of these two basic kinds of entailment are stated schematically in (33). It can be shown that anti-additivity implies downward-entailingness.

(33) Entailments:

a. f is a downward entailing (DE) context iff for each sets X, Y if $X \subseteq Y$ then $f(Y) \rightarrow f(X)$.

b. f is an anti-additive (AA) context iff for each sets X, Y, $(f(X) \wedge f(Y)) \leftrightarrow f(X \cup Y)$

The following examples show that the scope of *nobody* is a downward-entailing domain (34-a), and in fact an anti-additive domain (34-b). Thus, the theory correctly predicts that *lift a finger* can occur in the scope of *nobody* (34-c).

(34) a. see a sparrow $\subseteq$ see a bird
Nobody saw a bird. $\rightarrow$ Nobody saw a sparrow. (DE)

b. Nobody saw a sparrow and nobody heard a nightingale.
$\leftrightarrow$ Nobody saw a sparrow or heard a nightingale. (AA)

c. Nobody lifted a finger to help her.

Similarly, it can be shown that the complement position of *I don't believe* is an anti-additive context, from which the grammaticality of (35-b) is expected.

(35) a. anti-additive:
I don't believe that Kim saw a sparrow
and I don't believe that Kim heard a nightingale.
$\leftrightarrow$ I don't believe that Kim saw a sparrow or that Kim heard a nightingale.

b. I don't believe that Kim lifted a finger to help her.

However, the predicate *it is not the case/true that* also creates an anti-additive context, see (36), but is not an NR predicate, as evidenced by the ungrammaticality of (37):

(36) anti-additive:
It is not the case that Kim saw a sparrow
and it is not the case that Kim heard a nightingale.
$\leftrightarrow$ It is not the case that Kim saw a sparrow or that Kim heard a nightingale.

(37) a. It isn't true/the case that he'll get here (*until Sunday). (Horn, 1978, p. 207)

b. *It isn't true/the case that he'll lift a finger to help her.

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, in particular in light of the data in Section 2.2.2. Furthermore, non-NR predicates will require special marking as well to prevent NPI-licensing in cases like (37). 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 Approaches

Pragmatic approaches such as Horn (1978) or Tovena (2001) also assume that the negation in an NR construction is syntactically part of the matrix clause. Pragmatic strategies are, then, envoked to account for a "lowered" interpretation of this negation. In

the case of Horn, this is assumed to be possible for a predicate F if it occupies a middle position on some scale of certainty (such as *be likely* on the scale ranging from *be possible* to *be evident*). For such predicates there is not much difference between the meaning of $\neg F\phi$ and $F\neg\phi$, which explains their NR potential.[11] For Tovena, NR is the consequence of applying a "closed world assumption". This means that the conversation partners may assume that if there is no evidence for ϕ, it is possible to assume $\neg\phi$. NR predicates are lexical items which mark that such an assumption can be made due to their evaluative reading.

Tovena (2001, p. 345) points out that there is a difference between predicates that allow for an NR-type inference and those that license strict NPIs. Her account concentrates on the inference behavior. Similarly Horn (1978) uses NPI data to show that even they do not constitute convincing evidence for a syntactic raising analysis. His own approach does not integrate the NPI data, but focusses on the inferential properties of NR predicates. In the present paper, however, we are mainly concerned with formal reflexes of NR, in particular with NPI licensing.

Even if we confine our attention to inference behavior, the pragmatic approaches lack a way to account for the language-specific idiosyncrasies with respect to the class of NR predicates. Horn (1978) already discusses a number of predicates which are NR predicates, although close synonyms are not. The classical example is English *be likely* which is an NR predicate, but *be probable* is not; or the contrast between the NR predicate *suppose* and the non-NR predicate *guess* (Horn, 1978, p. 215). This problem extends to a cross-linguistic comparison of NR predicates (English *hope* is not an NR predicate, but its German or Latin equivalents are).

This short discussion showed that the pragmatic accounts of NR address issues such as why a certain predicate is an NR predicate or why a speaker would use an NR construction instead of a lower negation. Such issues, though important, are tangential to the main interest of this paper: the question of how an NR reading and the grammatical effect of NPI licensing under NR can be captured within a formally defined syntax-semantics interface.

4 Lexical Resource Semantics (LRS)

I will provide an analysis within the framework of *Lexical Resource Semantics* (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 subexpression relation between these expressions is constrained by the lexical properties of the words and by the syntactic constellations, but not fully determined. 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 items from the mentioned set of expressions that will play a role in the formulation of constraints on

[11] Blutner (2002) suggests that this type of account can be integrated into the framework of *Bidirectional Optimality Theory* in a natural way.

the possible readings. The following four have been singled out so far for LRS:

First, the MAIN contribution is the main semantic constant contributed by the lexical head of a phrase (think′, or come′). A selector can impose semantic selection requirements on the main contribution of a selected element. Second, the INDEX value is the referential index associated with a constituent. Third, the *internal content* (INC) 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 a negation, or quantified arguments that combine with the head of the phrase). In the case of *come* in (1), the INC value is come′(*e*, Peter). Finally, there is the *external content* (EXC). This is the semantic representation associated with a phrase. I will also refer to the EXC value of a sign as its *logical form*.

The different semantic attributes are integrated into the architecture of a linguistic sign as indicated in (38) (see Richter and Sailer (2004) and Sailer (2004)). In LRS descriptions attribute-value matrices (AVM) are employed, as is the standard in HPSG. We enrich these descriptions with expressions of a semantic representation language, Montague's *Intensional Logic* (IL).[12] In addition, lower case Greek letters are used as meta-variables to indicate parts of the logical form which are not specified in the word or phrase depicted.[13] The integration of IL into the HPSG description language has the consequence that we can indicate identities by means of boxed symbols (tags). We will use $\boxed{x}$, ... as tags over IL expressions for individuals and $\boxed{e}$, $\boxed{s}$, ... for those referring to events or situations. The meta-variables (α, β, ...) can also be understood as tags. In (38) the lexical entries of a simple verb, *come*, and a modal verb, *may*, are shown.

(38) a. Example lexical entry of the verb *come*:

$$\begin{bmatrix} \text{PHON } \langle come \rangle \\ \text{SYNSEM LOC CONT} \begin{bmatrix} \text{MAIN} & \text{come}' \\ \text{INDEX} & \boxed{e} \end{bmatrix} \\ \text{ARG-ST} \left\langle \text{NP}[\text{INDEX } \boxed{x}] \right\rangle \\ \text{LF} \begin{bmatrix} \text{EXC} & \alpha \\ \text{INC} & \text{come}'(\boxed{e}, \boxed{x}) \\ \text{PARTS} & \langle \boxed{e}, \exists \boxed{e}\, \beta, \text{come}', \text{come}'(\boxed{e}, \boxed{x}) \rangle \end{bmatrix} \end{bmatrix}$$

b. Example lexical entry of the verb *may*:

$$\begin{bmatrix} \text{PHON } \langle may \rangle \\ \text{SYNSEM LOCAL CONT} \begin{bmatrix} \text{MAIN} & \text{may}' \\ \text{INDEX} & \boxed{s} \end{bmatrix} \\ \text{ARG-ST} \left\langle \text{NP, VP}[\text{INDEX } \boxed{e}] \right\rangle \\ \text{LF} \begin{bmatrix} \text{EXC} & \gamma \\ \text{INC} & \alpha \\ \text{PARTS} & \langle \boxed{s}, \exists \boxed{s}\, \delta, \text{may}', \text{may}'(\boxed{s}, \beta[\boxed{e}, \alpha]) \rangle \end{bmatrix} \end{bmatrix}$$

[12] In other LRS publications, Ty2 (Gallin, 1975) is used instead of IL. IL allows us to have a simpler notation in the present paper. The analysis, however, can directly be reformulated in Ty2.

[13] Penn and Richter (2004) present a shorthand for the LF value. Their notation is used in the TRALE implementation of LRS. I will not use this notation here because (i) there is no shorthand for the values of MAIN and INDEX, and (ii) while I use the the intensor symbol (the "up operator" (^)) as in IL, it marks the external content in the notation of Penn and Richter (2004).

(where α is the INC value of the VP complement.)

These lexical entries encode the following information: The main semantic content of the verb *come*, i.e. its MAIN value, is the constant come'. The eventuality variable, $\boxed{e}$, appears as the INDEX value. These two bits are part of the SYNSEM information of the word, i.e., part of the information which is accessible for selection (Sailer, 2004). The LF value (LOGICAL FORM) contains the semantic components that play a role in the semantic combinatorics. The PARTS list contains all the semantic expressions which are associated with the verb *come*: its eventuality variable $\boxed{e}$, the existential binding of this variable $\exists_{\boxed{e}}\,\beta$, its main semantic constant come', and the combination of this constant with its arguments $\mathsf{come}'(\boxed{e},\boxed{x})$. The INC of the verb is identical to the main constant combined with its arguments, $\mathsf{come}'(\boxed{e},\boxed{x})$. The EXC value is not specified. Therefore, I simply put a meta-variable, α, in (38-a).

The lexical entry of the verb *may* is slightly more complicated and illustrates a case in which the INC value and the MAIN value are not related in a way as direct as is the case with *come*. The MAIN value is the constant may', the INDEX value is an eventuality variable, $\boxed{s}$. On the PARTS list, there is the eventuality variable, its existential binder $\exists_{\boxed{s}}\delta$, and the main constant. In addition, there is an expression in which the main constant is combined with its arguments ($\mathsf{may}'(\boxed{s},\beta)$). The notation $\beta[\boxed{e},\alpha]$ expresses that the variable $\boxed{e}$ and the expression α are subexpressions of β. The variable $\boxed{e}$ is the INDEX value of the subcategorized VP. This guarantees that the event associated with this VP will occur in the scope of the modal operator may'. The INC value of the modal is α, i.e., an expression which occurs in the second argument of may'. This is all we know about α at this place. In practice this opens the possibility for operators occurring in the higher clause to scope below may'.

After an example of a lexical entry, some remarks about the semantic combinatorics are in order. The MAIN value of a phrase is identical to that of its head daughter, as are the INDEX, EXC and INC values. A general well-formedness condition guarantees that the EXC of a given utterance will exclusively consist of all semantic items contributed by the words of this utterance (the EXTERNAL CONTENT PRINCIPLE).

At phrasal nodes in the structure, the syntax-semantics interface may impose additional embedding constraints on how the contributed subexpressions combine: For example, when an adjunct combines with a head, 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 in a higher clause than the one in which it occurs.

Existing LRS analyses showed that the MAIN, INDEX, INC and EXC are necessary to restrict the possible readings of utterances adequately. Applied to sentence (1-b), we get the simplified semantic representation in (39). In Figure 1 the syntactic structure and the semantic derivation are shown. Since nothing depends on the precise syntactic analysis I assume a structure in which the negation particle *not* is realized as a syntactic complement of the auxiliary verb, following Kim (1996).

(39) The semantic representation of (1-b):

John thinks Peter will not come.
$\exists s(\mathsf{think}'(s,\mathsf{John},\hat{}\neg(\exists e(\mathsf{come}'(e,\mathsf{Peter})))))$

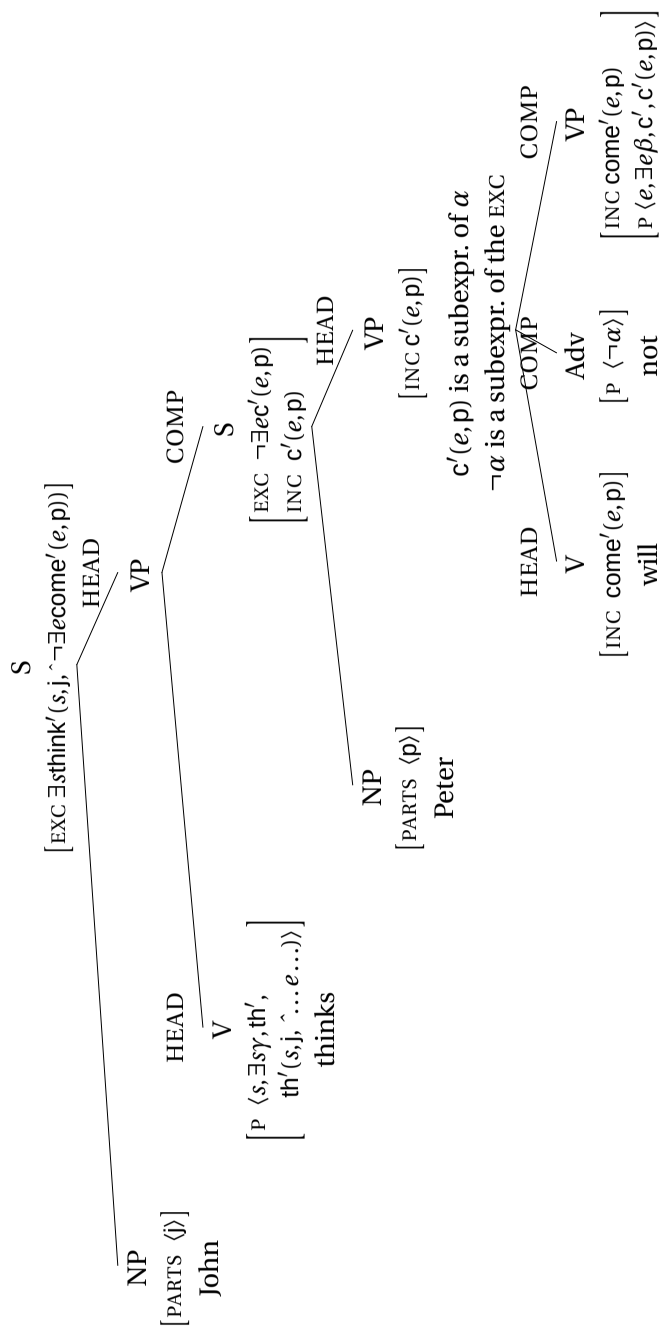

Figure 1: The derivation of the reading in (39)

In the tree structure in Figure 1 I indicate the PARTS list of the words (P ⟨...⟩). For phrases the INC and the EXC values are given where relevant, and the constraints on possible readings which follow from the syntax-semantics interface principles are included (for example "$\neg\alpha$ is a subexpression of the EXC" at the lowest VP node).

5 The Analysis

Since LRS is a lexicalist framework, the analysis of NR will mainly consist of the lexical entries of neg raising predicates, the negator and the determiners of the subject NPs. I will first present some assumptions about NPI licensing in Section 5.1. The lexical entries of NR predicates and the analysis of basic examples of neg raising are given in Section 5.2. Section 5.3 contains a discussion of the scope data from Section 2.2.4 and of the specialized n-word from Section 2.2.3. In Section 5.4 I will show that the analysis also applies to cases in which the negation is contributed by an n-word or another quantifier.

5.1 Assumptions about NPI Licensing

I make the simplifying assumption that a strict NPI is licensed if its MAIN value is in the immediate scope of a negation operator "¬" in the EXC of the smallest S which contains the NPI.[14] In (40-a) there is a negation in the EXC value of the sentence. In (b) the negation is part of the EXC value of the matrix clause, but not of the EXC value of the embedded clause. Therefore, the NPI is not licensed. In the analysis of NR the negation will appear in the EXC of the embedded clause. Thus, the occurrence requirements of the NPI are satisfied.[15]

(40) 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 NR Predicates

To account for NR it suffices to assume the following two lexical properties: (i) NR predicates are semantically like modal verbs in that their INC value is identical to that of one of their complements, and (ii) most modifiers impose a restriction on the INDEX value of the head they adjoin to, but negation does not.

We will address the first of these assumptions in this paragraph. This will allow us to derive the NR readings. 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. NR predicates

[14] The MAIN value is used because this is the only part of the logical form which is always genuinely contributed by the considered lexical item. Note that some NPIs, such as German *brauchen* (*need*) are modal verbs, i.e., their INC is raised from their complement VP.

[15] Soehn (2006) sketches a combination of a general collocational module and an LRS semantics to account for NPI licensing as a collocational requirement of the polarity item, as suggested in van der Wouden (1997). I will implicitly assume an architecture for NPI licensing along these lines here, but I will restrict my focus to the problem of the semantic combinatorics that allow us to derive the required logical forms.

behave like modals in that their INC is identical to that of their verbal complement. This is analogous to our treatment of *may* in (38-b). The lexical entries of the non-NR predicate *claim* and of the NR predicate *think* are given in (41).

(41) a. Example lexical entry of the non-NR predicate *claim*:

$$\begin{bmatrix} \text{PHON } \langle \textit{claim} \rangle \\ \text{SYNS LOC CONT} \begin{bmatrix} \text{MAIN} & \text{claim}' \\ \text{INDEX} & \boxed{\text{e}'} \end{bmatrix} \\ \text{ARG-ST} \left\langle \text{NP}\left[\text{INDEX } \boxed{\text{x}}\right], \text{S}\left[\text{INDEX } \boxed{\text{e}}\right] \right\rangle \\ \text{LF} \begin{bmatrix} \text{INC} & \text{claim}'(\boxed{\text{e}'}, \boxed{\text{x}}, \alpha) \\ \text{PARTS} & \langle \boxed{\text{e}'}, \exists \boxed{\text{e}'}\, \beta, \text{claim}', \text{claim}'(\boxed{\text{e}'}, \boxed{\text{x}}, \alpha[\boxed{\text{e}}]) \rangle \end{bmatrix} \end{bmatrix}$$

b. Example lexical entry of the NR predicate *think*:

$$\begin{bmatrix} \text{PHON } \langle \textit{think} \rangle \\ \text{SYNS LOC CONT} \begin{bmatrix} \text{MAIN} & \text{think}' \\ \text{INDEX} & \boxed{\text{s}} \end{bmatrix} \\ \text{ARG-ST} \left\langle \text{NP}\left[\text{INDEX } \boxed{\text{x}}\right], \text{S}\left[\text{INDEX } \boxed{\text{e}}\right] \right\rangle \\ \text{LF} \begin{bmatrix} \text{EXC} & \gamma \\ \text{INC} & \alpha \\ \text{PARTS} & \langle \boxed{\text{s}}, \exists \boxed{\text{s}}\, \delta, \text{think}', \text{think}'(\boxed{\text{s}}, \boxed{\text{x}}, \beta[\boxed{\text{e}}, \alpha]) \rangle \end{bmatrix} \end{bmatrix}$$

(where α is the INC value of the S complement.)

Let us turn to the NR example in (1-a) again. From the lexical entry for *think* in (41-b) it follows that the INC value of the matrix verb is identical to that of the embedded verb *come*, i.e. it is the expression $\text{come}'(e, \text{Peter})$. 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.

With the lexical entry of the NR predicate *think* in (41-b) and the general principles of LRS, it is possible to derive the NR reading of (1-a), whose logical form is given in (42). In Figure 2 this derivation is shown. It can be seen that the negation, *not*, is introduced in the matrix clause, but the negation operators occurs in the EXC of the embedded clause.

(42) The semantic representation of the NR reading of (1-a):

John does not think Peter will come.
$\exists s(\text{think}'(s, \text{John}, \hat{}\neg\exists e(\text{come}'(e, \text{Peter}))))$

Let us turn to the condition below the AVMs in (38-b) and (41-b), i.e. the required identity between the INC values of the higher verb and its verbal argument. This condition cannot be stated as part of the lexical entries because the INC value of selected elements is not part of the information on the ARG-ST list of the selecting word. This architecture was argued for in Sailer (2004). However, we can show that there is no need to specify the INC identity idiosyncratically in individual lexical entries. Instead, it follows from general semantic properties of the relevant predicates, i.e., it is a consequence of a general principle of the grammar.

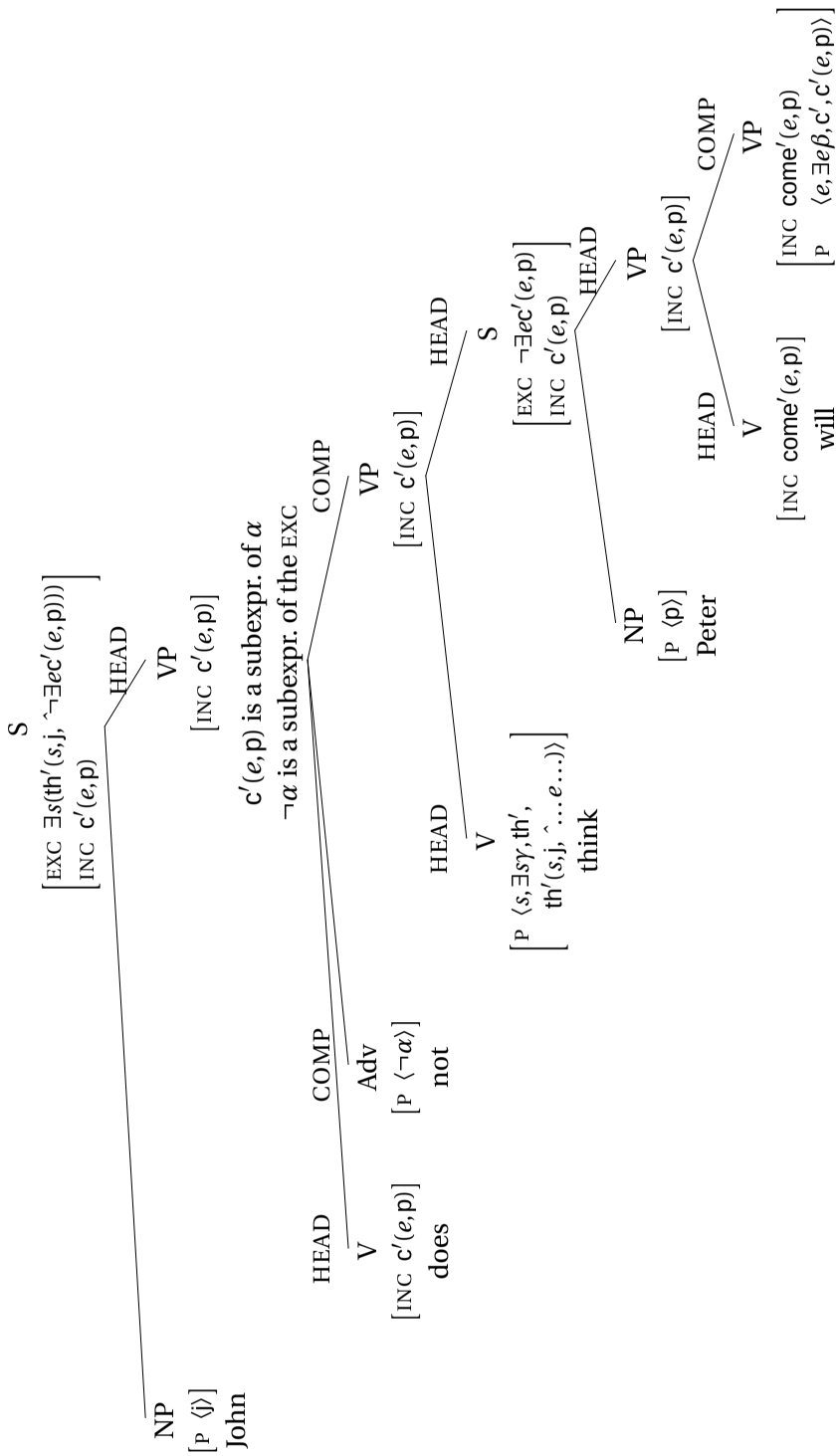

Figure 2: The derivation of the reading in (42)

In Richter and Sailer (2004) argument raising verbs in Polish are analyzed in such a way that they identify their INC value with that of their verbal complement. We can, however, give a more general characterization of the circumstances in which INC-identification occurs that includes argument raising predicates, modals and NR predicates: the INC value is a component of one argument slot of the MAIN value. The following principle expresses this idea formally.[16]

(43) The INC RAISING PRINCIPLE:

In a head-complement structure: if

the INC value of the head is a proper component of a semantic argument of the head's MAIN value, and
the INDEX value of the non-head occurs in this argument slot,

then the head's INC and the complement's INC are identical.

To illustrate the principle in (43), consider the VP headed by *think* in Figure 2. In the lexical entry of *think* it is specified that the INC value of *think* is some expression which occurs within an argument position of the constant think′ and the INDEX value of the complement clause is a subexpression of the same argument slot. Thus, the antecedent of the INC RAISING PRINCIPLE is satisfied and the consequent must be true as well. This means that the INC value of *think* and the complement clause must be identical.

Note that it is important that the INC of the matrix verb and the INDEX of the complement must be within the same argument slot of the matrix MAIN constant. This allows us to identify the complement whose INC value must be chosen.

5.3 Modifiers and Scope

The analysis developed so far correctly accounts for the NR reading of (1-a). However, it over-generates in two ways: (i) Nothing precludes other modifiers from also taking scope in the embedded clause, i.e., it is possible to assign the sentence in (44-a) a reading identical to that of the sentence in (44-b). (ii) Since we only require the negation to have scope over the INC value of the embedded clause, the obligatory wide scope of the negation with respect to embedded quantifiers and operators is not enforced (see the data in Section 2.2.4).

(44) a. ??I quickly believe that Pat runs.
b. ≠ I believe that Pat runs quickly.

The solution to both problems has two aspects: First, there is a general constraint on the relative semantic completeness of embedded clauses. Second, some items lexically require to be semantically interpreted within the clause in which they occur. In this subsection I will look at these two aspects.

[16] Throughout this papger I assume a formalization of HPSG as given in Richter et al. (1999) and Richter (2004), i.e., a powerful description language which provides relations, full classical negation and explicit quantification. Within this description language the principle in (43) can be formalized, just as all other principles used in this paper.

5.3.1 The Relative Semantic Completeness of Embedded Clauses

It was observed in Section 2.2.4 that a "raised" negation always has wide scope with respect to quantifiers and operators in the embedded clause. We can express this as a condition on the semantic completeness of clauses.[17]

(45) The EXTERNAL CONTENT PRINCIPLE FOR CLAUSES:

For every clause S with an EXC value ϕ,
there exists an expression ψ which is a subexpression of ϕ such that

all subexpressions of ψ occur in the PARTS list of S,
the INDEX value of S is bound in ψ, and
for each non-head phrase X in S,

if X's EXC is a subexpression of ϕ, then it is also a subexpression of ψ.

This principle guarantees that the semantic contribution of finite clauses has a complete expression which contains all the quantifiers and operators from this clause that take scope within the clause. This means that if semantic material from a higher clause takes scope within an embedded clause, then this material must have scope over the embedded operators.

For illustration, consider (29), repeated as (46). In its NR reading the embedded clause has the EXC value in (46-a). The expression ψ of (45) is the existential quantification over the eventuality variable s and its entire scope. This expression is built up entirely from expressions from the PARTS list of the clause. It contains the binding of the INDEX value. And it comprises all the EXC values of non-heads which take scope within this clause.

(46) I don't believe that the prisoners must make a phone call.

a. EXC of the embedded S (ϕ):
$\neg\exists s(\mathsf{must}'(s, \mathsf{the\text{-}prisoners}, \hat{}\exists e(\mathsf{call}'(e, \mathsf{the\text{-}prisoners}))))$

b. unavailable EXC of the embedded S (ϕ):
$\#\ \exists s(\mathsf{must}'(s, \mathsf{the\text{-}prisoners}, \hat{}\neg\exists e(\mathsf{call}'(e, \mathsf{the\text{-}prisoners}))))$

In (46-b) I mention an unavailable reading in which the matrix negation takes scope below the modal operator. This reading is excluded by the principle in (45) because we cannot find an appropriate ψ: since the INDEX value of the sentence must be bound in ψ, ψ must at least be the expression $\exists s(\mathsf{must}'(s, \mathsf{the\text{-}prisoners}, \hat{}\neg\exists e(\mathsf{call}'(e, \mathsf{the\text{-}prisoners}))))$. This expression, however, contains the negation operator ($\neg$), which is not on the PARTS list of the embedded clause.

The principle in (45) guarantees the wide scope of the matrix negation with respect to embedded quantifiers and operators. It also ensures that eventuality modifiers cannot be "raised". Such a hypothetical "raised" reading of (44-a) is given in (47-b). In this reading the semantic contribution of the modifier *quickly* occurs in the scope of the quantifier that binds the embedded eventuality variable. However, this part of the embedded EXC is required to contain only semantic material from the embedded clause itself.

[17] There might be a language-specific variation as to whether this principle applies to all clauses or only to finite or indicative clauses.

(47) a. I quickly believe that Pat runs
b. unavailable EXC of the embedded S: # $\exists e(\text{quickly}'(e) \wedge \text{run}'(e, \text{Pat}))$

This analysis also accounts for the unavailability of NR with the n-word *never* mentioned for instance in Klooster (to appear). Sentence (48-a) cannot have an NR reading, i.e., it cannot have the meaning paraphrased in (48-b). In (48-c) I give the hypothetical EXC value of the embedded sentence in such a reading.

(48) a. John never thinks that Peter will call.
b. $\neq$ John thinks that Peter will never call.
c. $\#\neg\exists t\exists e(\text{call}'(e, \text{Peter}) \wedge \text{occurs-at}'(e, t))$

I assume that *never* modifies an eventuality. In particular it introduces an existential quantification over a time variable t and locates the modified eventuality with respect to this time. The n-word also introduces a negation and the requirement that the existential quantifier be in the scope of the negation. It follows from this that at least the predicate $\text{occurs-at}'(e, t)$ must be part of the expression ψ from the principle in (45). Thus, NR is excluded with *never* for the same reasons that exclude an embedded reading for manner adverbials and, analogously, for other temporal modifiers.

5.3.2 Lexical Requirements

Next we will consider the influence of lexical requirements on the possibility of a embedded reading of an item from the matrix clause. I will consider two cases: modal adverbs and the specialized negators discussed in Section 2.2.3. The behavior of modal adverbs will follow from the general treatment of modal elements, the behavior of specialized negators from their idiosyncratic collocational restrictions.

Olivier Bonami (p.c.) points out that modal adverbials such as *probably* do not show NR readings either, i.e., sentence (49-a) can only have the reading in (49-b), but not the one in (49-c).

(49) a. Pat probably thinks that Chris will call.
b. $\text{probably}'(\hat{}\exists s(\text{think}'(s, \text{Pat}, \hat{}\exists e(\text{call}'(e, \text{Chris})))))$
c. $\#\exists s(\text{think}'(s, \text{Pat}, \hat{}\text{probably}'(\hat{}\exists e(\text{call}'(e, \text{Chris})))))$

As illustrated above with the lexical entry of *may* in (38-b), we treat modal verbs as INC raisers. As a consequence, if there is a sequence of modal verbs, they all have the same INC value. In principle this leaves the mutual scope relations among the modals open. However, as indicated in (38-b), a modal states that the INDEX value of its verbal complement occurs within one of its argument slots. Since *probably* is semantically similar to a modal verb, we will employ the same technique to exclude the reading in (49-c): The modal adverb requires that the INDEX value of the verb that it combines with be within its scope, in this case the INDEX of the NR predicate *think*. Thus, the unavailability of the reading in (49-c) is a consequence of the general treatment of modals.

Next, we will address the specialized negators such as German *einen Dreck*. As shown in Section 2.2.3, they cannot occur with an NR predicate. This can be reduced to their collocational restriction to co-occur with only a small class of verbs, in contrast to a general negation particle such as German *nicht* or English *not*. I will assume that

einen Dreck introduces a negation and a minimizing constant similar to *a bit*. Thus, the specialized negators behave analogously to *never* discussed in the previous paragraph. In addition *einen Dreck* requires that the eventuality to which the minimizer is applied is the index of a verb of intellectual concern.[18]

(50) Sketch of a description of the specialized negator *einen Dreck* (*a dirt*):

$$\left[\begin{array}{l}\textsc{phon}\ \langle \textit{einen Dreck}\rangle \\ \textsc{syns loc}\left[\textsc{cat head}\left[\textsc{mod}\ \ \textit{synsem}\right]\right] \\ \textsc{lf}\left[\begin{array}{ll}\textsc{exc} & \alpha\wedge\beta \\ \textsc{inc} & \text{minimal}'(\boxed{e}) \\ \textsc{parts} & \langle\neg\gamma, \text{minimal}'(\boxed{e}), \alpha\wedge\beta\rangle\end{array}\right]\end{array}\right]$$

and $\boxed{e}$ is the INDEX value of a verb of intellectual concern.

The combination of this lexical specification with the principle in (45) accounts for the contrast in (51) and (52). In (51) the negation contributed by *einen Dreck* has scope over the modal verb *brauchen* (*need*), but the minimizing is applied to the embedded eventuality. In the LRS analysis *brauchen* is a content raiser, i.e. its INC value is identical to that of the embedded verb. Since *brauchen* combines with an infinitival verb the principle in (45) does not apply and the reading in (51-b) is possible.

(51) a. Das braucht Peter einen Dreck zu interessieren.
this needs Peter a dirt to interest
'This doesn't need to be of any concern to Peter.'
b. $\neg\exists s(\text{need}'(s, \hat{}\exists s'(\text{concern}'(s', \text{this}, \text{Peter})\wedge\text{minimal}'(s'))))$

In (52), the matrix verb is an NR predicate. Its INC value also is identical to that of the embedded verb. Therefore, the collocational requirements of *einen Dreck* could be satisfied in the reading indicated in (52-b). However, this reading violates the principle in (45), as the minimizing predicate needs to occur inside the scope of the binder of the index of the embedded clause, i.e. inside $\exists s'(\ldots)$.[19]

(52) a. *Maria denkt einen Dreck, dass das Peter interessiert.
Maria thinks a dirt that this Peter interests
b. $\#\exists s(\text{think}'(s, \text{Maria}, \hat{}\neg\exists s'(\text{concern}'(s', \text{this}, \text{Peter})\wedge\text{minimal}'(s'))))$
c. $\#\neg\exists s(\text{think}'(s, \text{Maria}, \hat{}\exists s'(\text{concern}'(s', \text{this}, \text{Peter})))\wedge\text{minimal}'(s))$

In the hypothetical logical form in (52-c) the EXC of the embedded verb satisfies the principle in (45). The minimizing predicate is applied to the matrix situation s. This situation is not the INDEX value of a verb of intellectual concern and, therefore, sentence (52-a) cannot have this reading either.

[18] This condition can be encoded within a collocational module such as the one of Soehn (2006) which we also employ to encode NPIs (see footnote 15).

[19] Since the unavailability of this reading stems from the position of the minimizing predicate, it is irrelevant here whether the negation has scope over the matrix situation or only over the embedded situation.

5.4 Neg Raising with Matrix N-Words

In Section 2.2.2 I argued that a lexical decomposition of *none* and *few* is needed to account for the data in (9). In (53) I give a description of the word *none* as it occurs in (9). Its semantic contribution is a universal quantifier and a negation, where the negation is in the scope of the universal. LRS enables us to leave it open whether the negation is in the immediate scope of the universal quantifier or not.

(53) Parts of the lexical entry of *none* (universal reading):

$$\left[\begin{array}{l}\text{PHON } \langle none \rangle \\ \text{SYNS LOC CONT INDEX } \boxed{x} \\ \text{LF}\left[\begin{array}{ll}\text{EXC} & \forall\boxed{x}\,(\alpha \rightarrow \beta) \\ \text{PARTS} & \langle \boxed{x}, \neg\gamma, (\alpha \rightarrow \beta), \forall\boxed{x}\,(\alpha \rightarrow \beta)\rangle\end{array}\right]\end{array}\right] \quad \textbf{and} \quad \neg\gamma \text{ is a subexpression of } \beta$$

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 $\mathsf{think}'(x, \hat{}\ldots)$. 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 NR predicates and auxiliary verbs.

It should be noted that, in addition to the universal reading in (53), English n-words also have an existential reading. The two readings of the n-word only differ with respect to their LF values: For the existential reading, the EXC value is the expression $\exists x(\alpha \wedge \beta)$ and the PARTS list contains this existential quantifier, the conjunction $(\alpha \wedge \beta)$, the variable bound by the quantifier, and a negation which has scope over the existential quantifier.[20]

Clearly we cannot derive an NR reading for the existential reading of *none*, because (i) the variable bound by the existential occurs in an argument slot of the predicate think', but (ii) the negation must have scope over the existential. It is not possible to satisfy these two conditions if the negation occurs in the EXC value of the embedded clause.

At the end of this subsection, a remark on other quantificational items such as *few* is in order. To account for the data in Section 2.2.2 I assumed an ambiguity similar to that of n-words: for NR readings I required the semantic contribution of the quantifier to be of the form indicated in (13-b), i.e., as $\mathsf{many}x(\ldots)(\ldots\neg(\ldots)\ldots)$.

Based on this analysis it is possible in LRS to give a single lexical entry for *few* which also captures the two possible logical forms given in (13). In (54) I indicate the LF specification as it should appear in the lexical entry.

(54) LF value of the lexical entry of *few*:

$$\left[\begin{array}{ll}\text{EXC} & \mathsf{many}\boxed{x}\,(\alpha)(\beta) \\ \text{PARTS} & \langle \boxed{x}, \mathsf{many}\boxed{x}\,(\alpha)(\beta), \neg\gamma\rangle\end{array}\right] \quad \wedge\, \gamma \leq \mathsf{many}\boxed{s}(\alpha)(\beta)$$

(where $\phi \leq \psi$ means that ϕ is identical or a subexpression of ψ)

[20] It remains to be shown whether we are forced to stipulate a lexical ambiguity of n-words or whether there is a systematic way to relate existential and universal n-words, such as by a lexical rule or by underspecification in the lexicon, as in the case of *few* in (54).

LRS allows us to leave the relative scope of the negation underspecified. We only require that the negation either has immediate scope over many (i.e. γ = many…), or the negation is within the scope of the quantifier.[21] The description in (54) is compatible with the two readings in (55), which correspond to the two logical forms for *few* given in (13). Remember that $\beta[\neg\gamma]$ is the notation for stating that the expression $\neg\gamma$ occurs inside the expression β.[22]

(55) a. $\neg$many$x(\alpha)(\beta)$
b. many$x(\alpha)(\beta[\neg\gamma])$

If the narrow scope of the negation given in (55-b) combines with an NR predicate, the $\neg\gamma$ can take scope within the embedded clause, and, thus, license an embedded strict NPI as, for example, in (20).

This subsection has shown that the data from Section 2.2.2 can be handled within the analysis developed in this paper.

6 Conclusion

I have argued in this paper that intriguing properties of neg raising follow directly within a framework of semantic underspecification. I provided evidence that in an NR constellation, the negation is semantically part of the logical form of the embedded clause, while it is syntactically integrated into the matrix clause. This apparent conflict can be expressed within LRS by allowing for a narrow scope of the negation with respect to the main semantic contribution of the matrix verb.

The empirically new aspects of the paper are (i) the observations about NPI licensing by *few* in NR constellations and the relation to complement anaphora (Section 2.2.2), and (ii) the remarks on collocationally restricted negators in Section 2.2.3. I have shown that these observations are compatible with the LRS analysis developed in Section 5.

It is desirable to extend the analysis of NR constructions to other constructions which license strict NPIs in the absence of a clause-mate negation. One such context is the complement clause of adversative predicates such as *deny*, *doubt*, …. The most natural extension in the present framework would be a lexical decomposition of *deny* as "*assert … not*" and of *doubt* as "*think … not*". I leave such an extension to further research. Another group of contexts in which strict NPIs can occur are idiosyncratic combinations such as *I'll be damned if …* and *I'd rather die than …* (von Bergen and von Bergen, 1993). This type of context is explored in some detail in Sailer (2006).

The basic ideas of the LRS analysis of NR can in principle be expressed in other frameworks of underspecified semantics as well. For the details of the analysis, however, I relied heavily on properties of LRS such as its particular interface features (MAIN, INDEX, INC, and EXC). Other frameworks (*Constraint Language on Lambda Structures*,

[21] This use of a $\leq$-scope constraint is inspired by the constraint Kallmeyer and Romero (2006) use for the correct scope options of quantifiers which are embedded inside an NP.

[22] The lexical entry is compatible with a third reading: many$x(\alpha[\neg\gamma])(\beta)$. It is not clear whether the third reading is available or not. It can easily be excluded if we add the requirement that γ must not be a subexpression of α.

Minimal Recursion Semantics, or Lexicalized Tree Adjoining Grammar) do not use the same features. This may have an influence on the transferability of my analysis.

The present paper focused on the lexical representations of NR predicates. If there is a pragmatic motivation for some predicates to act as NR predicates, as argued for in Horn (1978), pragmatics can serve as a trigger for leaving the INC specification of the relevant predicates underspecified in the lexical entries. In addition, a lack of INC specification may arise from semantic reasons in the case of (English) modal verbs, and from syntactic reasons in the case of argument raising verbs in Polish or German.

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