On Modeling Scope of Inflectional Negation

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1   Introduction

In this paper, we investigate the representation of negated sentences in Minimal Recursion Semantics (Copestake, Flickinger, Pollard, & Sag, 2005). We begin with its treatment in the English Resource Grammar (Flickinger, 2000, 2011), a broad-coverage implemented HPSG (Pollard & Sag, 1994), and argue that it is largely a suitable representation for English, despite possible objections. We then explore whether it is suitable for typologically different languages: namely, those that express sentential negation via inflection on the verb, particularly Turkish and Inuktitut.[1] We find that the interaction between negation and intersective modifiers requires a change to the way in which (at least) one of them contributes to semantic composition, and we argue for adapting the analysis of intersective modifiers.

More generally, this work can be seen as a case study of universality in semantic representation in surface-oriented compositional semantics. Such representations are necessarily somewhat language-specific: notably in lexical semantics, but also in cases where translational equivalents display differences in structural relationships and/or elements that are usually treated as logical constants.[2] Nonetheless, we still expect to see many common structures in areas of semantics such as negation. As we strive to work with a surface-oriented, compositional framework, however, we must negotiate the surface-structural differences between languages so as to achieve those common semantic structures. Thus a cross-linguistically appropriate semantic representation must not only capture meanings as they are used in different languages but also be buildable on the basis of the diverse morphosyntactic scaffolding provided by the different languages.

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[1]We use the term 'inflection' here broadly to refer to any morphological process, and are not concerned with contrasting 'inflection' and 'derivation'.

[2]For example, Korean expresses situational possibility via a noun *swu* ('way') in combination with an existential verb (Sohn, 1994:348, see also Auwera & Ammann, 2011b):

(i) Halapeci-nun wuncenha-si-l   swu(-ka)   iss-usi-ta.
     grandpa-TOP drive-SUBJ.HON-PRES way-NMLZ exist-SUBJ.HON-DECL
     'My grandpa can drive.' [kor]

2 Semantic representation of negation in the ERG

In this section we review the semantic representation of negation in the English Resource Grammar (ERG, Flickinger, 2000, 2011) using Minimal Recursion Semantics (MRS, Copestake et al., 2005). The representation is motivated by semantic scope ambiguities involving negation and quantifiers, but it is challenged by other phenomena, including the focus-sensitivity of negation (e.g., Fischer, 1968) and "neg-raising" (e.g., Horn, 1978). Nonetheless, we will argue that the representation is appropriate for English.

To focus the discussion on the level of representation we are concerned with, we note that the MRS language and its model theory are designed to express the incompleteness of meaning that is revealed by linguistic form on its own, while capturing (very abstractly) those aspects of a linguistic phrase's content that are conveyed in *all* its possible discourse contexts. In general, then, an MRS must be a (perhaps partial) description of a fully specific and context-aware interpretation of the linguistic phrase that it represents. In particular, in those cases where even a syntactically disambiguated analysis of the phrase exhibits semantic scope ambiguities, its MRS must underspecify the relative semantic scope of the relevant constructors, while at the same time ensuring that the pragmatically preferred fully scoped reading satisfies the MRS's scope constraints.

Negation's scopal interaction with quantifiers is illustrated in (1). In (1), there are two readings, one in which the quantifier *some* is interpreted inside the negation (see (1a)), and one in which *some* is given wide scope (see (1b)):

(1)   Kim didn't read some book.
    a. $\exists x$ (book(x), ¬read(Kim,x))
    b. ¬$\exists x$ (book(x), read(Kim,x))

Accordingly, it is appropriate to produce a semantic representation (i.e., a partial description of a fully specific logical form such as (1a) or (1b)) which treats both negation and the quantifier as scopal elements but underspecifies their relative scope. For reasons that we turn to below, we give negation a fixed scopal position in the sentence while allowing quantifiers to scope in between it and the predicate it embeds (*read* in our example). In MRS, this is handled by giving the elementary predication corresponding to the negation (neg) a scopal argument position which is related to the verb's predication _read_v (corresponding in (1) to the the predicate read) via a 'qeq' (equal modulo quantifiers) constraint. This constraint says that neg either directly outscopes _read_v, or outscopes one or more quantifier relations which in turn outscope _read_v. The MRS representation assigned to (1) by the English Resource Grammar (Flickinger, 2000, 2011) is shown in Figure 2. Note how not only the scopal argument to negation is left underspecified, but likewise the formulae representing the restrictor and the body of the quantifier are also underspecified ($h_{15} =_q h_{16}$ and h_{14} in no expressed scopal constraints, respectively). The former handles scope ambiguities in noun phrases like *some chapters of every book* which do not concern us here. The latter scope ambiguity arises because the scope of quantifiers isn't fixed relative to other scopal elements (compare the different formulae representing the body of the quantifier in (1a) vs. (1b)). Roughly put,

$$\left\langle h_1, \left\{ \begin{array}{l} h_3:\text{proper\_q}(x_5, h_4, h_6), \\ h_7:\text{named}(x_5, \textit{Kim}), \\ h_8:\text{neg}(e_{10}, h_9), \\ h_{11}:\_\text{read\_v\_1}(e_2, x_5, x_{12}), \\ h_{13}:\_\text{some\_q\_indiv}(x_{12}, h_{15}, h_{14}), \\ h_{16}:\_\text{book\_n\_of}(x_{12}, i_{17}) \end{array} \right\}, \right.$$
$$\left. \{h_{15} =_q h_{16}, h_9 =_q h_{11}, h_4 =_q h_7\} \right\rangle$$

Figure 1: MRS for (1) from ERG

an MRS is satisfied by a fully scoped logical form if the following three conditions are met: (a) all scope constraints are satisfied; (b) each scopal argument (in other words, any label h that appears as an argument in Figure 2) is equated with a unique label of a predication (in other words, a label h' that is to the left of a colon, with a predicated formula to its right in Figure 2); and (c) all variables are within the scope of their associated quantifier, if there is such a quantifier (so, for example, this means that the body h_{14} of the quantifier some_q_indiv, which binds x_{12}, must outscope the label h_{11} of read_v). This interpretation of MRSs means that, abstracting away from quantifiers introduced by the proper names, the MRS in Figure 2 yields exactly two possible fully scoped forms: (1a) and (1b).

That the scope of sentential negation should be fixed with respect to other scopal modifiers by its position in the sentence seems uncontroversial in English. Consider (2), which arguably has the readings in (2a-c) but not those in (2d–e). That is, (2) cannot be paraphrased as "It is not the case that Kim deliberately read every book."

(2)   Kim deliberately didn't read every book.
    a. ∀x (book(x), deliberately(¬read (Kim,x)))
    b. deliberately(∀x (book(x), ¬read (Kim,x)))
    c. deliberately(¬∀x (book(x), read(Kim, x)))
    d. *¬deliberately (∀x (book(x), read(Kim, x)))
    e. *∀x (book(x), ¬deliberately(read(Kim,x)))

These facts are compatible with an analysis, such as that implemented in the ERG, where the negative element in the sentence (here the inflected form *didn't*) introduces the scopal neg as well as the qeq constraint connecting its argument position to the local top handle of the VP *read every book*.

2.1   Neg-raising

An apparent counter-example to the above claim that the scope of negation is fixed relative to everything except quantifiers by its syntactic position is the phenomenon of *neg-raising*

$$\left\langle h_1, \left\{ \begin{array}{l} h_3\text{:proper\_q}(x_5,\ h_4,\ h_6), \\ h_7\text{:named}(x_5,\ \textit{Kim}), \\ h_8\text{:neg}(e_{10},\ h_9), \\ h_{11}\text{:\_believe\_v\_1}(e_2,\ x_5,\ h_{12}), \\ h_{13}\text{:proper\_q}(x_{15},\ h_{14},\ h_{16}), \\ h_{17}\text{:named}(x_{15},\ \textit{Sandy}), \\ h_{18}\text{:\_happy\_a\_with}(e_{19},\ x_{15},\ i_{20}) \end{array} \right\}, \right.$$
$$\left. \{h_{14} =_q h_{17}, h_{12} =_q h_{18}, h_9 =_q h_{11}, h_4 =_q h_7\} \right\rangle$$

Figure 2: MRS for (3) from ERG

$$\left\langle h_1, \left\{ \begin{array}{l} h_3\text{:proper\_q}(x_5,\ h_4,\ h_6), \\ h_7\text{:named}(x_5,\ \textit{Kim}), \\ h_8\text{:neg}(e_{10},\ h_9), \\ h_{11}\text{:\_believe\_v\_1}(e_2,\ x_5,\ h_{12}), \\ h_{13}\text{:proper\_q}(x_{15},\ h_{14},\ h_{16}), \\ h_{17}\text{:named}(x_{15},\ \textit{Sandy}), \\ h_{18}\text{:\_happy\_a\_with}(e_{19},\ x_{15},\ i_{20}) \end{array} \right\}, \right.$$
$$\left. \{h_{14} =_q h_{17}, h_{12} =_q h_{11}, h_9 =_q h_{18}, h_4 =_q h_7\} \right\rangle$$

Figure 3: Alternative MRS for (3), not from ERG

(Horn, 1978).[3] In neg-raising, a certain class of predicates license a reading where negation appears to be interpreted semantically inside the clausal complement of the negated verb. For instance, the natural reading of (3) is paraphrasable as "Kim believes Sandy isn't happy", as represented (in a simplified way) in the logical form (3a):

(3) Kim doesn't believe Sandy is happy.

  a. believe(kim,¬happy(sandy))

The ERG produces the MRS shown in Figure 2 for sentence (3). In this MRS, the scopal argument of neg is related (via qeq, as always) to the label of _believe_v, which in turn takes the label of _happy_a_with as its second argument via a qeq. Figure 3 shows an MRS representation (not generated by the ERG) which would yield a fully scoped interpretation that is equivalent to (3a). The only change is in the handle constraints (qeqs). While the neg-raising examples appear to always have both readings (e.g., those represented by Figure 2 and Figure 3), the current analysis implemented in the ERG, which we are supporting here, only produces the first.

Our motivation for supporting an analysis that only produces representations of the type given in Figure 2 concerns the grounds for neg-raising readings. Gajewski (2005) argues, on

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[3]Neg-raising is so named because early accounts had the negative operator positioned in the lower clause in an underlying structure and then "raised" to its surface position.

$$\langle h_1, \left\{ \begin{array}{l} h_3\text{:\_the\_q}(x_5,\ h_6,\ h_4), \\ h_7\text{:\_dog\_n\_1}(x_5), \\ h_8\text{:neg}(e_{10},\ h_9), \\ h_{11}\text{:\_bark\_v\_1}(e_2,\ x_5), \\ h_{11}\text{:\_loud\_a\_1}(e_{12},\ e_2) \end{array} \right\},$$
$$\{h_9 =_q h_{11}, h_6 =_q h_7\}\rangle$$

Figure 4: MRS for (4) from ERG

the basis of NPI licensing facts, that neg-raising is best understood in terms of *presupposi-tions*. In particular, he argues that neg-raising predicates introduce a lexical presupposition of the assumption of the Excluded Middle. Because this presupposition can be canceled in appropriate contexts, two apparent readings emerge despite the lack of any semantic am-biguity. Gajewski's analysis posits only a semantic representation where negation attaches "high" (as indicated by its surface position). While the ERG does not currently handle the introduction and propagation of presuppositions (as would be required to implement Gajew-ski's analysis), it seems reasonable to assume that these would be handled separately from the MRS structure representing the constant semantic contribution of each sentence. As the MRS in Figure 2 represents the "high" attachment of negation that Gajewski argues is appropriate, the ERG's current analysis should be compatible with a presupposition-based approach to neg-raising.

2.2 Focus sensitivity

Another potential objection to an analysis of negation as having fixed scope comes from examples like (4), which has all of the possible continuations (4a–d). It is tempting to assume that (4a), (4b) and (4c) respectively provide evidence that the negation can outscope only the adverb, only the verb, or both.

(4)   The dog didn't bark loudly.

    a. It was really quiet, actually.

    b. It was whining loudly.

    c. It was whining quietly.

    d. That was a hyena that was barking.

The MRS generated by the ERG (shown in Figure 4), however, makes negation take scope over both _bark_v and _loud_a, as these two are required by the analysis of intersective modification to share the same scopal position (in other words, their respective predications are joined with a conjunction $\wedge$ in any fully scoped logical form).[4]

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[4]The subject NP introduces a quantifier which can scope above or below neg.

However, as noted by many authors (Fischer, 1968; Jackendoff, 1972; Karttunen & Peters, 1979; McCawley, 1998; Herburger, 2000; Krifka, 2006; Beaver & Clark, 2008), negation (in English, at least) is focus sensitive. Beaver and Clark (2008) present a detailed analysis of focus sensitivity, and argue that it is essentially pragmatic for all focus sensitive items, although certain items are conventionally focus sensitive. Negation is not one of these. On Beaver and Clark's analysis, negation is only quasi-focus sensitive. A quasi-association with focus, on their account, produces defeasible implicatures, but no truth-conditional effects. Thus, we can say that the semantics of (4) is as in Figure 4, i.e., the claim that there was no barking situation in which the dog was the barker and the barking was loud. The information structure of the utterance (not represented in English orthography) sets up the relevant contrast set, which in turn sets up the possibility of each continuation in (4). If *loudly* bears the focus-indicating pitch accent, then the focus will be just *loudly* (the so-called narrow focus reading, where the contrast set is other kinds of barking situations with that dog), or the VP *bark loudly* (the wide focus reading, where the contrast set is other things the dog might have done), etc.

2.3   Summary

To summarize this section, we have reviewed evidence from English that negation is scopal, and that its scope is fixed by its syntactic position in the sentence. Furthermore, the desired semantic representations can be built compositionally by having the negative formative (the word *not* or the affix *n't*) introduce the neg and its associated qeq.[5] We explored two possible types of counterexamples — neg-raising and the focus sensitivity of negation — and found that they do not require any revisions to the ERG's analysis.

3   Inflectional negation

We next ask whether this analysis can be extended to other languages. In particular, we are concerned with languages that express negation as an affix on main verbs. This is a fairly common pattern, occurring in 417 languages of the 1159 language sample in Dryer (2011). A problem arises for these languages when we consider the interaction of negation with intersective modifiers. Intersective modifiers are handled in MRS via handle-sharing: recall from Section 2 that they share the scope of the head they modify, meaning that in any fully-scoped reading the predicate introduced by the modifier and that introduced by its modifiee are conjuncts in a conjunction. This is shown in Figure 4, the MRS produced by the ERG for (4). We argued above that the MRS in Figure 4 is a reasonable representation for the semantics of the English example (4). Assuming for the moment that an analogous representation is appropriate for the Turkish translation in (5), we face the problem of how
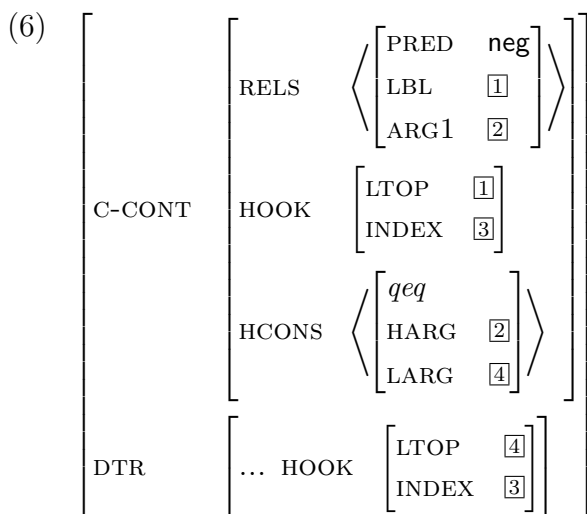
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[5]Kim and Sag (2002) note the relative scope of modals and negation is lexically specific, and take this as evidence that both sentential *not* and the affix *n't* (cf. Zwicky & Pullum, 1983) are introduced by lexical rules. The lexical rules in question can introduce the neg and assign its scope.

to build it compositionally.[6]

(5) Köpek yuksek ses-le   havla-ma-di.
    dog   loud   voice-INST bark-NEG-PST
    'The dog didn't bark loudly' [tur]

In (5), the intersective modifier is the phrase *yuksek sesle*, which bears instrumental case[7] licensing its use as an adverbial modifier. One analysis of such modifiers uses a non-branching rule to introduce a two place predication relating the NP and the VP (e.g., one called instrument). While the NP will presumably contain its own quantifier, the modifier as a whole will be treated as intersective, and as such we would want the instrument predication to share its label with that of the verb.

Meanwhile the negation is expressed by an affix on the verb (*-mA*, subject to vowel harmony).[8] The most straightforward analysis would be to have the negative affix attached via a meaning-contributing lexical rule, such as that sketched in (6).

$$
(6) \quad \begin{bmatrix} \text{C-CONT} & \begin{bmatrix} \text{RELS} & \left\langle \begin{bmatrix} \text{PRED} & \text{neg} \\ \text{LBL} & \boxed{1} \\ \text{ARG1} & \boxed{2} \end{bmatrix} \right\rangle \\ \text{HOOK} & \begin{bmatrix} \text{LTOP} & \boxed{1} \\ \text{INDEX} & \boxed{3} \end{bmatrix} \\ \text{HCONS} & \left\langle \begin{bmatrix} qeq \\ \text{HARG} & \boxed{2} \\ \text{LARG} & \boxed{4} \end{bmatrix} \right\rangle \end{bmatrix} \\ \text{DTR} & \begin{bmatrix} \ldots \text{ HOOK} & \begin{bmatrix} \text{LTOP} & \boxed{4} \\ \text{INDEX} & \boxed{3} \end{bmatrix} \end{bmatrix} \end{bmatrix}
$$

This rule introduces the neg and its associated qeq constraint. The LTOP of the mother's C-CONT (constructional content) and thus of the mother itself is the label of the neg. The label of the verb's relation is related, via the qeq, to the ARG1 of the neg, but is not otherwise available for further combination.

This is problematic, if we take the MRS in Figure 4 as the target for this Turkish sentence (modulo predicate names, which are language-specific, and the substitution of the equivalent

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[6]In order to show that the analogous representation is suitable for Turkish, we would need to find evidence of scope ambiguities between quantifiers and negation analogous to (1). We have found it difficult to elicit judgments from native speakers on such examples, and thus must leave this issue for later work. It seems plausible to us, however, that such scope ambiguities should occur across languages.

[7]Kornfilt (1997) refers to *-le* as an instrumental clitic. Its status as a clitic or an affix is orthogonal to the point at hand.

[8]Kornfilt (1997) notes that Lewis (1975) analyzes *-mA* as a clitic. Kornfilt argues that it is in fact an affix, on the basis of its position inside other affixes and its participation in vowel harmony.

of *with a loud voice* for *loudly*). The adverbial phrase *yuksek sesle* necessarily attaches outside the negative affix, unless we are willing to abandon the Lexical Integrity Hypothesis (Bresnan & Mchombo, 1995). But once the negative affix is attached, per the rule in (6), the label of the verb's relation is no longer available, meaning that the adverb would be predicted to be outside of the scope of the negative operator.

Returning to English for a moment, we can construct examples where adverbs attach semantically outside of negation:

(7) Kim pointedly didn't reply to the question.

(8) Kim didn't reply to the question, pointedly.

Again English uses syntax to establish the scope of negation. Note the contrast between (8) and (9):

(9) Kim didn't reply to the question pointedly.

Thus we wouldn't want to say that negation is necessarily the highest scoping non-quantifier in its clause. (Such an analysis would also run into problems with (2).)

To summarize, we sometimes need to allow intersective modifiers to take scope inside the negative operator. However, the morphosyntactic facts of Turkish require us to attach the negative operator first, if we wish to maintain Lexical Integrity. Furthermore, the mechanisms of semantic composition used in English, and adapted for Turkish, make the scopal position that the intersective modifiers would like to take inaccessible at the point at which they attach syntactically.

There appear to be two potential ways out of this puzzle: one involves changing the way we compose the semantics of negation; the other involves changing the way we compose the semantics of intersective modifiers. In the first, we could dissociate the morphological marking of negation from its semantic contribution. Alternatively, we could change the way that the label (LBL) of (intersective) modifiers relate to that introduced by the semantics of the constituent they attach to in syntax. These two alternatives are each explored in turn in Sections 4 and 5.

4 Dissociation of morphology and semantics

We start with the first approach mentioned above: to dissociate the morphological marking of negation from its semantic contribution. We assumed in rule (6) that one and the same lexical rule attaches the affix and introduces the neg. The alternative is to take the affix as simply marking the verb as part of a negated clause, while relegating the introduction of the semantics to a higher construction—i.e., a non-branching phrase structure rule. This analysis is essentially the same as that proposed for Turkish modal affixes by Fokkens, Poulson, and Bender (2009), in light of suspended affixation examples such as (10).

(10) Çocuk-lar film   izle-yip   pizza ye-meli-ler.
     child-PL   movie watch-COORD pizza eat-NEC-3.PL
     'The children must watch a movie and eat pizza.' [tur] (Fokkens et al., 2009, 111)

This example illustrates how the affix *-meli* meaning 'must' can take scope over multiple coordinated VPs. Fokkens et al. (2009) argue against treating it as a phrasal affix and show that the Lexical Integrity Hypothesis (Bresnan & Mchombo, 1995) can be maintained by adopting an analysis along the lines of Tseng's (2003) analysis of apparent phrasal affixes in French. On these analyses, the presence of the morphology is registered (either in HEAD, as in Turkish, or with an EDGE feature, in French) and used to trigger a non-branching construction higher in the tree.

Crysmann (2010) presents a similar constructional approach to negation in Hausa, arguing that neither of the two markers used in the discontinuous negation construction illustrated in (11) actually carries the negative force on its own. Rather, the markers signal the presence of a construction, in this case also a non-branching construction which requires both left and right EDGE features encoding the presence of both of the negative markers.

(11) màlāmai bà sù   ji kōmē   ba.
      teachers NEG 3.P.CPL hear anything NEG
      'The teachers did not hear anything.' [hau] (Newman, 2000, 357)

However, Crysmann's arguments for a constructional account of this Hausa negation strategy show it to be different in important ways from negation in Turkish. In particular, Crysmann shows that both of the markers are attached as affixes to the the words they are adjacent to and then observes that the semantics of negated sentences with VP coordination requires that the negative force must be integrated into the semantics "high" rather than at the level of the morphological attachment of one or the other of the markers:

(12) Mammàn nē bài   zō   ajî ya   dàuki jarràbâwā ba.
      Mamman FOC NEG.3.S.M.CPL come class 3.S.M.REL.CPL take exam   NEG
      'It was *Mamman* who didn't come to class and take the exam.' [hau] (Jaggar, 2001, 166)

In Turkish, the case for constructional introduction of negative force lacks such motivation. For one thing, the negative marker is not one of the affixes that can be suspended in "suspended affixation". Our consultants accepted (13a), where both constituents are negated separately.[9] However, when we put the negation on just one of the conjuncts, as in (13b) and (13c) the consultants rejected the sentences and offered alternatives with a *but* conjunction (13d).[10]

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[9]However, our consultants also said this would be an uncommon way to express this meaning, preferring instead a *neither ... nor* type construction, illustrated in (i):

(i) Çocuk-lar ne film izli-yor   ne de   pizza yi-yor-lar-di.
     Child-PL NEG movie watch-CONT NEG COORD pizza eat-CONT-3PL-PST
     'The children were neither watching a movie nor eating pizza.' [tur]

[10]One consultant accepted (13b) and (13c), but only with a reading where only the verb bearing the negation marker is interpreted as negated.

(13) a. Çocuk-lar film   izle-mi-yor   ve   pizza ye-mi-yor-lar-dı.
      Child-PL   movie watch-NEG-CONT and pizza eat-NEG-CONT-3PL-PST
      'The children were not watching a movie and were not eating pizza.' [tur]

   b. *Çocuk-lar film   izli-yor   ve   pizza ye-mi-yor-lar-dı.
      Child-PL   movie watch-CONT and pizza eat-NEG-CONT-3PL-PST
      Intended 'The children were (not) watching a movie and were not eating pizza.'
      [tur]

   c. *Çocuk-lar film   izle-mi-yor   ve   pizza ye-yor-lar-dı.
      Child-PL   movie watch-NEG-CONT and pizza eat-CONT-3PL-PST
      Intended 'The children were not watching a movie and were (not) eating pizza.'
      [tur]

   d. Çocuk-lar film   izli-yor   ama pizza ye-mi-yor-lar-dı.
      Child-PL   movie watch-NEG-CONT but pizza eat-NEG-CONT-3PL-PST
      'The children were watching a movie but were not eating pizza.' [tur]

Thus we find that negation is not subject to suspended affixation, and so suspended affixation cannot provide positive evidence for a constructional account of the introduction of the semantics of negation.
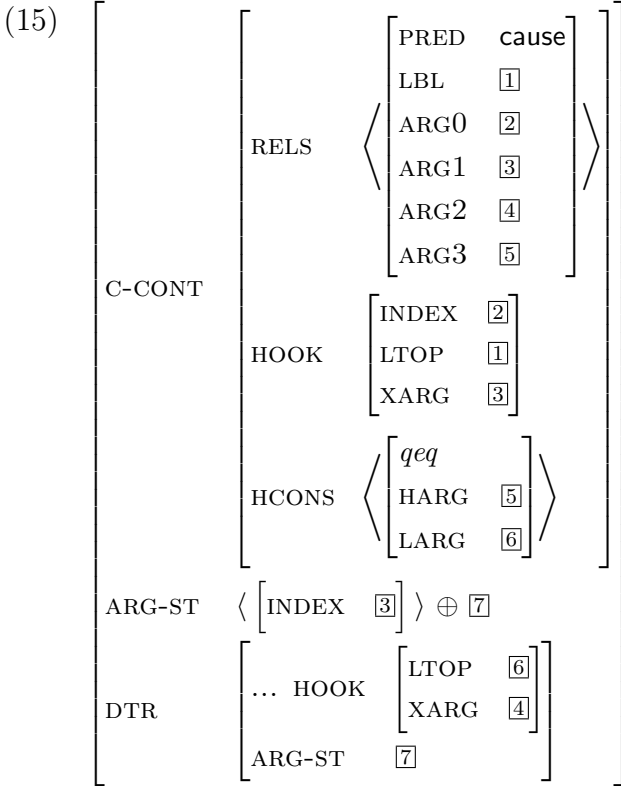
There is also evidence against a constructional account in Turkish, concerning the interaction of negation and the morphological causative. In particular, while in Turkish the order of these two morphemes is fixed, with negation attaching outside the causative, the semantics can go either way. That is, (14) can have either of the meanings given in (14a–b).

(14) Ebeveyn-ler çocuk-lar-ına meyve yedir-t-me-di-ler.
      Parent-PL   child-PL-DAT fruit   eat-CAUSE-NEG-PST-3PL

   a. 'The parents did not make (or force) the kids to eat the fruit.'

   b. 'The parents made the kids not eat the fruit.' [tur]

The constructional account is even less appealing for morphological causatives, as they affect not only semantics but also argument structure and linking. The effect of a causative lexical rule is to introduce the cause predication and link its arguments to the stem's arguments and the stem's own semantic contribution, as illustrated in (15).[11]

There are two coordination constructions in Turkish which both allow suspended affixation: affixal coordination with -(y)ip and coordination marked by the independent word *ve* (Fokkens et al., 2009). Only -(y)ip coordination appears to allow suspended affixation with scopal elements like -mEli. Interestingly, our consultants rejected constructed examples involving -(y)ip coordination and negation on either conjunct.

[11]In a given language, there might also be constraints on the CASE value of the ARG-ST elements.

(15)

$$
\begin{bmatrix}
\text{C-CONT} & \begin{bmatrix}
\text{RELS} & \left\langle \begin{bmatrix} \text{PRED} & \textsf{cause} \\ \text{LBL} & \boxed{1} \\ \text{ARG0} & \boxed{2} \\ \text{ARG1} & \boxed{3} \\ \text{ARG2} & \boxed{4} \\ \text{ARG3} & \boxed{5} \end{bmatrix} \right\rangle \\
\text{HOOK} & \begin{bmatrix} \text{INDEX} & \boxed{2} \\ \text{LTOP} & \boxed{1} \\ \text{XARG} & \boxed{3} \end{bmatrix} \\
\text{HCONS} & \left\langle \begin{bmatrix} qeq \\ \text{HARG} & \boxed{5} \\ \text{LARG} & \boxed{6} \end{bmatrix} \right\rangle
\end{bmatrix} \\
\text{ARG-ST} & \left\langle \begin{bmatrix} \text{INDEX} & \boxed{3} \end{bmatrix} \right\rangle \oplus \boxed{7} \\
\text{DTR} & \begin{bmatrix} \dots \ \text{HOOK} & \begin{bmatrix} \text{LTOP} & \boxed{6} \\ \text{XARG} & \boxed{4} \end{bmatrix} \\ \text{ARG-ST} & \boxed{7} \end{bmatrix}
\end{bmatrix}
$$

In order to get readings like (14b), where the negation attaches inside the causative, the negative-force introducing rule (lexical or constructional) would need access to the stem's semantic information. At the same time, the causative-introducing rule (argued to be lexical) needs access to the negative-introducing rule's semantic information, as it should set up a qeq constraint between the ARG3 of the cause and the LBL of the neg. This is already somewhat problematic in the case where both are lexical rules: if lexical rules are non-branching productions applying in sequence, once the causative rule in (15) applies, the verb stem's HOOK information is no longer available for further combination. Conversely, once the causative rule has applied, its qeq is fixed (it's linked to the verb stem's LTOP; see the co-occurrence of $\boxed{6}$ in rule (15)) and can't be modified by the negative rule. However, if all the processes involved are lexical, the apparent ordering of the suffixes could be treated as a templatic morphology effect (Hyman, 2003), essentially a morphophonological process which obscures the order of application of the morphosyntactic rules.[12] No such analysis would be available if the negative force were introduced constructionally.

The case against dissociating the morphology and semantics of negation is even stronger for Inuktitut, where both orders are possible and the order of the morphemes reflects semantic scope (Elke Nowak, pc, see also Nowak, 2008):

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[12]Alternatively, if the Turkish causative is ambiguous between a permissive reading ('allow') and a non-permissive one ('make' or 'force'), then both readings could involve the same relative scope of the negative and causative elements, namely, one which is consistent with their morphological realization.

(16) ani-nngit-tit-tara.
go.out-NEG-CAUSE-1S.3S.TR
'I cause him/her not to go out.' [ike]

(17) ani-tit-nngit-tara.
go.out-CAUSE-NEG-1S.3S.TR
'I did not make him/her go out.' [ike]

Even if it were possible to handle the causative and negative semantics both through syntactic constructions, the order of application of those constructions would have to mirror the order of the morphemes within the word. This in turn means that that order would have to be recorded somewhere.[13]

In summary, it seems that a syntactic introduction of negative force will not serve as a general solution to the problem of modifier scope in negated sentences in languages with negative inflection. We now turn to the other possible solution.

5 Modifier attachment

The second possible solution involves changing the way the attachment of intersective modifiers is handled in the composition. Recall that the problem is that we want the modifier to share the label of the verb (which is outscoped by negation), but that label is not 'visible' at the point where the modifier attaches. Here we explore the possibility of using handle constraints other than simple equality to circumvent this problem.[14]

While MRS in general allows for multiple different kinds of handle constraints, the ERG only uses the 'qeq' (equal modulo quantifiers) relation: $h_1 =_q h_2$ means that the scopal positions that h_1 and h_2 denote in any fully-scoped logical form (each such logical form being a model for interpreting MRS expressions) must have only 0 or more quantifiers intervening between them.[15] Another type that has been explored in other grammars is 'leq' (less than or equal to) (Schlangen, 2003; Alahverdzhieva & Lascarides, 2011). Thus one possibility would be to have the quantifiers constrain their own handles to be 'leq' the handle of the constituent they attach to. In words, $h_1 \leq h_2$ means that the scopal position denoted by h_1 in any fully-scoped logical form is outscoped by or equal to that denoted by h_2. In practice, this means that the constructor C_1 that is labeled by h_1 in the MRS is either outscoped by the constructor C_2 denoted by h_2—thereby allowing scopal elements like negation and modals, as well as quantifiers, to intervene between them—or (if $h_1 = h_2$) C_1 and C_2 are conjuncts joined by $\wedge$. In essence, $h_1 \leq h_2$ is a notational variant of the dominance relation $h_2 \lhd^* h_1$ from Egg, Koller, & Niehren, 2001.

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[13]The syntactic approach to linking suggested by Haugereid (2004) (see also Goldberg, 1995) might provide some wiggle room here. However, it would still be odd—and counter to lexical integrity in spirit, at least—to have the order of syntactic rules dictated by the order of morphological rules.

[14]We are grateful to Dan Flickinger for suggesting this strategy.

[15]The Grammar Matrix (Bender, Flickinger, & Oepen, 2002; Bender, Drellishak, Fokkens, Poulson, & Saleem, 2010), which aims to be able to create starter grammars for any natural language, currently follows the ERG in only using qeq constraints.

We will illustrate this first with an example from English: we show how to compose an MRS for *The dog didn't bark loudly*, using a semantic entry for *loudly* that introduces an leq constraint $l \leq h$. The semantics of *didn't bark* is what we would expect from above: in terms of the algebra from semantic composition from (Copestake, Lascarides, & Flickinger, 2001), we get (18).

(18)   hook =   <l1,e>
         slot =   <l4,x>
         rels =   l1:neg(h)
                   l2:_bark_v(e,x)
         hcons = $h =_q l2$

The *slots* in the semantic representations (also called *holes* in (Copestake et al., 2001)) record gaps in semantic form—in (18) the semantic gap will be filled by a subject NP. According to the rules of the algebra, slots are filled during semantic composition by being equated with the hook of the relevant constituent (note that these slots aren't shown in the more compact MRS notation in Figures 2 to 4, but rather the first element of the tuple in these figures corresponds to the label of the hook in the algebra notation, the second element to the rels, and the third element to the hcons).

Now we assume a structure in which *loudly* attaches high (i.e., to the VP *didn't bark*, instead of just *bark*). This isn't required for this English example, but it is what we would need for Turkish, as negation is part of the verb. As we just proposed, the semantics of *loudly* introduces an *leq constraint* as shown in (19): $l3 \leq h'$ will allow the label l3 of the _loud_a relation to fit lower in the scope tree than the label h' of whatever constituent *loudly* attaches to syntactically.

(19)   hook = $\langle h',e' \rangle$
         slot = $\langle h',e' \rangle$
         rels = $l3:$_loud_a(e'',e')
         hcons = $l3 \leq h'$

In particular, combining (18) and (19)—i.e., by equating the hook in (18) with the slot of (19))—yields the representation (20) for *didn't bark loudly*:

(20)   hook =   <l1,e>
         slot =   <l4,x>
         rels =   l1:neg(h)
                   l2:_bark_v(e,x)
                   $l3:$_loud_a(e'',e)
         hcons = $h =_q l2$
                   $l3 \leq l1$

In other words, we are using the leq constraints to allow intersective modifiers to effectively "tuck" their labels underneath the label of the constituent they attach to in the syntax, such that they can share scope with something lower in the syntax tree.

There are at least two potential problems with this approach. First, it may be the case that the 'equal to' reading isn't actually available. Consider (5), repeated here as (21):

(21) Köpek yuksek ses-le   havla-ma-di.
      dog   loud   voice-INST bark-NEG-PST
      'The dog didn't bark loudly.' [tur]

Similarly to the translation, there is probably no reading of this sentence where _loud_a shares its scope with neg. Such a reading would have to mean that what was loud was the lack of barking.

On the other hand, the lack of this reading could be captured via a pragmatic anomaly at the level of *speech acts* in the coherent use of the sentence in context (and this anomaly could be specified in the separate model theory for the language and logic of fully-specific logical forms). Specifically, we could, in principle at least, stipulate that any coherent assertion that an event is loud must also assert that the event happened. This constraint on coherent assertions is violated by any fully-specific logical form where the modifier _loud_a shares its scope with neg.[16] This would also be useful in English. The ERG actually licenses two structures for (5), the one we want (with the adverb attaching low) and a second one where the adverb attaches to the higher VP (*didn't bark*). This second parse gives rise to the semantic representation that we argue should not be a part of any coherent interpretation of (5) in context.

The second, and potentially more serious objection, is that we must establish a lower bound for the 'less than' part of the leq. If the modified verb takes a clausal complement, what is to stop the adverb from attaching its handle down inside that complement? The word order facts of Turkish make it somewhat difficult to find the relevant examples, but (22) provides a starting point.[17] This and similar examples would need to be investigated more thoroughly, but assuming that this example in fact only has the reading where the adverb attaches semantically high (to *inanıyorum*), then we need to make sure that the leq approach does not license readings where it attaches semantically low, if these are not warranted.

(22) Başarılı   ol-acağ-ınız-a   inan-ıyor-um   yürek-ten.
      Successful become-FUTPART-2PL-DAT believe-CONT-1SG heart-ABL.
      'I whole-heartedly believe that you will become successful.' [tur]

This can be handled via a constraint on the resolution of fully scoped MRSs from underspecified representations, analogous to the constraint that requires all variables to appear within the scope of their associated quantifiers (Copestake et al., 2005; see also the discussion in Section 2). In this case, we stipulate that the modifier may not take a position lower in the

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[16]This distinction between consistent at the domain level but anomalous at the speech act level is also the basis for solving Moore's paradox (Hintikka, 1962)—that one would never utter *It's raining but I don't believe it*. This is satisfiable, but it is never coherent to assert it.

[17]The post-verbal position of the adverb in this example is an attempt to remove the possibility of syntactic attachment of the adverb to the lower verb. However, it appears that Turkish has a construction that allows for displacement of constituents to the post-verbal position, suggesting that that adverb might have been 'extracted' from the lower clause anyway.

scope tree than the one associated with the predication that introduces the event variable it is modifying as its ARG0. In (22), that would be the elementary predication _believe_v introduced by 'believe'. In other words, this constraint ensures that in any fully-scoped form that satisfies the MRS (22), _firmly_a shares its scope with _believe_v.

So far, we have only considered intersective modifiers. However, it is also important to make sure that the analysis of negation interacts properly with scopal modifiers. In contrast to the intersective modifiers, preliminary evidence suggests that scopal modifiers in Turkish cannot inject their labels into a lower position in the scope tree. Thus our consultants say that (23) can only mean (23a) and not (23b).

(23)   Köpek muhtemelen havla-ma-di.
       Dog   probably   bark-NEG-PST.
       'The dog probably didn't bark.' [tur]

   a. $\exists\, x\; dog(x) \wedge probably(\neg\, bark(x))$

   b. *$\exists\, x\; dog(x) \wedge \neg probably(bark(x))$

Similarly in Inuktitut, a because-type modifier clause combining with a negated clause is outside the scope of that negation. That is, unlike its translation in English, (24) is unambiguous (Elke Nowak, pc):[18]

(24)   qiurami   qilunngittuq.
       qiu-rami   qilu(k)-nngit-tuq
       be.cold-3S.CAUS.ITR bark-NEG-3S.ITR
       'It does not bark because it feels cold.' [ike]

The English translation could either mean that the dog does not bark and the reason for that is that it is cold or that the dog is barking, but for some other reason. The Inuktitut sentence only has the former meaning.

This is consistent with the analysis we have given so far. For the scopal modifiers to attach (semantically) inside negation, they would need to not only constrain their labels to be leq the label of the constituent they combine with, but actually break the qeq constraint established by the negative morpheme and replace it with two of their own, such that the negation operator's argument is qeq the label of the scopal modifier (e.g., Turkish *muhtemelen* 'probably') and the scopal modifier's argument is qeq the label of the verb. In other words, we would need to create a partial MRS for *muhtemelen* 'probably' such that it could combine with the MRS in (25) to create the MRS in (26). Setting aside the problem of how to make the label of *havla-* 'bark' visible for combination, such a representation would at any rate be inconsistent with a monotonic approach to semantic composition, as it would have to remove information ($h2 =_q l3$). Leaving that qeq constraint in is not an option, as each of neg, _muhtemelen_a and _havla_v must their own position in the scope tree; $h2 =_q l3$

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[18]It remains to be seen, of course, whether the typical HPSG head-modifier structure is an appropriate model for the way in which these two clauses are combined. We assume for the sake of the argument that it is, while acknowledging that this can't be known without more careful study of Inuktitut using HPSG.

allows quantifiers to intervene between neg and _havla_v, but not fixed-scope elements like _muhtemelen_a.

(25)   hook =   <l1,e>
         rels =   l1:neg(h2)
                    l3:_havla_v(e,x)
         hcons =   h2 $=_q$ l3

(26)   hook =   <l1,e>
         rels =   l1:neg(h2)
                    l3:_havla_v(e,x)
                    l4:_muhtemelen_a(h5)
         hcons =   h2 $=_q$ l4, h5 $= q$ l3

   To summarize this section, it appears that adapting the way that intersective modifiers attach semantically to the constituents they modify allows us to compositionally construct the same type of semantic representations for Turkish (and by extension, for other languages with inflectional negation, such as Inuktitut) as we do for English, despite their differences in morphosyntax. Only intersective, and not scopal, modifiers appear to need this modification, which is furthermore another point in favor of the approach presented in this section and against that presented in Section 4. For example, assuming that *often* is a scopal modifier, thereby reflecting the fact that semantically it quantifies over times and/or events, our analysis of negation matches intuitions in that it yields just one reading for each of (27a) and (27b): namely, the one where the relative scope of often_a and neg in logical form matches the order of *often* and *n't* in the string.[19]

(27)   a. We often don't open the window.
         b. We don't often open the window.

   Note, finally, that the modifications we propose are only in the deployment of a particular type of handle constraint. The leq constraint is not new (cf. Schlangen, 2003; Alahverdzhieva & Lascarides, 2011; and Egg et al., 2001), just not previously deployed (to our knowledge) for this purpose. Furthermore, the analyses we propose for the semantic contributions of intersective modifiers are compatible with the existing algebra for MRS composition (Copestake et al., 2001).

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[19]Dan Flickinger (p.c.) points out that *often* does not pattern syntactically with other scopal adverbs in English. In particular, it can appear in a post-VP position with no pause in intonation and without prosodic stress on the modifier, and this is not generally possible for the others (Muller & Kasper, 2000):

   (i) We open the window often/*probably.

We leave this puzzle for future work.

6 Conclusion

In this paper, we highlighted a number of challenges in providing a unified analysis of negation both in languages (like English) where it is lexicalized and in languages (like Turkish) where it is a morphological suffix on the verb. We explored two different ways in which such an analysis might be achieved, and argued for a solution where the scope constraints introduced by intersective modifiers are 'relaxed': instead of the adverbial's semantic predicate *always* being joined via conjunction to its head's predicate in a fully-scoped logical form, it can optionally take a lower position in the scope tree. This allows negation to attach in the morphosyntax before the intersective modifier does, while still allowing the modifier to appear lower in the position in the scope tree—this is the desired effect, since in this way negation semantically outscopes the intersective modifier. Thus we are able to maintain parallel semantic representations across the languages despite their divergent morphosyntax.

In future work, we would like to explore whether our proposed analysis would be useful for capturing the right scopal readings of other types of scopal elements that appear as bound morphemes in some languages or free morphemes in others, such as modals of situational possibility (Auwera & Ammann, 2011b) or epistemic possibility (Auwera & Ammann, 2011a). In addition, we plan to test these analyses and their compatibility with further interacting phenomena by adapting the Grammar Matrix (Bender et al., 2002, 2010) to reflect them.

Finally, our model of negation captures cross linguistic data by relaxing only scope constraints on intersective modifiers. If one were also to relax the constraints that identify the event that is modified by an intersective modifier, then it may be possible to simplify the mapping between form and meaning for utterances with PPs. For instance, one could conceivably create a grammar which assigns just one syntactic analysis to (28), where the PP attaches high. In the MRS associated with this analysis, the ARG1 of on would be left underspecified. Then constraints on the algorithm for resolving that MRS to complete and specific interpretations would yield exactly the two desired readings: one where the decision occurs on Tuesday, and one where the room is reserved on Tuesday.

(28)   We decided to reserve a room on Tuesday.

However, achieving such an analysis would involve relatively radical changes to the algebra for composing semantic forms, and to the algorithms for listing fully scoped and specific meaning representations from the underspecified MRS, and so it is beyond the scope of this paper to pursue this line of analysis here.

Acknowledgments

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