Experimental evidence for neg-raising in Slavic[*]

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Abstract: This article discusses new experimental data that provide evidence for the existence of neg-raising in Slavic languages (in particular, in Czech). The results of the experiment are interpreted in Romoli's scalar theory of neg-raising (Romoli, 2012, 2013).

1 Introduction

Neg-raising (NR) is an interpretational phenomenon: in biclausal structure like (1) the negation of the root predicate (*think*) is most saliently interpreted on the embedded predicate, that is (1a) is normally interpreted as meaning (1b). Not every predicate shows this property. For instance, verbs of communication are not neg-raisers, cf. the intuition that *John says that it's not raining* does not follow from *John doesn't say that it's raining*.

(1)   a. John doesn't think that it's raining.
        b. ⤳ John thinks that it's not raining.

The NR interpretation isn't predicted by the standard semantics of propositional attitudes (see, e.g., Hintikka 1969). For example, the verb *think* is formalized as a universal quantifier over

possible worlds, restricted to some modal base – see (2). This predicts that (2-a) does not entail (2-b). Thus, it seems that the standard semantics correctly characterizes communication verbs, but it fails for verbs like *think*. To put it differently: if we want to formalize the reasoning from (1-a) to (1-b), something more has to be said about NR predicates.

(2) $\|think\|(p)(a)(w) = \forall w' \in M(w,a)[p(w')]$
         a. $\neg [\forall w' \in M(w,a)[p(w')]]$
         b. $\nrightarrow [\forall w' \in M(w,a)[\neg p(w')]]$

While *think* is probably the most well-known example of NR predicates, other propositional attitude (PA) verbs are neg-raisers, too. Since Horn (1989), it is common to split NR predicates into five classes, and we will use this categorization in the current article, as well:

a) intention (*want, intend, ...*),

b) obligation (*advise, should, ...*),

c) perception (*seem, appear, ...*),

d) opinion (*know, believe, ...*),

e) probability (*probable, likely, …*);

Most research studying NR focuses on English.[1] One notable exception is Bošković & Gajewski (2009) (B&G) and Dočekal (2014), which consider Slavic languages without articles. B&G argues that NR is absent in these languages and shows how the finding follows from Gajewski's (2005) NR theory, which is a modern, sophisticated and updated version of Bartsch's (1973) presuppositional approach to NR. In contrast to B&G, Dočekal (2014) argues that predicates of intention and obligation (a and b above) pass standard tests for neg-raisers in Czech (a Slavic language lacking articles), that is, Czech has NR predicates, at least in Dočekal's introspection.

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[1]   For recent theories of NR, see Gajewski (2007), Romoli (2013), Collins and Postal (2014).

There are three tests Dočekal considers.

As discussed already by Lakoff (1969) (see also Gajewski, 2005, 2011, for a recent discussion), strict negative polarity items (NPIs) can be licensed by negated NR predicates. We will discuss properties of strict NPIs later in the paper. At this point, it suffices to say that *until* modifying punctual events is standardly considered an example of a strict NPI and that we see that *until tomorrow* is possible when embedded under negated NRs, (3-a), and ungrammatical under non-NR predicates, see (3-b).

(3)   a. Bill didn't think that Mary would leave until tomorrow.

        b. *Bill didn't say that Mary would leave until tomorrow.

The second standard test for NR-hood is the cyclicity of NR inferences. For example, (4-a) is most saliently understood as (4-b), in which the negation is interpreted on the most embedded predicate. This inference is broken if any of the predicates is a non-NR predicate.

(4)   a. I don't believe that he wants me to think that he wrote it.

        b. I believe that he wants me to think that he didn't write it.

The third standard test for NR-hood concerns the inference that NR predicates yield when appearing in the scope of a negated universal, e.g. (5-a) implies (5-b).

(5)   a. Not every student thinks that John is a good teacher.

        b. There are some students who think that John isn't a good teacher.

According to Dočekal's intuitions, Czech NR predicates pass all the three tests listed above. However judgments related to NR are subtle and hard. For this reason, we want to consider the existence of NR in Czech experimentally. We argue that the experiment confirms Dočekal's (2014) position and provides evidence against the empirical claim of Bošković & Gajewski

(2009). We interpret our data in the scalar framework of NR (originally coined by Horn 1989 and formalized currently in Romoli 2012, 2013).

2 Experiment

2.1 Method

2.1.1 Introduction

The experiment testing NR predictes in Czech consisted of two parts:

a) an **acceptability** judgement task,

b) an **inference** task.

2.1.2 Acceptability task: materials

The acceptability task tested how Czech native speakers accept so-called strict negative polarity items, NPIs (Zwarts, 1998). Strict NPIs are licensed in the subset of environments that license weak NPIs (on the latter, see, e.g., Ladusaw, 1979). What is important for us, it has been shown that strict NPIs can be licensed by clausemate negation or by negated NR predicates, and thus, they have often been used as tests for NR-hood (see, e.g., Gajewski, 2003). We will consider two types of strict NPIs:

1. *ani jeden* 'even one' + N type (like *ani jedna ovce* 'even one sheep'),

2. *až do* 'until' + time expression

The acceptability of strict NPIs was judged on a Likert scale from 1 (*absolutně nepřijatelná věta*, `sentence completely unacceptable') to 5 (*věta je naprosto v pořádku*, `sentence fully acceptable').

We tested the acceptability of strict NPIs in 5 conditions:

(A) in positive sentences,

(B) in simple negative sentence,

(C) in clauses embedded under negated NR predicates of intention (e.g., *want*) and judgement/obligation (e.g., *advise*),

(D) in clauses embedded under negated NR predicates of opinion (e.g., *believe*),

(E) in clauses embedded under negated non-NR predicates (prototypically verbs of communication and causation – *say, make, …*)

We split NR predicates into two conditions, C and D, to see whether different semantic classes of NR predicates behave differently. This is of interest since B&G tested NR across Slavic languages only on a representative of the opinion class, and it is conceivable that their conclusion were correct for that class, while group C does show properties of NR in Czech.

There were 40 items in the acceptability task. 5 lists were constructed out of the items and conditions in such a way that each item appeared only once in any list and the 5 conditions were `cycled' through the lists (repeated Latin-square design). Half of the items were tested with the strict NPI *ani jeden*, the other half used the strict NPI *až do*. All the items in the acceptability task were tested in all the 5 conditions (A) – (E) from above. One example of an item with strict

NPI *ani jeden* is presented in (6) (verbs and strict NPIs are boldfaced in the example but they were not marked in the experiment).

(6)   a. **Ztratila** se **ani**   jedna ovce.
        Lost   SE even   one sheep
        'A single sheep is missing.'
    b. **Neztratila** se **ani**   jedna ovce.
        neg-lost   SE even   one   sheep
        'Not a single sheep is missing.'
    c. Nový bača   v Tatrách **nechce**, aby   se ztratila **ani**   jedna ovce.
        new shepherd in Tatras neg-wants C-SUBJ SE lost   even   one   sheep.
        'The new shepherd in the Tatra mountains does not want a single sheep to be missing.'
    d. Nový bača   v Tatrách si **nemyslí**, že   se ztratila **ani**   jedna ovce.
        new shepherd in Tatras SI neg-think C-IND SE lost   even   one   sheep
        'The new shepherd in the Tatra mountains does not think that a single sheep is
missing.'
    e. Nový bača   v Tatrách **neříká**, že-IND se ztratila **ani** jedna ovce.
        new shepherd in Tatras neg-say C   SE lost even one sheep
        'The new shepherd in the Tatra mountains does not say that a single sheep is missing.'

Since we deal with strict NPIs, we expect that negative sentences, (6b), are more acceptable than positive sentences, (6a). However, the most interesting case for us is the contrast between (6c) and (6d), on one hand, and (6e), on the other hand. If Czech has NR predicates we expect that the examples (6c) and (6d), in which strict NPIs are licensed, are more acceptable than (6e), in which the licensing of strict NPIs should not take place.

Careful readers might have noticed that embedded clauses in Conditions C and D in the example above differ in their mood: condition C uses subjunctive (glossed as SUBJ and realized on the complementizer), Condition D and Condition E use indicative (glossed as IND on the complementizer). In the experiment, not every item had this distribution of mood. The items were constructed in such a way that (i) subjunctive mood was always used in Condition C because NR predicates of that group disallow any other mood, and (ii) 10 items in Condition D

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had indicative mood, while the remaining 30 items used subjunctive. Furthermore, Condition E (non-NR predicates) had 15 items in subjunctive mood and the remaining 25 items in indicative mood. This arbitrary division of subjunctive and indicative was caused by the fact that we did not consider mood a relevant factor when designing the experiment. We will come back to this issue.

The verbs we used in testing of the (C) environment were intention/judgement/obligation verbs like: *chtít* 'want', *hodlat, dopustit* 'allow', *mít v úmyslu* 'have intention', *přát si* 'wish', *vyžadovat* 'require, *potřebovat* 'need', *usilovat* 'strive', *radit* 'advice', *doporučovat* 'recommend', *navrhovat* 'propose'. The examples of verbs from the (D) environment are opinion verbs like: *myslet* 'think', *věřit* 'believe', *předpokládat* 'suppose', *představovat* 'imagine', *očekávat* 'expect', *uvažovat o* 'speculate', *domnívat se* 'assume', *soudit* 'judge', *spoléhat se* 'count on'. Lastly in the (E) environment we used non-NR predicates as *říkat* 'say', *slyšet* 'hear', *tvrdit* 'assert', *rozhlašovat* 'rumour', *naznačit* 'indicate', *prozradit* 'reveal', *sdělit* 'tell', *zavolat* 'call', *napsat* 'write', *způsobit* 'cause', *vyrozumět* 'inform', *nutit* 'force', *číst* 'read', *chápat* 'understand'.

There were also 30 fillers in the acceptability task.

All the stimuli were presented in random order for each participant.

2.1.3 Inference task: materials

In the inference task, which always followed the acceptability task, we tested whether Czech native speakers found three entailments valid. The entailments are usually taken as another test for NR-hood (see Horn, 1989, a.o.). The first condition tested the validity of NR itself (¬ NR[P] ↝ NR[¬ P]) illustrated in (7). Participants were asked whether (7-b) follows from (7-a). Note

that the sentence is similar to the one used in the acceptability task but there is no strict NPI used here. The second condition tested whether participants accept cyclic neg-raising ($\neg$ NR$_1$[NR$_2$[P]] $\rightsquigarrow$ NR$_1$[NR$_2$[$\neg$ P]]). For example, they were asked whether (8-b) follow from (8-a). The last condition targeted the existential wide scope inference ($\neg\ \forall x$ NR$_1$[NR$_2$[P]] $\rightsquigarrow$ $\exists x$ NR$_1$[NR$_2$[$\neg$ P]]), i.e., whether (9-b) follows from (9-a).

(7)   a. Nový bača   v Tatrách nechce,   aby   se ztratila jediná ovce.
      new shepherd in Tatras neg-wants C-SUBJ SE lost   single   sheep

      'The new shepherd in the Tatra mountains does not want a single sheep to be missing.'

    b. Nový bača   v Tatrách chce, aby   se neztratila   jediná ovce.
      new shepherd in Tatras wants C-SUBJ SE neg-lost   single   sheep

      'The new shepherd in the Tatra mountains wants no sheep to be missing.'

(8)   a. Myslivci nevěří,   že   nový bača   v Tatrách chce, aby   se ztratila jediná ovce.
      hunters not-believe that new shepherd in Tatras wants C-SUBJ SE lost   single sheep

      'The hunters do not believe that the new shepherd in the Tatra mountains wants a single sheep to be missing.'

    b. Myslivci věří,   že   nový bača   v Tatrách chce, aby   se neztratila   jediná ovce.
      hunters believe that new shepherd in Tatras wants C-SUBJ SE neg-lost   single sheep

      'The hunters believe that the new shepherd in the Tatra mountains wants no sheep to be missing.'

(9)   a. Ne všichni myslivci věří,   že   nový bača   v Tatrách chce, aby   se ovce měly dobře.
      not all   hunters believe that new shepherd in Tatras wants C-SUBJ SE sheep had well

      'Not all the hunters believe that the new shepherd in the Tatra mountains wants sheep to prosper.'

    b. Někteří myslivci věří,   že   nový bača   v Tatrách chce, aby   se ovce neměly dobře.
      some   hunters   believe that new shepherd in Tatras wants C-SUBJ SE sheep neg-be good

      'Some hunters believe that the new shepherd in the Tatra mountains wants sheep not to

prosper.'

20 items were used in the inference task. The items were split into 3 lists, so that each item appeared only once in each list and the conditions were 'cycled' through the items (in the same manner as in the acceptability task). Apart from the experimental items, the inference task also included 30 fillers. The experimental fillers were uncontroversial cases of either deductively valid inferences (like modus ponens: paraphrase of premises – *If it rains, the streets are wet; It is raining*; conclusion: *The streets are wet*) and cases of deductively non-valid inferences (logical fallacies). It is unlikely that the fillers had any impact on the inferences in the items and vice versa. The stimuli were presented in random order.

2.1.4 Procedure and participants

The experiment was prepared in Ibex and participants filled the experiment on-line. The experiment started with instructions. These were followed by practice items and the acceptability task. After that, the inference task was presented.

The experiment was answered by 60 Czech native speakers, mostly students of linguistics in Brno, who received a course credit for their participation.

2.2 Results of acceptability task

The fillers in the acceptability task were uncontroversially grammatical or ungrammatical according to our intuitions, and we used them to check that participants understood the task.

More concretely, we checked whether the average of each participant's responses to ungrammatical fillers was lower than the average of his or her responses to grammatical fillers. Indeed, every participant passed this test (there was at least 1 point difference between the two averages). We kept all the participants for the subsequent analysis.

Responses in the acceptability task were modeled by mixed-effects ordered probit regression in the R package ORDINAL.[2] The model had one predictor, Condition (condition C, i.e., *want* type of neg-raisers, was the reference level). The model also included subject and item slope+intercept random effects. The statistical outcome was the following:[3]

a) simple negated sentences (Condition B) with strict NPIs were judged as better than NR predicates from the reference level ($\beta = 3.2, z = 7.3, p < .001$),

b) simple positive sentences (Condition A) with strict NPIs were judged as worse than any NRs ($\beta = -1.5, z = -9.2, p < .001$),

c) sentences with negated non-NR predicates (condition E) were worse than NR predicates ($\beta = -0.8, z = -5.6, p < .001$)

d) there was no significant difference between two types of NR predicates (Condition C and Condition D) (p > .1)

The boxplots of the acceptability ratings depending on the 5 conditions are in Figure 1 and we

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[2] The advantage of using ordered probit regressions compared to the more familiar linear regression models is that the former only assumes that responses 1-5 are ordered but does not presuppose that the points in the scale are evenly spaced. Rather, the distance between any two points is modeled from data. This is good since it is possible that participants do not treat Likert scales as linear, e.g., the difference between 1 and 2 may not be the same as the difference between 2 and 3.

[3] When interpreting the outcome, it should help to know that thresholds between responses had the following estimates: 1|2: β = -1.1; 2|3: β = -0.06; 3|4: β = 0.7; 4|5: β = 1.6.

think this graphical summary visually matches what has been found using inferential statistics. We conclude that the statistical analysis is compatible with the following hypotheses about Czech:

a) *ani jeden* 'even one' and *až do* 'until' are strict NPIs (if they would be weak NPIs, they would be grammatical in Condition E, negated non-NR predicates; if they wouldn't be polarity items, we would expect that they are acceptable in Condition A, positive sentences; both predictions are incompatible with our findings),

b) Czech has a class of NR verbs – NR verbs of intention, obligation and opinion are able (with some interesting variation, discussed further) to license strict NPIs in their embedded clauses unlike Czech non-NR predicates, hence the difference between Condition C and D, on one hand, and Condition E, on the other hand. At the same time, there is a difference between NR predicates and clausemate negation in that strict NPIs are less acceptable in the former environment (cf. the difference between Condition C and D, on one hand, and Condition B).
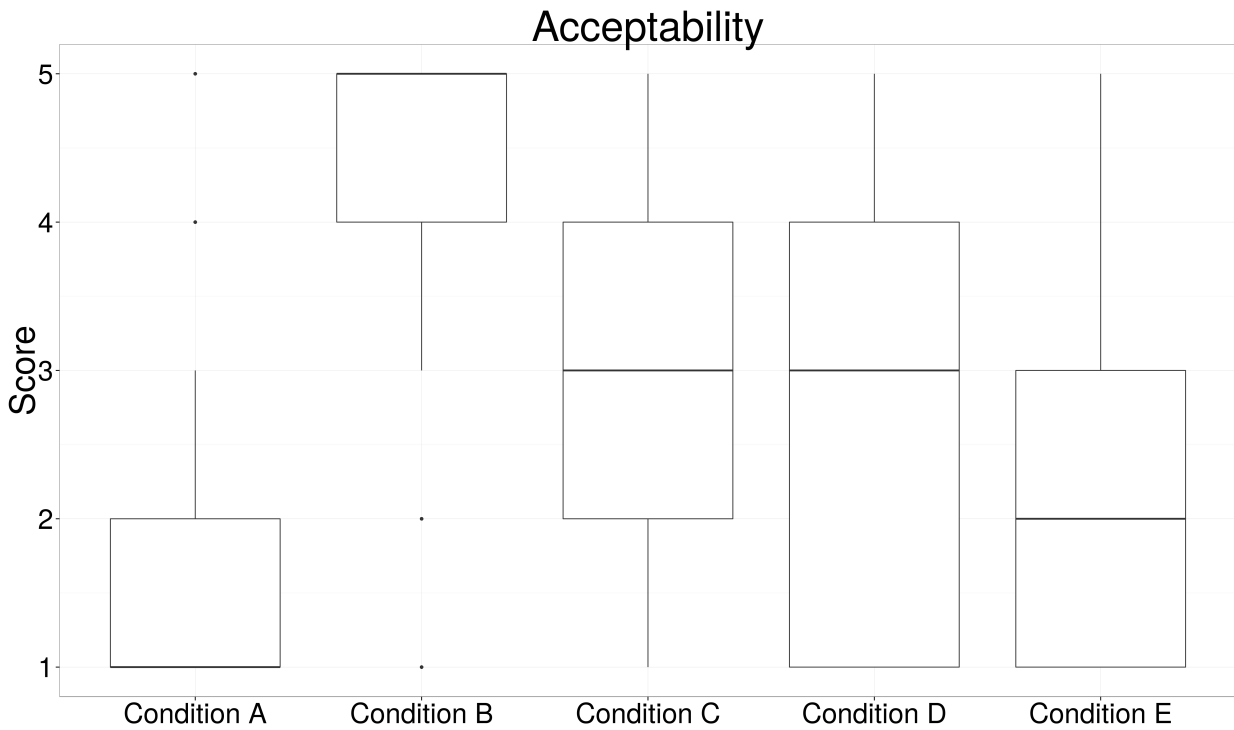
Figure 1: Results of the acceptability task

Two outstanding issues were investigated post-hoc. First, as noted above, we used two types of strict NPIs in the experiment. We wanted to see to what extent the two NPIs differ in acceptability. Second, two moods were used in NR predicates (subjunctive and indicative). Any differences between them in licensing strict NPIs were investigated. Importantly, the experiment was not designed to address either of the issues, so these results must be taken only as preliminary.

To study the first issue, we added a new factor to the model, NPI-type (with two factors, *ani jeden* `even one' and *až do* `until'; the former was the reference level) and its interaction with

Condition (as before, Condition C was the reference level). The model had the same random-effect structure as the previous one. What we see is that in Condition C, `until' is more acceptable than `even one' ($\beta = 0.4$, $z = 2.4$, $p < .05$). As before, positive sentences and non-NR predicates are judged as worse ($\beta = -1.7$, $z = -8.3$, $p < .001$ and $\beta = -1.1$, $z = -5.7$, $p < .001$, respectively), and negative sentences as better ($\beta = 4.7$, $z = 10.4$, $p < .001$). Condition D was judged as slightly worse with `even one' ($\beta = -0.4$, $z = 2.5$, $p < .05$). Importantly, NPI type interacted with Conditions: `until' × Condition D and `until' × Condition E led to higher acceptance ($\beta = 0.6$, $z = 2.6$, $p < .01$ and $\beta = 0.6$, $z = 2.3$, $p < .05$, respectively), while `until' × Condition B (simple negative sentences) was less acceptable ($\beta = -3.2$, $z = -6.4$, $p < .001$). The findings indicate that `even one' is a better representative of strict NPIs than `until' is. This is because `even one' is fully acceptable with clausemate negation and it is somewhat degraded with negated NR predicates and even more so with negated non-NR predicates, which is a behaviour one would expect from strict NPIs (disregarding the somewhat degraded status with negated NR predicates, which will be discussed later). The situation is more complex for `until'. As was the case for `even one', the best environment for `until' is clausemate negation, Condition B. But compared to `even one', `until' is *significantly less* acceptable there, which is surprising if it was just a plain strict NPI. Even more interestingly, `until' is *more* acceptable with negated NR and non-NR predicates (Conditions C, D and E) than `even one' is. To step back a bit, it seems that `until' lacks an environment that would fully license it, unlike `even one', at least as far as our experiment is concerned. This casts doubts on its status as a strict NPI and on using it as a testbed for NR-hood of predicates. Importantly for us, even when we restrict our attention only to `even one'-NPIs, we still see that NR predicates (Conditions C and D) are better licensors than

non-NR predicates or positive sentences.

The second post-hoc issue concerned the subjunctive/indicative difference. To study this factor, we analyzed only Conditions that used both moods (Condition D, NR predicates of opinion, and Condition E, non-NR predicates). Analyzing the data in mixed-effects ordered probit model with two fixed effects, Condition and Mood, we found that indicative mood degraded acceptability (β = -1.0, z = -4.7, p < .001), and so did non-NR predicates (β = -0.8, z = -5.4, p < .001). The interaction of the two factors was not significant (p > .1). To sum up, we see that mood plays a role in licensing strict-NPIs and unfortunately, this factor was not fully considered when we designed the experiment. At the same time, mood clearly cannot be the sole factor at play since even after we add it to the model, the difference between NR and non-NR predicates remains a highly significant predictor of the acceptability of strict NPIs.

2.3 Results of inference task

The inference task was analyzed in mixed-effects logistic regression where 1 = inference follows and 0 = inference doesn't follow, using R package LME4. Recall that the inference task consisted of three conditions:

Condition I: ¬ NR[P] ↝ NR[¬ P]

Condition II: ¬ NR$_1$[NR$_2$[P]] ↝ NR$_1$[NR$_2$[¬ P]]

Condition III: ¬ $\forall x$ NR$_1$[NR$_2$[P]] ↝ $\exists x$ NR$_1$[NR$_2$[¬ P]]

The model had one fixed factor, namely Condition. The model also included intercept-only

subject and item random effects (more complex models did not converge in LME4). In Condition I (the NR inference) the answer 1 (inference follows) was used in 65 percent of all cases, which was significantly higher than a chance (prob = 0.5) (β = 0.9, z = 3.3, p = .001),[4] so for Condition I we can safely say that NR reasoning was preferred.

For Condition II (cyclic NR) and Condition III (existential wide scope) the response 1 (inference follows) was used in 49% and 48% of all cases respectively, which was not statistically different from a chance (prob = 0.5) (p > 0.1). These mixed results are unexpected in all the previous theoretical accounts of NR, be it based on presuppositions or implicatures. We suspect that two factors play a role here:

i. The Condition II and III are more complex than acceptability task and Condition I. This was particularly clear from response times – Condition II and III took subjects 2-3 times longer than Condition I. It is reasonable that subjects got lost in complex sentences.

ii. Conditions II and III always used indicative mood in the first embedded clause. This will likely impede the NR-type inference, given that indicative mood also blocks the licensing of strict NPIs by NR predicates (see Section 2.2).

3 Analysis

We will now consider a framework that can explain all the main findings of our experiment. In

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[4]   The values are based on a mixed-effect logistic regression with one factor, Condition, and subject and item intercept-only random effects.

particular, there are two asymmetries that our theory of NR will have to deal with:

1. NR predicates of intention, obligation and opinion are better licensors of strict NPIs than non-NR predicates.

2. NR predicates are nevertheless worse strict-NPI licensors than clausemate negation.

We will consider a scalar approach to NR to capture both findings.

3.1 Scalar approach to NR

The scalar approach to NR was developed in Romoli (2012, 2013). In Romoli's approach, NR predicates are equipped with the set of alternatives that consists of the NR predicate itself, as well as the version in which the NR predicate is substituted by a predicate with excluded middle inference. An example is given in (10) for the NR predicate *want* and in (11) for *think*. The member in the set written as the first has the NR predicate itself, the second member is the predicate with the excluded middle inference. The second member can be paraphrased as being opinionated in case of *think*, or having a desire in case of *want*. Note that the (10a) and (11a) versions are just informal descriptions of (10b) and (11b).

(10)   a. Alt(want(p)(x)) = {want(p)(x), have a desire as to whether(p)(x)}
       b. Alt(want(p)(x)) = {$\Box_x[p]$, $[\Box_x[p] \lor \Box_x[\neg p]]$}
(11)   a. Alt(think(p)(x)) = {think(p)(x), have an opinion as to whether(p)(x)}
       b. Alt(think(p)(x)) = {$\Box_x[p]$, $[\Box_x[p] \lor \Box_x[\neg p]]$}

As an example, consider the computation of the meaning of the sentence *Susan wants to sleep*. We will write the interpretation as in (12), in which $\Box$ is the translation of the modal verb *want* (all the worlds compatible with Susan's wishes).

(12) $\Box_{susan}[sleep(susan)]$

Crucially, this interpretation can be further strengthened. Romoli (2013), following Chierchia (2004), assumes that propositions are strengthened by an exhaustivity operator, EXH, similar in its meaning to *only*. EXH is lexically specified as affirming the proposition to which it attaches and negating excludable alternatives. Excludable alternatives are alternatives that can be negated without contradicting the basic meaning, see (13).

(13)   a. $EXH(Alt(p))(p)(w) = p(w) \wedge \forall q \in Excl(p, Alt(p))[\neg q(w)]$
        b. $Excl(p, Alt(p)) = \{q \in Alt(p): \lambda w[\neg q(w)] \cap p \neq \varnothing\}$

Coming back to our example, we can indicate the basic meaning and the meaning of negated alternatives as in (14). What is worth noting is that neither negated alternative is excludable. Both members of the set contradict the basic meaning. This should be obvious for the first member of the set. The second member can be rewritten as $\neg\Box_{susan}[sleep(susan)]$ $\wedge\Box_{susan}[\neg sleep(susan)]$, which also clearly contradicts the basic meaning. Because of that, alternatives do not play any role in this case and consequently, we get (14) as the final meaning of the sentence.

(14)   Basic: $\Box_{susan}[sleep(susan)]$
        Negated alternatives:
        $\{\neg\Box_{susan}[sleep(susan)], \neg[\Box_{susan}[sleep(susan)] \vee \Box_{susan}[\neg sleep(susan)]]\}$

The situation changes when we consider the sentence *Susan does not want to sleep*. The negated alternatives are as shown in (15b), where *p* is an abbreviation of *sleep(susan)*. Now, the second alternative (the disjunction of two propositions) is excludable since it does not contradict the basic meaning. In fact, it strengthens it, as shown in (15b). The resulting interpretation is that

Susan wants not to sleep, which is the neg-raising inference.

(15)   a. Basic meaning: $\neg\square_{susan}[sleep(susan)]$

     a. Negated alternatives $= \{\neg\neg\square_{susan}[p],\neg\neg[\square_{susan}[p] \vee \square_{susan}[\neg p]]\}$

                                       $= \{\square_{susan}[p], [\square_{susan}[p] \vee \square_{susan}[\neg p]]\}$

     b. $\|EXH\| (\neg want_s[p]) = \neg\square_{susan}[p] \wedge [\square_{susan}[p] \vee \square_{susan}[\neg p]] \models want_s[\neg p]$

The consequence of exhaustification of NR propositions is that negation is interpreted as having

low scope. To put it more abstractly, $\neg$ *NR(p)* plus the alternative *NR(p)* $\vee$ *NR(¬p)* entails

NR(¬p).

But why should this entailment matter for strict NPIs? An answer to this question depends on

what we believe the exact mechanism for licensing strict NPIs to be. Currently, three standard

approaches are usually considered (see Gajewski, 2005, Gajewski, 2011 for summary and

details). Here, we will use that of Zwarts (1998): strict NPIs are licensed by anti-additive

functions. Anti-additive functions are defined in (16).

(16)   A downward-entailing function f is anti-additive iff for any a and b in the domain of f,

     $f(a)$ and $f(b) \leftrightarrow f(a$ or $b)$

Consider how (16) works for negation. (17b) follows from (17a) and vice versa, hence, we can

conclude that negation is anti-additive and can license strict NPIs, which is correct. The same

conclusion is shown more abstractly using propositional logic in (17c) and (17d). That (17c) and

(17d) are equivalent is a straightforward consequence of de Morgan's law.

(17)   a. It didn't rain and it didn't snow.
     b. It didn't rain or snow.
     c. $\neg p \wedge \neg q$
     d. $\neg[p \vee q]$

Crucially, the same conclusion holds for NR predicates. More concretely, (15b) follows from

(18a) and vice versa, or using modal logic, (18d) follows from (18c) and vice versa. To see the

latter, notice that (18c) says that in no worlds does p hold and in no worlds does q hold. But then, it follows that that there are no worlds in which $p \vee q$ holds. Similarly, if there are no worlds in which $p \vee q$ holds then it must be so that in no worlds does p hold and in no worlds does q hold.

(18)   a. Susan does not want to sleep and she does not want to dance.

      b. Susan does not want to sleep or dance

      c. $\Box \neg p \wedge \Box \neg q$

      d. $\Box \neg (p \vee q)$

For the equivalence of (18c) to (18d), we made use of NR-hood of the predicate *want*. Had we not done so, anti-additivity would not go through. In other words, (19b) does not follow from (19a). To see that, consider the following. (19a) is true if there is a world in which p is not true and a world in which q is not true. But (19b) requires that there is a world in which neither p nor q are true. That does not follow. In particular, if p is false only in the world w_1 and q is false only in the world w_2, then (19a) is true and yet, (19b) is false.

(19)   a. $\neg \Box p \wedge \neg \Box q$
      b. $\neg \Box (p \vee q)$

If this interpretation of NR and strict NPIs are correct, it follows that the NR inference (and with that, strict NPI licensing) should depend on various factors. First of all, the alternatives have to reach the EXH operator. Second, the alternatives have to be relevant (see Romoli, 2013, Sect. 7). Consider (20). The alternatives are relevant if (20) is an answer to a question under discussion (QUD) like *What does the new shepherd want his sheep to do?* But the exhaustification might not be an option. We will discuss this possibility in the next section.

(20)   'The new shepherd in the Tatra mountains doesn't want even one sheep to be missing.'

The last question we have to address is why we see no NR-like inferences with non-NR predicates. Romoli's answer, which we again follow here, is that alternatives triggering NR are absent for non-NR predicates. For example, the non-NR predicates *be certain* has universal and

existential quantification over possible worlds as its alternatives. This is shown in (21). Negating the existential alternative of (21) yields the inference shown in (21a). The full meaning is represented in (21b). Applied to the data in our experiment: we observed that negated non-NR predicates are unable to license strict NPIs in embedded clauses. This follows since non-NR predicates don't trigger the low scope interpretation of negation even when exhaustified and the anti-additive inference is not valid.

(21)   John isn't certain that Mary will arrive.
        a. ↝ It's possible for John that Mary will arrive.
        b. $\neg\Box_j[p] \wedge \Diamond_j[p]$

3.2 NR suspension – NR vs. simple negated sentences

We now turn to the question as to why strict NPIs are fully licensed by clausemate negation while negated NR predicates are worse licensors.

Gajewski (2007) observes that in English NR inferences can be suspended if the auxiliary in the main clause is stressed. *John DOESN'T think that Fred left* can be used to express that John is not sure about Fred's whereabouts. We believe that similar suspension can take place in Slavic.

One way to capture the suspension of inferences is to say that only relevant alternatives can yield inferences, and what counts as relevant can be modeled using questions under discussion (QUD). In this perspective, every sentence can be seen as an answer to its (implicit or explicit) QUD. QUDs, in turn, are questions that partition the common ground. Relevance is then defined as follows (following Romoli, 2013):

(22)   Relevance: A proposition p is relevant to a question Q iff p is (contextually equivalent with) the union of some subset of Q.

An example of a QUD is in (23). This question creates a partition like (20-a): affirmative propositonal attitude, negative propositional attitude and ignorance. In such a context the alternative triggering low scope negation is relevant because it is equivalent with c_3.

(23)   What does the new shepherd want his sheep to do?

    a. $Q = \{c_1 = want_s[p], c_2 = want_s[\neg p], c_3 = \neg(want_s[p] \vee want_s[\neg p])\}$

Given that QUDs affect inferences, they can modulate licensing of strict NPIs. Consider (24) where according to our intuitions the stress on the verb blocks the strict NPI in the embedded clause (a proper experimental study that would take intonation into account would be needed here, of course). What is focused is the affirmative/negative polarity of the clause. (There is another interpretation, in which the verb itself is focused, but that is irrelevant for now.) Theoretically we model this through the QUD in (25), which leads to the partition in (25-a). In this case, the alternative triggering low scope negation, namely, $\neg(think_s[p] \vee think_s[\neg p])$ is not relevant because it is not equivalent to any member in the partition. Consequently, the crucial inference licensing strict NPIs in the embedded clause is not calculated.[5]

(24)   Nový bača si NEMYSLÍ, že se ztratila *ani jedna ovce.
        New shepherd DOESN'T think that even-one one sheep dissapeared.

(25)   Does the new shepherd think that one sheep dissapeared?

    a. $Q = \{c_1 = think_s[p], c_2 = \neg think_s[p]\}$

This argumentation explains why simple negated sentences (Condition B) are always better as strict NPI licensors: their licensing ability is not dependent on exhaustification and hence it is not

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[5]   Romoli (2013) uses a different approach for licensing strict NPIs, following Gajewski (2011). Somewhat simplified, the theory states that strict NPIs are licensed only if the meaning strengthened by the application of EXH are downward-entailing. This approach would predict that cases like (24) allow strict NPIs.

sensitive to context manipulation. But, one might wonder, why do Czech and English differ? In English, licensing strict NPIs by NR predicates has never been questioned, as far as we know. In contrast to that, Slavic NRs have a less clear status, as seen in the disagreement in the literature (Bošković & Gajewski, 2009, vs. Dočekal, 2014), and as also visible in the lower scores of NR predicates in our acceptability study.

One option is that different morphosyntax of the two markers is to blame. English negation triggers do-support and thus, QUD targeting polarity can be straightforwardly marked by stressing the negation itself (plus its host, the semantically vacuous *do*). This is not possible in Czech where (the clausal) negation is a bound morpheme and has to be attached to the verb and cannot be independently stressed.[6] Since it is not possible to unambiguously mark the QUD targeting polarity, Czech speakers are likely to consider this interpretation without any specific signal. Consequently, Czech speakers might suspend the crucial inference more freely.

3.3 Subjunctive vs. indicative

We noted in our discussion of the experiment that two factors affect licensing of strict NPIs in embedded clauses: one was the type of the matrix predicate (NR or not-NR), and the analysis of that effect was provided in the previous section. The second factor is mood in the embedded clause (subjunctive vs. indicative). We assume that the indicative inhibition of NR inference is the second main factor behind the limited NR-hood of Slavic languages and we believe that it's not an accident that all B&G's examples against NR in Slavic are based on indicative embedded clauses.

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[6] This is also the reason that the example (21), with the stress on verb, can be understood as focusing the polarity of the sentence or the verb itself.

The indicative/subjunctive difference is orthogonal to our main interests and would probably deserve a paper on its own, so we will only shortly indicate what a possible approach could look like.

One option is that strict NPIs are better licensed by subjunctive than indicative mood because subjunctive is known to be more transparent for cross-clausal phenomena (see Progovac, 1993, a.o.). Translating this into semantics, it was observed (see Villalta, 2008) that only subjunctive mood transfers alternatives from the embedded clause to the matrix predicate, while indicative mood blocks them. Since the inference licensing strict NPIs requires the projection of alternatives from the embedded clause, it would follow that subjunctive mood is compatible with strict NPIs, while indicative mood is not.

4 Conclusion

This article discussed an experiment targeting neg-raising in Czech. Contra B&G (2009) we argued that NR exists in Czech (a Slavic language without articles). We showed that strict NPIs are more acceptable under NR predicates than under non-NR predicates, which follows naturally if Czech has a class of NR predicates. It is not clear to us how B&G (2009) could explain this contrast.

Somewhat surprisingly, we saw that there was a contrast between clausemate negation and NR predicates with respect to strict NPI licensing. However, we explained these data while maintaning that NR-hood exists in Czech. In particular, we argued that the data follow under the scalar theory of NR (Romoli, 2012, 2013) and the anti-additive licensing condition for strict NPIs.

Several issues were discovered in our experiment and remain open. One is the observed effect of mood on licensing of strict NPIs. Another one is the difference between `even one' and `until' and their interaction with licensing environments. Issues like these show that more than fifty years after Fillmore brought neg-raising to attention to linguists (Fillmore, 1963), neg-raising still did not say the last word.

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Summary: This article discusses new experimental data that provide evidence for the existence of neg-raising in Slavic languages (in particular, in Czech). The results of the experiment are interpreted in Romoli's scalar theory of neg-raising (Romoli, 2012, 2013).