When is not-believing believing that not?[1]

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Abstract. We present two experiments that studied the licensing conditions of two Czech expressions in neg-raising and non-neg-raising environments: *ani jeden* 'even one' and *až do* 'until'. English counterparts of these expressions are often treated as belonging to the same class, that of strict NPIs. However, our experiments revealed subtle differences between the two expressions, which we argue could be explained if we assume that only *ani jeden* 'even one' is a strict NPI, while *až do* 'until' is an expression sensitive to durativity of the predicate it modifies. The experiments furthermore showed that mood affects licensing of both *ani jeden* 'even one' and *až do* 'until' under neg-raising predicates. The role of mood on licensing is explained in Romoli's theory of neg-raising.

Keywords: Neg-raising, NPIs, mood, experimental semantics, Czech

1. Introduction

In this article we focus on an interaction of two phenomena: Neg-raising (NR) and Negative Polarity Items (NPIs) licensing. The phenomena have been treated as connected since the first formal approaches to NR. In particular, strict NPI licensing is standardly taken as a test of NR-hood (see Lakoff 1969 and Horn 1989, among others). NR is exemplified with (1): (1a) is in most contexts understood as (1b) – and this interpretation is the so-called NR reading of (1a).

(1) a. John doesn't believe that Mary was here.
b. $\rightsquigarrow$ John believes that Mary wasn't here.

The article has two aims: an empirical and a theoretical one. In the empirical part, we present new experimental data from Czech on NR and NPIs. The data show that the choice of mood (indicative vs. subjunctive) has an effect on licensing expressions sensitive to negation (NPIs being one main representative of such a category). Second, the data also show that not all expressions sensitive to negation are equal: in particular, we will observe that expressions like 'even' have a very different behavior from expressions like 'until' when interacting with negation. The theoretical point of the article is the argument that the effect of mood can be captured in Romoli's theory of NR-hood (Romoli, 2013), and that 'until' should not be classified in Czech as a strict NPI, in contrast to English.

The main part of the article discusses two experiments on NR, NPIs and mood, and the theoretical consequences of the experimental results. Before turning to the experiments and the theory, we need to prepare the ground. We begin so by giving a necessary background on Czech expressions sensitive to negation.

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2. Czech expressions sensitive to negation

In Czech, there are at least three groups of expressions sensitive to negation.

First, there is a class of weak NPIs, which is represented by the NP *sebemenší tušení* 'slightest suspicion'. We can see that it is a weak NPI since it requires a downward entailing (DE) environment in the at-issue meaning – see (2) – a standard condition for weak NPIs. There doesn't seem to be any locality constraint between this NPI and its licensor.

(2) Nikdo/málo lidí/*někdo o tom (ne)-měl-o/-0 sebemenší tušení.
nobody/few people/*somebody about that had slightest suspicion
'Nobody/few people/*somebody had slightest suspicion about that.'

In this article we stay agnostic as to the exact mechanism of weak NPI licensing (see, e.g., Gajewski 2011 and Crnič 2014 for two recent proposals). In fact, weak NPIs will not play any role in the following sections.

The second class consists of strict NPIs. These can be represented by NPs such as *ani jeden článek* 'not even one article'. Currently, several theoretical approches to strict NPIs co-exist (see Zwarts 1998, Giannakidou 2006, Gajewski 2011, Collins et al. 2014). Here, we will use that of Zwarts (1998): strict NPIs are licensed by anti-additive functions. Anti-additive functions are defined in (3).

(3) A downward-entailing function f is anti-additive iff for any a and b in the domain of f, $f(a)$ and $f(b) \leftrightarrow f(a \text{ or } b)$.

The condition of anti-additivity can explain why we observe the difference between (2) where the DE quantifier *málo lidí* 'few people' licensed the weak NPI and (4) where the licensing of the strict NPI is invalid:

(4) Nikdo/*málo lidí/*někdo (ne)-přečetl ani jeden článek.
nobody/*few people/*somebody read even one article
'Nobody/*few people/*somebody read even one article.'

On Zwarts' account, the explanation lies in the fact that the quantifier *málo lidí* is not anti-additive. To see this, consider a situation with six students, 3 of them dancing and (other) 3 of them singing. Assuming that 3 but not 6 is seen as a small number, the sentence *Few students were dancing and few students were singing* is true but the sentence *Few students were dancing or singing* is not – that is, the anti-additive condition is not satisfied by the DE quantifier *few people*). In general, since anti-additive licensors are a proper subset of DE licensors (see, e.g., Gajewski 2011) strict NPIs appear in some, but not all, environments that license weak NPIs.

A third class of expressions sensitive to negation are expressions of the type *až do* 'until + time expression', see (5).[2]

(5) Vojáci se *(ne)vystřídali až do půlnoci.
soldiers SE neg-change till to midnight
'The soldiers will not change until midnight.'

The English counterpart of *až do* is often taken as a good candidate for strict NPIs (when combining with predicates denoting episodic events). It is also widely used in testing NR properties of predicates (cf. Gajewski 2011, Romoli 2013). Nevertheless, we treat the Czech expression as a separate type. In particular, we assume it is an expression sensitive to durativity of the modified predicate (ESD), as can be seen by the fact that the Czech *až do* can appear with stative predicates, (6). The negative version of (5) is possible because negation changes a punctual predicate into a durative one (Krifka 1989, a.o.). We are not the first to take this position. In particular, *until* in English has been analyzed along this line by Smith (1974) and Mittwoch (1977). However, at least since Karttunen (1974), this type of analysis has been often challenged/substituted by an approach that postulates two types of *until*, one of which is sensitive to durativity and another one that appears with episodic predicates and is a strict NPI (see De Swart 1996 for a detailed discussion).

(6) Vojáci zůstanou až do půlnoci.
soldiers stay till to midnight
'The soldiers will stay until midnight.'

While we have nothing to say about the English case, we do have a novel argument that the Czech *až do* should not be analyzed this way. As we will demonstrate in the following part of the article, Czech examples containing *až do* 'until' with punctual predicates like (5) are very different from parallel cases of strict NPIs.

3. Experiments

In this section we describe the design of two experiments pertinent to the topic of the article. Both experiments targeted NR, NPI licensing and various factors influencing the licensing.

3.1. Experiment 1

The first experiment tested whether expressions sensitive to negation are accepted in clauses embedded under negated NR and non-NR predicates and how mood of the embedded predicate

[2] Apart from these three groups, Czech also has n-words (expressions requiring clause-mate negation):

(i) Nikdo *(ne)spal.
Nobody not-slept.
'Nobody slept.'

This class of negative expressions will not play any role in the rest of the article.

influences the acceptability. The experiment was a 3x2x2 design.

Three types of predicates were used (Condition: PREDICATE):

1. opinion class of NRs – see (7) for an item with a strict NPI;

2. probability class of NRs – see (8) for an item with a strict NPI;

3. non-NR predicates (mostly communication and causative verbs) – see (9) for an item with a strict NPI

All predicates embedded either indicative or subjunctive mood (Condition: MOOD). Finally, two types of expressions sensitive to negation were tested: either the strict NPI *ani jeden ...* 'not even one' or the ESD *až do* 'until' (Condition: NEGATIVE EXPRESSION). While the first two conditions were tested within items, the last one was a between-item condition. This was so because it would be hard, if not impossible, to have sentences that could be fully parallel up to the NPI/ESD difference.

An example with strict NPIs for opinion, probability and non-NR predicates are given here.

(7) Nemyslím, že 0/by ani jeden z běžců může/mohl ten závod vyhrát.
do-not-think-I that IND/SUBJ even one of runners can/could the race win
'I don't think that even one of the runners can/could win the race.'

(8) Není možné, že 0/by ani jeden z běžců může/mohl ten závod vyhrát.
it's-not possible that IND/SUBJ even one of runners can/could the race win
'It's not possible that even one of the runners can/could win the race.'

(9) Netvrdím, že 0/by ani jeden z běžců může/mohl ten závod vyhrát.
do-not-say-I that IND/SUBJ even one of runners can/could the race win
'I don't say that even one of the runners can/could win the race.'

The example items with ESDs *až do* 'until' are shown below for the same three predicate classes.

(10) Majitel toho hotelu neví, že 0/by kuchaři odjeli až do konce měsíce.
owner this hotel not-knows that IND/SUBJ cooks left up to end month
'The owner of this hotel doesn't know that cooks would leave/left until the end of the month.'

(11) Podle majitele toho hotelu není možné, že 0/by kuchaři odjeli až do konce měsíce.
according owner this hotel not possible that IND/SUBJ cooks left up to end month
'According to the new owner of the hotel it's not possible for the cooks to leave until the end of the month.'

(12) Majitel toho hotelu se nedoslechl, že 0/by kuchaři odjeli až do
owner this hotel not-hear that IND/SUBJ cooks left up to end
konce měsíce.
month
'The owner of this hotel doesn't hear that cooks would leave/left until the end of the month.'

The participants in this experiment judged acceptability of the items on 5-point Likert scale (5=best, 1=worst).

There were 36 experimental items. 18 experimental items were constructed with the ESD *až do* 'until', 18 experimental items appeared with the strict NPI *ani jeden* 'even one'. Furthermore, the experiment included 36 fillers, each of them an uncontroversially grammatical or ungrammatical sentence. All the fillers had their complexity comparable to the items.

60 Czech native speakers took part in the experiment which was run online on IBEX. 3 participants were excluded from the analysis due to their unreliable behavior in distinguishing good and bad fillers.[3]

3.2. Experiment 2

The second experiment also tested NR and NPI licensing in Czech. It consisted of two experimental methods – an acceptability and an inference task. For the topic of the current paper only the data from the acceptability part matter (for details of the whole Experiment 2 see Dočekal and Dotlačil 2016). In the acceptability test participants judged acceptability of *ani jeden* 'even one' and *až do* 'until'. The acceptability was judged on the 5-point Likert scale (5=best, 1=worst), as in the other experiment. 5 different environments were used in the experiment (Condition: ENVIRONMENT):

(a) simple positive sentences;

(b) simple negative sentences;

(c) clauses embedded under negated NR predicates of intention and judgment/obligation;

(d) clauses embedded under negated NR predicates of opinion;

(e) clauses embedded under negated non-NR predicates.

[3]On average, pariticipants judged grammatical fillers as better than ungrammatical ones by more than 2 points difference on the 5-point scale (the mean of the difference between judgements on good and bad fillers was 2.21) and every participant (apart from the three excluded ones) showed at least a 1-point difference. The mean difference between good and bad fillers for the three excluded participants was smaller than 1 point (0.62, 0.37 and 0.15). Since they reported much weaker sensitivity to grammatical/ungrammatical sentences, they were not used for further analyses.

In the conditions (c), (d) and (e) strict NPIs and ESDs were placed in embedded clauses. One item for all conditions is shown in (13).

(13) 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.'

The second manipulation was the type of negative expression. As in Experiment 1, either the strict NPI *ani jeden* 'even one' or *až do* 'until' was used. There were 40 items in total: 20 items appeared with the strict NPI 'even one' and other 20 items used the ESD 'until'. The experiment also included 30 fillers. The experiment was run on IBEX and 60 Czech native speakers participated in it.

Both experiments were filled out by students of Masaryk University and volunteers. While we do not know whether there were people participating in both experiments, we note that there was more than half a year break between the two experiments. Furthermore, different university classes were asked to participate in the two experiments, making it unlikely that the same participant was tested more than once.

4. Results

The results of Experiment 1, revealing the effect of mood and predicate type, are visualized in Figure 1.[4]

We analyzed the Experiment 1 using mixed-effects ordered probit models with two fixed effects: MOOD (indicative vs. subjunctive, the former being the reference level), PREDICATE (opinion (NR), probability (NR) and communication/causative (non-NR), the first one being the reference level), and their interaction. The model furthermore included intercept-only subject and item random effects. We found the following:

[4]Notice that the graph focuses on just a slice of the response scale (from 2.0 to 2.7), to make the contrast more transparent.

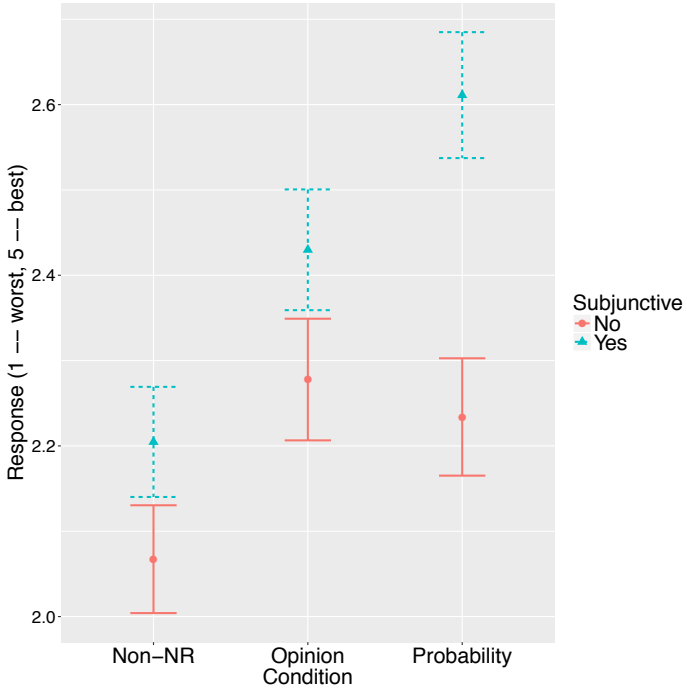

Figure 1: Experiment 1, means and standard errors for three predicates crossed by the subjunctive/indicative mood manipulation

1. NR predicates were judged as significantly better than non-NR predicates ($\beta = -0.22, z = -2.51, p = 0.012$). Recall that the acceptability was mostly influenced by the ESDs/NPIs and their licensing by the three types of predicates interacting with the mood.

2. There was no difference between the opinion and probability class of NR predicates.

3. The subjunctive mood acted as a facilitating factor in the acceptability: ESDs/NPIs embedded in subjunctive clauses were more acceptable than the ones embedded in indicative clauses: $\beta = 0.2, z = 2.39, p = 0.017$.

To study the effect of NPI type, we considered a second model, which added another fixed effect: NEGATIVE EXPRESSION ('even one' and 'until', the former being the reference level) and the interaction of this factor with MOOD and PREDICATE. The new model had a significantly better fit than the previous one (Likelihood ratio test, $p < .001$). The model revealed that ESDs 'until' were generally more acceptable than strict NPIs 'even one' ($\beta = 0.4, z = 2.65, p = .008$). The improvement was further strengthened in the case of probability predicates (there was a significant probability $\times$ 'until' interaction in the positive direction, $\beta = 0.48, z = 2.79, p = 0.005$).

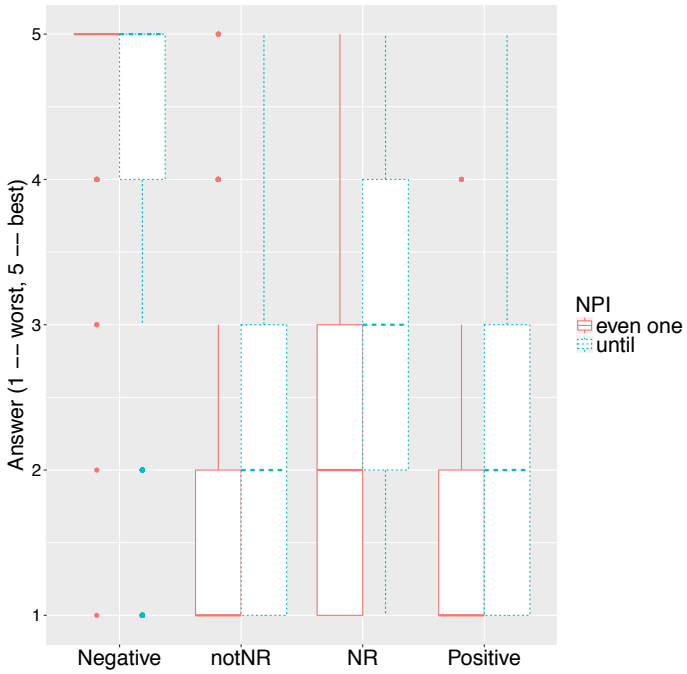

Figure 2: Experiment 2

The graphical summary of the second experiment is presented in Figure 2.[5] Recall that there were 5 environments tested in Experiment 2: NPIs/ESDs in simple positive clauses, in simple negative clauses, in clauses embedded under negated intention/judgment NR predicates, in clauses embedded under negated opinion NR predicates and in clauses embedded under negated non-NR predicates. To study the effect of these environments, we considered a mixed-effects ordered probit model with one factor, ENVIRONMENT (NR predicates of intention/judgment type were the reference level). The model also had the intercept+slope subjects and items random effects. The model showed that intention/judgement NR predicates were significantly worse than simple negative sentences ($\beta = 3.2, z = 7.3, p < .001$), and significantly better than positive sentences ($\beta = -1.5, z = -9.2, p < .001$). They were also significantly better than NPIs/ESDs embedded under non-NR predicates ($\beta = -0.8, z = -5.6, p < .001$), while there was no difference between two types of NR predicates (intention/judgement vs. opinion) ($p > .1$). The difference between NR and non-NR predicates seems stable – it was significant in both experiments, and we interpret it as showing that Czech has a class of neg-raising predicates, contra Bošković and Gajewski (2009) (see Dočekal and Dotlačil 2016 for the same point and more details).

To study the difference between the NPI 'even one' and the ESD 'until', we ran a second model, which consisted of the factor ENVIRONMENT, the factor NEGATIVE EXPRESSION (NPI or ESD, the former being the reference level) and their interaction. The model also included the full random structure for subjects and items.

[5] We did not use boxplots to summarize the results of Experiment 1 since the effects of mood are smaller than effects of NPIs and would be almost impossible to observe in such a graphical summary.

Replicating the results of the first experiment, the model yielded a significant effect for ESDs ($\beta = 0.45, z = 2.3, p = 0.02$), showing that 'until' was judged as better than 'even one' in the intention/judgement NR class. The positive effect was even stronger in the opinion class of NR predicates (opinion $\times$ ESD interaction – $\beta = 0.6, z = 2.43, p = 0.02$), as well as in non-NR sentences and positive sentences (non-NR $\times$ ESD interaction – $\beta = 0.6, z = 2.17, p = 0.03$; positive sentences $\times$ ESD interaction – $\beta = 0.89, z = 2.61, p = 0.009$). In our understanding, the positive interaction of 'until' with non-NR predicates and positive sentences shows that ESDs lead to less severe degradation than strict NPIs when appearing outside of their licensing environment. However, this would not explain why 'until' is better than 'even one' when embedded under NR predicates, since NR predicates should license both (cf., Gajewski 2005). It would also not explain the following finding: ESDs were *less* acceptable than NPIs when appearing in simple negative clauses (negative sentence $\times$ ESD interaction – $\beta = -3.92, z = -4.14, p < .001$). The last effect can be also observed in Fig. 2: while 'until' improves acceptability ratings in non-NR, NR and positive sentences compared to 'even one', it is clearly judged as worse than 'even one' in simple negative sentences.

5. Analysis and discussion

There are two main points of the results we want to address:

1. Why does subjunctive mood improve the acceptability of NPIs/ESDs?

2. Why is the ESD 'until' less acceptable than the NPI 'even one' in negative sentences, but more acceptable under NR predicates?

Let's start with the first queston.

We rely on Romoli (2013) and its scalar approach to NR: NR predicates contribute the at-issue meaning (universal quantification over possible worlds) and an excluded middle alternative (EM) implicature – formalized as the second alternative in (14a). Let's illustrate its working on an example: for a NR verb like *believe* EM is intuitively equivalent to subject's opinionatedness – a well-informed experiencer of the verb believes either the embedded proposition p (e.g. that it is raining) or its negation (that it is not raining). Consider now what happens when we interpret the sentence *John does not believe that it is raining*. Romoli, following Chierchia (2013), assumes that sentences come with an exhaustivity operator, EXH, that affirms the proposition and negates the alternatives that do not contradict the proposition (this is a slight simplification – see Romoli 2013 for the full account). Thus, when we combine the EXH operator with the sentence, the resulting meaning is as in (14b). This can be simplified into (14c). Intuitively: if John doesn't believe that it's raining and he's opinionated w.r.t. raining, then he believes it is not raining.

(14) a. $Alt(NR) = \{\lambda p \lambda x.\Box_x[p], \lambda p \lambda x.[\Box_x[p] \vee \Box_x[\neg p]]\}$
b. EXH(John does not believe that it is raining) = $\neg\Box_j p \wedge \neg\neg[\Box_j p \vee \Box_j \neg p]$
where $p =$ it is raining
c. $\Box_j \neg p$

The scalar theory of NR explains the acceptability of both ESDs and strict NPIs under negated NR predicates. For the former, it is crucial that negation creates a durative predicate (see, for example, Krifka 1989, a.o.). Given that it does and that the negation is interpreted on the embedded predicate, it suffices for the ESD 'until' to modify such a negated predicate to be licensed. For the latter, assume that strict NPIs are licensed in anti-additive environments (Zwarts, 1998). Then, they will be licensed when embedded under NR predicates. Somewhat more technically, since (15) is valid, strict NPIs are licensed under NR predicates. For more details, see Gajewski (2005).

(15) $\Box_x \neg p \wedge \Box_x \neg q \Leftrightarrow \Box_x \neg (p \vee q)$

But why would subjunctives facilitate licensing of strict NPIs/ESDs? We follow Villalta (2008) in her description of the subjunctive mood in embedded sentences as a transferer of alternatives into matrix clauses. According to Villalta, indicative mood, unlike subjunctive, stops such a transfer.

The observed effect of subjunctive follows from this approach. If alternatives can be transferred to the NR predicate, they can be computed. However, if they are not transferred (because they are stopped at the left periphery of the embedded sentence by the indicative mood), the exhaustification of the EM alternatives cannot proceed and the scope of the negation remains high. In this respect, Slavic languages reveal the dependency of NR interpretation on the availability of alternatives, which in turn supports the implicature approach to NR. The presuppositional approach (Gajewski, 2005) to NR would have to make some further assumptions to describe this type of dependency. The effect of mood could also be captured by syntactic accounts of NR (Collins et al., 2014), as subjunctives are generally more transparent for movement (Progovac, 1993).

We now turn to the second question: why do the ESD 'until' and strict NPI 'even one' differ from each other? First, notice that 'until' in Czech shows different scopal behavior than NPIs. NPIs generally cannot c-command their licensors (De Swart, 1998), see (16). Surprisingly, the reverse is true for the ESD 'until': while it is degraded in (17a) it improves when *až do půlnoci* 'until midnight' precedes/outscopes negation, (17b).

(16) a. Phil would not give me anything.
b. *Anything Phil would not give me.
(from De Swart 1998, ex. 8)

(17) a. ??Petr neusnul až do půlnoci.
Petr neg-fell-asleep up to midnight
'Petr didn't fall asleep until midnight.'
b. Až do půlnoci Petr neusnul.
up to midnight Petr neg-fell-asleep
'Until midnight Petr didn't fall asleep.'

In our experiment we used items with ESDs linearized after negated verbs (which is the default adverb placement), as illustrated in (18) (the simple negative condition).

(18) Vojáci se nevystřídají až do půlnoci.
soldiers SE neg-exchange up to midnight
'The soldiers will be not exchanged until midnight.'

Remember, that in such sentences ESDs were considered worse than strict NPIs. Changing the linearization seems to improve the acceptability of (18) considerably (although we lack a proper experimental support for our intuitions in this case). But recall that if *až do* 'until' would be an NPI, this effect would be totally unexpected. If anything, we would expect an opposite effect. This strongly suggests to us that *až do* 'until' is *not* a strict NPI (in contrast to what is commonly assumed about its English counterpart). More concretely, since Czech is a language in which arguments/adjuncts are often interpreted in their surface position (i.e., QR is much less common than in English), the ESD 'until' is interpreted as a modifier of the (non-negative) VP when appearing after the verb. This VP is punctual and thus, it cannot satisfy the requirement of 'until'. The change in linearization as in (17b) allows a different parse, one in which 'until' modifies the negated event, hence the improved acceptability of the ESD in this case.

But why would 'until' be more acceptable (as compared to the strict NPI 'even one') when modifying punctual predicates embedded under NR predicates? One explanation could go as follows. Negation is interpreted in the embedded clause at the logical form via pragmatic mechanisms. Since it is not syntactically present there, there is no signal from syntax whether the 'until' modifier should be interpreted in its scope or above it. In other words, there is no evidence from syntax that would support either interpretation. Given that, readers are free to pick the interpretation that is more suitable – and that is the one in which the ESD is interpreted above negation and the condition of the ESD is satisfied. Notice that this does not predict that ESDs should be better under NR predicates than in simple negative clauses. If the strengthening to EM is marginal to begin with (as Dočekal and Dotlačil 2016 argue), ESDs might be still less acceptable in this case than in simple negative clauses. What is (correctly) predicted is a relative difference: ESDs should be less acceptable than strict NPIs in simple negative clauses, but this difference should disappear in clauses embedded under NR predicates. Since ESDs are generally less degraded when lacking their licensor, compared to strict NPIs (as witnessed by the fact that ESDs are more acceptable than strict NPIs in positive sentences and clauses embedded under non-NR predicates), we furthermore expect that under NR predicates, ESDs should not just be as good as strict NPIs, but in fact, even more acceptable than strict NPIs – and this is correct.

6. Conclusion

We discussed two experiments that studied the licensing conditions of two expressions in Czech: *ani jeden* 'even one' and *až do* 'until'. English counterparts of these expressions are often treated as belonging to the same class, that of strict NPIs (Gajewski 2005 and references there). However, our experiments revealed subtle differences between the two expressions, which we argued could be explained if we assume that only *ani jeden* 'even one' is a strict NPI, while *až do* 'until' is an expression sensitive to durativity of the predicate it modifies. Aside from that, we also saw that Czech reveals effects of mood in licensing both *ani jeden* 'even one' and *až do* 'until' under NR predicates. The role of mood on licensing was explained in Romoli's theory of NR. Both points show that experimental work on languages less often stud-

ied (from the perspective of formal semantics) can clearly enrich our current understanding of language variation and interpretation.

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