

# The role of time in double NPI constructions with epistemic accessibility relations\*

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## 1. Introduction

The goal of this paper is to draw attention of the linguistic community to what can be descriptively called *double Negative Polarity Item (NPI) constructions*. These are bi-clausal constructions with embedding predicates, such as *think*, *believe*, and *expect*, in which one NPI scopes in the matrix clause and another NPI scopes in the complement clause. Importantly, the NPI in the complement clause is what is known in the literature as *strong/strict* NPIs. Example (1a) illustrates a double NPI construction. Throughout this paper, we will underline NPIs and refer to the NPI in the matrix clause as *high NPI* and to the NPI in the complement clause as *low NPI*. Example (1a) is reported to be ungrammatical (e.g., Lakoff 1969, Seuren 1974, Prince 1976, Gajewski 2005, Crowley 2019). This is surprising given that in the same configuration, the two NPIs separately are acceptable, see (1b) and (1c).

- (1) a. \*I didn't ever/at all think John would arrive until 10pm.  
b. I didn't ever/at all think John would arrive.  
c. I didn't think John would arrive until 10pm.

Most studies of double NPI constructions have been revolving around the paradigm in (1) and have focused on the contribution of the embedding predicates. These predicates form a natural class of verbs which allow negation in the matrix clause to be interpreted in the complement clause, the so-called *Neg-raising* predicates (NR). That is to say, they allow the inference from (2a) to (2b). This inference is illicit for other predicates, such as *say*, *prove*, and *accept*, compare (3a) with (3b).

- (2) a. John doesn't believe/think/expect that Mary is home.  
b. John believes/thinks/expects that Mary is not home.

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- (3) a. John didn't say/prove/accept that Mary was home.  
b. John said/proved/accepted that Mary was not home.

In section 2, we briefly discuss previous studies of double NPI constructions and their connection to the mechanism underlying NR. Generally speaking, there are two approaches to NR: a syntactic approach and a semantic/pragmatic approach. We will see that either of them can be used to explain (1). However, the moment we step beyond the examples in (1) and start exploring a larger range of double NPI constructions, the predictions of either the syntactic or semantic/pragmatic approach are no longer borne out.

In section 3, we present results of a study conducted on the Amazon Mechanical Turk (MTurk) platform, showing that the distribution of double NPI constructions is more intricate than previously assumed (and reported) in the literature. More precisely, we show that the level of acceptability of double NPI constructions depends on the choice of low as well as high NPI. Three conclusions are drawn from the results of our study: First, neither the syntactic nor semantic/pragmatic approach to NR combined with standard syntactic and semantic/pragmatic approaches to NPI licensing can explain the distribution of double NPI constructions. Moreover, no amendment of the syntactic approach to NR is conceivable. Thus, rather than being a strong argument in favour of the syntactic approach to NR (e.g., Crowley 2019), double NPI constructions, in fact, provide additional grounds for eliminating this approach (for other arguments against the syntactic approach to NR see, for example, Zeijlstra 2018).

The second conclusion that can be drawn from the results of our study is that double NPI constructions are interesting on their own rights (past Neg-raising). For example, they can inform us about the connection between the representation of epistemic predicates and domain-widening flavour of (some) NPIs. In section 4, we analyze a subset of the new observations building on the semantic/pragmatic approach to NR and the system of NPI licensing as in Gajewski 2011. The new data raise other questions. For example, they show that *not...ever* and *never* are not equivalent when it comes to the acceptability of double NPI constructions. We hope that these new observations attract interest to the phenomenon and will be useful for future research.

The third conclusion of our study is that more empirical research is needed in this area with a larger range of NPI combinations, a larger number of participants, and more diverse contexts. Section 5, which concludes our paper, discusses some of these questions and implications.

## 2. Double NPI constructions and Neg-raising

In this section, we look more closely at double NPI constructions and their connection to Neg-raising. Before we begin, a quick reminder about the distinction between weak and strong/strict NPIs is in order since, as mentioned in the introduction, the low NPI in double NPI constructions must be a strong/strict NPI. Expressions such as *in weeks*, *in years*, *in*

ages, and (punctual) *until*,<sup>1</sup> are NPIs with more restricted distribution compared to NPIs like *any* and *ever*. In particular, the former, but not the latter, are restricted to Anti-Additive (AA) contexts, (4),<sup>2</sup> and the former, but not the latter, have a locality restriction, (5). Because of these two properties, *in weeks*, *until*, and some other expressions are referred to as *strong/strict* NPIs, whereas *any* and *ever* are called *weak* NPIs (van der Wouden 1997, Zwarts 1998, Szabolcsi 2004, Gajewski 2007, 2011, Chierchia 2013, Collins and Postal 2014, a.o.).

- (4) a. John hasn't seen his mother anytime recently/in years.  
b. At most half of the students have seen their mothers anytime recently/\*in years. (Collins and Postal 2014:38)
- (5) a. Nobody has seen their mother anytime recently/in years.  
b. Nobody who has seen their mother anytime recently/\*in years is here.

One important consequence of the strong/strict vs. weak distinction is that in embedded clauses, weak NPIs are licensed under negated NR as well as non-NR predicates, whereas strong/strict NPIs are licensed only under NR predicates, compare (6a) with (6b) and (6c). Depending on the approach to NR, these observations can be attributed to the fact that the latter group of NPIs is strong or strict (see section 2.2).

- (6) a. Calvin did not believe/claim that Mona stole any of the money.  
b. Calvin did not believe/\*claim that Mona would move in until June.  
c. I don't think/\*agree that Teresa has been seen in days. (Collins and Postal 2014:6,8)

The purpose of the above discussion is to make it explicit where the specifications of double NPI constructions stem from. The low NPI must be a strong/strict NPI because only these NPIs exhibit the locality restriction. The embedding predicate must be NR because otherwise strong/strict NPIs would be unacceptable in the complement clause. This also makes it very understandable why initially, double NPI constructions have been used to inform us about the mechanism underlying NR.

## 2.1 Double NPI constructions in the literature

Several linguists have pointed out the paradigm in (1) repeated as (7), see Lakoff 1969, Seuren 1974, Prince 1976, Gajewski 2005, and Crowley 2019. In (7a), the strict/strong NPI punctual *until* is licensed under the negated NR predicate *think*. In (7b), *ever* and *at*

<sup>1</sup>*Until* was traditionally described as being ambiguous between a durative and a punctual reading. Recently, Iatridou and Zeijlstra (2019) have provided arguments for a unified analysis of *until*. As only the punctual *until* shows NPI properties, we keep its specification as punctual, for clarity.

<sup>2</sup>A function *f* is Downward Entailing (DE) iff for any arbitrary *A*, *B*, if  $A \subseteq B \rightarrow f(B) \subseteq f(A)$ . A function *f* is Anti-Additive (AA) iff for any arbitrary *A*, *B*,  $f(A \cap B) = f(A) \cup f(B)$ . It is easy to check that *at most* is DE, but not AA, whereas *not* and *nobody* are DE and AA.

*all*, two weak NPIs, are licensed in the same configuration in the matrix clause. However, when both the low and the high NPI are present the sentence becomes ungrammatical, (7c). It is important to make sure that *until* is interpreted in the complement clause, as indicated by the brackets in (7). In the rest of this paper, we omit the brackets, but assume that this requirement is met everywhere.

- (7) a. I didn't think [John would arrive until 10pm].  
 b. I didn't ever/at all think John would arrive.  
 c. \*I didn't ever/at all think [John would arrive until 10pm].

To the best of our knowledge, double NPI constructions have not been studied as a phenomenon on its own right. They have been mentioned as a side (or footnote) phenomenon in the literature on NR and are mostly restricted to the paradigm in (7). Below, we briefly review studies known to us which deal with double NPI constructions indicating the judgments provided by the authors. The upshot of this review is that the empirical grounds are not settled. First, the data sample is not representative as it usually involves the same low and high NPIs (*until* and *ever/at all*). Second, the grammaticality judgments are often controversial or even contradictory.

Lakoff (1969:142) mentions the contrast between (8a) and (8b)-(8d) and suggests that it casts doubt on the rule of Negative Transportation (Fillmore 1963), an ancestor of the modern syntactic approach to NR (see below).

- (8) a. I didn't think John would leave until tomorrow.  
 b. \*I didn't ever think that John would leave until tomorrow.  
 c. \*I never thought that John would leave until tomorrow.  
 d. \*At no time did I think that John would leave until tomorrow.

However, Lakoff (1969) also provides the examples in (9), which have a similar structure, but are grammatical, according to her judgements. She does not propose an explanation for the contrast between (8a) and (8b)-(8d), nor between (8b)-(8d) and (9).

- (9) a. No one thought that John would leave until tomorrow.  
 b. It wasn't thought by anyone that John would leave until tomorrow.

Seuren (1974, reprinted as Seuren 2001) repeats Lakoff's examples in (8b)-(8d) and adds the examples in (10):

- (10) a. \*I didn't think yet that Fred would get here until midnight.  
 b. \*Often I don't think he has got it yet.  
 c. \*He usually doesn't think there is as much as a shred of evidence.

Seuren (1974) attributes the ungrammaticality of (8b)-(8d) and (10) to the presence of the adverb in the matrix clause that blocks NR. He also points out that it is plausible that there is a deeper semantic reason for the blocking effect, but leaves this reason unexplored.<sup>3</sup>

Prince (1976:fn.7) independently points out the examples in (11) attributing them to Richard Smaby. For her, the ungrammaticality of (11c) is predictable in terms of the syntactic (raising) analysis of NR, the requirement on *until* to be clause-mate licensed, and *at all* to be under the scope of negation.

- (11) a. I don't at all think that John will leave.  
b. I don't think that John will leave until next week.  
c. \*I don't at all think that John will leave until next week.

The subsequent literature (Gajewski 2005, Crowley 2019) uses Prince's paradigm in (11) for their main (although opposite) claims. Moreover, Gajewski (2005:fn.2) challenges Lakoff's judgements (as well as her conclusions) reporting that according to his informants, (8c) is grammatical whereas (9b) is ungrammatical:

- (12) Lakoff 1969:  
a. It wasn't thought by anyone that John would leave until tomorrow.  
b. \*I never thought that John would leave until tomorrow.
- (13) Gajewski 2005:  
a. \*It wasn't thought by anyone that John would leave until tomorrow.  
b. I never thought that John would leave until tomorrow.

The discussion in this section shows that double NPI constructions have not been well studied from the empirical perspective. The data are scarce and grammaticality judgments are often controversial. In section 2.2, we take a look at the theoretical argument that double NPI constructions have been claimed to support.

## **2.2 Double NPI constructions and Neg-raising**

Double NPI constructions have been claimed to provide a strong argument in favour of a syntactic approach to Neg-raising (NR). As we saw above, NR is a phenomenon in which with certain predicates, such as *think*, *believe*, *expect*, and others, matrix negation can be interpreted in the embedded clause, (14). According to the syntactic approach to NR (in its modern version), NEGation originates in the embedded clause and then undergoes syntactic movement to the matrix clause, (15). The NR-reading arises when the low copy of NEG is interpreted (e.g., Collins and Postal 2014).

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<sup>3</sup>In modern terms, (10b) and (10c) can be explained as an intervention effect for NPI licensing, as in Chierchia 2013. This explanation, however, is not available for (10a).

- (14) John didn't think/believe/expect it would snow.  
 $\rightsquigarrow$  John thought/believed/expected it wouldn't snow. (NR-reading)
- (15) [ John did NEG think [ it would ~~NEG~~ snow ]]

Under the syntactic approach, punctual *until* in (7a) is locally (clause-mate) licensed by NEG in the embedded clause, whereas *ever/at all* in (7b) is licensed by the moved NEG in the matrix clause. Recall that *until* but not *ever/at all* is subject to the locality restriction. (7c) is unacceptable because, depending on a particular implementation, one of the NPIs remains unlicensed.<sup>4</sup>

An alternative to the syntactic approach to NR is a semantic-pragmatic approach, which derives the embedded reading of negation from the Excluded Middle (EM) inference (Bartsch 1973, Gajewski 2005, Romoli 2012, a.o.). For instance, the assertion in (16a) together with the EM in (16b) entails the NR-reading in (16c).

- (16) a. John didn't think it would snow.  
 b. EM: John thought it would snow or John thought it wouldn't snow.  
 c.  $\rightsquigarrow$  John thought it wouldn't snow. (NR-reading)

This approach has had little-to-nothing to say about the deviance of (7c) with the exception of Gajewski 2005. Gajewski (2005:71-2) suggests that double NPI constructions are unacceptable because with *ever/at all* in the matrix clause, EM projects existentially rather than universally, which does not guarantee the entailment in (16c) necessary for licensing *until*. This approach assumes that *until* being a strong NPI is licit only in AA environments which are derived at the entailment in (16c).

Both the syntactic and the semantic/pragmatic approach to NR explain the ungrammaticality of double NPI constructions by appealing to the way NR is derived. This reasoning predicts that the acceptability of double NPI constructions *does not* depend on a particular NPI in the embedded and/or matrix clause. For the syntactic approach, what is important is that the low NPI is a strict NPI, which requires clause-mate negation. Punctual *until* is one such NPI. Other strict NPIs and minimizers, like *in weeks*, *a living soul*, and *sleep a wink*, are predicted to be equally unacceptable in double NPI constructions. For the semantic/pragmatic approach, in addition to the above prediction, the high NPI should be an existential quantifier. In other words, the semantic/pragmatic approach predicts, for example, that substituting *not...ever* in (7c) by *never* should make (7c) fully acceptable for the EM under *never* projects universally and nothing interrupts the entailment necessary for licensing a strong NPI in the embedded clause.

<sup>4</sup>Arguably, this reasoning is supported by examples like *John didn't ever arrive until (after) 10pm*, where the two NPIs are licensed when occurring in the same clause.

### **3. Empirical landscape**

#### **3.1 Experimental foray**

As shown above, the empirical landscape leaves much to be desired. First, in terms of the scarceness of studies on double NPI constructions and second in terms of the conflicting judgments. Hence, we find ourselves in a position which calls for pursuing several preliminary goals before proceeding with the investigation. The first is to establish a better understanding of this construction by enlarging the quantity of empirical examples. The second is to move away from the introspective methodology in an attempt to gain better judgments. While introspection is a powerful linguistic tool in many cases, at certain points it is not enough. Among the problems discussed in the literature concerning this methodology (Wasow and Arnold 2005, Gibson and Fedorenko 2013), the following, adopted from Gibson and Fedorenko 2013, seem to play a role in the case of double NPI constructions: (a) the small number of experimental participants; (b) the small number of experimental stimuli; (c) possible cognitive biases on the part of the researcher and participants stemming from the unavoidable human factor and (d) the effect of the preceding context, for example, other constructions the researcher may have been recently considering.

Hence, in an attempt to untangle the intricate empirical landscape, we foray into the realm of quantitative methodology. Our goals – to enlarge the number of participants, to add more stimuli and to try and reduce our cognitive biases and the effect of the preceding context. In order to achieve that, we utilize the Amazon Mechanical Turk (MTurk) platform, widely used for linguistic based, as well as other, experiments (see Sprouse 2011 on MTurk’s reliability as an experimental tool).

#### **3.2 Amazon Mechanical Turk survey**

37 participants were recruited over the platform. We excluded 9 participants who did not complete the survey, resulting in 28 overall. In each trial, a participant was presented with a sentence containing target items and then asked to rank its level of acceptability on a 5 point Likert scale where 1 is the least acceptable and 5 is the most acceptable. There were 3 practice trials, 32 experimental trials, out of which 11 were fillers not containing any target items, and one trial checking the participant’s attention. Target items and fillers were pseudo-randomized.

Four items were designed to check baseline judgments. They contained the NPIs *until* and *in weeks/months* embedded under *think*, in either a negative environment with a wide scope negation or a non-negative environment.<sup>5</sup> The baseline items are shown in (17) with the mean judgements in square brackets, see also Figure 1. The standard prediction that strict/strong NPIs are licensed under negated Neg-raising predicates is borne out.

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<sup>5</sup>The survey also originally contained sentences with *sleep a wink*. The data on this NPI manifested a pattern which did not fit any of the theory-related predictions on NPIs, including high acceptance values in environments that do not license NPIs and low acceptance values in environments that do license NPIs. Since accounting for this puzzling behavior is beyond the scope of this paper, *sleep a wink* items were not taken into consideration.

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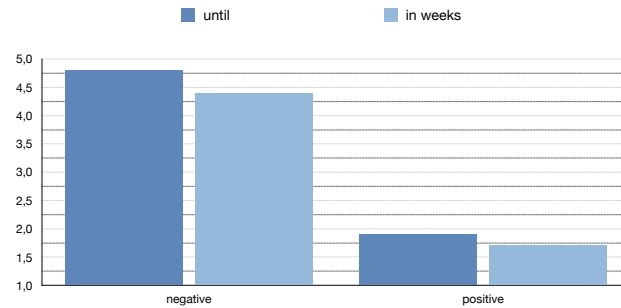


Figure 1: Baseline

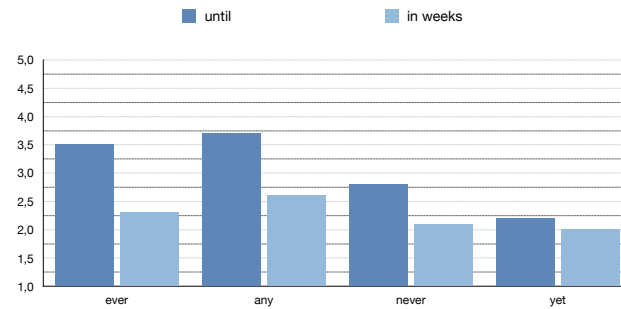


Figure 2: Different combinations of low and high NPIs

- |      |    |   |          |
|------|----|---|----------|
| (17) | a. | I don't think that Mary will arrive <u>until Thursday</u> . | [4.63/5] |
|      | b. | I don't think that John has been here <u>in weeks</u> .     | [4.31/5] |
|      | c. | I think that Sue will leave <u>until next week</u> .        | [1.89/5] |
|      | d. | I think that Mary has visited us <u>in months</u> .         | [1.73/5] |

The other trials in the survey dealt with double NPI constructions and tested for the combination of high NPIs *ever*, *any*, *never*, *yet* with low NPIs *until*, *in days/weeks/years*. The items with corresponding mean judgements are shown in (18) and Figure 2.

- |      |    |   |          |
|------|----|---|----------|
| (18) | a. | I didn't <u>ever</u> think that Harry would arrive <u>until Monday</u> .            | [3.42/5] |
|      | b. | I didn't <u>ever</u> think that Kate had been here <u>in years</u> .                | [2.26/5] |
|      | c. | I don't believe to <u>any degree</u> that Miriam will leave <u>until tomorrow</u> . | [3.57/5] |
|      | d. | I don't believe to <u>any degree</u> that Kyle has come <u>in days</u> .            | [2.52/5] |
|      | e. | I <u>never</u> believed that Dan arrived <u>until Friday</u> .                      | [2.73/5] |
|      | f. | I <u>never</u> believed that Charlie had visited us <u>in weeks</u> .               | [2.05/5] |
|      | g. | I didn't think <u>yet</u> that Jack would get here <u>until midnight</u> .          | [2.1/5]  |
|      | h. | I didn't think <u>yet</u> that Laura had been here <u>in weeks</u> .                | [2/5]    |

Note that the relatively high acceptability of *until* with *ever/to any degree*, compared to *in weeks*, goes against the predictions of the syntactic approach to NR. In addition, the low acceptability of sentence with *never* compromises the semantic/pragmatic approach.



A bar chart comparing the number of days 'until' (dark blue) and the number of weeks 'in weeks' (light blue) for three categories: 'down', 'flat', and 'up'. The y-axis represents the count, ranging from 1.0 to 5.0 in increments of 0.5. For the 'down' category, the 'until' value is approximately 4.3 and the 'in weeks' value is 2.5. For the 'flat' category, both 'until' and 'in weeks' values are approximately 4.6. For the 'up' category, the 'until' value is approximately 2.6 and the 'in weeks' value is 4.0.

Category	until	in weeks
down	4.3	2.5
flat	4.6	4.6
up	2.6	4.0

An interesting picture emerges when *at all* is used in the matrix clause of double NPI constructions. This picture, as the findings above, cannot be explained by the syntactic approach to NR. The configuration with *at all* shows three distinct patterns depending on whether *until* or *in weeks* is used in the embedded clause. We label these patterns ‘Down’ (*until* is (significantly) more acceptable than *in weeks*), ‘Flat’ (both *until* and *in weeks* are acceptable), and ‘Up’ (*in weeks* is more acceptable than *until*). The items with their means are given in (19) and illustrated in Figure 3. In the next section, we will concern ourselves with this observation.

- ### 3.3 Summary and outlook

#### 4. Proposal for *not...at all...until/in weeks*

(20) a. ??I don't think at all that John arrived until Friday. [2.6/5]  
b. I don't think at all that John has been here in weeks. [4/5]

Our proposal capitalizes on three ideas: (i) punctual *until* has a non-cancellable (modal) inference that the action occurs after the time specified by *until* (Karttunen 1974, Condoravdi 2008, Iatridou and Zeijlstra 2019), (ii) epistemic accessibility relations include a time index as well as a world one, and (iii) NPI-like predicate modifiers, such as *at all*, can be re-conceptualized from a domain-widener to an inhibitor of a contextual domain restriction. We elaborate on these ideas in the next three sections (sections 4.1-4.3). In section 4.4, we attend to the remaining two patterns ‘Down’ and ‘Flat’ in Figure 3 and suggest a tentative explanation for them.

#### 4.1 Change of State Inference of *until*

The observation that punctual *until* has a Change of State Inference (CoSI) goes back at least to Karttunen 1974. He points out that sentences like (21a) have the presupposition in (21b), which explains the infelicity of (21c). The status of the inference in (21b) (presupposition vs. non-cancellable implicature) is controversial (see Iatridou and Zeijlstra 2019 for the discussion), therefore, we refer to it simply as an *inference*.

- (21) a. John didn’t arrive until 10pm.  
 b.  $\rightsquigarrow$  John arrived after 10pm. (CoSI)  
 c. #John didn’t arrive until 10pm and maybe he didn’t arrive at all.

Following Iatridou and Zeijlstra (2019), we assume that the non-cancellable CoSI of *until* is modal, that is to say, it can be satisfied by a non-actual world, when the proposition is embedded under a modal. This assumption resolves the tension between infelicity of (21c) and felicity of (22). In (22), John’s leaving after 10p can be true in some non-actual future world.

- (22) John won’t leave until 10pm, if at all.

#### 4.2 Think and the satisfaction of CoSI

The key point of our proposal is that for the modal CoSI of *until* to be satisfiable, the set of worlds over which an attitude predicate like *think* ranges must be restricted along the time index. To model our account, we take the universal quantifier associated with epistemic attitudes like *think* to range over  $\langle w, t \rangle$ -pairs as shown in (24), where the time span of the doxastic accessibility relation  $R_x$  is contextually restricted by the selection function  $S_{[m,n]}$ .<sup>6</sup> This selection function can be thought of as analogous to the ordering source in Kratzerian double-base semantics for modals (Kratzer 1991, 2012). We assume that the flow of time is held fixed in a rigid manner due to the doxastic accessibility relation’s reliance on a *stereotypical* ordering source, whose assumptions adhere to a stereotypical flow of time across the relevant worlds. The intuition is that ‘ $x$  thinks  $\phi$ ’ does not make a statement about

<sup>6</sup>We retain the standard term *accessibility relation* although strictly speaking we represent this relation as a function.

all time intervals in  $x$ 's life, but is rather defined over an implicitly contextual time interval. Furthermore, we propose that when  $\phi$  contains punctual *until*, the domain of quantification of *think* is further contextually restricted on the right temporal boundary to align with the time specified by *until*, (25).

(23) **Notations used in this paper:**

$S_{[m,n]}$  = selection function restricting a set of  $\langle w, t \rangle$ s to  $t \in [m, n]$

$R_x$  = doxastic accessibility relation

$\langle w_c, t_c \rangle$  = actual  $\langle w, t \rangle$

$g1, g2$  = contextual time points such that  $g1 | \dots \dots \dots 10pm \dots \dots \dots | g2$

$C_{[m,n]}$  = time interval concept (i.e.,  $g(C_{[g1,g2]}) = \lambda w. \text{ a time interval in } w \text{ with } g1 \text{ and } g2 \text{ as its left and right boundaries}$ )

$\tau$  = event time span

$$(24) \quad \text{think}_x \phi = 1 \text{ iff } \forall \langle w, t \rangle \in S_{[g1,g2]}(R_x(\langle w_c, t_c \rangle)) : \langle w, t \rangle \in \phi$$

$$(25) \quad \neg \text{think}_x \phi[\text{until } 10pm] = 1 \text{ iff } \neg \forall \langle w, t \rangle \in S_{[g1,10pm]}(R_x(\langle w_c, t_c \rangle)) : \langle w, t \rangle \in \phi$$

The intuition (25) captures is that *until* makes statements like ' $x$  doesn't think  $\phi$ ' irrelevant after the time specified by *until* when the epistemic state is updated and the matter ( $\phi$  or  $\neg\phi$ ) is settled. More importantly, the additional domain restriction in (25) is necessary to ensure that CoSI of *until* is satisfied, (26). The assertion of (21a) is as in (26a), which states that it is not the case that in all speaker's belief  $\langle w, t \rangle$  pairs such that  $t$  spans  $[g1, 10pm]$ , John arrives before 10pm. (26b), which spells out the CoSI of *until*, (21b), says that from any speaker's belief  $\langle w, t \rangle$  with  $t \in [g1, 10pm]$ , there is an epistemically accessible  $\langle w', t' \rangle$  in which John arrives after 10pm. Crucially, if *think* ranges over  $\langle w, t \rangle$  with  $t \in [g1, g2]$  (unrestricted by *until*), CoSI cannot be satisfied since from  $\langle w, t \rangle$  with  $t \in [10pm, g2]$  where John arrived *before* 10pm,  $\langle w', t' \rangle$  where John arrives *after* 10pm is not accessible, (26c).

(26) a. Assertion of (21a):

$$\neg \forall \langle w, t \rangle \in S_{[g1,10pm]}(R_{sp}(\langle w_c, t_c \rangle)) : \\ \langle w, t \rangle \in \exists \tau [\tau = C_{[t,10pm]}(w) \wedge \exists e [\text{arrive}(e, j) \wedge e \subseteq \tau \wedge e < w]]$$

b. CoSI of *until*, (21b):

$$\forall \langle w, t \rangle \in S_{[g1,10pm]}(R_{sp}(\langle w_c, t_c \rangle)) \exists \langle w', t' \rangle \in R_{sp}(\langle w, t \rangle) : \\ \langle w', t' \rangle \in \exists \tau [\tau = C_{[10pm, g2]}(w') \wedge \exists e [\text{arrive}(e, j) \wedge e \subseteq \tau \wedge e < w']]$$

c. #CoSI of *until* (*think* is unrestricted):

$$\forall \langle w, t \rangle \in S_{[g1, g2]}(R_{sp}(\langle w_c, t_c \rangle)) \exists \langle w', t' \rangle \in R_{sp}(\langle w, t \rangle) : \\ \langle w', t' \rangle \in \exists \tau [\tau = C_{[10pm, g2]}(w') \wedge \exists e [\text{arrive}(e, j) \wedge e \subseteq \tau \wedge e < w']]$$

Informally, when an addressee contemplates the assertion of (21a), they contemplate the possibility of John arriving after 10pm. In order to do that, it must be the case that the contemplation is done *while there is something to contemplate*, that is to say, while the matter is not yet established. This is the work done by *until*—marking the point in

time after which new information affects the ordering source in a way that makes further contemplating a matter which has already been settled, inappropriate.

### 4.3 *At all* as predicate modifier that inhibits domain restriction

*At all*, in *John is \*(not) tired at all*, is standardly analyzed as a property modifier that triggers domain widening (in the sense of Kadmon and Landman 1993) by obligatorily introducing non-exhaustive alternatives, which explains its NPI status (Krifka 1995, Chierchia 2013, a.o.). In other words, *at all* requires to consider even minimal degrees of precision for tiredness, which are normally disregarded as pragmatically irrelevant. We propose that classical domain widening by *at all* can be re-conceptualized as a ban on (contextual) domain restriction. That is to say, instead of requiring to consider even the minimal degrees of tiredness, *at all* inhibits domain restriction to pragmatically relevant degrees of tiredness:

- (27) a. John is \*(not) tired at all.  
 b. Alternatives for *at all*:  $\{ P \mid P \subset \mathbf{tired} \wedge \neg \min(P) \}$  (simplified)  
 c. Non-exhaustivity:  $\cup \{ P \mid P \subset \mathbf{tired} \wedge \neg \min(P) \} \subset \mathbf{tired}$

With this re-conceptualization, it is easy to see how the paradigm in (7) is explained: (7a) has no *at all* and is derived similarly to (26a) and (26b). In (7b), *at all* requires that *think* ranges over all world-time pairs with an unrestricted time interval. This is unproblematic as there is no *until*. However, when both *until* and *at all* are present, (7c), the domain of quantification of *think* cannot be restricted by *until* for *at all* requires the widest possible domain and CoSI cannot be satisfied, as in (26c), which explains the infelicity of (7c). As *in weeks* does not have CoSI, we also explain the contrast in (20).

### 4.4 A note on three groups

Above, we proposed an explanation why in double NPI constructions, *until* is less acceptable than *in weeks*. We argued that the culprit is the non-cancellable Change of State Inference of *until*. However, in Figure 3, we saw that there are actually three patterns, which we labelled ‘Down’, ‘Flat’, and ‘Up’.

We tentatively suggest that these three patterns represent distinct groups of population that differ with respect to their pragmatic strategies. Recently, Haida et al. (2018) argue that the high error rate (>80%) in experiments concerning logical reasoning may be due to not taking into account different reasoning strategies. They provide experimental evidence that at least three groups of people can be distinguished with respect to whether they compute scalar implicatures (SIs) in premises, conclusions, or both in syllogistic arguments, see Table 1.

Given these findings, the difference between ‘Up’-group, on the one hand, and ‘Flat’ and ‘Down’ groups, on the other hand, may be attributed to the fact that the former but not the latter compute CoSI for *until* when judging the naturalness of a sentence. More research needs to be done (including more experimental work) to confirm this suggestion as well as to get to the bottom of the difference between the ‘Flat’ and the ‘Down’ patterns.

	<b>Logicians</b> don't compute SIs	<b>Validators</b> SIs for premises, but not conclusions	<b>Strengtheners</b> SIs for premises and conclusions
premise	weak	strong	strong
conclusion	weak	weak	strong

Table 1: Different reasoning strategies (Haida et al. 2018)

## 5. Concluding remarks

This paper's contribution to the literature on negation, via examination of double NPI constructions, is both theoretical and empirical. Our glimpse into the empirical landscape using an MTurk survey yielded a much more intricate picture than previously reported. The three conclusions that can be drawn from our study are: (i) the new data favors the semantic/pragmatic approach to Neg-raising over the syntactic one, (ii) double NPI constructions can inform us about matters far beyond Neg-raising and thus, deserve closer attention, and (iii) more empirical work is needed. Our analysis of a subset of double NPI constructions, in which both time and world indices play a role in epistemic accessibility relations, offers a semantic/pragmatic way to account for these constructions as well as a re-conceptualization of NPI-like predicate modifiers as contextual domain restriction inhibitors rather than domain-wideners.

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