languages

MDPI

Article

Not…Until across European Languages: A Parallel Corpus Study

Henriëtte de Swart [1,*], Jos Tellings [1] and Bernhard Wälchli [2]

[1] Utrecht Institute of Linguistics OTS, Utrecht University, 3512 JK Utrecht, The Netherlands; j.tellings@gmail.com
[2] Department of Linguistics, Stockholm University, 10691 Stockholm, Sweden; bernhard@ling.su.se
* Correspondence: h.deswart@uu.nl

Abstract: We present a parallel corpus study on the expression of the temporal construction 'not…until' in a sample of European languages. We use data from the Europarl corpus and create semantic maps by multidimensional scaling, in order to analyze cross-linguistic and language-internal variation. This paper builds on formal semantic and typological work, extending it by including conditional constructions, as well as connectives of the type *as long as*. In an investigation of 7 languages, we find that (i) languages use many more different constructions to convey this meaning than was expected from the literature; and (ii) the combination of polarity marking (negation/assertion) strongly correlates with the type of connective. We corroborate our results in a larger sample of 21 European languages. An analysis of clusters and dimensions of the semantic maps based on the enlarged dataset shows that connectives are not randomly distributed across the semantic space of the 'not…until' domain.

Keywords: temporal connectives; polarity; multidimensional scaling; compositionality; cross-linguistic variation; linkage

Citation: de Swart, Henriëtte, Jos Tellings, and Bernhard Wälchli. 2022. *Not…Until* across European Languages: A Parallel Corpus Study. *Languages* 7: 56. https://doi.org/10.3390/languages7010056

Academic Editors: Juana M. Liceras and Raquel Fernández Fuertes

Received: 1 October 2021
Accepted: 17 January 2022
Published: 1 March 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

This paper is a corpus study of 'not…until' constructions across a sample of European standard languages extracted from the parallel text corpus Europarl (Koehn 2005). A typical Europarl example is (1).

(1) The guidelines are *not* implemented *until* the end of 2010. [sentence uttered before 2010]

Until in (1) is a temporal preposition linking two event phases: a negative pre-phase of not implementing the guidelines is followed by a positive post-phase of implementation of the guidelines. The change from the negative to the positive phase occurs at or shortly after the time denoted by the NP complement of *until* (the end of 2010). As a temporal connective, *until* can also link two clauses, as in (2).

(2) Naturally, Turkey can*not* join the EU *until* all the criteria are met.

The speaker in (2) is a member of the European Parliament who argues that the situation of Turkey not-joining the EU will last until something happens that will lead to a change in state. Such clause linking is frequently encoded by *not…until* in Europarl, but we also find other means of expression, such as *only…when* in (3) or *if* in (4).

(3) *Only when* corruption has genuinely been eradicated in European countries should we try reverting to the imperious recommendations granted to various countries in the resolutions adopted, unfortunately, by us.
(4) Europe must mobilise the Solidarity Fund and we know that *if* the budget is *not* approved, the fund cannot be mobilised.

The examples report a change in state or a potential change in state. With the PP in (1), this is a purely temporal change from a negative phase to a positive phase. In

complex sentences like (2)-(4), the change in state is driven by the event of the subordinate clause. The grammar of *until* in (2) builds on a negative main clause and an affirmative temporal subordinate clause, a configuration that we abbreviate as NA. Temporality and conditionality are often mixed (note the modal verbs *should* in (3) and *can* in (4)), which leads to various related expressions. To give an idea of the range of possibilities, a non-exhaustive list of English paraphrases is provided in Table 1. Table 1 anticipates our results about the major types of expressions in the 'not. . . until' domain across European languages. Throughout the paper, we use small caps (UNTIL, BEFORE, IF) to refer to cross-linguistic types of connectives, and italics (*until, before, if*) to refer to language-specific instantiations of a particular category.[1]

Table 1. Set of paraphrases of *not. . . until* in (1) and (2).

IF (NN)	Turkey can*not* join the EU *if* all the criteria are *not* met.
UNLESS (NN)	Turkey can*not* join the EU *unless* all the criteria are met.
WITHOUT (NN)	Turkey can*not* join the EU *without* Turkey meeting all the criteria.
AS.LONG.AS (NN)	Turkey can*not* join the EU *as long as* all the criteria are *not* met.
UNTIL (NA)	Turkey can*not* join the EU *until* all the criteria are met. The guidelines are *not* implemented *until* the end of 2010.
BEFORE (NA)	Turkey can*not* join the EU *before* all the criteria are met. The guidelines are *not* implemented *before* the end of 2010.
ONLY.WHEN (AA)	Turkey can *only* join the EU *when* all the criteria are met. The guidelines are *only* implemented *at* the end of 2010.
ONLY.AFTER (AA)	Turkey can *only* join the EU *after* all the criteria are met.

Table 1 illustrates that the meaning conveyed by the original sentences in (1) and (2) can be expressed by various temporal connectives (UNTIL, BEFORE, WHEN, AFTER), exceptive phrases (WITHOUT) or conditionals (IF, UNLESS). Depending on the connective used, we find a negation in the main clause (UNTIL, BEFORE: NA), a negation in both main and subordinate clause (AS.LONG.AS, IF, WITHOUT, UNLESS: NN), or a focus particle (ONLY) in the main clause that combines with an affirmative subordinate clause (temporal or conditional: AA). Interestingly, the configuration AN is missing: there is no paraphrase in Table 1 that combines an affirmative main clause with a negative temporal clause. Examples with temporal NPs (rather than full clauses) have equivalents to the NA- and AA-construals, but not to the NN-construal.

Table 1 illustrates that both temporal and conditional strategies are used. We know that these meanings are intertwined, for instance, in the use of English *when* as a temporal connective and a domain restrictor (see Farkas and Sugioka 1983 for discussion). Our corpus study looks at these overlapping domains from a new angle by investigating the distributional patterns within and across languages. In this paper, we will investigate to what extent grammatical paraphrases of *not. . . until* such as the ones listed in Table 1 occur in a range of European languages represented in the Europarl corpus, and what determines their choice language-internally and cross-linguistically. The research questions we will address in the paper are listed in Table 2.

Table 2. Research questions addressed (Q1–Q4).

(Q1) To what extent can the various strategies in Table 1 be identified in the parallel corpus data, and what is their distribution?
(Q2) To what extent do connectives and polarity interact, and can we provide a compositional semantics for the patterns NN, NA and AA?
(Q3) To what extent does the choice of coding strategy depend on 1. cross-linguistic differences 2. semantics and pragmatics, or, 3. is it free variation?
(Q4) What is the relationship between temporality and conditionality in the 'not. . . until' domain?

The methodology relies on parallel corpus data, and we use multidimensional scaling as a statistical and visualization technique to reveal the patterns. This resembles the approaches in Wälchli and Cysouw (2012), Wälchli (2018/2019), and has been dubbed *Translation Mining* by van der Klis et al. (2017). The methodology will be introduced in Section 3, but see van der Klis and Tellings (2022) for a more exhaustive overview. A special feature of this paper is that we do not only use Translation Mining to investigate cross-linguistic variation in a lexical domain (in our case, choice of connective), but also to study the co-occurrence of two grammatical markers: connective and polarity marking in main and subordinate clauses. These markers interact compositionally to determine the semantics and pragmatics of the 'not. . . until' construction. Hereby we contribute to the underexplored field of cross-linguistic variation with respect to compositional meaning (see von Fintel and Matthewson 2008 for the need to study variation of meaning composition). Finally, this work can be seen as connecting insights and methodology from the typological approach and the formal semantic approach.

Our corpus study proceeds in two steps that are based on two different multilingual datasets, named D1 (fewer languages, more parallel datapoints) and D2 (more languages, fewer parallel datapoints), both extracted from Europarl. We start in Section 3 with dataset D1, which is constructed based on information from the literature discussed in Section 2. It contains 7 European languages, which exemplify the main clusters of connectives found in Wälchli (2018/2019). The intermediate results of analyzing D1 in Section 4 reveal that there is stability with respect to the combination of connective and polarity pattern, as predicted by compositional semantics (research question Q2). Future vs. past time reference turns out to play a role in the balance between conditionality and temporality, and in that sense the Europarl data fill a gap in comparison to earlier discussions in the literature (Q4). Surprisingly, we find much more variation in connective choice than previous literature led us to expect (research questions Q1 and Q3). In order to deal with the large amount of variation, we created a second dataset D2 which contains fewer datapoints, but more languages. The increase in number of languages to 21 allows for more robust statistical testing of patterns of cross-linguistic variation and stability (Section 5). The analysis of D2 in Section 5 replicates the two main findings from D1 in terms of strategies (Q1) and compositionality (Q2). The larger set of languages reveals more language-internal and cross-linguistic stability in the data after all, and thus resolves some of the issues that arose after D1 (research question Q3). Before we proceed to the parallel corpus study, we provide a short background on the construction at hand from the perspective of the semantic and typological literature in Section 2.

2. Theoretical and Typological Reflections on NOT. . . UNTIL

2.1. Formal Semantics of NOT. . . UNTIL

The formal semantic literature on NOT. . . UNTIL focuses on scope, polarity and lexical composition in relation to (constructed) examples like (5) (see de Swart 1996).

(5) The princess did *not* wake up *until* nine o'clock.
(6) The princess slept *until* nine o'clock.

Under the formal semantics of Kamp (1968), *until* is expected to combine with durative verb phrases like *sleep* in (6), but not *wake up* as in (5). The felicity of a telic verb like *wake up* in contexts like (5) has been taken to support three possible analyses:

(i) A scopal ambiguity analysis of negation as an aspectual operator leading to durative phrases as its output (Smith 1974; Mittwoch 1977);
(ii) A lexical ambiguity analysis in which there is a punctual *until* meaning 'before' functioning as a negative polarity item (NPI) next to the familiar durative *until* (Karttunen 1974) or
(iii) A construction-based analysis in which 'until *t*' directly composes with *not* to mean 'from *t* onwards' (Hitzeman 1991) or 'only at *t*' (Declerck 1995).

All analyses claim to account for the fact that the event of the princess waking up actually took place, and that this was considered late (the speaker or the addressee might have expected it to occur earlier than nine o'clock). However, the authors follow different routes in building up the meaning of (5). de Swart (1996) uses a standard event-based compositional semantics and basic insights from the pragmatic literature about conversational implicatures to probe into approaches (i)–(iii) to *not*... *until*. She argues that they are equivalent in that they all derive the relevant meaning components of a sleeping phase followed by an awake phase that starts at, or shortly after, nine o'clock. What is part of the truth conditions under one analysis ends up being a conversational implicature under another one, and vice versa, so equivalence of meaning requires a combination of semantics and pragmatics. We do not replicate the argumentation, but refer to de Swart (1996) for technical details. We focus here on her suggestion that the different proposals are motivated by cross-linguistic variation in the expression of the particular meaning at stake. This idea is grounded in Karttunen's (1974) observation that Finnish would use *ennen* 'before' in configurations like (5), but clearly this connective is used to translate *before* in affirmative sentences. Hitzeman (1991) and Declerck (1995) might be inspired by the fact that German and Dutch use scalar adverbs like *erst* and *pas* in the translation of examples like (5), as we see in the Dutch example in (7).

(7)	De	prinses	werd	*pas*	om	negen	uur	wakker.	[Dutch]
	the	princess	became	only	at	nine	o'clock	awake.	
	'The princess didn't wake up until nine o'clock.'								

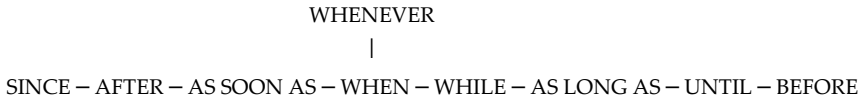
The adverbs *erst* and *pas* are focus particles similar to English *only*, except for the fact that they convey exclusion on a scale. So (7) excludes all times before nine o'clock as wake up times for the princess. We have encountered *not*... *before* and *only*... *when* as possible counterparts of the *not*... *until* configuration in Table 1, so the emerging hypothesis is that languages use different strategies to convey the meaning that English encodes as *not*... *until* in (6), and native speaker intuitions may have inspired the various authors to their respective analyses. The combination of the focus particle *only* and the temporal connective *when* in affirmative main and subordinate clauses profiles the positive post-phase, leading to a different balance between assertion and implicature than the configuration with *not*... *until* in (2). In contrast, the conditional sentence in (4) profiles the negative pre-phase by using negation in both clauses to convey the dependency of mobilization of the funds on approval of the budget.

One of the aims of this paper is to check whether parallel corpora provide empirical support for the idea that different languages use different grammatical strategies to convey the meaning of examples like (6). Research question Q1 in Table 2 is driven by typological investigations of NOT... UNTIL.

2.2. NOT... UNTIL *from a Typological Point of View*

Most typological investigations of temporal clauses address much larger domains such as subordination (Cristofaro 2003) or adverbial clauses (Kortmann 1997; Thompson et al. 2007; Hetterle 2015). Kortmann (1997: 185) offers the semantic map of temporal

connectives in European languages in Figure 1 as a "simplified view of the TIME network". Its horizontal dimension can be read as a scale from anterior via simultaneous to posterior temporal relations and its vertical dimension opposes definite time (bottom) to indefinite time (top), where generalizing temporal clauses (contingency) are added. In Kortmann's map, UNTIL and BEFORE occur as adjacent domains, but 'not. . . until'—as elsewhere in the typological literature—does not figure as a domain of its own.



(Latinate labels replaced by English labels and boxes replaced by lines).

Figure 1. Semantic map of temporal clauses following Kortmann (1997, p. 185).

Wälchli (2018/2019) focuses on the three temporal connectives at the right end of the scale in European languages (including some Indo-European languages in Asia). He investigates 133 passages from the New Testament in 72 languages (*doculects* in his terminology). He constructs a semantic map where NOT. . . UNTIL figures in an intermediate zone between BEFORE and UNTIL and identifies Modern Swedish *förrän* as a dedicated temporal connective in negative contexts. The same holds for Icelandic *fyrr en* and Faroese *fyrr enn*. A Swedish example from the Bible corpus is in (8).

(8)

Han	rörde	henne	*inte*	*förrän*	hon	
3SG.M.NOM	touch.PST	3SG.F.OBL	not	NPI	3SG.F.NOM	
hade	fött	en	son.			[Modern Swedish]
have.PST	give.birth.SUP	a	son			

'and did not have sexual relations with her until she gave birth to a son.'

The other languages of the sample all display some sort of overlap between markers in the 'not. . . until' domain with connectives that also express BEFORE, UNTIL or AS.LONG.AS, notably BEFORE in other Northern European languages such as Finnish and Danish, UNTIL in Western European languages and connectives not differentiating between AS.LONG.AS/UNTIL in many Eastern European languages. His special interest resides in Baltic languages, and he shows that all three patterns are found in this language group.

de Swart (1996) and Wälchli (2018/2019) investigate essentially the same meaning, but they do so from different perspectives. Wälchli shows that NOT. . . UNTIL emerges as a temporal domain of its own between UNTIL and BEFORE. The overlap with UNTIL or BEFORE aligns with two of the three analyses of NOT. . . UNTIL in the semantic literature reviewed by de Swart. The forms taken into account vary slightly across the two papers. Both discuss the configurations NOT. . . UNTIL and NOT. . . BEFORE, with a link to negative polarity. De Swart adds the configuration ONLY. . . WHEN as a strategy found in Germanic languages like Dutch and German. No languages using ONLY. . . WHEN occurs in Wälchli's dataset as a major strategy in the 'not. . . until' domain, but he adds the configuration NOT. . . AS.LONG.AS. . . NOT, which was not part of de Swart's paper. Table 1 suggests that we further need to branch out into conditionality and exceptive phrases (identified by Wälchli 2018/2019 as minor strategies, but not dominant in any language of the sample).

This paper investigates all possible configurations to convey the meaning of examples like (1)–(3) and (5)–(6). As a representative set of languages that we expect to instantiate these configurations, for D1 we take Swedish (NOT. . . UNTIL$_{NPI}$), Finnish (NOT. . . BEFORE), English (NOT. . . UNTIL), Lithuanian (NOT. . . AS.LONG.AS. . . NOT), German and Dutch (ONLY. . . WHEN). We add French to the dataset, because it is unclear from de Swart (1996) what strategy this language adopts. In this study, we use Europarl to collect independent evidence for the generalizations made in Wälchli (2018/2019) in a different corpus.

2.3. NOT. . . UNTIL *Constructions and Linkage*

In Section 1 we introduced the idea that *not. . . until* links clauses and expresses a potential change in state. Many Europarl examples verbalize a particular kind of crossover of interests and control. In example (2) we see that the change considered necessary by the speaker is not controlled by the speaker, but by Turkey, as this country has to take action to meet the criteria. The utterance further suggests that if and when all the criteria are met, this will qualify Turkey for joining the EU. The Europarl corpus contains political content, and therefore it is not surprising that we find many examples illustrating this crossover of interests and control: one party desires one event to take place of which the other party is in control and vice versa. This phenomenon is called *linkage* (or *iunctim*) in political literature. Bow (2010: 3) defines political linkage as "efforts to break an impasse or otherwise improve one's bargaining position on a particular issue by tying it to another, unrelated issue". For a linguist, this statement is reminiscent of Lehmann's (1988: 182) definition of clause linkage: "a relation of dependency or sociation obtaining between clauses". If particular issues to be linked are articulated in clauses, political linkages can be expressed by clause linkage. Political linkage is a prototypical domain for 'not. . . until' constructions in the Europarl corpus.

3. A Parallel Corpus Approach

3.1. The Problem of Bias

A parallel corpus investigation of NOT. . . UNTIL has two main advantages. First, corpus data in general are to be preferred over made up examples, because they provide us with meaning in context. If we have a large enough dataset, the similarities between datapoints give rise to patterns of language use that we can relate to grammar. Second, we do not need to define the meaning independently of the language under consideration. We trust the professional European translators to agree on the meaning that is expressed in the context at hand, and to select the appropriate expression to convey that meaning in the target language.

This assumption comes with the potential problem of translation biases, such as source language interference. This problem is not specific to Translation Mining, but applies to all methodologies that use parallel corpus data. Le Bruyn et al. (2022) discuss various traditions of parallel corpus research and how these methodologies deal with translation bias. In the Translation Mining approach, the problem is addressed in two ways. First, we focus on larger cross-linguistic patterns rather than individual words or sentences. Second, a parallel corpus study is generally followed up by monolinguistic corpus studies or experimental work to replicate results. Since the current paper is an initial study in this domain, we leave such follow-up studies for future research. In this study, we adopt two strategies that aim to minimize the problem. We check to what extent bias influences our results by investigating whether or not it is orthogonal to the research questions asked. The other strategy is to consider more than one set of datapoints, here Dataset 1 (fewer languages, more parallel datapoints) and Dataset 2 (more languages, fewer parallel datapoints).

Using a parallel text corpus, we explore the encoding of 'not. . . until' across languages by means of sampling datapoints that instantiate this domain. This is basically an onomasiological approach (from meaning to form). However, there is no way to find all meanings reflecting a domain directly in a large corpus otherwise than via markers that typically express it. Put differently, there must be one or several semasiological steps (from form to meaning) involved, which will introduce bias to one or several particular languages. Especially in D2, but also in D1, we make use of the fact that Swedish has a negative polarity item *förrän* that exclusively occurs in the 'not. . . until' domain. If we only sample datapoints in which *förrän* occurs, we will obviously miss other possible strategies in Swedish. This may result in an underrepresentation of diversity in the results, but not in an overrepresentation of diversity. We address the underrepresentation in D1 by adding search strings from other languages, at the cost of having to deal with bias toward several languages

and several constructions and construction types. While adding increasingly more search strings from more languages will distribute the bias more equally across languages, it will be increasingly more difficult to control for the effects of bias induced. Using search strings from all 21 languages of Europarl would entail that the results for all languages were at least partly determined by the search strings (statisticians speak of overfit in such constellations). For the research questions asked in this study it is more important to be able to control for the bias than to distribute it evenly across the languages considered.

We argue that the bias towards Swedish is orthogonal to our research questions (Q1–Q4; see Table 2). Swedish is the only language with a negative polarity connective, so *förrän* does not correspond to any of the eight paraphrases in Table 1. If we find connectives reflecting these configurations in the other 20 languages, this cannot be due to the initial bias (Q1). Because Swedish *förrän* strictly goes with the NA polarity pattern, NA may be the preferred choice in parallel examples in other languages, but this preference cannot explain the occurrence or distribution of the NN and AA patterns (Q2). Swedish *förrän* cannot explain cross-linguistic and language-internal variation patterns in its translation equivalents in Europarl (Q3) and Swedish *förrän*—being a temporal and not a conditional connective—cannot explain the occurrence of conditional connectives as translation equivalents.

3.2. Dataset D1 and Annotation

Europarl is a parallel corpus of proceedings of the European parliament from between 1996 and 2012 in 21 languages. In total, it has 759M tokens and 30.3M sentence fragments (we used Europarl version 8, distributed by OPUS; Tiedemann 2012). Of course, the number of languages in Europarl is more limited than in the Bible corpus, but we are not targeting a full-fledged typological analysis here. For dataset D1, we start with seven languages that correspond to the main clusters of connectives found in Wälchli (2018/2019) (Swedish [swe], Finnish [fin], Lithuanian [lit], English [eng], Dutch [nld], German [deu] and French [fra]). For D2, we extend the number of languages to all 21 languages in Europarl.

In the construction of dataset D1, we first searched for occurrences of *(inte)…förrän* in the Swedish part of the corpus, and the corresponding translations in the six other languages.[2] 130 datapoints were selected from a fragment of Europarl that only covered the years 2009 to 2011. This is already much more than the 25 datapoints for 'not…until' in Wälchli (2018/2019: 160). This method does not allow us to study variation in Swedish, because only one construction is extracted by design. In order to also explore potential variation in Swedish, data were added based on extraction of the construction *not…until* in English (n = 30), and the Dutch constructions *pas…wanneer* (ONLY…WHEN) (n = 32) and *niet…zolang…niet* (NOT AS.LONG.AS NOT) (n = 33). All in all, D1 contains markers that reflect three of the eight paraphrases in Table 1. In addition to biclausal constructions, these data include combinations with a nominal or PP complement after *until*/*zolang*. In total, dataset D1 consists of 225 parallel datapoints.

The data were manually annotated using the *TimeAlign* software.[3] In all 7 languages, the following properties were annotated (when there is a PP or nominal complement, the dependent clause fields were left empty):

1. connective (the lexical item that was used, such as *until, förrän, voordat*, etc.)
2. polarity in both main clause and dependent clause (whether the clause is negative or affirmative, in some languages we indicated extra distinctions such as expletive negation, etc.)
3. temporal/focus adverb or particle (if present, the adverb that is used in the main clause, such as German *erst* or Dutch *pas*)
4. clause type (syntactic information about the type of dependent clause: tensed clause, conditional clause, PP, etc.)
5. tense in both main and dependent clause (past, present, perfect, future, etc. as cross-linguistic tense categories)
6. clause order (whether the dependent clause precedes or follows the main clause)

For the categorization of the connectives, we relied on Wälchli (2018/2019). We learnt from this paper that modern Swedish *förrän* is a negative polarity expression that always co-occurs with negation, which inspired us to extract examples containing *förrän* in the first place. We know that Finnish *ennen kuin* occurs in non-negative contexts in which English uses *before*, so we categorize it as BEFORE. Dutch *totdat*, German *bis*, and French *jusqu'à ce que* were categorized as UNTIL, Dutch *voordat*, German *bevor* and French *avant que* as BEFORE, etc. Appendix A lists all the connectives in the dataset with their categorization in this paper.

3.3. MDS Semantic Maps

Once the data from the parallel corpus have been extracted and annotated, they can be used to create visualizations of cross-linguistic variation by means of *multidimensional scaling* (MDS). MDS is a statistical technique that reduces a complex dataset with variation in many dimensions to a lower-dimensional representation that can be displayed visually as a scatterplot, known as a *semantic map*. This methodology has been used both in large-scale cross-linguistic examinations, such as Croft and Poole (2008) and Wälchli and Cysouw (2012), as well as in studies comparing just a few languages, such as van der Klis et al. (2017). van der Klis and Tellings (2022) provide the technical background of MDS, an explanation of how to interpret MDS maps, and an overview of the application of MDS in linguistic theory. We refer the reader to that paper for a more comprehensive background than we can provide here.

The type of MDS map that is interesting for our purposes is a scatterplot in which the dots represent individual sentences (contexts) from the corpus. The algorithm places the dots based on a measure of similarity between contexts: similar contexts end up close together on the map, and dissimilar contexts end up far apart. This similarity measure is based on the annotation of the data: for example, when considering the annotation label 'connective', we can count two contexts as more similar when more languages use the same connective in both contexts. Table 3 illustrates with a fragment from a table of connectives used across languages in D2. It displays the connective used in 6 languages in 6 contexts from Europarl.

Table 3. Extract from the connective cross table.

Context No.	*Bulgarian*	*Czech*	*Danish*	*German*	*Greek*	*English*
1	dokato	dokud	før	bis	mexri=na	until
2	dokato	do=doby=než	før	solange	eOs=otou	until
3	dokato	dokud	før	bis	Ospou=na	until
4	predi=da	však=než	før	bevor	protou	before
5	predi=da	než	før	bevor	prin	before
6	dokato	dokud	førend	bis	eOs=otou	until

On the basis of this table, a *dissimilarity matrix* consisting of all pairs of contexts can be calculated with Hamming distance as distance measure. For example, the pair of the first two contexts (written as <1,2>) has a dissimilarity of $1-3/6 = 0.5$ since the connective is the same in 3 of 6 languages. It is hence more similar than the pair <5,6> where none of the connectives are the same, which results in the maximal dissimilarity value of 1.0. (See van der Klis and Tellings 2022: sec. 3 for more details on how dissimilarity matrices are constructed and used). The dissimilarity matrix determines the spatial configuration of the points in the map. This map is of linguistic interest: clusters of dots that are close together indicate that these dots are similar in the relevant sense, which invites further analysis of the linguistic properties of the corresponding sentences. The interpretation of clusters and dimensions is the main part of the interpretation of an MDS map. We will illustrate dimension and cluster interpretation of MDS maps in Section 5.

In the literature that uses parallel corpus data to create semantic maps by means of MDS, typically only a single feature of a construction is annotated for, such as the lexical item used, or the tense of the construction (van der Klis and Tellings 2022 list many examples of such studies). A special feature of the current work is that we annotated multiple different properties in all languages, which makes it possible to not only study cross-linguistic variation for each feature individually, but also how a combination of features varies from language to language. For our purposes, the variation with respect to the feature 'connective' is important (providing information about (semi)lexical variation for *not…until* constructions), but also variation with respect to the interaction between the connective and polarity values, as the formal semantic analysis makes predictions about this interaction.

4. Results for Dataset D1

4.1. Variation in Connective Choice

In this section we present the main quantitative results obtained from the analysis of dataset D1, centered around the following two observations already anticipated here:

- Observation 1: variation with respect to connective choice is very high.
- Observation 2: compositional semantics/pragmatics of the interaction between negation and connective is respected in all languages.

The expectation that languages use different expressions to convey the same meaning, but do so using strategies that are semantically and pragmatically equivalent is met. However, the expectation that all languages use a single predominant strategy in the NOT…UNTIL configuration is not met.

Observation 1 breaks down into three observations. First, there is a high amount of language-internal variation. All languages have between 20 and 23 attested constructions in the dataset, so there is substantial variation in the constructions used within each language (as opposed to the four search strings from four languages we started with in D1). Second, there is widespread distribution over constructions, so there is no clear dominant strategy appearing in more than 50% of the datapoints, except for Swedish *förrän*. Note that the high numbers of Swedish *förrän* and English *until* are probably skewed because they defined the search criterion in respectively 130 and 30 contexts of the dataset, respectively. The most frequent connectives for each language, in decreasing order of frequency, are:

> Swedish *förrän* NPI (145) >> English *until* (104) >> Lithuanian *kol* 'as long as, until' (80) >> Finnish *ennen kuin* 'before' (68) >> German *wenn* 'if' (58) >> Dutch *zolang* 'as long as' (58) >> French *tant que* 'as long as' (57).

Third, there is a high amount of cross-linguistic variation. Each context in D1 has translations in 7 languages, forming a 7-tuple (the rows in Table 3). We can count these *translation tuples* to assess the amount of variation. All translation tuples have low frequencies, so there is substantial variation in the combinations used across languages. In the set of 225 datapoints, the highest frequency of combinations of connectives across all seven languages is 6 (one tuple). We find another tuple with 5 occurrences, one tuple with 4 occurrences, three tuples with 3 occurrences, and 12 tuples with 2 occurrences; all other tuples are unique combinations of connectives.

The most common connectives for each language are collected in Table 4, where we use colours and symbols to indicate categories. For each language, connectives are sorted by frequency (note that there is no horizontal correspondence between the connectives in the columns, each column is an independent list). We distinguish three main categories. The first category is the combination of one or two negations with a temporal, possibly NPI, connective: NOT…UNTIL$_{\text{NPI}}$ ●, NOT…UNTIL ⧫, NOT…BEFORE ★, NOT…AS LONG AS…NOT □. The second category is the combination of a scalar or non-scalar focus adverb with a connective or preposition indicating temporal overlap or inclusion, temporal sequence ('after') or a condition, or a bare time adverb not introduced by a prepo-

sition (ONLY/PAS. . . WHEN/IF/IN/AT/ON/ONCE/AFTER/- ○). We set aside the exceptive clauses (EXCEPT) as a third category.

We conclude that there is no single strategy that any given language uses exclusively. However, across languages, we see the same configurations appearing in most languages, so there are limits to the variation in construction. Note that the configuration of 'focus adverb + time of focus' is realized with different connectives/prepositions, and sometimes no preposition at all ('bare' time adverb). This is a major reason behind the observation that all languages use 20-23 constructions each. All languages have low-frequent configurations not included in Table 4.

Table 4. Data with category indication.

Swedish	English	French	Dutch	German	Finnish	Lithuanian
förrän (145) ●	*until* (104) ⧫	*tant que* (57) □	*zolang* (58) □	*wenn* (58) ○	*ennen kuin* (58) ★	*kol* (80) □
nar (14) ○	*when* (10) ○	- (26)	*als* (39) ○	*bis* (46) ⧫	- (68)	*kai* (24) ○
om (12) ○	- (17)	*avant (que)* (29) ★	- (29)	*solange* (31) □	*kun* (33) ○	*iki* (19) ●
innan (10) ★	*once* (11) ○	*lorsque* (19) ○	*tot(dat)* (26) ⧫	- (30)	*niin kauan kuin* (13) □	- (19)
sa lange (9) □	*if* (10) ○	*si* (15) ○	*wanneer* (19) ○	*(be)vor* (21) ★	*jos* (11) ○	*jei* (11) ○
- (8)	*as/so long as* (10) □	*jusqu'à ce que* (15) ⧫	*voor(dat)* (16) ★	*nach(dem)* (12) ○		*po* (10) ○
	after (9) ○	*après* (9) ○	*in* (11) ○	*ohne* (8)		
	before (9) ★		*na(dat)* (11) ○			

4.2. Connectives and Polarity

Compositional semantics/pragmatics of the interaction between negation and connective is respected in all languages. Table 5 summarizes how connectives combine with negation or affirmation in the main and subordinate clause.

Table 5. Polarity patterns for connectives.

Lang.	Connective	Category	Polarity Pattern <Main Clause Polarity, Dep. Clause Polarity>			
			NN	**NA**	**AA**	**AN**
		NN				
fra	tant=que	AS.LONG.AS	**47**	7	0	3
nld	zolang	AS.LONG.AS	**43**	13	0	2
deu	solange	AS.LONG.AS	**21**	9	1	0
deu	bevor	BEFORE	**7**	3	0	0
fin	ellei	EXCEPT	**5**	0	0	0
eng	without	EXCEPT	**2**	0	0	0
		NA				
swe	förrän	$\text{UNTIL}_{\text{NPI}}$	0	**93**	0	1
eng	until	UNTIL	0	**78**	2	0
deu	bis	UNTIL	2	**23**	1	1
nld	tot/totdat	UNTIL	1	**17**	2	0
fra	jusqu=à=ce=que	UNTIL	0	**7**	2	0
fin	ennen=kuin	BEFORE	0	**67**	0	0
nld	voor(dat)/vooraleer	BEFORE	0	**13**	0	0
swe	innan	BEFORE	0	**10**	0	0

Table 5. *Cont.*

Lang.	Connective	Category	Polarity Pattern <Main Clause Polarity, Dep. Clause Polarity>			
			NN	**NA**	**AA**	**AN**
eng	before	BEFORE	0	**5**	0	0
fin	niin=kauan=kuin	AS.LONG.AS	1	**11**	1	0
eng	as=long=as / so=long=as	AS.LONG.AS	1	**8**	0	0
eng	while		1	**4**	1	0
		AA				
deu	wenn	WHEN	4	6	**47**	1
fin	kun	WHEN	1	5	**26**	1
lit	kai	WHEN	0	3	**21**	0
nld	wanneer	WHEN	0	2	**17**	0
eng	when	WHEN	0	3	**16**	1
fra	lorsque	WHEN	0	0	**15**	0
eng	once	WHEN	0	0	**11**	0
swe	när	WHEN	1	3	**10**	0
eng	if	IF	2	0	**7**	1
fin	jos	IF	3	0	**7**	1
deu	als	IF	0	0	**3**	0
nld	nadat	AFTER	0	0	**3**	0
deu	nachdem	AFTER	0	0	**3**	0

The main import of Table 5 is that most connectives exclusively combine with a single polarity pattern. All instances of UNTIL and BEFORE combine with negation in the main clause and an affirmative subordinate clause (NA pattern). Most instances of WHEN and IF combine with a focus adverb like ONLY or its scalar counterpart PAS, and have affirmative main and subordinate clauses (AA). The pattern AN is, with a few exceptions, not attested. Many of the exceptions have to do with problems of annotating negation across languages, such as dealing with lexical verbs that encode negation and expletive negation—see Sections 4.5.2 and 4.5.3 for further discussion.

According to Table 5, AS.LONG.AS frequently combines with negation in both the main and the subordinate clause (NN), but sometimes displays an NA pattern. The data extracted on the basis of Dutch *zolang* contain 13 constructions with an affirmative dependent clause (likewise there are 9 NA German *solange* cases, and 7 NA French *tant que* cases). An example of the NA pattern is given below:

(9) a. Deze oorzaken zijn gelegen in de kapitalistische productierelaties en kunnen *niet* opgeheven worden *zolang* deze relaties blijven bestaan. [Dutch]
b. These causes, which are rooted in the capitalist relations of production, *cannot* be eliminated *as long as* these relations exist. [English]
c. Diese Ursachen, die in den kapitalistischen Produktionsverhältnissen wurzeln, können, *solange* diese Verhältnisse bestehen, *nicht* beseitigt werden. [German]
d. Ces causes sont enracinées dans les relations de production du capitalisme et *ne* peuvent être écartées *tant que* ces relations existent. [French]

All 8 instances of English *as long as* and *so long as* in the NA pattern in the D1 dataset are translations of the 13 NA constructions that have Dutch as a source language (hence English appears in the NA section of Table 5). English *as long as* almost exclusively occurs

with an affirmative subordinate clause in the NA pattern (and AA, but those are not present in the dataset), whereas Dutch, German and French *zolang/solange/tant que* are more inclined to tolerate negative subordinate clauses (NN). Dutch NEG *zolang* NEG constructions are translated in English with a variety of other constructions such as *not... until, not ... if not*. We conclude that English AS.LONG.AS has a polarity restriction that Dutch, German, and French AS.LONG.AS do not have. This might explain why AS.LONG.AS has not played a role in the formal semantic literature discussed in Section 2.1.

The polarity pattern of AA with ONLY.WHEN and ONLY.IF can be understood by considering the semantics of the focus particle *only* (or its scalar counterparts Dutch *pas* and German *erst*). The (enormous) theoretical literature on *only* states that *only* combines with a prejacent p, negates all non-entailed focus alternatives to p, and presupposes the truth of p (see Beaver and Clark 2008 for discussion and references). A number of technical issues arise in the analysis of *only if* conditionals when *only* and the meaning of the conditional are combined compositionally, but typically the semantic entry of *only* as described above is preserved (see Bassi and Bar-Lev 2018; Herburger 2019 for some recent work). We illustrate with (10), which asserts that Turkey cannot join under all non-entailing alternative conditions (they meet only some of the criteria, meet none of the criteria, etc.), and implies (presupposes) that Turkey can join if all the criteria are met.

(10) Turkey can only join if/when all the criteria are met.

Hence, the same meaning components in the *not... until* as described in Section 2.1 are encoded in *only... if* (the event taking place when the criteria are met, and the negative quantificational component that the event does not take place at times when the criteria are not met).

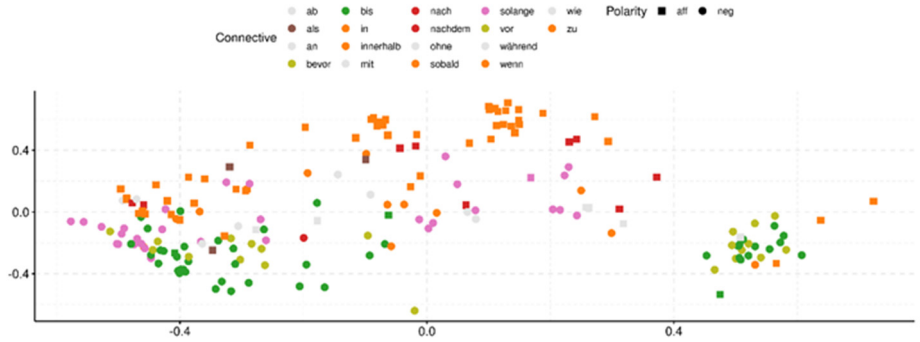
The marker UNLESS is infrequent in our dataset, but can be categorized as a conditional marker. English *unless* has been compared to and analyzed as *only if not* (Vostrikova 2018), another example of the lexical encoding of polarity and a focus particle.

4.3. MDS Maps

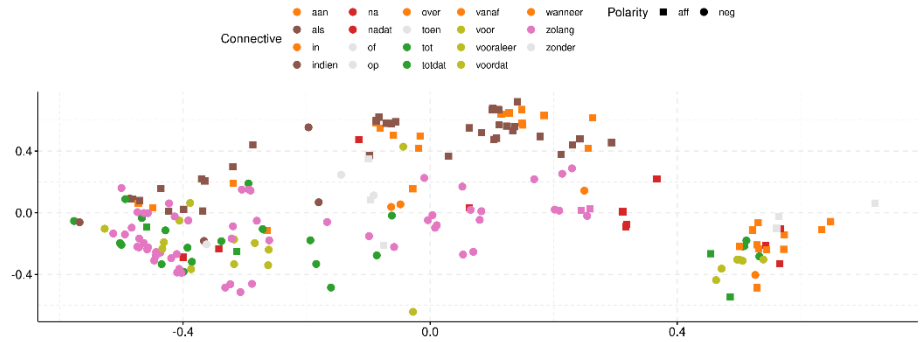
The stability of the polarity patterns can also be seen in the MDS maps in Figure 2, created in R (R Core Team 2020) using the smacof package.[4] Each symbol indicates a context from D1, and the measure of similarity used to construct the maps is based on both the connective and the polarity of the main clause.[5] The legend explains how the combination of color and shape indicates connective choice and the polarity of the main clause. Different colors correspond to categories of connectives: green for UNTIL, orange for WHEN, pink for AS.LONG.AS, olive for BEFORE, brown for IF, and red for AFTER (infrequent connectives are in gray). Shapes correspond to polarity: a square indicates affirmation, and a circle indicates negation. Each map in Figure 2 has the same configuration of points, but the colors/shapes reflect the language-specific marking ('map coloring' in the terminology of van der Klis and Tellings 2022).

The fixed color-shape combinations reflect the stability in compositionality: orange (WHEN) symbols are invariantly squares, green (UNTIL) symbols are circles, etc. Comparing the maps pairwise, it is also useful to see how colors change from language to language. Consider the large cluster of green UNTIL points on the left side in the map in English. Most other languages have a different dominant connective type than UNTIL, e.g., BEFORE in Finnish and AS.LONG.AS in Lithuanian (matching with Table 4). The UNTIL contexts in English are translated by these different markers, and this can be seen by the different coloring for the points in this cluster. We will postpone further analysis of clusters of symbols in the map, and the interpretation of the dimensions, until the analysis of dataset D2 in Section 5, as the larger number of languages in D2 facilitates this process.

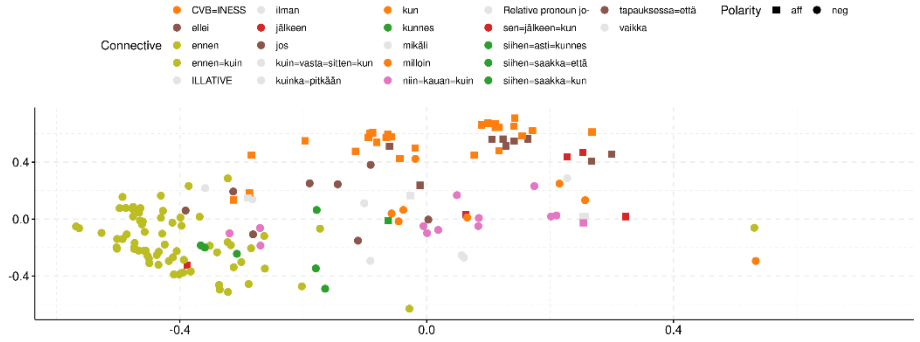
German



Dutch



Finnish



French

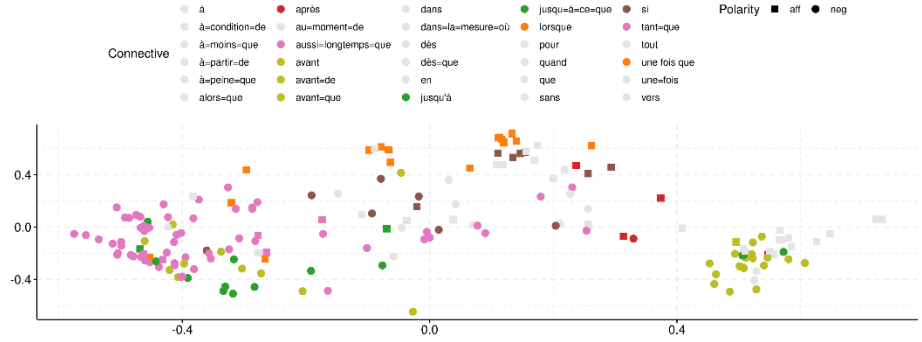


Figure 2. *Cont.*

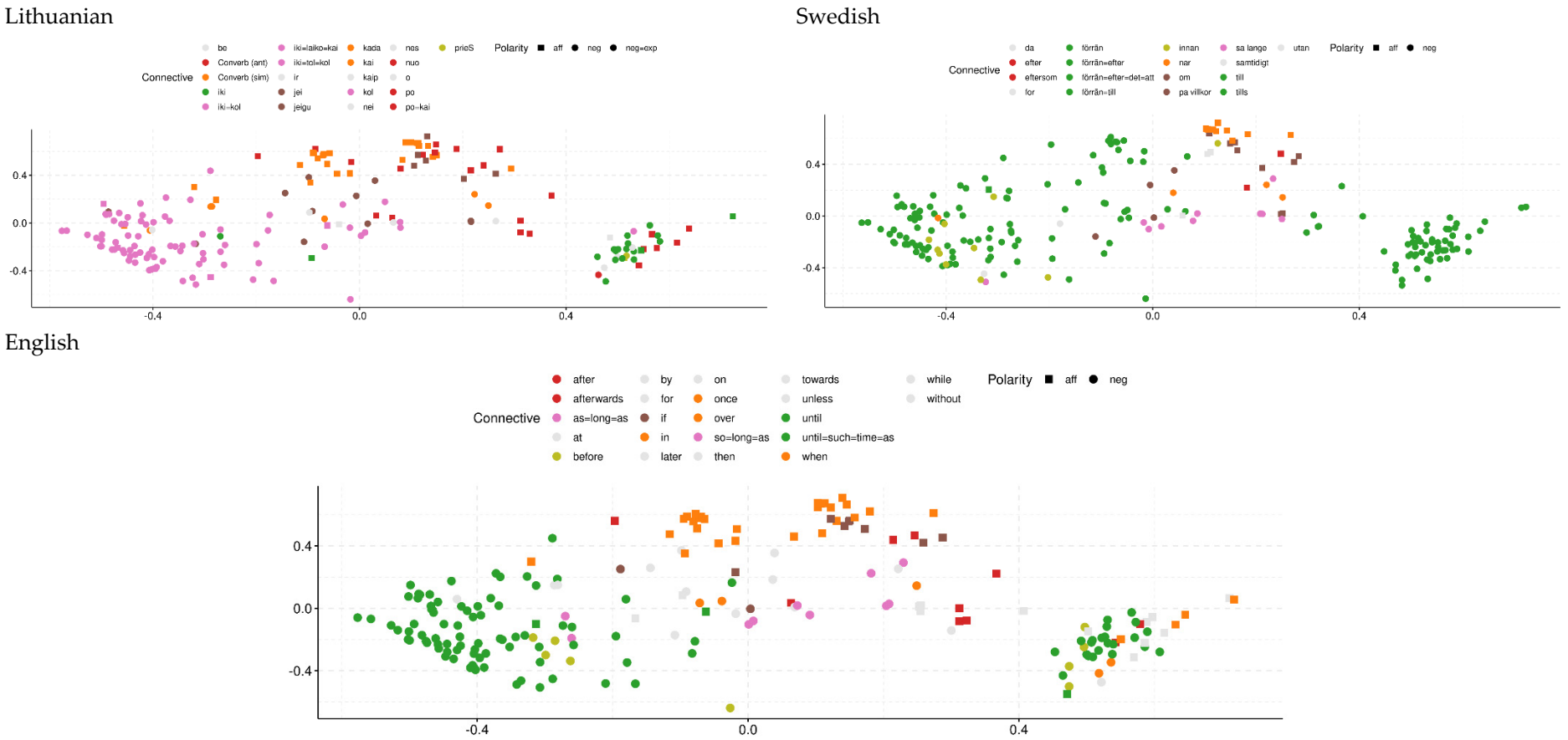


Figure 2. MDS map of connectives and polarity.

4.4. Temporal and Conditional Meanings

Table 1 listed not only constructions with temporal connectives, but also conditional constructions (*if*, *unless* in English, *si* in French, etc.). The overlap of temporal and conditional meanings in the domain of 'not…until' was not taken into consideration in the earlier formal (de Swart 1996) or typological work (Wälchli 2018/2019),[6] but emerges from the corpus analysis.

The conditional construction comes with additional restrictions over the purely temporal ones. The Europarl conditional example in (4) (repeated as 11a) has future time reference, and this seems to be crucial for using (*only*)…*if*. We can reformulate (11a) with *not*…*until*, as in (11b), but we cannot rephrase the constructed past tense example in (12a) with (*only*) *if*, as illustrated in (12b–d). (12b) and (12d) are unacceptable (#), unless a quantified, 'whenever' reading is intended.

(11) a. Europe must mobilise the Solidarity Fund and we know that *if* the budget is *not* approved, the fund can*not* be mobilised.
b. The fund can*not* be mobilized *until* the budget is approved.

(12) a. The princess didn't wake up *until* the prince kissed her.
b. #The princess *only* woke up *if* the prince kissed her.
c. The princess *only* woke up *when* the prince kissed her.
d. #The princess didn't wake up *if* the prince kissed her.

The data in D1 were annotated for tense in both clauses, and we find that the IF cases generally occur with present tense on modal verbs (which have a future orientation, Condoravdi 2002), or with future tense. We conclude that with future time reference in both main clause and subordinate clause, the use of *only*…*if* is equivalent to *not*…*until* (11), but in the past domain, this equivalence does not work (12). The incompatibility of *only*…*if* with past tense in (12b/d) is due to additional grammatical properties of the conditional marker, namely that it introduces a hypothetical clause. This is incompatible with factual past events. *When* (12c) does not have this restriction, even though *when* and *if* are sometimes interchangeable in conditional constructions (Farkas and Sugioka 1983).

The formal semantic literature discussed by de Swart (1996) mostly discussed past tense examples such as (12a), so the role of tense has not come up so far. We can understand the conditional realization of the 'not…until'-meaning in the Europarl corpus by looking at the phenomenon of (political) linkage, discussed in Section 2.3. The 'not…until'-construction conveys that a change from a negative to a positive phase occurs at the time of the occurrence of some event. In contexts with reference to future events, and in particular in the political language of Europarl, this event is typically the fulfilment of a *condition* for the event described in the main clause. Hence, linkage is both temporal and conditional in nature. In conditional clauses, the protasis usually comes before the main clause ('if *p* then *q*'; Lehmann 1974; Comrie 1986), and a number of factors have been described that explain this ordering effect (Diessel 2001, 2005). However, 'not…until' constructions in European languages are more often expressed in the order *q p*. Why is this? The temporal order established by linkage is actually *p q* (e.g. in example (2) in the introduction: first meet all criteria, then join the EU). However, the order *p q* emphasizes the perspective on event *p* ('linker-perspective'), and for establishing linkage, it is often more appropriate to emphasize event *q* ('linkee-perspective'). The linkee is interested in *q*, not in *p*, so in order to arouse the interest of the linkee it is therefore more useful to start with *q*, i.e. the desire of the linkee (or its denial) comes first. See Section 6 below for further comments about clause order.

4.5. Intermediate Conclusions and Some Annotation Issues

4.5.1. Conclusions Based on D1

Dataset D1 confirms that compositional semantics of the NOT…UNTIL configuration is respected in all languages, so the NN, NA, and AA patterns we established for English in Table 1 are also found in other languages. The different translations are equivalent in

context, if we take meaning to be the combination of truth conditions and presuppositions/implicatures. Much to our surprise, the cross-linguistic patterns were not as stable as the discussions in de Swart (1996) and Wälchli (2018/2019) suggested. We expected languages to vary along the lines of the strategies outlined in Table 1, but we did not expect to find as much language-internal variation with as wide a spread as we observed in Table 4 and Figure 2. In order to achieve a better understanding on the amount of variation with respect to connective choice found in D1, we construct a new dataset D2 that is smaller in terms of parallel datapoints, is based only on a single initial search string (Swedish *förrän*) and is restricted to clause linkage (no PPs), but contains more languages. The increased number of languages makes it easier to find overall cross-linguistic patterns with statistical methods, and it allows us to replicate the findings reported in this section in a larger sample.

Before we move to D2, we discuss two practical issues we encountered in the annotation of negation in D1: lexical negation and expletive negation.

4.5.2. Lexical Negation

Negation can be expressed grammatically, but also by means of lexically negative verbs, such as English *refuse* in (13). However, this annotation leads to outliers in Table 1 and Figure 2, so in dataset D2 we made the choice to adjust the polarity, and annotate such configurations as NA.

(13) . . . telling Italians that the waste problem had been resolved, the European Union is doing the right thing by *refusing* to grant Italy funding *until* an environmentally friendly waste system based on recycling of waste and composting has been presented.

Put differently, English *refuse* will be counted as negation in D2, even though for this particular example, 16 of 21 languages in D2 have a grammatically affirmative construction with some sort of 'refuse'-verb. While the majority of examples treated with polarity adjustment in our database contain clearly lexically negative verbs in the main clause, such as Italian *bloccare*, English *fail* or French *déconseiller* 'advise against', there are less straightforward examples, such as Latvian *klusējāt* [be.silent.PST.2PL] 'you were silent', corresponding to English *you did not speak out*. Lexical negation is no absolute phenomenon; it is always relative to a paraphrase with grammatical negation. Put differently 'be silent' is the lexically negative paraphrase of 'not speak out', but it need not be lexically negative in absolute terms.

Aside from clearly lexically negative verbs, another relevant group of examples are phasal verb constructions, such as French *continuera de violer* 'will continue to violate', which is lexically negative relative to English *there is no end to the violations*.

4.5.3. Expletive Negation

Expletive negation is a phenomenon in which negation does not get its normal truth-conditional interpretation of logical negation. It appears in a variety of configurations, including comparative clauses, negative exclamatives, UNTIL- and BEFORE-clauses (Espinal 2000; Greco 2020, and references therein).

In many languages, UNTIL- and BEFORE-connectives can be combined with expletive negation, as illustrated from Italian and Latvian from the Europarl data in (14) and (15). Formally speaking, the polarity values are NN (negation in both main and affirmative clause), but based on the connective we would expect the configuration NA here (as in English *not. . . before*).

(14)	Ho	posto	cinque	interrogazioni	alla	Commissione	
	have.1SG	raised	five	questions	to.the	Commission	
	e	*non*	intendo	prendere	parola		
	and	not	intend	take	word		
	finché	*non*	mi	viene	data	risposta.	
	until	not	me	comes	given	answer	[Italian]

(15)	Esmu	Komisijai	uzdevusi				
	be.PRS.1SG	commission.DAT.SG	on.give.PTCP.PST.NOM.SG.F				
	piecus	jautājumus,	un	es	*ne*vēlos		
	five.ACC.PL	question.ACC.PL	and	1SG	NEG.desire.PRS.1SG.REFL		
	uzstāties,	*pirms*	*ne*būšu	saņēmusi			
	perform.INF.REFL	before	NEG.be.FUT.1SG	receive.PTCP.PST.NOM.SG.F			
	atbildes.						[Latvian]
	answer.ACC.PL						

'[. . .] I do not intend to speak until I hear the answers.'

A question discussed in the literature is whether expletive negation has any semantic functions, counter to what the name "expletive" suggests. Espinal (2000) argues for Catalan that expletive negation is sensitive to veridicality, so non-factual and potentially non-factual examples are more likely to bear a negation marker. According to Wälchli (2018/2019), WITHOUT- and negative AS.LONG.AS-sentences are common diachronic sources of expletive negation in the 'not. . . until' domain. Another function of expletive negation in temporal clauses might be to disambiguate UNTIL and AS.LONG.AS in languages where UNTIL- and AS.LONG.AS -connectives have the same form. Wälchli (2018/2019) suggests a model with different layers where the reasons for the presence of expletive negation differ from the reason why it expands over (nearly) the whole 'until' domain as in most Slavic languages (Iordanskaja and Mel'čuk 2009 for Russian).

The practical problem when working with corpus data from different languages is that the majority of examples does not contain any clues to distinguish expletive negation by formal criteria. We therefore decided to annotate expletive negation as N negative in both datasets D1 and D2.

5. Dataset D2: Expansion to 21 Languages

5.1. Data Extraction and Annotation

For dataset D2, we included 21 of the 24 official European Union languages (Bulgarian [bul], Czech [ces], Danish [dan], Dutch [nld], English [eng], Estonian [est], Finnish [fin], French [fra], German [deu], Greek [ell], Hungarian [hun], Italian [ita], Latvian [lav], Lithuanian [lit], Polish [pol], Portuguese [por], Romanian [ron], Slovak [slk], Slovenian [slv], Spanish [spa], Swedish [swe]). Croatian, Irish and Maltese were the only official languages not included in our sample: translation to Irish (Hoyte-West 2020) and Maltese is limited,[7] and Croatia joined the EU only in 2013. From an areal point of view, our sample very much coincides with Standard Average European (van der Auwera 2011). Genealogically, the sample covers 7 genera (Baltic [2], Germanic [5], Greek [1], Romance [5], Slavic [5], Finnic [2] and Ugric [1]) of two language families (Indo-European and Uralic). This sample may be considered small compared to some large-scale typological work, and also note that the standard varieties sampled can deviate from non-standard varieties in systematic ways (Murelli and Kortmann 2011). However, our aim is not to capture the entire world-wide diversity in the 'not. . . until' domain, but rather how language-internal and cross-linguistic variation interact. We think that for this purpose Europarl is an appropriate choice of corpus.

Dataset D2 is based on only one source language, Swedish (as compared to 3 source languages in D1), because the NPI *förrän* is the simplest and most straightforward diagnostic for the 'not. . . until' domain. We selected 79 Swedish sentences (out of a larger set of 203) with *förrän* as a clausal connective and few missing translations in the 20 other languages.

The examples sampled were annotated for

1. Connective;
2. Polarity of main and subordinate clause; and
3. Clause order (subordinate clause post- or preposed)

We adjusted annotation for lexical negation, as described in Section 4.5.2 above. In total, 36 instances of lexical negation with adjustment were registered, only 5 of which were from subordinate clauses, and of which 16 cases relate to a single example, viz. (13) discussed above.

The notion of connective was applied very broadly. Restrictive adverbs and particles, such as German *erst* and English *only*, were included if not adjacent, as well as temporal adverbs or correlative elements, such as German *dann* in (16). As before, all annotations were made manually. Below, we will represent letters with diacritics by upper case letters, and spaces by equal signs.

(16) German: coded connective **erst=dann=wenn**; polarity: **AA**; order: **postposed**
Drittens sollten die Zeitintervalle **erst dann** beginnen, **wenn** alle Sprachversionen—ich wiederhole, alle Sprachversionen—zur Verfügung stehen.
'Thirdly, the periods should **only** start **once** all the language versions—I repeat, all the language versions—have been received.'

As in Section 4, we used multidimensional scaling to create semantic maps (using the function cmdscale( ) in R). In addition, principal component analysis (R: prcomp( )) was used, applied directly to the binarized crosstable of connectives (see Jolliffe and Cadima 2016 for a background on principal component analysis). The two procedures yield largely the same results, but an important advantage of principal component analysis is that it also yields values for which connectives contribute the largest effect for the two poles of each dimension, which is very valuable for interpreting the dimensions.

5.2. Results for dataset D2

Figure 3 displays the MDS plots of the first two (the most informative) dimensions for a selection of 6 languages; maps for the other languages in the sample can be found in Appendix B. As in Figure 2, every symbol stands for a parallel example and the configuration of examples is the same for all languages. The maps in Figures 2 and 3 differ in two respects. First, the maps in Figure 3 are based on a distance measure that only takes connectives into account (as in the example in Table 3 discussed above). Second, the coloring scheme is different: in Figure 3, the colors do not correspond do not correspond with cross-linguistic categories, but with frequency. For example, in each map the red symbols indicate the most common connective in the language in question. The legend is ordered according to the number of examples with the same connective [given in brackets].

All maps have the same configuration. Conditional connectives appear at the top of Dimension 2; for instance, English *if* and *unless*, Spanish *si* 'if' and *a menos que* 'unless', Bulgarian *ako* 'if', German *wenn* 'if' and Finnish *ellei* 'if not [3SG]'. Markers meaning 'only if' appear on the right hand side of Dimension 1. As can be seen there is a large variety of different markers here. English has three different connectives: *only when*, *only once* and *only after*. Swedish is the only map where all examples have the same connective, *förrän* 'not…until', because this was the sampling criterion for D2. Most examples cluster in the bottom left corner, where markers meaning 'until' (such as English *until* and Spanish *hasta que*), 'before' (such as Finnish *ennen kuin*) and 'as long as' (such as German *solange*) can be found.

The discussion of the results will be divided in two parts. First, we see how D2 replicates our findings from dataset D1, reported in Section 4. Second, we will interpret the maps from Figure 3 by doing a dimension analysis (assigning a linguistic interpretation to the positive and negative poles of the two most important dimensions), and a cluster analysis (identifying and interpreting clusters in the maps).

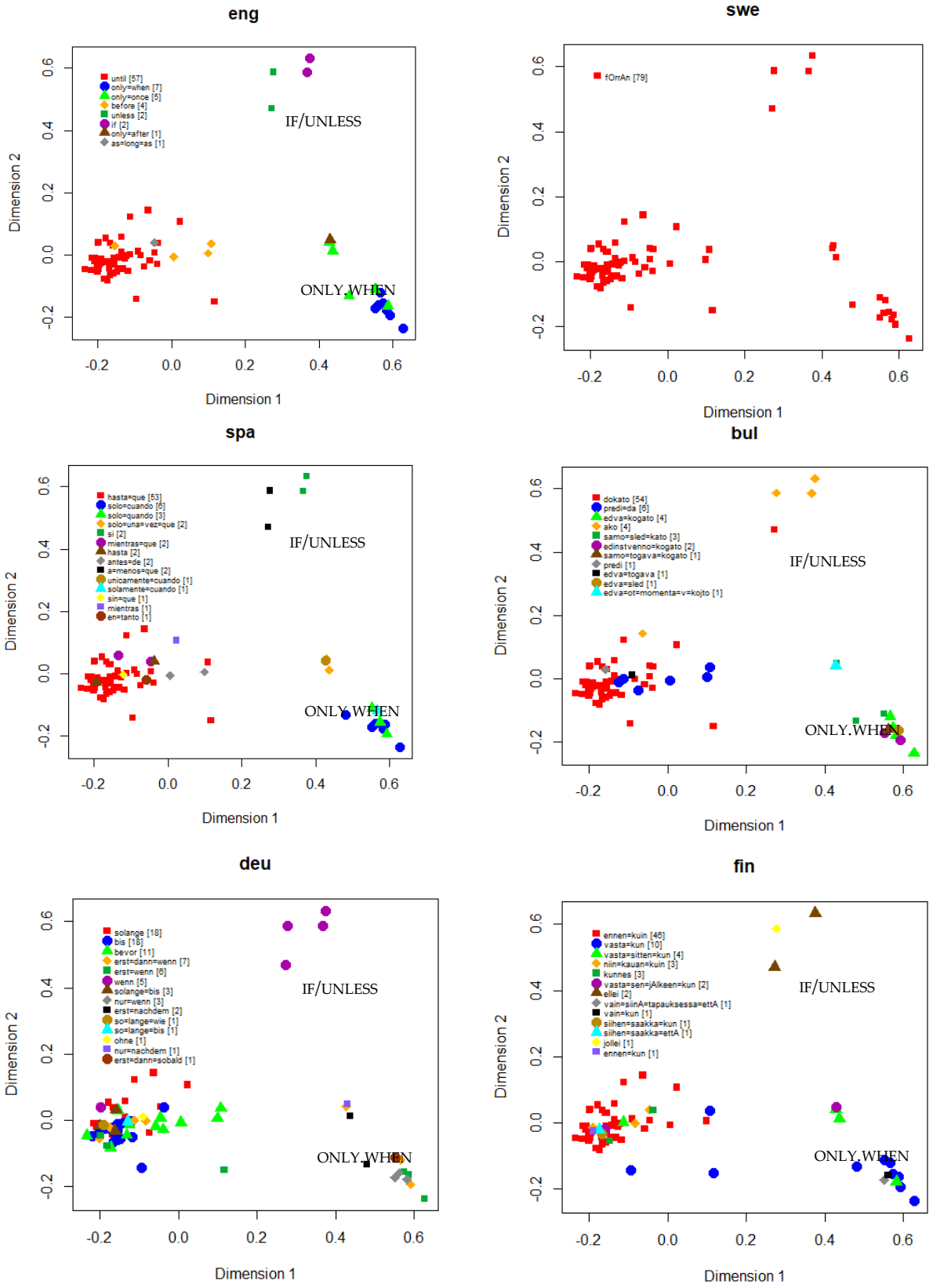


Figure 3. MDS plots with symbols indicating language-specific lexicalizations.

5.3. Replication of Results in D1

The dataset D2 with more languages replicates the high amount of language-internal variation with respect to connective choice. Except for Swedish (only one connective

because this was a sampling criterion), we find that the most common connective (marked with red squares) occurs, on average, only 35 times out of 79. Hence in many languages, there is no clear dominant strategy. As the legends in the plot indicate, even in the smaller set of 79 datapoints, we find 8 to 20 different strategies in each language.

The cross-linguistic stability of the combination of connectives with polarity patterns is confirmed in dataset D2. Figure 4 uses size of circles—in the same configuration as the MDS maps in Figure 3—to indicate the frequency of polarity values averaged for all languages. The cluster in the bottom right can be identified as ONLY.WHEN (further discussion of clusters below), which shows a high proportion (large circles) in the affirmative-affirmative (AA) plot. The top right cluster can be identified as the IF cluster, and this has a large proportion of NN patterns. These correspond with our earlier findings (see Section 4).

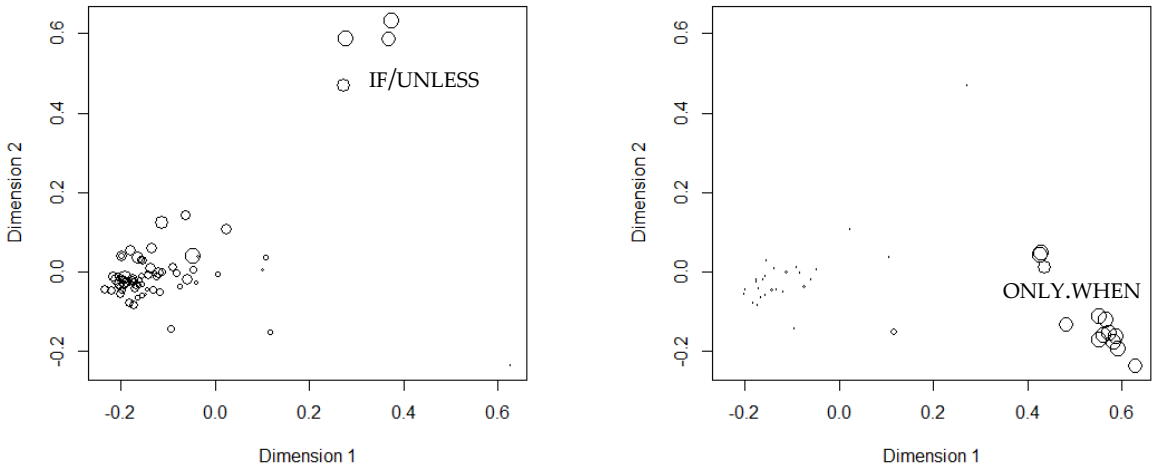


Figure 4. Polarity patterns (left NN; right AA) averaged over all languages.

We now take a closer look at the configuration of dots in the maps in Figure 3.

5.4. Dimension Analysis

The functional domain that Figure 3 visualizes is semantically very narrow. Recall that it was selected on the basis of identical marking in one language, Swedish. Thus, for Swedish, all dots have the same color and the legend contains a single item: *förrän*. It can therefore be expected that semantic differences will not be particularly strong signals in the dataset and indeed the most dominant signal in Dimension 1 is the degree of conventionalization of a dominant marker. All languages in Figure 3 have red dots (always the most frequent connective topping the legend) in the negative pole of Dimension 1 in the most crowded area of the space. The plot in Figure 5 indicates by means of size of circles how rare connectives are on average across all languages in the dataset. We see that the smallest dots on the negative pole of Dimension 1 indicate the most prototypical 'not…until' contexts, where languages tend to use their most frequent markers. These markers also peak the set of markers in the principal component analysis of the negative pole of Dimension 1: English *until* [55 tokens of 79], Bulgarian *dokato* 'as long as, until' [54], Slovenian *dokler* 'as long as, until' [50], Spanish *hasta que* 'until' [54] and so on. The positive pole of Dimension 1 accommodates ONLY.WHEN and IF/UNLESS connectives which are both rare in the dataset and Dimension 2 further splits these up into two clusters: negative pole ONLY.WHEN (in English *only when*, such as (17), and *only once*) and positive pole IF/UNLESS (in English *if (not)*, such as (18), and *unless*). See Table 6.

(17) English: most extreme ONLY.WHEN example (bottom right) [AA, postposed]
We will *only* be able to consider it actually over *when* employment has returned to pre-crisis levels.

(18) English: most extreme IF example (top right) [NN, postposed]
Mr. President, we will *not* achieve the objectives of the Europe 2020 strategy, neither will we make the economy more innovative and competitive, *if* we do *not* treat the Single Market holistically.

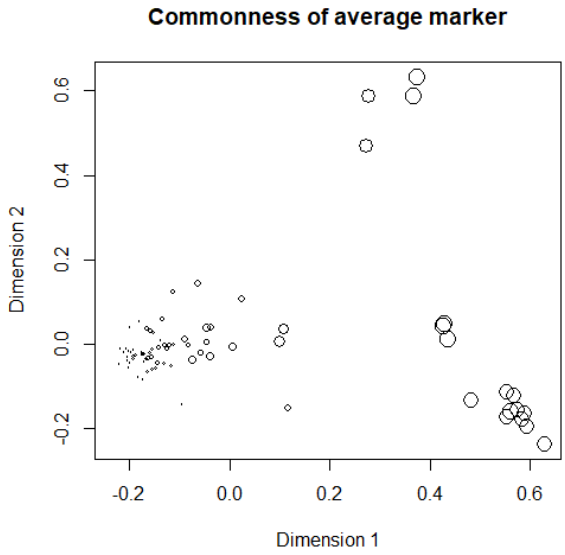


Figure 5. Commonness of average marker.

Table 6. Poles of Dimensions 1 and 2 from the principal components.

	Negative Pole	Positive Pole
Dimension 1	Most conventionalized connectives (e.g., Eng *until*)	ONLY.WHEN and IF
Dimension 2	ONLY.WHEN	IF (and to a much lesser extent: BEFORE)

5.5. Cluster Analysis

Clusters can be identified by visual inspection of the maps, but a more systematic method to group examples into clusters is *partitioning* (for more on clustering analysis methods, see van der Klis and Tellings 2022). In Table 7, we use Partitioning Around Medoids (R: pam( )) with 5 clusters. This method clearly sorts out IF (Cluster 5), ONLY.WHEN (Cluster 4), and BEFORE (Cluster 3), whereas UNTIL and AS.LONG.AS cannot be easily split up by this method, perhaps because there are many conventionalized connectives which are both 'until' and 'as long as'. Clusters 1 and 2 do not distinguish UNTIL and AS.LONG.AS. Five rather than four clusters are used, because BEFORE does not appear as a cluster with k=4.

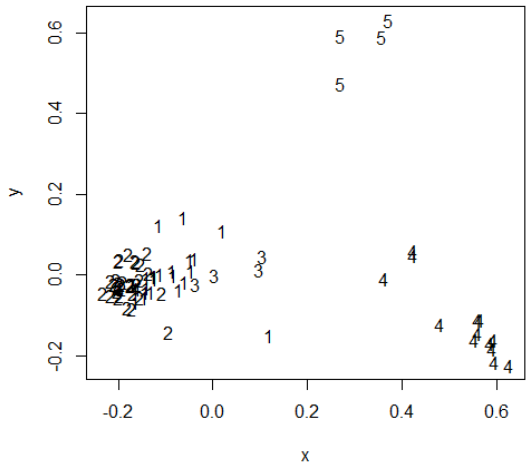
The location on the configuration of the MDS plot of the five clusters singled out by pam( ) with k=5 is shown in Figure 6.

In sum, the methods of multidimensional scaling, principal components and partitioning provide evidence that the functional domain of NOT...UNTIL is internally structured and not subject to entirely free variation.

Table 7. Partitioning Around Medoids pam() with 5 clusters for selected languages.

CL	1	2	3 (BEFORE)	4 (ONLY.WHEN)	5 (IF)
deu	bis [8], solange [5], bevor [4], erst=dann=wenn [2]	solange [13], bis [10], bevor [3], solange=bis [2], erst=wenn [2], erst=dann=wenn [2]	bevor [4]	nur=wenn [3], erst=wenn [3], erst=dann=wenn [3], erst=nachdem [2]	wenn [4]
eng	until [23]	until [33]	before [3]	only=when [7], only=once [5]	unless [2], if [2]
est	kuni [9], enne=kui [9], seni=kuni [2]	enne=kui [20], kuni [10], seni=kui [2]	enne=kui [4]	alles=siis=kui [8]	kui [4]
fin	ennen=kuin [15], kunnes [3], niin=kauan=kuin [2]	ennen=kuin [29]	ennen=kuin [2]	vasta=kun [7], vasta=sitten=kun [3]	ellei [2]
fra	tant=que [13], jusqu=A=ce=que [4], ne=que=lorsque [3]	tant=que [20], avant=que [5], aussi=longtemps=que [3], A=moins=que [2]	avant=de [2]	ne=que=lorsque [4], ne=que=une=fois [2], ne=que=aprEs [2]	si [4]
nld	zolang [5], pas=als [5], totdat [4], tot [3]	zolang [14], tot [6], voordat [4], totdat [2], pas=als [2], als [2]	voordat [2]	pas=wanneer [4]	als [2]
spa	hasta=que [19]	hasta=que [32]	hasta=que [2], antes=de [2]	solo=cuando [6], solo=quando [3]	a=menos=que [2]
swe	fOrrAn [24]	fOrrAn [34]	fOrrAn [4]	fOrrAn [12]	fOrrAn [4]

Only connectives with more than one occurrence per cluster are listed.



pam() with *k*=5: 3:BEFORE, 5:IF(NOT), 4:ONLY.WHEN

Figure 6. Location of the 5 clusters obtained with pam(*k*=5).

6. Discussion

In this section, we address the research questions we formulated in Table 2 using the combined insights gained from datasets D1 and D2. We end with a brief discussion of the way our results fit into the larger context of cross-linguistic research by considering some additional issues.

Q1: Various strategies

D1 displayed much more language-internal variation than we expected, and this variation was replicated in D2. All strategies corresponding to the paraphrases in Table 1 were found in the cross-linguistic parallel text data, even though only three strategies were

reflected in the search string for D1 and none in D2 (with Swedish *förrän* not corresponding to any of the strategies in Table 1).

However, variation is not infinite:

(i) We find predominantly UNTIL, BEFORE and AS.LONG.AS;

(ii) There are a few cases of alternative strategies revealing an extension into the domain of conditionals ((ONLY)... IF next to ONLY... WHEN/ONLY... AFTER) and in the domain of exceptive clauses (NOT... WITHOUT);[8]

(iii) Although none of the languages under investigation uses a single strategy to convey the 'not... until'-meaning, we find some languages in which one or two forms are used as dominant strategies.

Q2: Interaction of connectives and polarity

The interaction of connective type and polarity largely corresponds to the expectations we set out from in Table 1. There are exceptions, but they are all systematic. They can be accounted for by lexical negation (Section 4.5.2) and expletive negation (Section 4.5.3). Expletive negation is restricted to the UNTIL- and BEFORE-strategies. A third arguable type of exceptions concerns 'only' containing a negative element, such as French *ne... que* 'only', as part of the ONLY.WHEN-strategy.

Q3: Language-internal and cross-linguistic variability

Section 5 based on D2 suggests that variability across the 'not... until' domain can be explained by systematic language-internal and cross-linguistic variability. Two strategies, (NOT.)IF and ONLY.WHEN are mainly due to language-internal differences. Minor exceptions are German, Dutch and Danish, where the ONLY.WHEN-strategy is slightly more common than in other languages (which is no surprise for Dutch and German, see Section 2.1). Some languages have one marking strategy that occurs in more than 50% of the data in D2. This is either BEFORE (Finnish and Danish), a specific dedicated marker (Swedish *förrän*, diachronically deriving from BEFORE), UNTIL (English and Spanish) or an underspecified AS.LONG.AS/UNTIL marker (Bulgarian, Slovene, Czech and Slovak). Other languages, including Portuguese, Latvian, and Polish, are mixed. So far the results are largely the same as in Wälchli (2018/2019) for data from the New Testament. Our results differ, however, for French, Dutch, German and Estonian, which are also mixed in the Europarl data. Notably, the relevance of the AS.LONG.AS-strategies in French (*tant que*) and Dutch (*zolang*) was entirely missed in both de Swart (1996) and Wälchli (2018/2019). As expected (see Section 4.5.3), expletive negation only occurs in BEFORE-, UNTIL- and underdifferentiated AS.LONG.AS/UNTIL-connectives.

In the data considered, conventionalization (dominant markers) is so strong that it is the major signal in the multidimensional scaling and principal component analyses. Hence, it is safe to conclude that a large part of the 'not... until' domain is strongly conventionalized in European languages, but all languages also have less conventionalized parts where language-internal variation occurs. Our results demonstrate that the encoding of the 'not... until' domain can only be properly understood if cross-linguistic and language-internal variability are both taken into account at the same time.

We have shown that the various strategies in Table 1 are not entirely synonymous. Yet, we cannot say either that different markers in the 'not... until' domain in European languages have neatly distinct meanings. There are no strict semantic borders across the domain and thus no strict absence of synonyms. The various strategies can safely be considered to be near-synonyms since the semantic differences between them are entirely gradual, they differ in meaning only as a tendency. Two strategies, the ones at the extreme poles, IF and ONLY.WHEN, are somewhat more different, BEFORE, UNTIL and AS.LONG.AS are overlapping to a larger extent. We have attested both "underdifferentiation" and "overdifferentiation" in this domain:

Underdifferentiation: In some languages, not all strategies can be distinguished. Lithuanian *kol*, for instance, means both 'as long as' and 'until'. Hence, the two strategies UNTIL and AS.LONG.AS are not easily distinguished.

Overdifferentiation: Some languages have more than one connective of the same "type". Greek *mexri (na)*, *méxris ótu*, *éos otu* and *óspu na* all mean 'until'. Swedish has a connective *(inte) förrän* dedicated to '(not)…until', which is different from both *innan* 'before' and *tills* 'until'.

Q4: Relationship between temporality and conditionality

Our results show that the 'not…until' domain not only hosts temporal, but also conditional connectives. Given the nature of political linkage discussed in 2.3, this need not come as a surprise. Dimension analysis in Section 5 indicates that we can map the data on a scale of more temporal expressions (e.g., UNTIL) vs. more conditional expressions. There is no strict borderline between temporal and conditional meaning in this domain, as we can easily understand a phase change of an eventuality e_1 at the time of another eventuality e_2, as e_2 being a condition for the occurrence of e_1.

Further Issues

Research questions Q1-Q4 do not in any way exhaust the range of issues that could be picked up. We illustrate this with a brief note on the order of main and subordinate clauses in the constructions under investigation. Figure 7 shows the ratio of initial subordinate clauses averaged through all 21 languages of the D2 sample by size of circles.

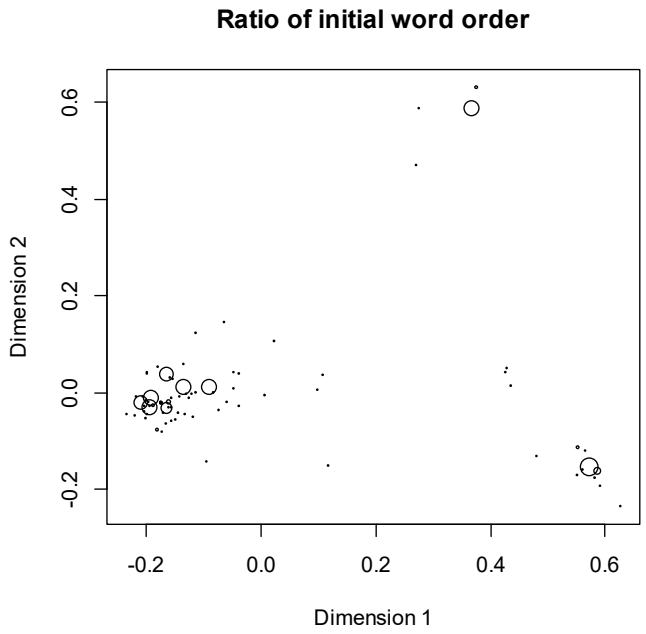


Figure 7. 'not…until' and word order.

As can be seen, final word order strongly prevails and there is no obvious pattern of distribution of deviant initial order across the clusters. As many as 44 contexts never have initial order in any translation and the maximum value is 0.9 (there is no context where all languages have initial subordinate clauses). These findings agree with our hypothesis that speakers typically put the 'linkee'-perspective first in a configuration of linkage (see Section 2.3). However, it may also be the case that word order preference is biased by the choice of initial search strings.

Other questions not addressed in this paper are the relationship of 'not…until' and tense and aspect forms in main and subordinate clauses and the great variability of expressions in different languages used in the ONLY.WHEN-strategy.

7. Conclusions

In this study we have investigated the expression of 'not…until' in the Europarl parallel corpus in two datasets: D1 (7 languages and 225 datapoints) and D2 (21 languages

and a more restricted set of 79 datapoints). We set out with a set of paraphrases and our research questions concerned the ways these strategies are reflected in the cross-linguistic corpus data, how the different strategies interact with polarity, to what extent diversity is constrained cross-linguistically and language-internally and what the interplay of temporality and conditionality is in the 'not…until' domain. In both datasets we found that languages have a bewildering wealth of different constructions to convey the 'not…until'-meaning. Further analysis of dataset D2, based on analysis of clusters and dimensions in semantic maps created by MDS, reveals that this variation is neither unlimited, nor purely a matter of free variation. We were able to identify clusters of meaning corresponding to BEFORE, IF, and ONLY.WHEN, as well as a cluster of highly conventionalized expressions of the 'not…until'-meaning. The interaction between connectives and polarity is stable in the sense that cross-linguistically, categories of connectives combine with a single polarity pattern in the main and subordinate clauses (see Table 5), unless there is a specific reason for deviation, such as expletive negation. This aligns with predictions from the formal literature that different semantic encodings of the 'not…until'-meaning are semantically/pragmatically equivalent, but originate in different lexicalizations of the construction (de Swart 1996). We have thus shown how an analysis of parallel corpus data can verify predictions about meaning composition made in the semantic literature. However, the corpus data do not only confirm earlier predictions, they also expand our perspective. Many examples deal with possible future events in terms of linkage expressing a crossover of interests and control, contexts which have so far been largely ignored in the semantic literature.

To summarize, what we find is much more diversity than expected from earlier semantic and typological literature, but also some very clear trends how diversity is constrained both cross-linguistically and language-internally. Despite some obvious methodological difficulties in using translation data, we cannot see any way in which the results we obtained could be reached by other methodologies. Our study demonstrates that cross-linguistic corpus research is indispensable in semantic studies. Semantic studies cannot abstract from cross-linguistic and language-internal diversity before having controlled for it, which presupposes empirical cross-linguistic and corpus research.

Author Contributions: Author names are in alphabetical order to reflect a shared responsibility for the content of this paper. Conceptualization: H.d.S., J.T. and B.W.; data extraction: J.T.; data analysis: H.d.S. and J.T. (for D1), B.W. (for D2); writing and revision: H.d.S., J.T. and B.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Dutch Research Council (NWO), grant number 360-80-070.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data reported in the study come from Europarl, the parallel corpus extracted from the Proceedings of the European Parliament, and are accessible through https://www.statmt.org/europarl/ (accessed on 1 October 2021).

Acknowledgments: We thank three anonymous reviewers for their very detailed and constructive feedback that helped us to improve this paper. All remaining errors are ours.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

1 1st person, 2 2nd person, 3 3rd person, AA affirmative-affirmative, ACC accusative, DAT dative, F feminine, FUT future, INF infinitive, NA negative-affirmative, NN negative-negative, M masculine, NOM nominative, NPI negative polarity item, OBL oblique, PL plural, PRS present, PTCP participle, REFL reflexive, SG singular, SUP supine.

Appendix A

Below is a list of connectives attested in the D1 dataset and their categories in the various languages.

Table A1. List of attested connectives.

English	
until, until=such=time=as	UNTIL
when, once	WHEN
if, unless	IF
after, afterwards	AFTER
before	BEFORE
without	WITHOUT
as=long=as, so=long=as	AS.LONG.AS
over, on, by, towards, at, for, in, then, later	Other markers
Dutch	
zolang	AS.LONG.AS
als, indien	IF
wanneer	WHEN
tot, totdat	UNTIL
voor, voordat, vooraleer	BEFORE
na, nadat	AFTER
zonder	WITHOUT
in, op, over, aan, vanaf, toen, of	Other markers
Swedish	
förrän, förrän=efter, förrän=till, förrän=efter=det=att, till, tills	UNTIL
när	WHEN
om, pa villkor	IF
innan	BEFORE
så länge	AS.LONG.AS
utan	WITHOUT
efter, sedan	AFTER
eftersom, da, samtidigt, för	Other markers
German	
wenn	WHEN
bis	UNTIL
solange	AS.LONG.AS
vor, bevor	BEFORE
nach, nachdem	AFTER
ohne	WITHOUT
ab, als, an, mit, zu, in, gegen, während, wie, innerhalb, sobald	Other markers
French	
tant=que, aussi=longtemps=que	AS.LONG.AS
avant, avant=que, avant=de	BEFORE

Table A1. *Cont.*

lorsque, une=fois=que	WHEN
si, à=moins=que	IF
après	AFTER
jusqu'à, jusqu=à=ce=que	UNTIL
sans	WITHOUT
en, quand, que, à=partir=de, dans, pour, vers, alors=que, à, à=peine=que, à=condition=de, alors, au=moment=de, au=terme=de, dès=que, tout, dès, dans=la=mesure=où	Other markers
Lithuanian	
kol	AS.LONG.AS
kai, kada	WHEN
iki, iki=laiko=kai	UNTIL
jei, jeigu	IF
po, po=kai	AFTER
prieš	BEFORE
be	WITHOUT
ir, kaip, nes, nei, o, nuo	Other markers
iki=kol, iki=tol=kol	(Combinations)
Finnish	
ennen=kuin, ennen	BEFORE
kun	WHEN
niin=kauan=kuin	AS.LONG.AS
ellei, jos, tapauksessa=että	IF
ilman	WITHOUT
jälkeen, sen=jälkeen=kun	AFTER
kunnes, siihen=saakka=että, siihen=asti=kunnes	UNTIL
milloin, vaikka, mikäli, kuinka=pitkään	Other markers
siihen=saakka=kun, kuin=vasta=sitten=kun	(Combinations)

Appendix B

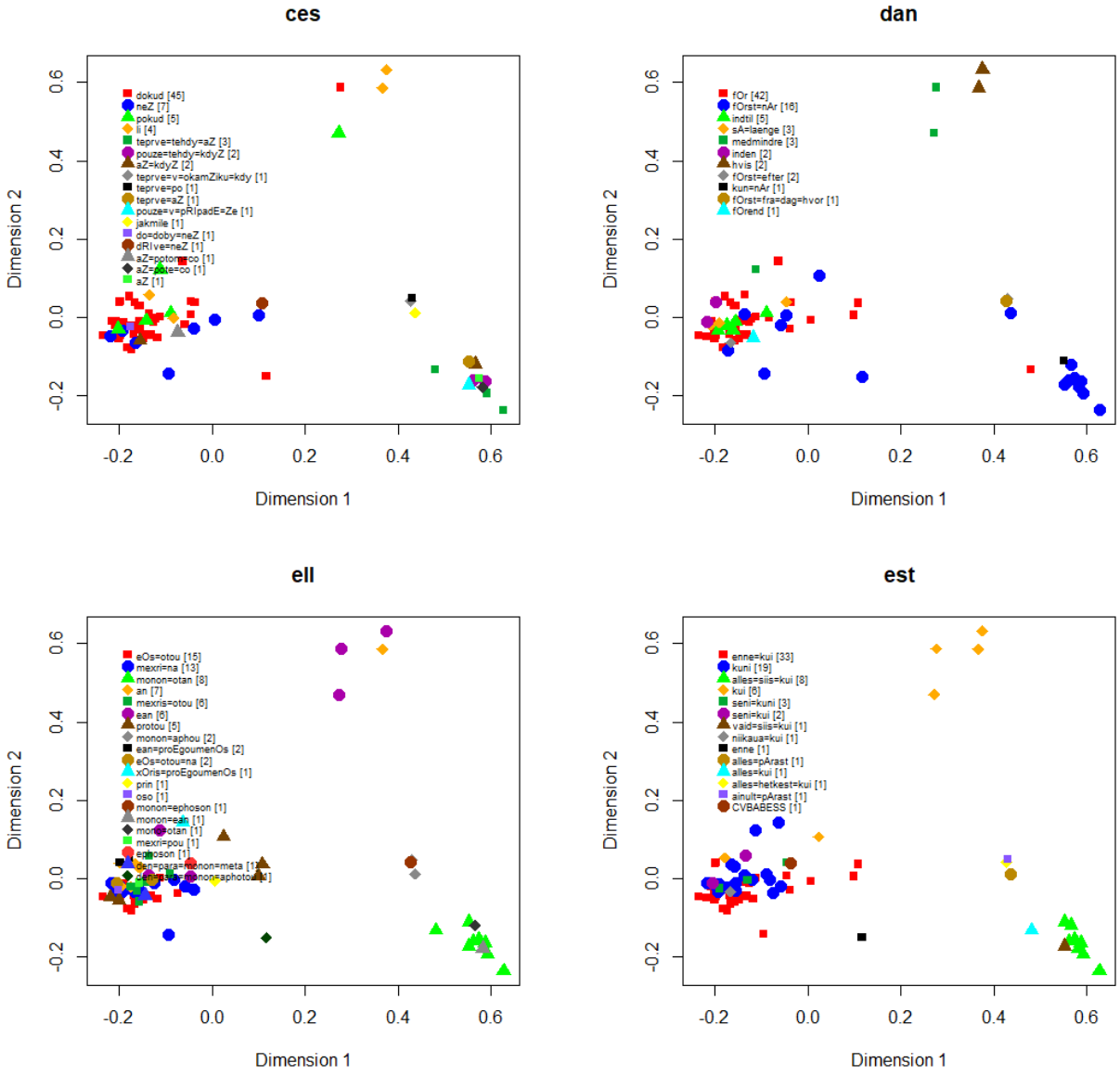


Figure A1. *Cont*.

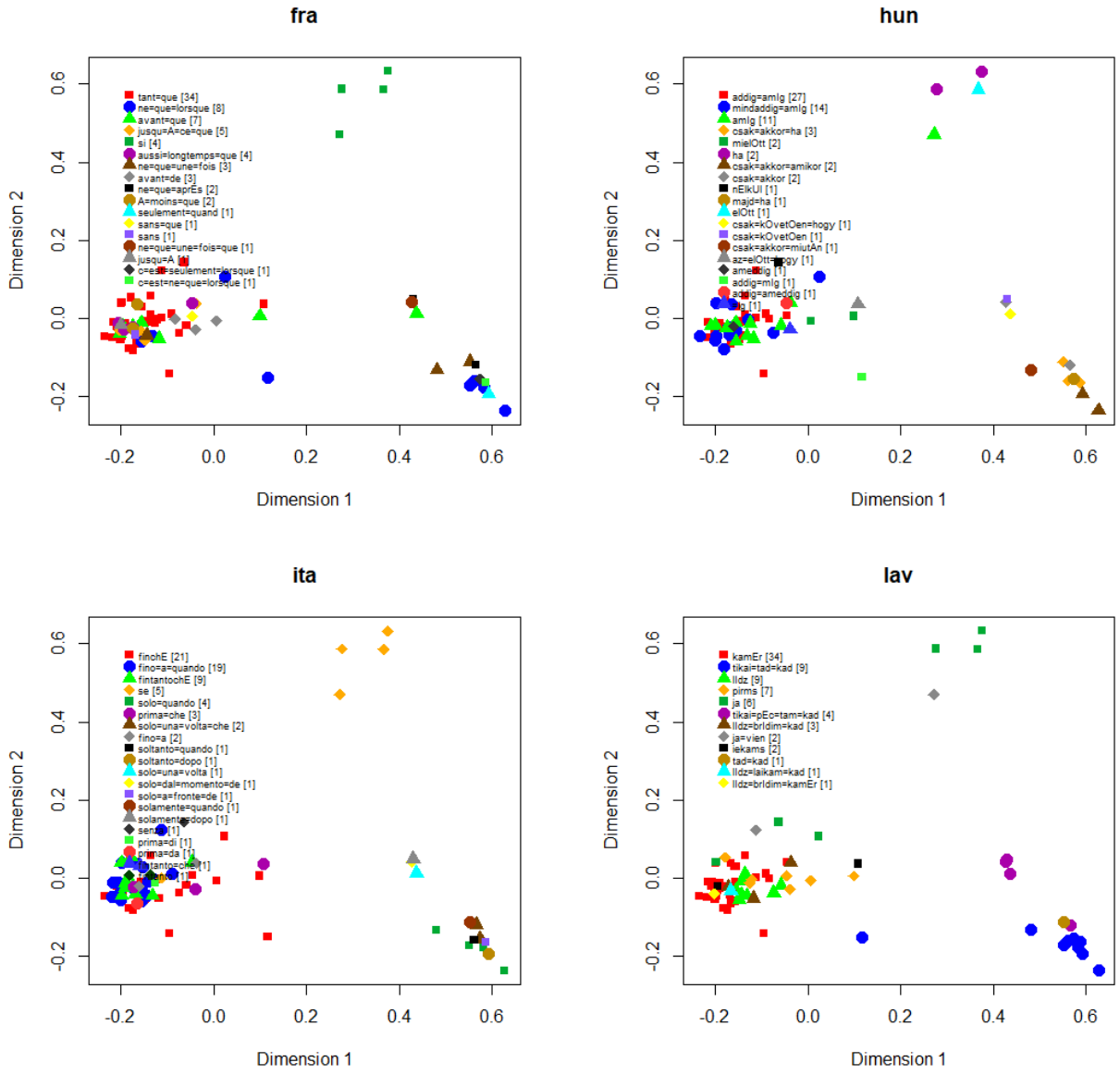


Figure A1. *Cont.*

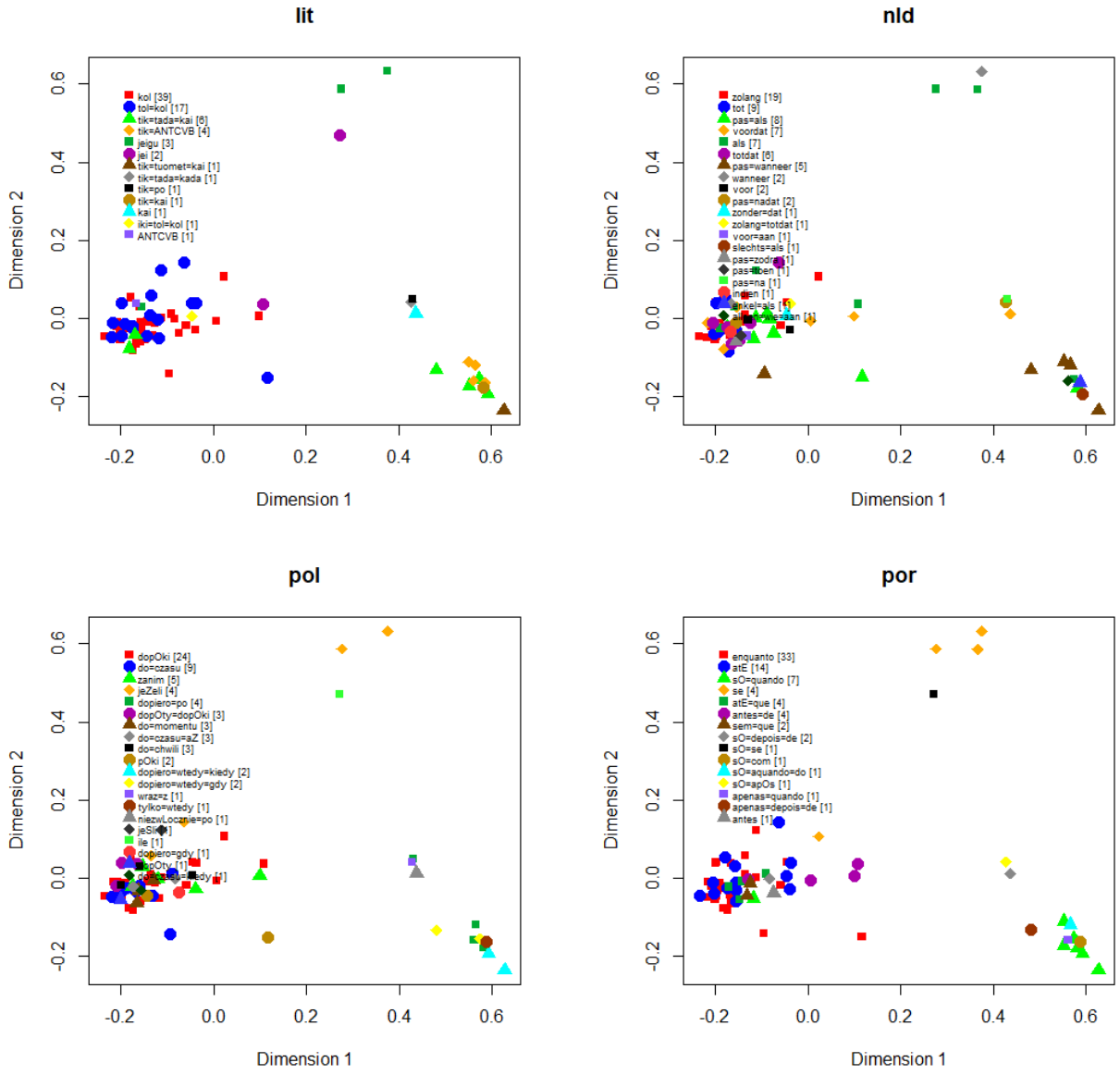


Figure A1. *Cont*.

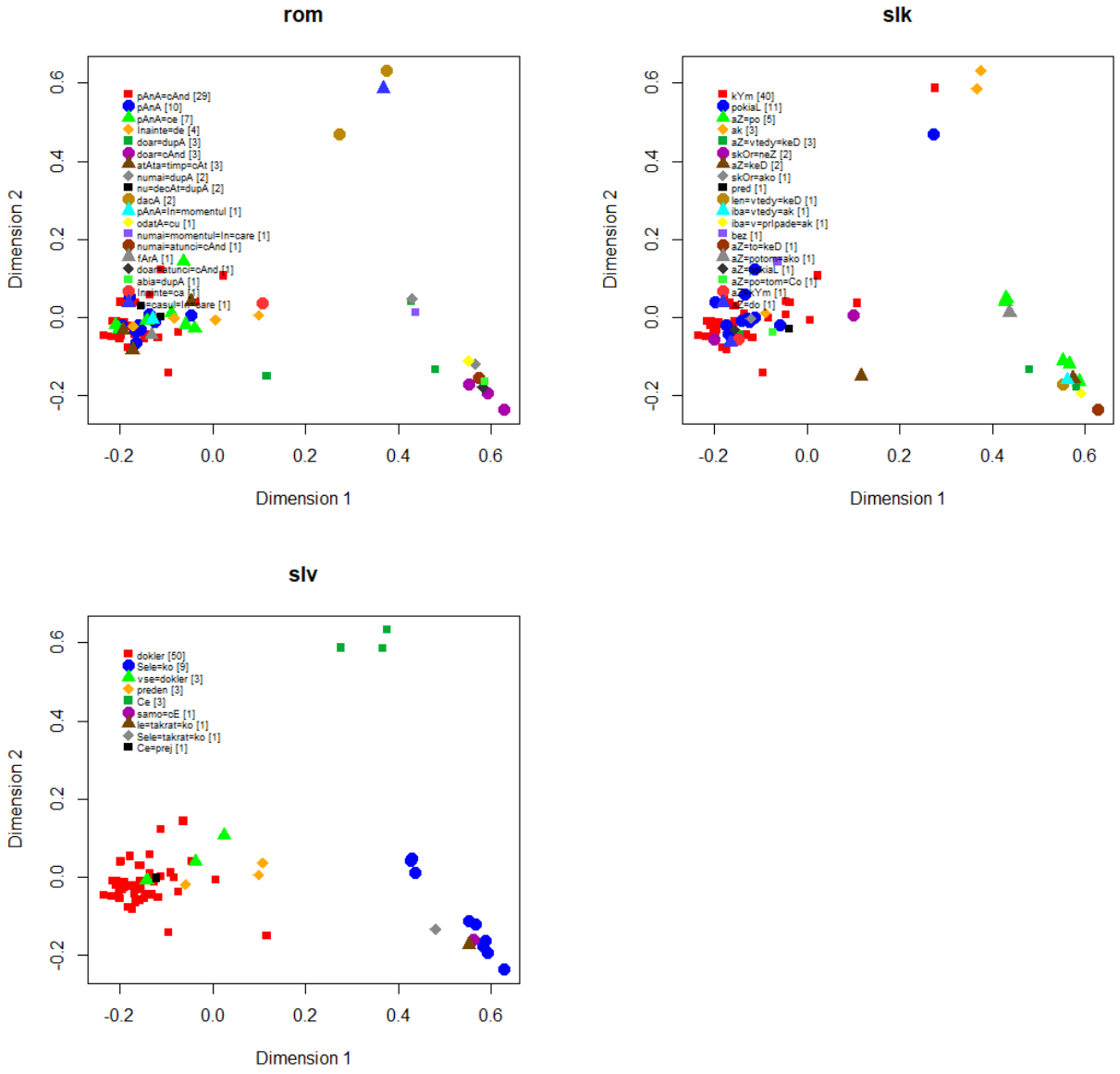


Figure A1. Maps of other languages than those in Figure 3.

Notes

1 Some annotation conventions: for symbolizing polarity, we always use the order main clause–subordinate clause even if clause order is the opposite, as in (4). Negative connectives such as *without* and *unless* are coded as heading negative clauses. Multiple negative elements within a single clause are counted as contributing single negation in negative concord languages (e.g. French *ne…pas*). In some languages, the counterpart of *only* contains a (formally) negative particle, e.g. French *ne…que*; such expressions are coded as ONLY, and the clauses they occur in are coded as affirmative.

2 In Europarl it is not always clear what language is the original source language, and what language is the translated language (but see van Halteren 2008). We do not consider this to pose a major problem for our approach, since we are primarily interested in the inventory of expressions available in various languages.

3 *TimeAlign* is software that facilitates the annotation of parallel corpus data, and is available at https://github.com/UUDigitalHumanitieslab/timealign.

4 See https://cran.r-project.org/web/packages/smacof/index.html for details and references on the *stress minimization using majorization* (smacof) algorithm for MDS.

5 We chose here to only display main clause polarity, instead of the full polarity pattern (NN vs. AA vs. NA). This keeps the maps more readable, but maps displaying the full polarity pattern can be constructed in the same manner.

6 According to Wälchli (2018/2019: 191), negative conditional clauses may be a source for expletive negation in the 'not…until' domain.

[7] See https://termcoord.eu/2016/09/eu-languages-maltese-and-irish/.

[8] The number of exceptive clauses in our corpus data is low, so further investigation is needed, but this falls outside the scope of this paper.

References

Bassi, Itai, and Moshe E. Bar-Lev. 2018. A Unified Existential Semantics for Bare Conditionals. *Proceedings of Sinn Und Bedeutung* 13: 125–42.

Beaver, David I., and Brady Z. Clark. 2008. *Sense and Sensitivity: How Focus Determines Meaning*. Chichester: Wiley-Blackwell.

Bow, Brian. 2010. *The Politics of Linkage: Power, Interdependence, and Ideas in Canada-US Relations*. Vancouver: UBC Press.

Comrie, Bernard. 1986. Conditionals: A typology. In *On Conditionals*. Edited by Elizabeth Closs Traugott, Alice ter Meulen, Judy Snitzer Reilly and Charles A. Ferguson. Cambridge: Cambridge University Press, pp. 77–99.

Condoravdi, Cleo. 2002. Temporal interpretation of modals: Modals for the present and for the past. In *The Construction of Meaning*. Edited by David I. Beaver, Luis D. Casillas Martínez, Brady Z. Clark and Stefan Kaufmann. Stanford: CSLI, pp. 59–88.

Cristofaro, Sonia. 2003. *Subordination*. Oxford: Oxford University Press.

Croft, William, and Keith T. Poole. 2008. Inferring universals from grammatical variation: Multidimensional scaling for typological analysis. *Theoretical Linguistics* 34: 1–37. [CrossRef]

de Swart, Henriëtte. 1996. Meaning and use of *not…until*. *Journal of Semantics* 13: 221–63. [CrossRef]

Declerck, Renaat. 1995. The problem of *not…until*. *Linguistics* 33: 51–98. [CrossRef]

Diessel, Holger. 2001. The ordering distribution of main and adverbial clauses: A typological study. *Language* 77: 433–55. [CrossRef]

Diessel, Holger. 2005. Competing motivations for the ordering of main and adverbial clauses. *Linguistics* 43: 449–70. [CrossRef]

Espinal, M. Teresa. 2000. Expletive negation, negative concord and feature checking. *Catalan Working Papers in Linguistics* 8: 47–69.

Farkas, Donka F., and Yoko Sugioka. 1983. Restrictive if/when clauses. *Linguistics and Philosophy* 6: 225–58. [CrossRef]

Greco, Matteo. 2020. On the syntax of surprise negation sentences: A case study on expletive negation. *Natural Language & Linguistic Theory* 38: 775–825.

Herburger, Elena. 2019. Bare conditionals in the red. *Linguistics and Philosophy* 42: 131–75. [CrossRef]

Hetterle, Katja. 2015. *Adverbial Clauses in Cross-Linguistic Perspective*. Berlin: De Grutyer Mouton.

Hitzeman, Janet. 1991. Aspect and adverbials. In *Proceedings of Semantics and Linguistic Theory (SALT) 1*. Ithaca: Cornell University, pp. 107–27.

Hoyte-West, Antony. 2020. The 23rd language: Official EU status for Irish as portrayed in the Republic of Ireland's English-language press. *English Studies at NBU* 6: 173–83. [CrossRef]

Iordanskaja, Lidija, and Igor Mel'čuk. 2009. Semantics of the Russian conjunction POKA 'while, before, until'. In *Wiener Slawistischer Almanach. Sonderband 73*. Edited by Tilman Berger, Markus Giger, Sibylle Kurt and Imke Mendoza. Von grammatischen Kategorien und sprachlichen Weltbildern—Die Slavia von der Sprachgeschichte bis zur Politsprache. München: Sagner, pp. 253–62.

Jolliffe, Ian T., and Jorge Cadima. 2016. Principal component analysis: A review and recent developments. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 374: 20150202. [CrossRef] [PubMed]

Kamp, Johan Anthony Willem. 1968. Tense Logic and the Theory of Linear Order. Ph.D. thesis, University of California, Los Angeles, CA, USA.

Karttunen, Lauri. 1974. Until. In *Papers from the Tenth Regional Meeting of the Chicago Linguistic Society*. Chicago: Chicago Linguistic Society, pp. 284–97.

Koehn, Philipp. 2005. Europarl: A parallel corpus for statistical machine translation. *MT Summit* 5: 79–86.

Kortmann, Bernd. 1997. *Adverbial Subordinators. A Typology and History of Adverbial Subordinators Based on European Languages*. Berlin: Mouton de Gruyter.

Le Bruyn, Bert, Mo Chou, Martín Fuchs, Martijn van der Klis, Jos Tellings, and Henriëtte de Swart. 2022. Parallel corpus research: The contrastive, typological and Translation Mining approaches.

Lehmann, Christian. 1974. Prinzipien für 'Universal 14'. In *Linguistic Workshop II*. Edited by Hansjakob Seiler. München: Fink, pp. 69–97.

Lehmann, Christian. 1988. Towards a typology of clause linkage. In *Clause Combining in Grammar and Discourse*. Edited by John Haiman and Sandra A. Thompson. Amsterdam: Benjamins, pp. 181–225.

Mittwoch, Anita. 1977. Negative sentences with *until*. In *Proceedings of CLS 13*. Chicago: Chicago Linguistic Society, pp. 410–17.

Murelli, Adriano, and Bernd Kortmann. 2011. Non-standard varieties in the areal typology of Europe. In *The Languages and Linguistics of Europe. A Comprehensive Guide*. Edited by Bernd Kortmann and Johan van der Auwera. Berlin: De Gruyter Mouton, pp. 525–44.

R Core Team. 2020. *R: A Language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing.

Smith, Steven Bradley. 1974. *Meaning and Negation*. Mouton: The Hague.

Thompson, Sandra A., Robert E. Longacre, and Shin Ja J. Hwang. 2007. Adverbial clauses. In *Language Typology and Syntactic Description*. Edited by Timothy Shopen. Cambridge: Cambridge University Press, vol. 2, pp. 238–300.

Tiedemann, Jörg. 2012. Parallel Data, Tools and Interfaces in OPUS. In Proceedings of the 8th International Conference on Language Resources and Evaluation (LREC 2012), Istanbul, Turkey, May 21–27.

van der Auwera, Johan. 2011. Standard Average European. In *The Languages and Linguistics of Europe. A Comprehensive Guide*. Edited by Bernd Kortmann and Johan van der Auwera. Berlin: De Gruyter Mouton, pp. 291–306.
van der Klis, Martijn, and Jos Tellings. 2022. Generating semantic maps through multidimensional scaling: Linguistic applications and theory. Advance online publication. *Corpus Linguistics & Linguistic Theory*. [CrossRef]
van der Klis, Martijn, Bert Le Bruyn, and Henriëtte de Swart. 2017. Mapping the PERFECT via Translation Mining. Presented at the 15th Conference of the European Chapter of the Association for Computational Linguistics, EACL 2017, Valencia, Spain, April 2–7; Vol. 2, pp. 497–502.
van Halteren, Hans. 2008. Source language markers in EUROPARL translations. Presented at the 22nd International Conference on Computational Linguistics (Coling 2008), Manchester, UK, August 18–22; pp. 937–44.
von Fintel, Kai, and Lisa Matthewson. 2008. Universals in semantics. *The Linguistic Review* 25: 139–201. [CrossRef]
Vostrikova, Ekaterina. 2018. On the similarity between *unless* and *only-if-not*. *Proceedings of Sinn und Bedeutung* 21: 1271–88.
Wälchli, Bernhard, and Michael Cysouw. 2012. Lexical typology through similarity semantics: Toward a semantic map of motion verbs. *Linguistics* 50: 671–710. [CrossRef]
Wälchli, Bernhard. 2018/2019. 'As long as','until' and 'before' clauses. *Baltic Linguistics* 9: 141–236.