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Research proposal [Part B1]

Universal Paradigmatic Gaps

UNPAG

Prof. Dr. Hedzer (Hedde) Hugo Zeijlstra
Georg-August-Universität Göttingen Stiftung Öffentlichen Rechts
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Universal paradigmatic gaps are gaps in linguistic paradigms that appear across languages and across users of a given language. As of yet, only very few gaps of this kind have been discussed in the literature. The one gap that has received substantial discussion concerns the universal absence of a lexicalized negated form for the quantifiers *all*, *every* or *always*: There appears to be no language in the world that exhibits a single word (or lexical item) that means ‘not all’, ‘not every’ or ‘not always’, an observation dating back to Thomas Aquinas (1225-1274). **UNPAG will show that the landscape of *universal paradigmatic gaps* is in fact much richer and more varied than generally imagined.**

It is deeply enigmatic that such words do not exist across languages and cultures. Clearly, any theory seeking to explain such missing lexicalizations, i.e. any theory of universal paradigmatic gaps, should be able to make clear predictions about what may or may not be lexicalized, and why that is the case. Such a theory has thus far not been developed. It is also without question that such a theory should have a broad empirical foundation. To date, the pool of data has been heavily slanted toward well-studied, Western, Indo-European, adult spoken language, and negative quantifiers therein. No existing study has thus far come even close to targeting a richer empirical base, even though many more universal gaps can be observed! **UNPAG will be the long-overdue filler of this gap.**

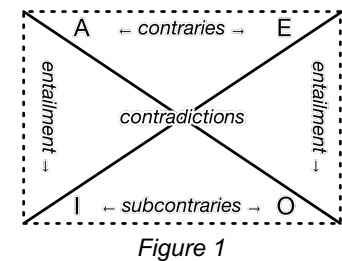
Understanding the nature, distribution and behaviour of *universal paradigmatic gaps* will have several profound implications for our understanding of human cognition, language and communication. UNPAG is the first panoramic study of *universal paradigmatic gaps*. **Why is it that we cannot always say what is thinkable?** UNPAG will provide an answer to this question and show when, how and why universal paradigmatic gaps may emerge in the languages that we speak or sign.

1. Universal Paradigmatic Gaps

Universal paradigmatic gaps are gaps in linguistic paradigms that appear **across languages** and **across users of a given language**. For instance, there appears to be no language in the world that exhibits a single word (or lexical item) that means ‘not all’, ‘not every’ or ‘not always’. In fact, a simple Google search will reveal that the occurrence of non-lexicalized *not all* is highly abundant (more than a billion occurrences on April 2, 2023). **So, why is it the case that no language in the world appears to have a single word for ‘not all’, ‘not every’ or ‘not always’?** Is it really a universal ban or rather a cross-linguistic rarity? Does it only hold only for quantifiers like ‘not all’, ‘not ever’ and ‘not always’, or also for modal quantifiers, i.e. quantifiers over possible worlds? Does it hold equally for spoken and sign languages? And are there more universal paradigmatic gaps like this that have yet to be observed? **These are questions that to date have hardly been addressed in the literature, but have strong implications for our understanding of human cognition, language and communication. UNPAG will address these questions and will show that the landscape of universal paradigmatic gaps is much richer than generally imagined, and that certain alleged universal paradigmatic gaps do not exist despite prima facie evidence to the contrary.**

Horn (1972, 1989, 2012 a.o.) famously observed that the absence of a word like *nall*, meaning ‘not all’, an observation dating back to Thomas Aquinas (1225-1274), is part of a broader systematic absence of words with a particular logical footprint (see also Barwise & Cooper 1981, von Stechow & Matthewson 2008). This is demonstrated by Boethius’ (480-525) renowned *Square of Oppositions* (SoO, Fig. 1). The SoO is a visualization that depicts the four major types of propositions under Aristotelian logic: universal affirmatives (A), existential affirmatives (I), universal negatives (E), and existential negatives (O), each of them illustrated below (the abbreviations correspond to the Latin *Affirmo* (‘I assert’) and *nEgO* (‘I deny’), and their logical relations). For instance, (1a) and (1d) are contradictions; (1a) and (1c) are contraries.

- (1) a. Universal affirmative (A): *every car is red*
 b. Existential affirmative (I): *some car is red*
 c. Universal negative (E): *no car is red*
 d. Existential negative (O): *not every car is red*



Apart from quantifiers, many other logical elements stand in such relations. For instance, the connective *and* (A) entails *or* (I) and is a contrary of *nor* (E) which contradicts *or* (I) again. The same holds for *both* (A), which stands in similar relations to *one* (I) and *none* (E). Strikingly, the O-corners appear never to be lexicalized, neither in English nor in any other language we know of: words like *noth* (meaning ‘not both’) or *nand* (meaning ‘not and’) are likewise never found. The so-called *nall problem* thus concerns the universal, systematic absence of the lexicalization of the O-corner in the SoO, and not just the absence of particular logical operators. **However, I will show that these are not the only universal paradigmatic gaps that can be attested and require explanation and study; UNPAG will reveal several others.**

2. Scientific significance: Cognition, communication or ...?

2.1 Cognitive approaches

Various accounts for this *nall* problem have been provided. Going back to Jespersen (1917, 1924) and Löbner (1987, 1990), one branch of analyses (Jaspers 2005, Seuren 2006, Larson & Jaspers 2011, Seuren & Jaspers 2014) argues that although the SoO contains four corners, cognitively, there are only three prime oppositions (between A, I, and E), with approaches differing whether the E-corner reflects an operator *some and possibly all* or *some but not all*. If indeed the core oppositions only involve A, I and E, and not O, the absence of lexicalizations of O could receive a direct cognitive explanation: if cognitively, there is only a *Triangle of Oppositions*, there is no question then as to why the missing corner is never lexicalized. Sbardolini (2023) takes such triangles as the basis of his *Logic of Lexical Connectives* (see also Incurvati & Sbardolini 2023). However, as Jaspers (2005) acknowledges, even if the O-corner is not a prime cognitive concept, the question remains open why logically conceivable complex meanings, such as ‘not all’, ‘not both’, or ‘not and’ still cannot be lexicalized at all. Again, this point becomes especially relevant in the light of the aforementioned observation that the complex construction ‘not ... every’ is in fact highly pervasive (see also Hoeksema 1999).

More recently, Seuren & Jaspers (2014) argue that the SoO is actually best replaced by a hexagon (after Jacoby 1950, 1960, Sesmat 1951, Blanché 1952, 1953, 1966), which comprises all logical relations between A, I, E and O, and two other ones: Y ($\equiv I \wedge \neg A$, *some but not all*) and U ($\equiv A \vee \neg I$, *all or nothing*). Of the six corners of this hexagon, they argue, U and O are never realized. The corners that form a kite are the only candidates for lexicalization (see Fig. 2). Note that, Seuren (2013) and Seuren & Jaspers (2014) take both Y and I to be realized by the same lexical item *some*; in fact, they argue that every realization of the I-corner is systematically homophonous with that of the Y corner, without providing a reason why this is the case.

The reason why U and O are never realized, for them, is that they take lexicalized logical operators to be restrictors of a universe. The primary means of restricting a universe, they argue, is that between E (*no*) and I (*some or all*); the secondary means is the subdivision of I between A (*all*) and Y (*some but not all*). This way, neither O nor U can be used as further restrictor and are therefore never realized. However, these are not the only possible restrictions that could conceivably be made. One could equally well first divide a universe between A and O, and have O further be subdivided between E and I. It is unclear why these restrictions could not then be lexicalized to the exclusion of Y and U. Seuren & Jaspers (2014) here follow Jaspers (2005) and Larson & Jaspers (2011) in assuming that the distinction between E and I is ‘pivotal’. Again, by assigning exceptional cognitive status to E and I over A and O, the absence of O-lexicalizations could be accounted for, but it is not clear why E and I must be cognitively more primitive. Indeed, the fact many languages lack an E realization as well (e.g. Hindi, see Zeijlstra 2022) casts considerable doubt on this.

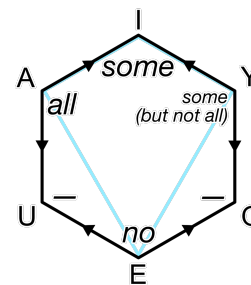


Figure 2

Moreover, the observation that natural languages never exhibit a single word for U can already be independently explained in terms of connectedness. As Chemla et al. (2019) have shown, connectedness is a necessary condition for both content and function words. We thus do not find words meaning ‘bottle or eagle’ or ‘less than five or more than 10’. A single word meaning ‘all or nothing’ would violate connectedness, as the intermediate ‘some’ cannot be expressed by it.

2.2 Communicative approaches

An alternative approach has been built upon the notion of efficient communication, and, more explicitly, pragmatic blocking. In short, the existence of a lexicalization for the I-corner blocks lexicalization for the O-corner. This approach has originally been put forward by Horn (1972, 1989, 2012) and has recently been reimplemented by Katzir (2007), Katzir & Singh (2013), Uegaki (2022), Enguehard & Spector (2021), Züfle & Katzir (2022) and Bar-Lev & Katzir (2022) in different ways. Their main argument, in short, is that, while I- and O-type sentences are semantically different, their pragmatic contributions are in fact similar. To see this, let us take into consideration the joint meaning contributions of the following two examples:

- | | | | | | | |
|-----|----|--------------------|-------------------------------|----|---------------------|-------------------------------|
| (2) | a. | Assertion | Some car is red | b. | Assertion. | Not every car is red |
| | | <u>Implicature</u> | <u>Not every car is read</u> | | <u>Implicature.</u> | <u>Some car is read</u> |
| | | Joint meaning: | Some but not every car is red | | Joint meaning: | Some but not every car is red |

Since the joint meaning contributions made by the corresponding I- and O-type sentences are the same, natural language only needs to exploit one. This way, only three out of the four lexical corners need to be lexicalized in order to convey the overall meanings of all four corners. The reason, then, that it is O (and not I) that never gets lexicalized has to do with markedness. Because Horn takes negative expressions to be always marked in comparison to their positive counterparts, the possible existence of I-type terms blocks the existence of O-type terms (though see Enguehard & Spector 2021 and Bar-Lev & Katzir 2022 who aim to derive this effect in independent terms). In short, if a language is to lexicalize either the I- or the O-corner, it must be the I-corner.

As Hoeksema (1999) points out though, pragmatic equivalence is by nature much weaker than semantic equivalence. One can easily utter the assertion in (2a) about a particular subset of cars without knowing anything about the colours of the other cars, but the pragmatic equivalence of (2) and (2) is then already disrupted. Moreover, if conveying I-type sentences blocks conveying O-type sentences, the question emerges why utterances containing expressions like ‘not ... every’ or ‘not ... all’ are nevertheless allowed and fully interpretable; as mentioned previously, their appearance is abundant. Hence, this approach is, in one way, too weak (pragmatic equivalence is too weak to account for such blocking), and, in another, too strong (it predicts the exclusion not only of O-lexicalization, but also that of O-type sentences generally).

2.3 Or ...

All approaches so have presented arguments why lexicalizations like *nall* and *nand* should be grammatically or lexically ruled out. However, **novel evidence** is available that shows that such lexicalizations can be observed **both inside and outside the domain of negated quantifiers**. This shows that what is still needed is a proper theory of when certain logical operators can be lexicalized or not. It is without question that any theory of such missing lexicalizations, i.e. any theory of universal paradigmatic gaps, should make clear predictions about what may or may not be lexicalized, and why that is the case. **Such a theory thus far not been developed.** It is equally without question that a theory should have a profound empirical basis, whereas currently, the pool of data has been heavily slanted toward well-studied, Western, Indo-European, adult spoken language, and negative quantifiers therein. **No existing study has thus far come even close to targeting a richer empirical base, even though many more universal gaps can be observed! UNPAG will be the long-overdue filler of this gap.**

3. Universal Paradigmatic Gaps: Extending the landscape

3.1 Extending the NALL problem

It has been received wisdom for a long time that languages systematically lack realizations of the O-corner. But while there is a clear pattern, whether such a claim is really cross-linguistically sound has never been investigated. No typological study has been devoted to it, and there may be reasons to doubt that lexicalized O-terms are universally absent. As Seuren & Jaspers (2014) have pointed out, data from Kinyarwanda may actually falsify it; Kinyarwanda has a series of expressions like *sibose* or *sihose* that appear to mean ‘not all people’ or ‘not everywhere’, respectively, though it is unclear whether they mean just that or rather ‘some but not all people’ or ‘somewhere but not everywhere’.

In addition, Kuhn & Pasalskaya (2023) have shown that examples in the domain of modals O-lexicalizations can be regularly attested, arguing against esp. Enguehard & Spector (2021). Bimorphemic *unnecessary* is a good example, as is, they claim, monomorphemic *optional*. However, unlike *unnecessary*, *optional* may strongly infer possibility, rendering it not a true O-lexicalization: *it is unnecessary; in fact it is even forbidden*, is perfectly acceptable, whereas *it is optional; in fact it is even forbidden* sounds unnatural. This may suggest that simplex words with an O-meaning still cannot be attested, even among modals. However, Kuhn & Pasalskaya (2023) demonstrate that in certain sign languages, such monomorphemic O-lexicalizations can nevertheless be found; E.g., French Sign Language has a simplex sign for *unnecessary*.

Lin et al. (2015, 2018) have also shown using corpus studies and experiments that in the first stages of languages acquisition (2;0-3;10), the Dutch modal verbal stem *hoef* (‘need’) is always used as a fixed expression with the negative marker *niet* (like *hoefnie(t)*). As Lin et al. demonstrate, children first take this to be a lexical construct prior to determining that this verb can also appear in other constructions. Consequently, this lexical expression *hoefnie* also qualifies as an O-lexicalization.

This shows that O-lexicalizations indeed are not systematically ruled out. Naturally, this claim will have to be further substantiated typologically and experimentally. Moreover, it will need to be investigated what restrictions O-lexicalizations (modal vs non-modal, sign language vs spoken language, etc.) are subject to and why. UNPAG will carry out these investigations.

3.2 Lexicalization constraints in the domain of Polarity-Sensitive Items

Similar gaps on lexicalizations can be attested among Polarity-Sensitive Items (PSIs), at least those PSIs that quantify over individuals or time variables. PSI come about in two types. One is called a Positive Polarity Item (PPI), as it is restricted to positive contexts; the other is called a Negative Polarity Item (NPI), as it is restricted to negative contexts. As an example, English *any*, a realization of I, is an NPI as it can only appear in sentences that in one way or another count as negative (see Ladusaw 1979, Giannakidou 1999 among any others): **She ate any cookies* is an unacceptable sentence in English, but *She didn’t eat any cookies* isn’t. The mirror image of *any* is *some*, another I-term. *Some*, by contrast, is a PPI can only appear in positive environments. To the extent that *She didn’t eat some cookies* is an acceptable sentence, it is only acceptable under the reading that there are some cookies that she failed to eat, and not that she ate no cookies.

However, while PSIs are not restricted to low scalar endpoints (like all I-terms), no PSI that is an A-term has been attested among quantifiers over individuals or time variables. Put differently, while higher scalar expressions like *much* (NPI) or *rather* (PPI) can indeed be attested (see Israel 1996), no language in the world so far has been identified as having a word like *every* that is an NPI or a PPI. That is, there is no language with an expression X meaning ‘every’ that is allowed only in negative contexts or only in positive contexts.

For modals, the empirical landscape is fundamentally different. In the domain of deontic modals—modals expressing obligation and permission—the facts seem to be reversed. English universal modal A-terms *must* and *should*, for instance, are uncontroversially taken to be PPIs (see Israel 1996, Iatridou & Zeijlstra 2013, Homer 2015), which explains why *Alex mustn’t/shouldn’t leave* means that it must/should be the case that she does not leave (note that word order does not determine such scopal relations; *Alex hasn’t (got) to leave* means that it is not the case that she has to leave). Similarly, universal A-modals like English *need*, Dutch *hoeven* (‘to need’) or German *brauchen* (‘to need’), when taking a verbal complement, are well-known NPIs. However, in the domain of deontic modality, existential NPIs or PPIs crucially are not attested. There is no known existential PPI meaning *may* and there are only very few, if any, existential NPIs (see Van der Auwera 2001, Meijer 2014, Zeijlstra 2022 for discussion of some possible examples). And finally, among epistemic modals—modals concerning knowledge and beliefs—all six types can be found. Existential PPIs (*may* as in *She may (not) be in her office*), existential NPIs (*can* as in *She can’t/*can be in her office*), Universal PPIs (*should* as in *She should (not) be in her office*) and Universal NPIs (*need* as in *She need*(n’t) be in her office*). In addition, both existential and universal polarity-insensitive elements can be found, such as *could* or *has to*.

This demonstrates that for PSIs, in certain domains (quantification over individuals or time variables) no clear O-like terms (here, universal PSIs) can be attested. However, in other domains (quantification over possible worlds or situations), either O-like, but not E-like PSIs can be attested (as in the case of deontic modals), or both may be (as in the case of epistemic modals). These data necessitate systematic inquiry into

the degree to which these empirical generalizations about PSIs are consistent with cross-linguistic data, and into whether such absent PSIs are grammatically impossible. Such an investigation will also be conducted under UNPAG.

3.3 Weak vs strong modals and Neg-Raising

Traditionally, universal modals have been divided into two categories: strong necessity and weak necessity modals. This categorization targets the observation that strong necessity modals (such as *must* or *have to*) are semantically stronger than weak necessity modals (such as *should* or *ought to*), as the following examples show: *You should leave but you don't have to* is acceptable, while *#You have to leave but you shouldn't* is much odder. However, despite morphological similarities, modals like *might* or *could* do not stand in a similar strength relation to *may* or *can*: *#You could/might leave but you can't / may not* sounds contradictory. Mirrazi & Zeijlstra (2023), building upon work by von Stechow & Iatridou (2008), show that *might/could* behave as existential duals of strong necessity modals and tend to yield strong possibility readings. English thus appears to lack weak possibility modals. In other words, there may be both strong and weak modal A-terms, but weak modal I-terms never appear to be lexicalized. This is not a coincidence; hardly any language lexically exhibits weak possibility modals (though see Mocnik 2018 for a potential exception in Slovenian).

The absence of weak modal I-terms at first glance seems related to the fact that weak necessity modals, when negated, can give rise to so-called Neg-Raising (NR) readings, while strong necessity modals cannot. Though both *must* and *should*, being PPIs, generally outscope negation, when embedded under a negated NR predicate, *should* is able to outscope matrix negation, whereas *must* is not:

- (3) a. I don't think that John should marry Susan. (✓*should* > not)
 b. I don't think that John must marry Susan. (*#must* > not) (Homer 2015)

This shows that *should* is an NR predicate but *must* is not. Similar observations can be made for other strong and weak necessity modals: weak necessity modals are always Neg-Raisers, strong necessity and possibility modals never are. The latter is unsurprising, as it has been known since Horn (1989) that NR predicates are high scalar elements. However, no fundamental explanation as to why strong necessity modals are not Neg-Raisers and weak necessity modals are is currently available (though see Mirrazi & Zeijlstra 2023 for some hypotheses). Naturally, UNPAG will also evaluate these paradigmatic gaps.

4. Research Questions & Hypotheses

4.1 Research Questions

UNPAG will address the following **Research Questions**:

RQ1: What kind of universal paradigmatic gaps can be attested with respect to the lexicalization of logical elements in natural language?

RQ1a: What kind of universal paradigmatic gaps can be attested with respect to the lexicalization of negative and positive quantifiers over individuals and over possible worlds in natural language?

RQ1b: What kind of universal paradigmatic gaps can be attested with respect to the lexicalization of polarity-sensitive quantifiers over individuals and over possible worlds in natural language?

RQ1c: What kind of universal paradigmatic gaps can be attested with respect to the lexicalization of weak and strong quantifiers over possible worlds in natural language and the way they interact with Neg-Raising?

RQ2: What determines the landscape of lexicalized logical elements in natural language?

RQ2a: To what extent are the attested absent lexicalizations universal, as opposed to simply being cross-linguistically rare?

RQ2b: To what extent are the attested lexicalization constraints sensitive to the modality of a language (spoken languages vs. sign languages)?

RQ2c: To what extent are the attested lexicalization constraints sensitive to the nature of the domain of quantification (quantification over individuals/time variables vs. quantifiers over possible worlds)?

RQ2d: To what extent are the apparently absent lexicalizations still learnable?

RQ3: How can the landscape of lexicalized logical elements in natural language be explained?

RQ3a: What explains the existence of the observed constraints on the lexicalization of logical elements?

RQ3b: Why do lexicalization constraints in the domain of quantifiers over individuals / time variables appear to apply primarily to universal elements?

RQ3c: Why do lexicalization constraints in the domain of quantifiers over possible worlds appear to apply primarily to existential elements (if at all)?

RQ3d: Why are lexicalization constraints sensitive to modulation?

4.2 Hypotheses

Given the above, the general hypothesis is that unlike all existing approaches concerning universal paradigmatic gaps with respect to the lexicalization of logical elements in natural language, such gaps are not universally ruled out in natural languages. Rather, when closely investigating what constitutes such universal gaps, it is revealed that such lexical elements either have a meaning that appears to be very weak, or have

semantic properties that make them far more opaque than the existing lexicalizations. Since elements with very weak meanings and elements with very opaque properties are very hard to learn, **they are universally rare but can be attested.**

General Hypothesis (H): Universal paradigmatic gaps are not ruled out by the grammar. They are only much harder to identify.

H1: Absent O-lexicalizations are rare, as processes of lexicalizations where a negative marker and another scalar element melt together into one word only target unfocused elements. As the meaning of unfocused negated universal quantifiers is much weaker than those of focused ones, such unfocused negated universal quantifiers are less likely to emerge as candidates for lexicalizations. When lexicalization works in a different fashion (e.g. in sign languages or in the acquisition of negative modals), O-lexicalizations can be more readily attested (Zeijlstra 2022).

H2: In order to understand constraints on the lexicalization of polarity-sensitive elements, one needs to first understand what renders some element an NPI or a PPI. Assigning these properties to other quantificational elements does not naturally result in run-of-the-mill PSIs (Zeijlstra 2017, 2022).

H2a: Assigning the properties that Chierchia (2013) attributes to existential NPIs to universal quantifiers does not yield universal PPIs but rather universal quantifiers that can appear below negation but cannot reconstruct below it. Such elements can be attested.

H2b: Assigning the properties that Zeijlstra (2022) attributes to existential PPIs to universal quantifiers does not yield universal NPIs, but rather universal quantifiers that can appear in non-negative clauses but must reconstruct below a clausemate negation when present. Such elements can also be attested.

H3: The difference between weak and strong necessity modals is that the latter have to have the actual world in their domain of quantification, but the former do not (Silk 2016, 2022).

H3a: Existential modals that do not have to make references to the actual world have a meaning that is so weak that these either are not lexicalized, or when they are, are obligatorily strengthened in most positive contexts (see Mirrazi & Zeijlstra 2021).

H3b: Modals that make reference to the actual worlds can never undergo strengthening (neither in negative nor in positive contexts). Strong necessity modals can therefore never trigger Neg-Raising effects, while weak necessity modals can (see Mirrazi & Zeijlstra 2021, 2023).

5. Setting up the project

The project consists of 4 pillars, each exploring one type of lexicalization constraint. Pillar 1 examines negated universal quantifiers and investigates the predictions made by **H1**; Pillar 2 examines existential NPIs and universal quantifier PPIs and investigates the predictions made by **H2a**; Pillar 3 examines existential PPIs and universal quantifier NPIs and investigates the predictions made by **H2b**; Pillar 4 explores the differences between weak and strong modals and the effect they have on triggering Neg-Raising readings, and investigates the predictions made by **H3a-b**. Each PhD student will work on one of the Pillars, focusing on **RQ1a-c**.

Apart from studying the intricacies of each phenomenon within the respective Pillars, all phenomena will also be approached “horizontally” along two axes: a cross-linguistic and an experimental axis. Cross-linguistically, the investigation will follow the method of language sampling, based on Rijkhoff et al. (1993) and Rijkhoff & Bakker (1998), and along the lines of Baker (2010). It will delineate the exact landscape of universal paradigmatic gaps with respect to the lexicalization of logical elements in natural language, and how this landscape is sensitive to the domain of quantification and the choice of modality. Experimentally, it will implement the method of artificial language learning (see a.o. Culbertson 2012, 2023, Culbertson and Adger 2014, Martin et al. 2019, 2020, Chemla et al. 2019) to discern first whether lexicalized negative universal quantifiers and weak possibility modals can still be acquired by language learners (Pillars 1 and 4), and second, whether plain universal NPIs and PPIs, unlike those with the special reconstruction possibilities, cannot be acquired (Pillars 2 and 3). One 4-year postdoc will be responsible for the cross-linguistic angle (incl. sign languages); another 4-year postdoc will be responsible for the experiments. These postdocs will jointly address **RQ2a-d**.

The overall theoretical analysis will be developed under the oversight of the PI and the 5-year postdoc, in full collaboration with the other postdocs and the PhD students. They will develop a full theoretical account of how and why certain cells in a given paradigm are so weak or opaque that they give rise to the impression that they are universally absent. This part of the project addresses **RQ3a-d**.

The overall project consists thus of $3 \times 4 = 12$ Subprojects (SPs). Within each SP, project members intensively collaborate, but will also be part of an Axis or Pillar for which one project member is the main investigator. Team members thus share responsibility for subprojects, but simultaneously maintain a fair level of independence. This ensures a high likelihood of success for the project, and also fosters a stimulating work environment, while at the same time leaving room for team members to build their own careers by taking primary responsibility over parts of the project.

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1. Universal Paradigmatic Gaps

Universal paradigmatic gaps are gaps in linguistic paradigms that appear **across languages** and **across users of a given language**. As of yet, only very few gaps of this kind have been discussed in the literature. One gap that has received substantial discussion concerns the universal absence of a lexicalized negated form for the quantifiers *all*, *ever* or *always*. There appears to be no language in the world that exhibits a single word (or lexical item) that means ‘not all’, ‘not every’ or ‘not always’, an observation dating back to Thomas Aquinas (1225-1274). **It is deeply enigmatic that such words do not exist across languages and cultures**. As the meaning of such an element is logically fully accessible, it cannot be the case that such a word is difficult or impossible to conceptualize. In fact, a simple Google search will reveal that the occurrence of non-lexicalized *not all* is highly abundant (more than a billion occurrences on April 2, 2023). So, why is it the case that no language in the world appears to have a single word for ‘not all’, ‘not every’ or ‘not always’? Is it really a universal ban or rather a cross-linguistic rarity? Does it only hold only for quantifiers like ‘not all’, ‘not ever’ and ‘not always’, or also for modal quantifiers? Does it hold equally for spoken and sign languages? And are there more universal paradigmatic gaps like this that have yet to be observed? **These are questions that to date have hardly been addressed in the literature, but have strong implications for our understanding of human cognition, language and communication. UNPAG will address these questions and will show that the landscape of universal paradigmatic gaps is much richer than generally imagined, and that certain alleged universal paradigmatic gaps do not exist despite prima facie evidence to the contrary.**

Horn (1972, 1989, 2012 a.o.) famously observed that the absence of a word like *nall*, meaning ‘not all’, an observation dating back to Thomas Aquinas (1225-1274), is part of a broader systematic absence of words with a particular logical footprint (see also Barwise & Cooper 1981, von Stechow & Matthewson 2008). This is demonstrated by Boethius’ (480-525) renowned *Square of Oppositions* (SoO, Fig. 1). The SoO is a visualization that depicts the four major types of propositions under Aristotelian logic: universal affirmatives (A), existential affirmatives (I), universal negatives (E), and existential negatives (O), each of them illustrated below (the abbreviations correspond to the Latin *Affirmo* (‘I assert’) and *nEgO* (‘I deny’), and their logical relations). For instance, (1a) and (1d) are contradictions; (1a) and (1c) are contraries.

- (1) a. Universal affirmative (A): *every car is red*
 b. Existential affirmative (I): *some car is red*
 c. Universal negative (E): *no car is red*
 d. Existential negative (O): *not every car is red*

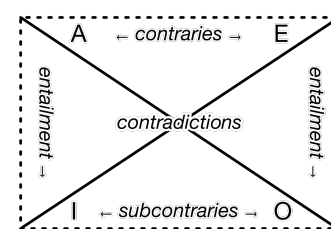


Figure 1

Apart from quantifiers, many other logical elements stand in such relations. For instance, the connective *and* (A) entails *or* (I) and is a contrary of *nor* (E) which contradicts *or* (I) again. The same holds for *both* (A), which stands in similar relations to *one* (I) and *none* (E). Strikingly, the O-corners appear never to be lexicalized, neither in English nor in any other language we know of: words like *noth* (meaning ‘not both’) or *nand* (meaning ‘not and’) are likewise never found. The so-called *nall problem* thus concerns the universal, systematic absence of the lexicalization of the O-corner in the SoO, and not just the absence of particular logical operators. **However, I will show that these are not the only universal paradigmatic gaps that can be attested and require explanation and study; UNPAG will reveal several others.**

2. Scientific significance: Cognition, communication or ...?

2.1 Cognitive approaches

Various accounts for this *nall* problem have been provided. Going back to Jespersen (1917, 1924) and Löbner (1987, 1990), one branch of analyses (Jaspers 2005, Seuren 2006, Larson & Jaspers 2011, Seuren & Jaspers 2014) argues that although the SoO contains four corners, cognitively, there are only three prime oppositions (between A, I, and E), with approaches differing whether the E-corner reflects an operator *some and possibly all* or *some but not all*. If indeed the core oppositions only involve A, I and E, and not O, the absence of lexicalizations of O could receive a direct cognitive explanation: if cognitively, there is only a *Triangle of Oppositions*, there is no question then as to why the missing corner is never lexicalized. Sbardolini (2023) takes such triangles as the basis of his *Logic of Lexical Connectives* (see also Incurvati & Sbardolini 2023). However, as Jaspers (2005) acknowledges, even if the O-corner is not a prime cognitive concept, the question remains open why logically conceivable complex meanings, such as ‘not all’, ‘not both’, or ‘not and’ still cannot be lexicalized at all. Again, this point becomes especially relevant in the light of the aforementioned observation that the complex construction ‘not ... every’ is in fact highly pervasive (see also Hoeksema 1999).

More recently, Seuren & Jaspers (2014) argue that the SoO is actually best replaced by a hexagon (after Jacoby 1950, 1960, Sesmat 1951, Blanché 1952, 1953, 1966), which comprises all logical relations between A, I, E and O, and two other ones: Y ($\equiv I \wedge \neg A$, *some but not all*) and U ($\equiv A \vee \neg I$, *all or nothing*). Of the six corners of this hexagon, they argue, U and O are never realized. The corners that form a kite are the only candidates for lexicalization (see Fig. 2). Note that, Seuren (2013) and Seuren & Jaspers (2014) take both

Y and I to be realized by the same lexical item *some*; in fact, they argue that every realization of the I-corner is systematically homophonous with that of the Y corner, without providing a reason why this is the case.

The reason why U and O are never realized, for them, is that they take lexicalized logical operators to be restrictors of a universe. The primary means of restricting a universe, they argue, is that between E (*no*) and I (*some or all*); the secondary means is the subdivision of I between A (*all*) and Y (*some but not all*). This way, neither O nor U can be used as further restrictor and are therefore never realized. However, these are not the only possible restrictions that could conceivably be made. One could equally well first divide a universe between A and O, and have O further be subdivided between E and I. It is unclear why these restrictions could not then be lexicalized to the exclusion of Y and U. Seuren & Jaspers (2014) here follow Jaspers (2005) and Larson & Jaspers (2011) in assuming that the distinction between E and I is ‘pivotal’. Again, by assigning exceptional cognitive status to E and I over A and O, the absence of O-lexicalizations could be accounted for, but it is not clear why E and I must be cognitively more primitive. Indeed, the fact many languages lack an E realization as well (e.g. Hindi, see Zeijlstra 2022) casts considerable doubt on this.

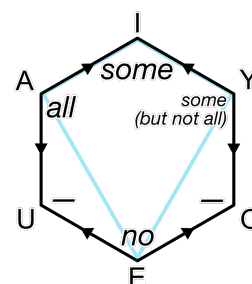


Figure 2

Moreover, the observation that natural languages never exhibit a single word for U can already be independently explained in terms of connectedness. As Chemla et al. (2019) have shown, connectedness is a necessary condition for both content and function words. We thus do not find words meaning ‘bottle or eagle’ or ‘less than five or more than 10’. A single word meaning ‘all or nothing’ would violate connectedness, as the intermediate ‘some’ cannot be expressed by it.

2.2 Communicative approaches

An alternative approach has been built upon the notion of efficient communication, and, more explicitly, pragmatic blocking. In short, the existence of a lexicalization for the I-corner blocks lexicalization for the O-corner. This approach has originally been put forward by Horn (1972, 1989, 2012) and has recently been reimplemented by Katzir (2007), Katzir & Singh (2013), Uegaki (2022), Enguehard & Spector (2021), Züfle & Katzir (2022) and Bar-Lev & Katzir (2022) in different ways. Their main argument, in short, is that, while I- and O-type sentences are semantically different, their pragmatic contributions are in fact similar. To see this, let us take into consideration the joint meaning contributions of the following two examples:

- | | | | | | | |
|-----|----|--------------------|-------------------------------|----|---------------------|-------------------------------|
| (2) | a. | Assertion | Some car is red | b. | Assertion. | Not every car is red |
| | | <u>Implicature</u> | <u>Not every car is read</u> | | <u>Implicature.</u> | <u>Some car is read</u> |
| | | Joint meaning: | Some but not every car is red | | Joint meaning: | Some but not every car is red |

Since the joint meaning contributions made by the corresponding I- and O-type sentences are the same, natural language only needs to exploit one. This way, only three out of the four lexical corners need to be lexicalized in order to convey the overall meanings of all four corners. The reason, then, that it is O (and not I) that never gets lexicalized has to do with markedness. Because Horn takes negative expressions to be always marked in comparison to their positive counterparts, the possible existence of I-type terms blocks the existence of O-type terms (though see Enguehard & Spector 2021 and Bar-Lev & Katzir 2022 who aim to derive this effect in independent terms). In short, if a language is to lexicalize either the I- or the O-corner, it must be the I-corner.

As Hoeksema (1999) points out though, pragmatic equivalence is by nature much weaker than semantic equivalence. One can easily utter the assertion in (2a) about a particular subset of cars without knowing anything about the colours of the other cars, but the pragmatic equivalence of **Error! Reference source not found.** and **Error! Reference source not found.** is then already disrupted. Moreover, if conveying I-type sentences blocks conveying O-type sentences, the question emerges why utterances containing expressions like ‘not ... every’ or ‘not ... all’ are nevertheless allowed and fully interpretable; as mentioned previously, their appearance is abundant. Hence, this approach is, in one way, too weak (pragmatic equivalence is too weak to account for such blocking), and, in another, too strong (it predicts the exclusion not only of O-lexicalization, but also that of O-type sentences generally).

2.3 Or ...

All approaches so have presented arguments why lexicalizations like *nall* and *nand* should be grammatically or lexically ruled out. However, **novel evidence** is available that shows that such lexicalizations can be observed **both inside and outside the domain of negated quantifiers**. This shows that what is still needed is a proper theory of when certain logical operators can be lexicalized or not. It is without question that any theory of such missing lexicalizations, i.e. any theory of universal paradigmatic gaps, should make clear predictions about what may or may not be lexicalized, and why that is the case. **Such a theory thus far not been developed.** It is equally without question that a theory should have a profound empirical basis, whereas currently, the pool of data has been heavily slanted toward well-studied, Western, Indo-European, adult spoken language, and negative quantifiers therein. Such a data pool fails to confirm the universality of a given gap,

and cannot be used to determine whether the motivations for such gaps are developmental, cognitive, logical, or otherwise, even if such gaps are indeed universal. **No existing study has thus far come even close to targeting a richer empirical base, even though many more universal gaps can be observed! UNPAG will be the long-overdue filler of this gap.**

3. Universal Paradigmatic Gaps: Extending the landscape

3.1 Extending the NALL problem

It has been received wisdom for a long time that languages systematically lack realizations of the O-corner. But while there is a clear pattern, whether such a claim is really cross-linguistically sound has never been investigated. No typological study has been devoted to it, and there may be reasons to doubt that lexicalized O-terms are universally absent. As Seuren & Jaspers (2014) have pointed out, data from Kinyarwanda may actually falsify it; Kinyarwanda has a series of expressions like *sibose* or *sihose* that appear to mean ‘not all people’ or ‘not everywhere’, respectively, though it is unclear whether they mean just that or rather ‘some but not all people’ or ‘somewhere but not everywhere’.

In addition, Kuhn & Pasalskaya (2023) have shown that examples in the domain of modals O-lexicalizations can be regularly attested, arguing against esp. Enguehard & Spector (2021). Bimorphemic *unnecessary* is a good example, as is, they claim, monomorphemic *optional*. However, unlike *unnecessary*, *optional* may strongly infer possibility, rendering it not a true O-lexicalization: *it is unnecessary; in fact it is even forbidden*, is perfectly acceptable, whereas *it is optional; in fact it is even forbidden* sounds unnatural. This may suggest that simplex words with an O-meaning still cannot be attested, even among modals. However, Kuhn & Pasalskaya (2023) demonstrate that in certain sign languages, such monomorphemic O-lexicalizations can nevertheless be found; e.g., French Sign Language has a simplex sign for *unnecessary* (Fig. 3).



Figure 3

Lin et al. (2015, 2018) have also shown using corpus studies and experiments that in the first stages of languages acquisition (2;0-3;10), the Dutch modal verbal stem *hoef* (‘need’) is always used as a fixed expression with the negative marker *niet* (like *hoefniet*(t)). As Lin et al. demonstrate, children first take this to be a lexical construct prior to determining that this verb can also appear in other constructions. Consequently, this lexical expression *hoefniet* also qualifies as an O-lexicalization.

This shows that O-lexicalizations indeed are not systematically ruled out. Naturally, this claim will have to be further substantiated typologically and experimentally. Moreover, it will need to be investigated what restrictions O-lexicalizations (modal vs non-modal, sign language vs spoken language, etc.) are subject to and why. UNPAG will carry out these investigations.

3.2 Lexicalization constraints in the domain of Polarity-Sensitive Items

Similar gaps on lexicalizations can be attested among Polarity-Sensitive Items (PSIs), at least those PSIs that quantify over individuals or time variables. PSI come about in two types. One is called a Positive Polarity Item (PPI), as it is restricted to positive contexts; the other is called a Negative Polarity Item (NPI), as it is restricted to negative contexts. As an example, English *any*, a realization of I, is an NPI as it can only appear in sentences that in one way or another count as negative (see Ladusaw 1979, Giannakidou 1999 among any others): **She ate any cookies* is an unacceptable sentence in English, but *She didn't eat any cookies* isn't. The mirror image of *any* is *some*, another I-term. *Some*, by contrast, is a PPI can only appear in positive environments. To the extent that *She didn't eat some cookies* is an acceptable sentence, it is only acceptable under the reading that there are some cookies that she failed to eat, and not that she ate no cookies.

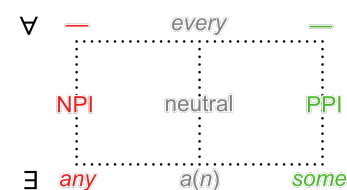


Figure 4

However, while PSIs are not restricted to low scalar endpoints (like all I-terms), no PSI that is an A-term has been attested among quantifiers over individuals or time variables (see Fig. 4). Put differently, while higher scalar expressions like *much* (NPI) or *rather* (PPI) can indeed be attested (see Israel 1996), no language in the world so far has been identified as having a word like *every* that is an NPI or a PPI. That is, there is no language with an expression X meaning ‘every’ that is allowed only in negative contexts or only in positive contexts.

For modals, the empirical landscape is fundamentally different. In the domain of deontic modals—modals expressing obligation and permission—the facts seem to be reversed. English universal modal A-terms *must* and *should*, for instance, are uncontroversially taken to be PPIs (see Israel 1996, Iatridou & Zeijlstra 2013, Homer 2015), which explains why *Alex mustn't/shouldn't leave* means that it must/should be the case

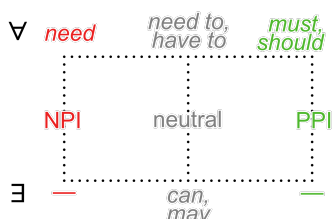


Figure 5

that she does not leave (note that word order does not determine such scopal relations; *Alex hasn't (got) to leave* means that it is not the case that she has to leave). Similarly, universal A-modals like English *need*, Dutch *hoeven* ('to need') or German *brauchen* ('to need'), when taking a verbal complement, are well-known NPIs. However, in the domain of deontic modality, existential NPIs or PPIs crucially are not attested (see Fig. 5). There is no known existential PPI meaning *may* and there are only very few, if any, existential NPIs (see Van der Auwera 2001, Meijer 2014, Zeijlstra 2022 for discussion of some possible examples). And finally, among epistemic modals—modals concerning knowledge and beliefs—all six types can be found (see Fig. 6).

Existential PPIs (*may* as in *She may (not) be in her office*), existential NPIs (*can* as in *She can't/*can be in her office*), Universal PPIs (*should* as in *She should (not) be in her office*) and Universal NPIs (*need* as in *She need*(n't) be in her office*). In addition, both existential and universal polarity-insensitive elements can be found, such as *could* or *has to*.

This demonstrates that for PSIs, in certain domains (quantification over individuals or time variables) no clear O-like terms (here, universal PSIs) can be attested. However, in other domains (quantification over possible worlds or situations), either O-like, but not E-like PSIs can be attested (as in the case of deontic modals), or both may be (as in the case of epistemic modals). These data necessitate systematic inquiry into the degree to which these empirical generalizations about PSIs are consistent with cross-linguistic data, and into whether such absent PSIs are grammatically impossible. Such an investigation will also be conducted under UNPAG.

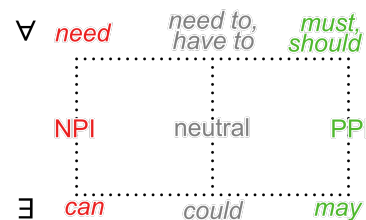


Figure 6

3.3 Weak vs strong modals and Neg-Raising

Traditionally, universal modals have been divided into two categories: strong necessity and weak necessity modals. This categorization targets the observation that strong necessity modals (such as *must* or *have to*) are semantically stronger than weak necessity modals (such as *should* or *ought to*), as the following examples show: *You should leave but you don't have to* is acceptable, while *#You have to leave but you shouldn't* is much odder. However, despite morphological similarities, modals like *might* or *could* do not stand in a similar strength relation to *may* or *can*: *#You could/might leave but you can't / may not* sounds contradictory. Mirrazi & Zeijlstra (2023), building upon work by von Stechow & Iatridou (2008), show that *might/could* behave as existential duals of strong necessity modals and tend to yield strong possibility readings. English thus appears to lack weak possibility modals (see Fig. 7). In other words, there may be both strong and weak modal A-terms, but weak modal I-terms never appear to be lexicalized. This is not a coincidence; hardly any language lexically exhibits weak possibility modals (though see Močnik 2018 for a potential exception in Slovenian).

	\forall	<i>must</i>		<i>should</i>	
			neutral		
	\exists	<i>can, could</i>			
strong					weak

Figure 7

The absence of weak modal I-terms at first glance seems related to the fact that weak necessity modals, when negated, can give rise to so-called Neg-Raising (NR) readings, while strong necessity modals cannot. Though both *must* and *should*, being PPIs, generally outscope negation, when embedded under a negated NR predicate, *should* is able to outscope matrix negation, whereas *must* is not:

- (3) a. I don't think that John should marry Susan. (\checkmark *should* > not)
 b. I don't think that John must marry Susan. ($\#$ *must* > not) (Homer 2015)

This shows that *should* is an NR predicate but *must* is not. Similar observations can be made for other strong and weak necessity modals: weak necessity modals are always Neg-Raisers, strong necessity and possibility modals never are. The latter is unsurprising, as it has been known since Horn (1989) that NR predicates are high scalar elements. However, no fundamental explanation as to why strong necessity modals are not Neg-Raisers and weak necessity modals are is currently available (though see Mirrazi & Zeijlstra 2023 for some hypotheses). Naturally, UNPAG will also evaluate these paradigmatic gaps.

4. Research Questions & Hypotheses

4.1 Research Questions

UNPAG will address the following **Research Questions**:

RQ1: What kind of universal paradigmatic gaps can be attested with respect to the lexicalization of logical elements in natural language?

RQ1a: What kind of universal paradigmatic gaps can be attested with respect to the lexicalization of negative and positive quantifiers over individuals and over possible worlds in natural language?

RQ1b: What kind of universal paradigmatic gaps can be attested with respect to the lexicalization of polarity-sensitive quantifiers over individuals and over possible worlds in natural language?

RQ1c: What kind of universal paradigmatic gaps can be attested with respect to the lexicalization of weak and strong quantifiers over possible worlds in natural language and the way they interact with Neg-Raising?

RQ2: What determines the landscape of lexicalized logical elements in natural language?

RQ2a: To what extent are the attested absent lexicalizations universal, as opposed to simply being cross-linguistically rare?

RQ2b: To what extent are the attested lexicalization constraints sensitive to the modality of a language (spoken languages vs. sign languages)?

RQ2c: To what extent are the attested lexicalization constraints sensitive to the nature of the domain of quantification (quantification over individuals/time variables vs. quantifiers over possible worlds)?

RQ2d: To what extent are the apparently absent lexicalizations still learnable?

RQ3: How can the landscape of lexicalized logical elements in natural language be explained?

RQ3a: What explains the existence of the observed constraints on the lexicalization of logical elements?

RQ3b: Why do lexicalization constraints in the domain of quantifiers over individuals / time variables appear to apply primarily to universal elements?

RQ3c: Why do lexicalization constraints in the domain of quantifiers over possible worlds appear to apply primarily to existential elements (if at all)?

RQ3d: Why are lexicalization constraints sensitive to modulation?

4.2 Hypotheses

Given the above, the general hypothesis is that unlike all existing approaches concerning universal paradigmatic gaps with respect to the lexicalization of logical elements in natural language, such gaps are not universally ruled out in natural languages. Rather, when closely investigating what constitutes such universal gaps, it is revealed that such lexical elements either have a meaning that appears to be very weak, or have semantic properties that make them far more opaque than the existing lexicalizations. Since elements with very weak meanings and elements with very opaque properties are very hard to learn, **they are universally rare but can be attested.**

General Hypothesis (H): Universal paradigmatic gaps are not ruled out by the grammar. They are only much harder to identify.

H1: Absent O-lexicalizations are rare, as processes of lexicalizations where a negative marker and another scalar element melt together into one word only target unfocused elements. As the meaning of unfocused negated universal quantifiers is much weaker than those of focused ones, such unfocused negated universal quantifiers are less likely to emerge as candidates for lexicalizations. When lexicalization works in a different fashion (e.g. in sign languages or in the acquisition of negative modals), O-lexicalizations can be more readily attested (Zeijlstra 2022).

H2: In order to understand constraints on the lexicalization of polarity-sensitive elements, one needs to first understand what renders some element an NPI or a PPI. Assigning these properties to other quantificational elements does not naturally result in run-of-the-mill PSIs (Zeijlstra 2017, 2022).

H2a: Assigning the properties that Chierchia (2013) attributes to existential NPIs to universal quantifiers does not yield universal PPIs but rather universal quantifiers that can appear below negation but cannot reconstruct below it. Such elements can be attested.

H2b: Assigning the properties that Zeijlstra (2022) attributes to existential PPIs to universal quantifiers does not yield universal NPIs, but rather universal quantifiers that can appear in non-negative clauses but must reconstruct below a clausemate negation when present. Such elements can also be attested.

H3: The difference between weak and strong necessity modals is that the latter have to have the actual world in their domain of quantification, but the former do not (Silk 2016, 2022).

H3a: Existential modals that do not have to make references to the actual world have a meaning that is so weak that these either are not lexicalized, or when they are, are obligatorily strengthened in most positive contexts (see Mirrazi & Zeijlstra 2021).

H3b: Modals that make reference to the actual worlds can never undergo strengthening (neither in negative nor in positive contexts). Strong necessity modals can therefore never trigger Neg-Raising effects, while weak necessity modals can (see Mirrazi & Zeijlstra 2021, 2023).

5. Setting up the project

5.1 General set up

The project consists of 4 pillars, each exploring one type of lexicalization constraint. Pillar 1 examines negated universal quantifiers and investigates the predictions made by **H1**; Pillar 2 examines existential NPIs and

universal quantifier PPIs and investigates the predictions made by **H2a**; Pillar 3 examines existential PPIs and universal quantifier NPIs and investigates the predictions made by **H2b**; Pillar 4 explores the differences between weak and strong modals and the effect they have on triggering Neg-Raising readings, and investigates the predictions made by **H3a-b**. Each PhD student will work on one of the Pillars, focusing on **RQ1a-c**.

Apart from studying the intricacies of each phenomenon within the respective Pillars, all phenomena will also be approached “horizontally” along two axes: a cross-linguistic and an experimental axis. Cross-linguistically, the investigation will follow the method of language sampling, based on Rijkhoff et al. (1993) and Rijkhoff & Bakker (1998), and along the lines of Baker (2010). It will delineate the exact landscape of universal paradigmatic gaps with respect to the lexicalization of logical elements in natural language, and how this landscape is sensitive to the domain of quantification and the choice of modality. Experimentally, it will implement the method of artificial language learning (see a.o. Culbertson 2012, 2019, Culbertson and Adger 2014, Martin et al. 2019, 2020, Chemla et al. 2019) to discern first whether lexicalized negative universal quantifiers and weak possibility modals can still be acquired by language learners (Pillars 1 and 4), and second, whether plain universal NPIs and PPIs, unlike those with the special reconstruction possibilities, cannot be acquired (Pillars 2 and 3). One 4-year postdoc will be responsible for the cross-linguistic angle (incl. sign languages); another 4-year postdoc will be responsible for the experiments. These postdocs will jointly address **RQ2a-d**.

The overall theoretical analysis will be developed under the oversight of the PI and the 5-year postdoc, in full collaboration with the other postdocs and the PhD students. They will develop a full theoretical account of how and why certain cells in a given paradigm are so weak or opaque that they give rise to the impression that they are universally absent. This part of the project addresses **RQ3a-d**.

The overall project consists thus of $3 \times 4 = 12$ Subprojects (SPs) (see Fig. 8). Within each SP, project members intensively collaborate, but will also be part of an axis or pillar for which one project member is the main investigator. Team members thus share responsibility for subprojects, but simultaneously maintain a fair level of independence. This ensures a high likelihood of success for the project, and also fosters a stimulating work environment, while at the same time leaving room for team members to build their own careers by taking primary responsibility over parts of the project.

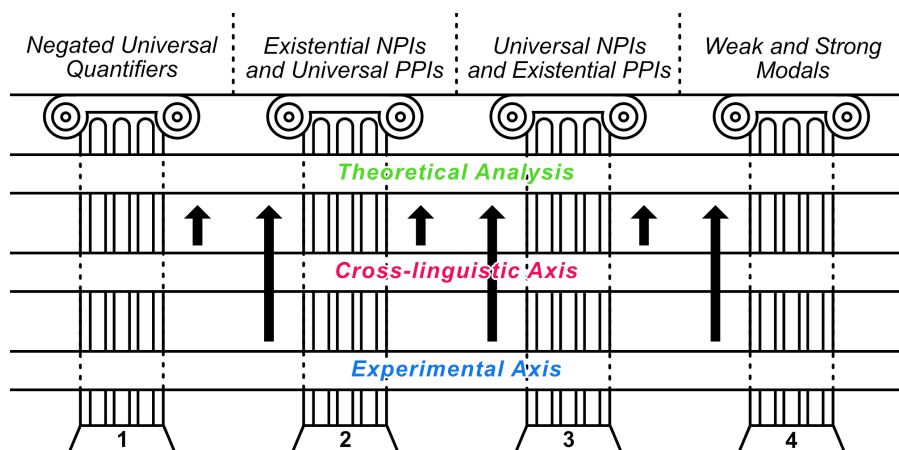


Figure 8

Given the experience and research infrastructure available in Göttingen, the project can begin immediately. The setup is such that the PI will first recruit a postdoc (Postdoc 1) who will serve as a main researcher on the theoretical part for the entire duration of the project for 70% of their time. To render this position more attractive as a full-time position for the duration of 5 years, this person will also be given a 30% assistant position, financed by the University of Göttingen.

The PI and this postdoc coordinator will then recruit the other two postdocs (Postdocs 2 and 3), who will begin 6 months later and whose positions will last 4 years. Each of the postdocs will be an expert in their respective axes: language variation (incl. sign languages) and artificial language learning experiments. Involving Postdoc 1 in the hiring processes will ensure a maximally successful collaboration among all postdocs within UNPAG. Much in the same vein, the PhD students will begin 6 months after the starting date of Postdocs 2-3. Again, this will enable all the postdocs to co-select the PhD students with whom they will work intensively. This also allows the postdocs, together with the PI, to set up the experiments and other empirical case-studies in Pillars 1-4. This means that once the PhD students are hired, they will be provided with the resources and support to begin immediately, a necessary ingredient for completion of the PhD thesis in three years.

After the submission of the three PhD theses, Postdocs 2-3 will be able to further connect the outcomes of the pillars and axes and draw up the final empirical and theoretical conclusions of each of the pillars together

with the PI and the Postdoc 1. In the final 6 months of the project, all outcomes will be integrated together by the PI and Postdoc 1, leading to the publication of an all-encompassing theory that explains the nature, distribution and emergence of universal paradigmatic gaps.

5.2 Subprojects

SP1: The null problem cross-linguistically (Postdoc 2, PhD student 1)

Goal: The goal of this SP is to address **RQ1a** and **RQ2a-c** and see whether O-lexicalizations are universally ruled out, both in the domain of quantifiers over individuals/time variables and quantifiers over possible worlds/situations, or not. At present, we only have detailed information about O-lexicalizations for a small number of mostly Indo-European languages (see Section 3.1), which also happen to be relatively similar in terms of their quantificational and modal systems. The task of **SP1** is therefore to identify a number of cases that could advance our current understanding of the possible dimensions of variation. We will therefore chart the cross-linguistic spread of O-lexicalizations, a completely novel endeavor in linguistics scholarship. As for modal systems, this is especially pressing, as it is known (Matthewson 2016) that modal systems are sometimes quantificationally underspecified, though fixed for modal force. For instance, Lilloet Salish =*ka* can express both permission and obligation. Here, the question emerges as to whether such modals can be negated and, if so, what restrictions, if any, this imposes upon their quantificational status. In the same vein, we will look at different strategies to negate scope-taking elements in general.

Hypothesis: The hypothesis (**H1**) is that such negated universal quantifiers are not systematically ruled out, but much harder to identify. Rather, the strategy by which quantifiers are negated and differences therein (e.g. between spoken and sign languages), may induce particular constraints on whether O-lexicalizations are licit. For instance, it is hypothesized in languages where negative quantifiers stem from a negative affix that is incorporated in the quantifiers (as is the case in all most Indo-European languages, cf. Haspelmath 1997, Jäger 2010), O-lexicalization could historically not have occurred, the reason being that negative affixes can only attach to unfocused quantifiers, whereas functionally negated quantifiers are generally focused (see Zeijlstra 2022). However, in languages with other systems for marking scope-taking elements as negative, O-lexicalization may emerge more naturally (such as in sign languages, where negation of a particular element can be expressed simultaneously instead of sequentially, e.g. by means of headshakes, cf. Pfau 2016). In the same vein, negations of modal expressions could also be different in nature. For instance, *un-* in *unnecessary* is a marker of contrary negation, not of contradictory negation (as was the case for negative quantifiers in English, cf. Horn 1989). The hypothesis is that the syntax, semantics, morphology and prosody, as well as the modulation of negative and quantificational elements, together determine whether O-lexicalizations are possible.

Method: For this, the postdoc responsible for the cross-linguistic investigation (Postdoc 2) and the PhD student in this Pillar (PhD student 1) member will identify 15-20 languages of potential interest, including 1-3 sign languages. The selection of these languages will take place according to the sampling method developed by Rijkhoff et al. (1993) and Rijkhoff and Bakker (1998) and fit within the generative typological approach (Baker 2010). This way, it will be ensured that these languages would be genetically and geographically independent. The research will use existing descriptive work, and where applicable, follow up on it with short investigations in search of more fine-grained data (with the help of language consultants and native informants). The purpose of this stage is to collect a sample of languages that features a range of systems with widest possible variation between quantifying elements and ways of negation these. The project will carry this out for both regular quantifiers (over individuals/time variables) and modal expressions (quantifiers over possible worlds/situations).

Afterwards, Postdoc 2 will engage in an in-depth investigation of 5 languages from the sample, selecting these languages with the aim of capturing as much variation as possible in a tiny sample, while also taking into account the practicality of obtaining new primary data from the languages in question. The reason a second stage is required is that many negation-related properties of quantifiers and modals are quite subtle, and can only be determined through a careful empirical investigation of the primary facts. As such investigation is time-consuming, it would not be practicable to target the whole 15-20-language sample, but the PI's prior work demonstrates that carefully examining 5 languages within the timespan of the project is feasible. In this phase the Postdoc 2 will be involved in synthesizing the cross-linguistic findings, and formulating a reasonable hypothesis about the cross-linguistic range of possible systems of O-lexicalizations. The resulting typology should update, and quite likely significantly expand, the typology that emerges from the current literature.

SP2: Learning null-quantifiers (Postdoc 3, PhD student 1)

Goal: The goal of this SP is to address **RQ1a** and **RQ2b-d** and see whether O-lexicalizations are still learnable for (artificial) language learners. The task of **SP2** is therefore to see whether adult speakers of a language can still acquire an (artificial) language that in fact contains O-lexicalizations. One relevant question is whether these lexicalizations can be bimorphemic, monomorphemic with a still recognizable negative part (as in *null*)

or fully simplex. Another question concerns whether the acquisition of such lexicalizations works in the same way for the acquisition of a sign language and a spoken language, and whether there are differences between modal and non-modal negated expressions in this sense.

Hypothesis: The hypothesis (**H1**) is that such negated universal quantifiers are not systematically ruled out, but much harder to identify. For instance, if diachronic lexicalization processes underlie the absence of negative universal quantifiers, it should still be possible to fully acquire them when they are present in the language input. There should then be no synchronic ban on O-lexicalizations, neither in sign, nor in spoken languages and neither among modals and non-modals.

Method: For this, the postdoc responsible for the experimental investigation (Postdoc 3) and the PhD student in this Pillar (PhD student 1) will design a number of artificial language learning experiments. A growing body of research uses laboratory language learning studies to investigate adult learners' knowledge of language, with results that reliably mirror findings about natural language acquisition (see Culbertson 2012 *et seq.*). Here, we will conduct an artificial language learning experiment requiring learners to acquire the lexicalized O-corners from an input that contains single words for all four corners of the Square of Opposition. These experiments will be carried out for both spoken and sign languages where for the latter, a demographic distinction will be made between native and non-native signers. Naturally, the experiments will target both modal and non-modal expressions and will also target cases where quantifiers (be they modal or non-modal) are underspecified for (universal/existential) force. As the first round of experiments will undoubtedly lead to a number of follow-up questions, Postdoc 3 will be tasked with designing follow up studies to address these issues experimentally.

SP3: Explaining the nall-problem (PI, Postdocs 1-3, PhD student 1)

Goal: The goal of this WSP is to address **RQ3a** and explain what constrains the observed (non-)occurrences of lexicalized O-corners in the SoO. Depending on the outcomes of **SP2-3**, the PI and Postdoc 1 (in collaboration of Postdocs 2-3 and PhD student 1) will explore the possibilities to theoretically account for the observed variation.

Hypothesis: The hypothesis (**H1**) is that there is no inherent grammatical ban, either cognitively or communicationaly, on O-lexicalization and that the manner in which negative and quantificational material is compressed into a single word determines whether such processes are likely to emerge or not. This then puts the burden of likelihood of O-lexicalizations on the morphological make-up, the modulation of linearization and the domain of quantification.

Method: This project is largely theoretical and will explore how the outcomes of **WP1-2** can be captured in terms of constraints on (diachronic) lexicalization processes, constraints on the differences with respect to linearization of functional (esp. negative) material in spoken and sign languages, and syntactic, semantic and pragmatic differences between quantifiers over possible worlds/time variables and modal quantifiers. This SP will also illustrate the consequences of these outcomes for existing theories, including those that aim at explaining O-lexicalizations in terms of cognitive or communicative biases.

SP4: Existential NPIs and universal PPIs cross-linguistically (Postdoc 2, PhD student 2)

Goal: The goal of this SP is to address **RQ1b** and **RQ2a-c** and explore the landscape of existential NPIs and universal PPIs. The reason that these two PSIs will be studied in juxtaposition is that most theories that have been developed to account for existential NPI-hood are in principle also applicable to universal PPIs. Following a line of reasoning initiated by Kadmon & Landman (1993) and followed up by Krifka (1995), Lahiri (1998) and Chierchia (2006, 2013), NPIs are elements that (i) obligatorily introduce domain alternatives and that (ii) obligatory exhaustify all non-weaker alternatives of that set. An utterance like *I ate any cookies* then asserts (4a) (in a model where there are only 3 cookies *a*, *b* and *c*) and at the same time states that non-weaker alternatives, such as the ones in (4b), must be false. However, the joint meaning contribution of (4a) and the negated alternatives forms a contradiction, and it is this contradiction that renders the utterance unacceptable (following Gajewski 2002, 2011). As under negation (and downward entailing (DE) contexts in general) the direction of inference is reversed, when negated, the alternatives of *I didn't eat any cookies* become stronger than the assertion and exhaustification applies vacuously.

(4) a. $\exists x \in \{a,b,c\} \ \& \ \text{ate}(I, x)$

b. $\exists x \in \{a,b\} \ \& \ \text{ate}(I, x), \exists x \in \{b,c\} \ \& \ \text{ate}(I, x), \exists x \in \{a\} \ \& \ \text{ate}(I, x), \exists x \in \{b\} \ \& \ \text{ate}(I, x), \text{ etc.}$

Assigning these properties to universal quantifiers would predict that such universal quantifiers could not appear in negative or other downward entailing contexts. Hence, the question arises as to whether and why such quantifiers are hardly ever attested, at least in the domain of quantifiers over individuals or time variables.

Hypothesis: The hypothesis (**H2a**) is that such negated universal quantifiers are not systematically ruled out, but much harder to identify. The explanation is that for NPIs, the reasoning above states that the only scopal construal under which such NPIs are felicitous is EXH>NEG/DE>NPI, where EXH stands for the obligatory exhaustifier. This way, the scopal construal EXH>NEG/DE>PPI is infelicitous. But that does not mean that

the other scopal construals for PPIs are infelicitous as well. If EXH must apply on top of a PPI, the scopal order NEG/DE>EXH>PPI is still fine. That means, as Zeijlstra (2017) has pointed out, that universal quantifier PPIs can take scope below negation as long as EXH is able to intervene. The only surface order, then, for universal quantifier PPIs to be ruled out is a surface order in which they appear above negation but would scope under it. In most languages, universal quantifiers do exactly this (e.g., English *Every girl doesn't walk* can mean 'not every girl walks'), but in several languages (Dutch, Japanese, Levantine Arabic, see Zeijlstra 2017, 2022) they cannot. The hypothesis is that this is indeed a reflection of their PPI nature. Note that the same holds for modals. Universal PPI *must* cannot take scope below negation as in *Mary mustn't leave*, but can in examples where negation precedes it (*Nobody mustn't leave* means that nobody is such that they have to leave). It is thus hypothesized that universal PPIs exist, just like existential NPIs, but that their distribution makes them more opaque, as they only cannot reconstruct below their offenders.

Method: As in **SP1**, the postdoc responsible for the cross-linguistic investigation (Postdoc 2) and the PhD student in this Pillar (PhD student 2) will identify 15-20 languages of potential interest, including 1-3 sign languages. The selection criteria for these languages will be the same as that in **SP1**. This project investigates for each language the extent to which universal quantifiers are polarity sensitive, and if they are, whether they are truly anti-licensed in negative or downward entailing contexts or whether they only cannot reconstruct below the introducers of such contexts. The project will compare both modals and non-modals. A cross-linguistic investigation into the scopal behaviour of universal quantifiers has never been carried out before.

Afterwards, Postdoc 2 will conduct an in-depth investigation of 5 languages from the sample, selecting these languages with the aim of capturing as much variation as possible in a tiny sample, while also taking into account the practicality of obtaining new primary data from the languages in question. Here, the Postdoc will undertake meticulous investigations to determine whether the behaviour of those quantifiers that cannot reconstruct below negation is due to their PPI-hood or whether another factor is at play. As such, the Postdoc 2 will build upon the cross-linguistic findings, and further develop the typology of polarity-sensitive universal PPIs in accordance with that of existential NPIs.

SP5: Learning existential NPIs and universal PPIs (Postdoc 3, PhD student 2)

Goal: The goal of this SP is to address **RQ1b** and **RQ2b-d** and see whether universal PPIs, both of the type exemplified and 'plain' universal PPIs that cannot appear in negative or downward contexts at all above are learnable or not.

Hypothesis: The hypothesis (**H2a**) is that only universal PPIs of the type discussed above are learnable, but that plain PPIs are not (i.e., one should expect expressions like *pevery*, such that *I ate pevery cookie* is fine, but *I didn't eat pevery cookie* is not. The same holds for modal existential NPIs. Even though these may functionally be less motivated (as modal auxiliaries reconstruct below negation anyways, cf. Iatridou & Zeijlstra 2013), they should still be learnable as such.

Method: The postdoc responsible for the experimental investigation (Postdoc 3) and the PhD student in this Pillar (PhD student 2) will set up a number of artificial language learning experiments. Here, we will conduct an artificial language learning experiments requiring learners to acquire PSIs from an input that contains existential NPIs and universal PPIs of the kinds described above. The inclusion of existential NPIs (quantifying over individuals) verifies whether PSIs are generally learnable in such an experiment. These experiments will involve both quantifiers over individuals and modals, the latter split up in epistemic and deontic modals. As the first round of experiments will undoubtedly lead to a number of follow-up questions, Postdoc 3 will be tasked with designing follow up studies to address these issues experimentally.

SP6: Explaining the distribution of existential NPIs and universal PPIs (PI, Postdocs 1-3, PhD student 2)

Goal: The goal of this SP is to address **RQ3b** and explain the existence and distribution of (no-modal) universal PPIs and (modal) existential NPIs. Depending on the outcomes of **SP4-5**, the PI and Postdoc 1 (in collaboration of Postdocs 2-3 and PhD student 1), will explore the possibilities to theoretically account for the observed variation.

Hypothesis: The hypothesis (**H2a**) is that there is no inherent, grammatical ban, either cognitively or communicationaly, on universal PPIs but that the properties that underlie such PPIs render them such that they can appear only in the surface scope of their offending contexts. The same holds for existential modal NPIs. This way, both existential NPIs and universal PPIs are grammatically possible, albeit that the latter are more opaque than plain NPIs (as are existential modal NPIs) and therefore harder to identify, and unlikely to emerge for the same reasons.

Method: This project is largely theoretical and will explore how the outcomes of **SP4-5** can be captured in terms of the different distributional footprints of existential NPIs and universal PPIs. In addition, in this SP the full comparison between modal and non-modal PSIs will be carried out, such that the landscape of both (epistemic and deontic) modal and non-modal existential NPIs and universal PPIs will be fully understood.

This SP will also spell out the consequences of these outcomes for existing theories, in particular those that underlie the nature of existential NPI-hood.

SP7: Existential PPIs and universal NPIs cross-linguistically (Postdoc 2, PhD student 3)

Goal: The goal of this SP is to address **RQ1b** and **RQ2a-c** and explore the landscape of existential PPIs and universal NPIs. The reason that these two PSIs will be examined in parallel is that theories that can account for existential PPI-hood are also applicable to universal NPIs. To date, theories that can account for existential PPI-hood and universal NPI-hood have not seen development comparable to theories of existential NPI-hood (and in their slipstream universal PPIs). After Szabolcsi's (2004) seminal work, two types of approaches have been developed to account for PPIs. The first one, developed by Spector (2014) and Nicolae (2017a,b), aims at applying Chierchia's approach in terms of obligatory strengthening of domain alternatives. This approach does not discuss a wide range of PPIs but rather focuses on instances of French *soit ... soit...* (either ... or) and *ou* ('or'). However, the way this strengthening mechanism is incompatible with Chierchia's original approach and would therefore require an additional explanation for the distribution of existential NPIs and universal PPIs (see Crnić 2014 for an attempt in this direction). The other one, developed by Zeijlstra (2022) for existential PPIs and Kamali & Zeijlstra (2023), for universal NPIs, argues that certain quantifiers are lexically encoded with an (arguably presuppositional) condition that they cannot entail the non-existence of referents satisfying their description. Under this approach, the reason why *some* cannot take scope below negation in, for instance, an example like *I didn't eat some cookies* is that that would entail the non-existence of cookies eaten by the speaker. By contrast, the available inverse scope reading ('There are cookies uneaten by me') does not violate this condition. One major difference between the two approaches is that only the latter correctly predicts that existential PPIs are only anti-licensed by anti-additive elements. Another major crucial difference between the two approaches is that the latter, but not the former predicts there to be a particular subtype of universal NPI, where the same property assigned to English *some* is applied to universal quantifiers.

Hypothesis: The hypothesis (**H2b**) is that such negated universal quantifiers are not systematically ruled out, but much harder to identify. The reason for this is Kamali & Zeijlstra's (2023) argument that assigning the same property that *some* has to universal quantifiers derives the mirror effect of universal PPIs. Such quantifiers may appear in positive utterances (e.g. *Everybody left*), but when in negative contexts, they have to take scope below negation. Hence, such quantifiers can only give rise to an inverse scope reading in sentences like *Everybody didn't leave*. As Kamali & Zeijlstra show, Turkish universal quantifiers indeed exhibit this behaviour even though Turkish itself is heavily scope-rigid (cf. Keleşir 2001, Özyıldız 2017, Demirok 2022):

- (5) Her öğrenci gel-me-z.
every student come-NEG-AOR 'Not every student comes'; #'No student comes'

The hypothesis is that this is indeed a reflection of their NPI nature. Note that the same holds for modals. As Zeijlstra (2022) has argued for, modals like *may* or *might* are also assigned this non-entailment-of-non-existence condition, which is why these modals, when used epistemically, indeed behave like PPIs, as in *She may/might not have been there*. Their modal bases may not consist of worlds only where the prejacent is false. In addition, Zeijlstra argues that deontic *may* does not give rise to this effect as here, the modal base of *may* is a superset of the set of worlds over which the deontic *may* actually quantifies (see Kratzer 1981, 1991). This also predicts that similar universal modals should exist as well that, at least epistemically, may not outscope clausemate negation. So far, such modals have not been attested, although the issue has critically lacked proper investigation.

Method: As in **SP1,4**, the postdoc responsible for the cross-linguistic investigation (Postdoc 2) and the PhD student in this Pillar (PhD student 3) member will identify 15-20 languages of potential interest, including 1-3 sign languages. The selection method for these languages will be the same as that for **SP1,4**. This project investigates for each language to what extent universal quantifiers are polarity sensitive, and if they are, whether they are truly anti-licensed in negative or downward entailing contexts or only cannot take scope above the introducers of such contexts. The project will compare both modals and non-modals. A cross-linguistic investigation of the scopal behaviour of both existential and universal quantifiers in this respect has never been carried out before.

Afterwards, Postdoc 2 will engage in an in-depth investigation of 5 languages from the sample, selecting these languages with the aim of capturing as much variation as possible in a tiny sample, while also taking into account the practicality of obtaining new primary data from the languages in question. Here, the Postdoc will meticulously investigate whether the behaviour of those quantifiers that must take scope below clausemate negation (when present) is due to their NPI-hood or whether another factor is at play. As such, Postdoc 2 will build upon the cross-linguistic findings, and further develop the typology of polarity-sensitive universal NPIs in accordance with that of existential PPIs.

SP8: Leaning existential PPIs and universal NPIs (Postdoc 3, PhD student 3)

Goal: The goal of this SP is to address **RQ1b** and **RQ2b-d** and evaluate whether universal NPIs, both of the

Turkish type demonstrated before and ‘plain’ universal NPIs that only appear in negative or downward contexts at all above are learnable or not. In addition, when it comes to these ‘plain’ NPIs, the exact strength will be studied, since existing universal NPIs, like English *need* and their Dutch/German translations *hoeven/brauchen*, have a distribution that is different from weak and strong NPIs in that they can appear in some but not in all non-anti-additive, downward entailing contexts (see Lin et al. 2015, Zeijlstra 2022).

Hypothesis: The hypothesis (**H2b**) is that only universal NPIs of the Turkish type are learnable, but that plain strong or weak PPIs are not (i.e., one should not expect there to be expressions like *nevery*, where *nevery cookie* cannot only appear in anti-additive or in downward entailing contexts. In addition, it will be investigated whether epistemic existential PPI modals will be taken to be deontic PPIs as well, or not by language learners, or that this PPI-hood, as predicted, is restricted to epistemic usages only.

Method: For this, the postdoc responsible for the experimental investigation (Postdoc 3) and the PhD student in this Pillar (PhD student 3) will set up a number of artificial language learning experiments. Here, we will conduct an artificial language learning experiment requiring learners to acquire PSIs from an input that contains existential PPIs and universal NPIs of the kinds described above, both among modals and non-modals. Note that the inclusion of existential PPIs quantifying over individuals verifies whether PSIs are generally learnable in such an experiment. As the first round of experiments will undoubtedly lead to a number of follow-up questions, Postdoc 3 will be tasked with designing follow up studies to address these issues experimentally.

SP9: Explaining the distribution of existential PPIs and universal NPIs (PI, Postdocs 1-3, PhD student 3)

Goal: The goal of this SP is to address **RQ3c** and explain observed constraints the distribution of existential PPIs and universal NPIs. Depending on the outcomes of **SP7-8**, the PI and Postdoc 1 (in collaboration of Postdocs 2-3 and PhD student 3) will explore the possibilities to theoretically account for the observed variation.

Hypothesis: The hypothesis (**H2b**) is that there is no inherent, grammatical ban, either cognitively or communicationally, on universal NPIs but that the properties that underlie such NPIs render them such that they can appear above the surface scope of their offending contexts. This way, both existential NPIs and universal PPIs are grammatically possible, albeit that the latter are more opaque than the former and therefore harder to identify, and unlikely to emerge for the same reason. Furthermore, the aforementioned theory involving existential PPIs will be further developed, addressing the question as to why most existential PPIs are weak PPIs (i.e. only anti-licensed by anti-additive contexts) and why modals with different modal bases exhibit different PSI behaviours.

Method: This project is largely theoretical and will explore how the outcomes of **SP7-8** can be captured in terms of the different distributional footprints of existential PPIs and universal NPIs. In addition, in this SP the full comparison between modal and non-modal PSIs will be conducted, such that the landscape of both (epistemic and deontic) modal and non-modal existential NPIs and universal PPIs will be fully understood. This SP will also spell out the consequences of these outcomes for existing theories, in particular those that underlie the nature of existential PPI-hood, which remain poorly developed.

SP10: Strong and weak (NR) modals cross-linguistically (Postdoc 2, PhD student 4)

Goal: The goal of this SP is to address **RQ1c** and **RQ2a-c** and explore the landscape of weak and strong modals and to explore how and why modal strength correlates with the possibility to trigger Neg-Raising (NR) readings. The first question concerns the typology of strong and weak universal (i.e. necessity) vs. existential (i.e. possibility) modals. Is it really the case that only weak necessity and not weak possibility modals can be attested? Or can weak possibility modals in fact be attested, as has been claimed by Močnik (2019), albeit very infrequently? The second goal concerns NR. Is it really the case that weak necessity modals can but strong necessity modals cannot trigger NR readings? Special emphasis is placed on investigations of modals that are quantificationally underspecified. Newkirk (2022a,b) has, for instance, shown that in Kinande, possibility modals can be strengthened into necessity modals, but only into weak ones. The question emerges as to whether this pattern is replicable in other languages.

Hypothesis: Here, the hypotheses are twofold. The first one (**H3a**) is that weak modals, unlike strong modals, do not necessarily make reference to the actual world (see Silk 2016, 2022). That is, following Kratzer (2013, 2020), modals whose final domain include the actual world are strong modals and modals whose final domain does not necessarily include the actual world are weak ones. In a sentence like *It must be raining*, the actual world is among the raining worlds (in the final domain), but for *it should be raining*, that does not have to be the case (see also von Stechow & Gillies 2010, 2021, pace Giannakidou & Mari 2018). Consequently, possibility modals that do not have to make references to the actual world have a meaning that is so weak that that it is nearly trivial. That something can be the case in a possible world different from ours is almost trivially true (see Mirrazi & Zeijlstra 2023). Consequently, such modals are either not lexicalized or obligatorily strengthened. This means that weak possibility modals should be very rare but not impossible to attest.

The second hypothesis (**H3b**) is that following Kratzer (2012) and Mirazzi & Zeijlstra (2023), modals that make reference to the actual world cannot be strengthened under negation. The reason for this, according to Mirazzi & Zeijlstra (2023), is that parallel to the implicature account of Free Choice (Fox 2007, Bar-Lev & Fox 2017) and homogeneity (Bassi & Bar-Lev, 2018; Magri, 2014; Bar-Lev, 2020), strengthened readings to are the result of the application of an exhaustivity operator. This operator has to make reference to every domain alternative, including the singleton domain alternatives. But following Kratzer (2012), such singleton alternatives are too specific to be cognitively viable when they may contain the actual world. For an actual human to believe such a singleton proposition would mean that they are omniscient in a strong sense. This predicts that only modals that do not make reference to the actual world can be strengthened. Consequently, only weak possibility modals can be strengthened into weak necessity modals and only weak necessity modals, and not strong ones, can trigger NR readings.

Method: As in the other SPs, the postdoc responsible for the cross-linguistic investigation (Postdoc 2) and the PhD student in this Pillar (PhD student 4) member will identify 15-20 languages of potential interest, including 1-3 sign languages. The selection method for these languages will be the same as that for the other cross-linguistic projects. This project investigates for each language to what extent weak and strong possibility modals can be attested, whether these can be strengthened into weak or strong necessity modals, and whether weak and/or strong necessity modals can trigger NR readings. A cross-linguistic investigation into weak and strong modals and possible modal Neg-Raisers like this never took place before.

Afterwards, Postdoc 2 will engage in an in-depth investigation of 5 languages from the sample, selecting these languages with the aim of capturing as much variation as possible in a tiny sample, while also taking into account the practicality of obtaining new primary data from the languages in question. At least one of these languages should be a language where modals appear quantificationally underspecified. Here, the postdoc will look at the exact circumstances under which strengthening of the two types can or must take place.

SP11: Leaning strong and weak (NR) modals (Postdoc 3, PhD student 4)

Goal: The goal of this SP is to address **RQ1c** and **RQ2b-d** and assess whether both weak and strong possibility modals are learnable or not, and whether NR is only learnable for weak but not for modals.

Hypothesis: The hypotheses (**H3a-b**) are that (i) weak possibility modals should be learnable despite their crosslinguistic absence or rarity, and (ii) that only weak but not strong modals can be acquired to undergo strengthening. This means that in languages where modal force appears to be underspecified possibility modals can only be strengthened into weak necessity modals and that only weak necessity modals can be Neg-Raisers.

Method: For this, the postdoc responsible for the experimental investigation (Postdoc 3) and the PhD student in this Pillar (PhD student 4) will design a number of artificial language learning experiments. Here, we will conduct artificial language learning experiments requiring learners to acquire weak and strong possibility modals from an input that contains both of them and have to acquire both strong and weak modals that undergo NR. The experiments will contain both quantificationally fixed and underspecified modals. This way the predictions concerning learnability of (strengthened) weak and strong modals will be assessed.

SP12: Explaining the behaviour of strong and weak (NR) modals (PI, Postdocs 1-3, PhD student 4)

Goal: The goal of this WP is to address **RQ3c** and explain the observed difference between strong and weak possibility and necessity modals, and the way modal strength correlates with NR. Depending on the outcomes of **SP10-11**, the PI and Postdoc 1 (in collaboration with Postdocs 2-3 and PhD student 4), will explore the possibilities to theoretically account for the observed variation.

Hypothesis: The hypothesis (**H3a**) is that there is no inherent, grammatical ban, either cognitively or communicationally, on weak possibility modals but that these have a weak meaning that is so weak that it will hardly ever emerge in natural language; either such modals will not occur, or they will be strengthened (outside downward entailing contexts). In addition, the hypothesis (**H3b**) is that it is a necessary condition for modals that can undergo strengthening that their modal domain of quantification does not have to contain the actual world. The hypothesis is built on the conjecture that strengthening results from exhaustification of domain alternatives all the way up to singleton-level, but that the ability to distinguish singleton domain alternatives that contain the actual world from those that do not is cognitively unviable (cf. Kratzer 2012).

Method: This project is largely theoretical and will explore how the outcomes of **SP10-11** can be captured in terms of differences in modal bases between strong and weak modals. Moreover, it will investigate under what circumstances strengthening of possibility modals (outside negation or other downward entailing contexts) can or must take place, and, similarly, when strengthening of necessity modals under negation emerges. This SP will also illustrate the consequences of these outcomes for existing theories, both concerning the nature of weak modals (in comparison to their strong counterparts) and theories of NR. As for the latter, these will involve a shift from syntactic approaches (cf. Collins & Postal 2014) and existing pragma-semantic approaches (e.g. Gajewski 2007 or Romoli 2013) to NR to exhaustification-based approaches to NR (see Staniszweski 2021, Mirazzi & Zeijlstra 2023, Jeretič 2021).

5.3 Deliverables

The results of the 12 SPs will result in the following research output. First, each Pillar will deliver three co-authored papers (per Pillar, one on cross-linguistic variation, one on language learnability and one containing the theoretical explanation). In addition, each PhD student will also provide a single-authored paper on the lexicalization constraints in their Pillar. These four papers will together yield a cumulative PhD thesis in full accordance with the Goettingen PhD guidelines on cumulative theses with co-authored articles. Apart from the co-authored articles, Postdocs 2-3 will each write a methodological paper on their respective axes and up to four single-authored papers. The PI and Postdoc 1 will work on the theoretical articles in each Pillar (together with the other postdocs and the PI) and will deliver a synthesizing monograph on universal paradigmatic gaps at the end of the project. In addition, the PI and Postdoc 1 will each provide several more single and/or co-authored articles on the theory behind lexicalizations of negative elements, polarity-sensitivity, strong vs. weak modality and Neg-Raising.

In addition, UNPAG will organize and host two workshops with internationally well-established scholars, but also with a call for papers, to include promising early-career researchers working on topics that are related and/or relevant to the project. The first workshop will take place in the beginning of the second year once the entire team has convened. The second workshop will take place in the final year of the project. In this workshop the PI, Postdocs and PhD students will all present their project results. Special journal issues resulting from these workshops are envisioned.

6. High-gain & high-risk and feasibility

The overall goal of understanding how and why apparent constraints apply to the lexicalization of logical elements in natural language is a formidable challenge. Confronting this obstacle is a critical step toward a more comprehensive understanding of linguistic communication and cognition, and tackles the highly fundamental question of how human language and how human thinking are intertwined: does the linguistic logical lexicon reflect the way logic integrates into human cognition and communication? An inevitable risk of the project, however, is its broad scope. Each of the linguistic phenomena under consideration (negating quantifiers, polarity-sensitivity, modal strength) is notoriously complex in itself. This makes the goal of unravelling the connections and interactions between them particularly intricate, something that could not possibly be achieved within the scope of a single research paper or PhD thesis, and requires more granular planning and a highly coordinated team effort.

To maximize its gains and constrain its risks, the project has been structured into twelve well-defined SPs, making it possible to develop different parts of the overall theory and data elicitation in parallel, and to test each of the hypotheses with a clearly delineated set of relevant linguistic data, rendering the project maximally tractable. Specific hypotheses for each of these SPs have been formulated as well (see Part B2 for a more detailed discussion of these (sub)hypotheses). This will concentrate attention upon each step in the process, and thus upon the intermediate targets, that are of great scientific value in their own right.

To further ensure the feasibility of the project, significant groundwork has been laid related to some of the SPs. Results reported in Zeijlstra (2017, 2022) and Mirrazi & Zeijlstra (2021, 2023) provide a firm basis for the hypotheses **H1-3**. The PI's expertise and track record in the domain of negation, polarity-sensitivity, quantification and modality also underline the feasibility of the project. As exemplified by his early achievements in his scientific career, the PI has made several high-impact contributions to the field which are directly relevant to the present project. He also possesses an extensive international network and ample experience providing leadership to large-scale research programmes, illustrated by the many projects he has successfully applied for and carried out.

Finally, the designated host institution, the University of Goettingen, is one of the premier centres for linguistics research in Germany and across the globe. The university has produced groundbreaking work in syntax, semantics, typology, sign linguistics, and experimental linguistics. The strength of the proposed project lies in the exceptional diversity of experience brought forth by its participants on one hand, and the unity of their scientific vision on the other. It will greatly benefit from day-to-day guidance of senior faculty members, such as Prof. Nivi Mani and Dr. Thomas Weskott (experimental linguistics), Prof. Guido Mensching (syntax), Prof. Stavros Skopeteas (typology), Prof. Markus Steinbach (sign languages), and Prof. Steiner-Mayr in addition to the community of postdocs and PhD candidates that are embedded in the Linguistics in Goettingen (LinG) platforms and the Research Training Group 2636 on form-meaning mismatches, the director of which is the PI of this project.

7. Description of resources

Personnel:

- The Principal Investigator (PI) will be working 30% for the project: EUR 190,760;
- Postdoc1 will be hired for 5 years (70%) for the project (EUR 295,400);
- 2 Postdocs will be hired for 4 years (100%, months 7-54): EUR 333,000 per postdocs = EUR 666,000;

- 4 PhD students will be hired for 3 years (65%, months, 13-48). EUR 140,400 per PhD student = EUR 561,600;

Student assistants:

- 1 student research assistant will be hired for 5 years (BA, each ca. 20 hours per month, 15€/hour) to support the PI and Postdoc1: EUR 18,000;

- 1 student research assistant will be hired for 4 years to support Postdoc2 and Postdoc3 (BA, each ca. 20 hours per month, 15€/hour): EUR 14,400;

- 2 student research assistants will be hired for 3 years to support the PhD students (BA, each ca. 20 hours per month, 15€/hour): EUR 10,80 per student = EUR 21,600. Total: EUR 54,000.

Traveling: 1 Conference in EU (EUR 1,000/trip) and 1 Conference in the USA/intercontinental per year (EUR 2,000/trip) = EUR 3,000 per year/per person = EUR 90,000. Est. conference fees: 6,000 (200 per conference). Total: EUR 96,000.

Publication (open access): Estimated amount of single and co-authored articles: 34 EUR 2,000/article = 68,000. One monograph, EUR 10,000. 4 PhD Theses: EUR 3,000/thesis (on average) = 12,000. Total: EUR 90,000.

Workshops: 2 workshops (EUR 10,000 each), one at the beginning of the project (beginning of the 2nd year) and one towards the end (end of 4th year). Total: EUR 20,000.

Consumables: An amount of EUR 2,000 is reserved to compensate participants in experiments. An additional EUR 8000 is reserved for materials for experiments (cameras, voice recorders).

Audits: EUR 10,000.

8. Time plan

Months	PI	Postdoc 1	Postdoc 2	Postdoc 3
1-6	Set up the subprojects in Pillars 1-4; hire Postdocs 2-3.	Assist in setting up subprojects in Pillars 1-4; hire Postdocs 2-3.		
7-12	Initial work on the state-of-the-art; hire PhDs; mentor postdocs; organize starting workshop.	Initial work on the state-of-the-art; hire PhDs; organize starting workshop.	Initial work on the state-of-the-art; hire PhDs.	Initial work on the state-of-the-art; hire PhDs.
13-18	Oversee the languages studies / experiments; supervise PhDs and mentor postdocs; prepare theoretical studies (with Postdoc 1).	Work with Postdocs 2-3 to design first language studies / experiments; prepare theoretical studies (with PI).	Prepare relevant study material for PhD students; selection of the languages.	Prepare relevant study material for PhD student; design first experiments.
19-24	Oversee the language studies/experiments; supervise PhDs and mentor postdocs; develop the theoretical architecture (with Postdoc 1).	Work with Postdocs 2-3 on the theoretical aspects of the language studies/experiments; theoretical studies; develop the theoretical architecture (with PI).	Conduct empirical and theoretical studies on the first set of 10-15 languages (with PhD Students 1,4).	Carry out the experiments (with PhD Students 2-3).
25-30	Oversee the language studies / experiments; supervise PhDs and mentor postdocs; develop the theoretical architecture (with Postdoc 1).	Work with Postdocs 2-3 on the theoretical aspects of the language studies/experiments; theoretical studies; develop the theoretical architecture (with PI).	Conduct detailed (statistical) analyses of outcomes of the language studies (with PhD Students 1,4); follow-up studies; publication with PhD students 1,4.	Conduct detailed (statistical) analyses of outcomes of the experiments (with PhD Students 2-3); follow-up experiments; publication with PhD students 2-3.
31-36	Oversee the language studies/experiments; supervise PhDs and mentor postdocs; develop the theoretical architecture (with Postdoc 1).	Work with postdocs 2-3 on the theoretical aspects of the language studies / experiments; theoretical studies; develop the theoretical architecture (with PI).	Conduct empirical and theoretical studies on the first set of 10-15 languages (with PhD Students 2-3).	Carry out the experiments in (with PhD Students 1,4).
37-42	Oversee the language studies/experiments; supervise PhDs and mentor postdocs; assist Postdocs 1-3 and PhD students 1-4 to connect the outcomes of the subprojects; proposal of the first version of the overall grammatical model; preliminary joint theoretical conclusions per Pillar.	Assist the PI, Postdocs 2-3 and PhD students 1-4 to connect the outcomes of the subprojects; proposal of the first version of the overall grammatical model; preliminary joint theoretical conclusions per Pillar.	Conduct detailed (statistical) analyses of outcomes of the language studies (with PhD Students 2-3); follow-up studies in Pillar 2-3; publication with PhD students 2-3.	Conduct detailed (statistical) analyses of outcomes of the experiments (with PhD Students 1,4); follow-up experiments; publication with PhD students 1,4.
43-48	Supervise PhDs and mentor postdocs; Co-develop with Postdoc 1 the final version of the overall grammatical model; theoretical publication per Pillar.	Co-develop with the PI the final version of the overall grammatical model; theoretical publication per Pillar.	Analysis of the overall language studies; theoretical publication per Pillar.	Analysis of the overall experimental studies; theoretical publication per Pillar.
49-54	Mentor postdocs; (co-)publish findings; write the monograph with Postdoc 1; prepare follow-up studies; organize final workshop.	(Co-)publish findings; write the monograph with PI; organize final workshop.	Publish major theoretical and empirical findings; organize final workshop; explore future career options.	Publish major theoretical and empirical findings; organize final workshop; explore future career options.
55-60	Mentor Postdoc 1; (co-)publish findings with Postdoc 1; finalize the monograph with Postdoc 1; prepare follow-up studies.	(Co-)publish findings; finalize the monograph with PI; explore future career options.		
Months	PhD Student 1	PhD Student 2	PhD Student 3	PhD Student 4

13-18	Initial work on the state-of-the-art.	Initial work on the state-of-the-art.	Initial work on the state-of-the-art.	Initial work on the state-of-the-art.
19-24	Conduct empirical and theoretical studies on the first set of 10-15 languages in Pillar 1 (with Postdoc 2).	Carry out the experiments in Pillar 2 (with Postdoc 3).	Carry out the experiments in Pillar 3 (with Postdoc 3).	Conduct empirical and theoretical studies on the first set of 10-15 languages in Pillar 4 (with Postdoc 2).
25-30	Conduct detailed (statistical) analyses of outcomes of the language studies in Pillar 1 (with Postdoc 2); publication with Postdoc 2.	Conduct detailed (statistical) analyses of outcomes of the experiments in Pillar 2 (with Postdoc 3); publication with Postdoc 3.	Conduct detailed (statistical) analyses of outcomes of the experiments in Pillar 3 (with Postdoc 3); publication with Postdoc 3.	Conduct detailed (statistical) analyses of outcomes of the language studies in Pillar 4 (with Postdoc 2); publication with Postdoc 2.
31-36	Carry out the experiments in Pillar 1 (with Postdoc 3).	Conduct empirical and theoretical studies on the first set of 10-15 languages in Pillar 2 (with Postdoc 2).	Conduct empirical and theoretical studies on the first set of 10-15 languages in Pillar 3 (with Postdoc 2).	Carry out the experiments in Pillar 4 (with Postdoc 3).
37-42	Conduct detailed (statistical) analyses of outcomes of the experiments in Pillar 1 (with Postdoc 3); publication with Postdoc 3.	Conduct detailed (statistical) analyses of outcomes of the language studies in Pillar 2 (with Postdoc 2); publication with Postdoc 2.	Conduct detailed (statistical) analyses of outcomes of the language studies in Pillar 3 (with Postdoc 2); publication with Postdoc 2.	Conduct detailed (statistical) analyses of outcomes of the experiments in Pillar 1 (with Postdoc 2); publication with Postdoc 3.
43-48	Complete thesis; theoretical publication per Pillar; explore future career options.	Complete thesis; theoretical publication per Pillar; explore future career options.	Complete thesis; theoretical publication per Pillar; explore future career options.	Complete thesis; theoretical publication per Pillar; explore future career options.

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