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Czech Negation from the Formal Perspective

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To the memory of my parents

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Introduction

1 Acknowledgments

I am very grateful to my dear colleagues and students who read or heard large portions of this book and provided me with so much needed comments and feedback. I especially want to thank to the three reviewers of my book (in the alphabetical order): Jaroslav Peregrin, Lída Veselovská and Hedde Zeijlstra. Thanks to their comments and suggestions the book looks better and hopefully reads a bit easier too. Ivona Kučerová helped me to shape many ideas which appear scattered through the book, so big thanks to her across the ocean. My greatest intellectual debt is undoubtedly in Fred Landman's work, as I use his Language of Events and Plurality in every chapter of this book. I hope I didn't simplified his theories too much and I am very grateful to him for his kind explanation of more difficult parts of his framework to me. I also want to thank members of the Department of Linguistics and Baltic languages for providing me with a great working place, particularly I am grateful to Ondřej Šefčík for being the best boss which I ever had (honestly) and Václav Blažek for kindly reminding me that I should finish the book better sooner than later; finally all the others member of our department for making Brno a good place for the intellectual work.

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Some ideas in this book are based on earlier versions of my attempts to describe the formal properties of Czech negation. A previous version of chapter 3 was published as Dočekal (2011). Some of the ideas of chapter 4 appeared in Dočekal (2012b). The material presented in chapter 6 is a part of a joint work with Ivona Kučerová and is to some extent contained in our article Dočekal and Kučerová (2013). However, much of the text in these articles was rewritten and a lot of material was added. And the present book improves upon the analyses reported in the articles in many respects.

The last three years in which I worked on this book were filled with major changes in my life. I became the father of my lovely twins, Mariana and Mojmír and even though I haven't looked like that all the time, I certainly know that nothing in Czech negation is more important than their screaming *ne ne ne ne, tati.* I also want to express very special thanks to my wife Markéta, because without her support I wouldn't have written a single word of this book.

2 Introduction

This book deals with the meaning of Czech negation. The general framework is formal semantics, a model-theoretic style of explaining the meanings of natural language through the reference of its expressions. I build on the nowadays well established tradition which started 40 years ago with Montague (1973). I focus a lot on the formal analyses of negation (as already suggested by the title of the book), which necessarily means that some (very interesting) aspects of natural language negation lie beyond the grasp of my theories. This is the main reason I mostly just touch the issues which are concerned with the pragmatics of negation and which were of the central interest to Czech linguists dealing with negation (such as Hajičová (1973), Hajičová (1974) and Petr et al. (1986)).

In Chapter 1, I introduce the semantic theory developed in Landman (2000) and Landman (2004). Landman's Language of Events and Plurality will be the main framework I will use in the rest of the book as it offers very restrictive and heuristically extraordinarily useful formalization of natural language negation.

In chapter 2, I will be concerned with the formalization of the meaning of negative noun phrases in Czech. I will aim to establish their indefinite status and compare them with regular quantifiers which can be found in non-negative concord languages like English.

In Chapter 3, I will be concerned with the interaction between negation and lexical aspect. As negation seems to behave in some cases as a lexical aspect operator which is able to turn telic events into atelic ones. Regarding that issue, I will claim that the proper understanding of the natural language aspect allows us to retain the simple semantics for negation as the truth-reversing function and that natural language negation doesn't have any special aspectual properties.

In Chapter 4, I will be concerned with the scope preferences of negation in sentences with universal subjects. I will claim that the most decisive factor is the concurrence in natural language and that for most cases this concurrence results in the fixation of scope between the negation and the universal quantifier.

In Chapter 5, I will be concerned with two types of negative questions – negative degree and negative manner questions. Such questions were reported in some languages as ungrammatical which was theoretically explained as them being weak islands – schematically configurations from which wh-movement isn't possible. Czech negative manner and degree questions are grammatical though which I take as an empirical argument against the current theories of weak islands. An attempt to reduce the cross-linguistic variation of the negative degree and manner questions to the exhaustivity and intervention effects is accomplished in that chapter.

This book is not intended to play the role of the comprehensive guide to Czech negation (or negation cross-linguistically – see Horn (1989) for the Book of that kind). The nature of the tools I use and my own intellectual limits restrict my linguistic enterprise so that it results in four case studies connected by the data and the method – Czech negation and formal semantics respectively. Nevertheless, at least for me the case studies reveal a nice and elegant grammar machine of Czech even if in small details. I can only hope that this impression will be at least partially shared by the potential readers of the book.

3 List of frequently used symbols

Symbol	**Description**
1	truth value True
0	truth value False
$\neg$	negation
$\wedge$	conjunction
$\vee$	disjunction
$\rightarrow$	material implication
$\leftrightarrow$	equivalence
$\forall$	universal quantifier
$\exists$	existential quantifier
$t, t', t'', \ldots$	variables over time
$x, y, z, \ldots$	variables over entities
$e_1, e_2, \ldots$	variables over events
$[\![\alpha]\!]$	semantics of α
$X \subseteq Y$	X is a subset or equals Y
$P, Q, R, \ldots$	variables over predicates
$X, Y, Z, \ldots$	variables over sets
$\emptyset$	empty set
$\cap$	set intersection
$\cup$	set union
$\|X\|$	cardinality of X
$\langle d \rangle$	type of entities
$\langle e \rangle$	type of events
$\langle t \rangle$	type of truth-values
$\langle \alpha, \beta \rangle$	type of functions from α-entities to β-entities
*	ungrammatical expression (especially in front of natural language expressions)
*	pluralization (in front of Language of Pluralities expressions)
#	semantical anomaly
$Ag, Th, \ldots$	thematic roles
$\uparrow$	group formation
$\lambda x.\alpha$	function from x into α
$a \sqcup b$	sum of a and b

1 The Frameworks

The main topic of this book is the natural language negation and its interaction with various aspects of the grammar of natural language: the second chapter of the book explores how the morphological negation on verb and on noun phrases is interpreted in Czech (as a negative concord language) and English, in the third chapter I will explore the interaction between negation and grammatical aspect, in the fourth chapter I will look at various scope interactions between negation and different quantified and numerical noun phrases, and in the last chapter I will examine the interpretation of some types of negative questions.

But before I will go for the different topics I just mentioned, I will summarise two big frameworks for the treatment of natural language semantics. First, in the section 1.1 I will provide an introduction into the framework of generalized quantifiers, a framework that has proven its great use for the study of natural language quantification in the past three decades, see Barwise and Cooper (1981) for the classical reference.

Second, in the section 1.2 I will show the main ingredients of the Language of Events and Plurality (LoP henceforth). LoP is based on the work of Landman (2000) and Landman (2004) which on Landman's previous work on the plurality in natural language, as reported in Landman (1989) and Landman (1997). LoP is extensively used for the description of plurality interpretation in the current formal semantics. But LoP offers a very exciting perspective for treatment of negation in natural language, as it fixes the scope of the verbal negation in the formalization over the existential closure of the event variable as I will demonstrate in the section 1.2.

Second motivation for my usage of LoP is the simple fact that it represents one of the rare exceptions in the modern formal semantics: it is a full blown framework with formalization of many ideas which were treated just as intuitions before. And lastly, the usage of LoP allowed me to understand many subtle issues of the plurality and aspect interactions with negation which I think are not possible to handle in any alternative framework I am aware of. But before I will introduce LoP, let me go through one historical step – a summary of the main concepts of the Generalized Quantifiers framework, which I think allows us to understand comparatively what is so important and beautiful about LoP.

1.1 NPs as generalized quantifiers

The article by Barwise and Cooper (1981) can be considered a cornerstone in the field of formal semantic treatment of noun phrases meaning. Barwise and Cooper (1981) draw on Montague (1973) in building an unified semantics of any kind of NPs, be they as different as definites, indefinites, quantified noun phrases or noun phrases headed by cardinals. We can interpret this style of theory as the followers of Montague's idea that one syntactic category should be always translated as the same semantic object. Even if this unification can be required from the methodological point of view, its realisation collides with some empirical data as we will see. But let's put this aside and for now I will provide a brief introduction into the framework of Generalized Quantifiers.

Barwise and Cooper (1981) start with two critical comments regarding the predicate logic treatment of quantification in natural language. First, the syntactic structure of quantified formulas in predicate logic and the syntactic structure of quantified sentences in natural language are according to Barwise and Cooper unsatisfactorily different. As an illustration, let's look at the following examples with the predicate logic formalization. The quantifiers *every/some* must be translated as "discontinuous" constituents made of predicate logic operators $\forall ... \rightarrow$ and $\exists ... \wedge$ respectively. This of course renders the truth conditions of the sentences right but goes a lot against the well established assumption that there's a correspondence between "constituent" structure of natural and formal language. Which means that if we have one phrase in natural language, we would expect that there's one unit in the formal language which will correspond to it.

(1) a. Every student is lazy.
a' $\forall x[student(x) \rightarrow lazy(x)]$
b. Some students are lazy.
b' $\exists x[student(x) \wedge lazy(x)]$

Second, Barwise and Cooper proved, that an NP such as *most N* isn't expressible the predicate logic of the first order. The natural language sentence like (2) cannot be formalized in the first-order predicate logic, even if we enrich its vocabulary with a third quantifier M corresponding to the natural language *most*. There are two possible translations of *most* into predicate logic – (3-a) and (3-b) – parallel to the existential and universal quantifiers as the formal logic translation of *some* and *every*.

(2) Most students are lazy.

(3) a. $Mx[student(x) \wedge lazy(x)]$
b. $Mx[student(x) \rightarrow lazy(x)]$

Consider a situation in which there are 20 people, 5 of them are students. If 4 of these students are lazy, sentence (2) is uncontroversially true. But the truth conditions of (3-a) would output falsehood, as it's not true that most of the individuals (20) in the universe of discourse are both students and both lazy. In other words: the formalization in (3-a) doesn't render the truth conditions of the natural language sentence right.

But (3-b) doesn't fare better – it would output true in a first scenario but in a different scenario with 20 people, 5 students and only one of the students being lazy, (3-b) would be true unlike its natural language counterpart. Why? Because implication returns truth for any case where its antecedent is false, so 15 non-students would make the whole formula true, regardless of the number of lazy individuals among the students. Again a wrong result.

The discussion above indicates some of the problems that are met when one tries to define the first-order version of *most*. The main problem with the predicate-logic formalization of natural language quantification is that predicate logic does allow unrestricted quantification (e.g. predicate-logic formula $\forall x P(y)$ is syntactically and semantically well-formed in predicate logic) but every natural language quantifier comes with a restriction. This restriction can be a bit sloppily emulated with the predicate-logic connectives in case of the quantifiers like *all/some/two/...* but this strategy fails in the case of the quantifier *most* e.g. I refer the diligent reader to Barwise and Cooper (1981) for further details and for the formal proof of unusability of the first order logic for the treatment of natural language quantifiers like *most*. This is one of the main reasons why Barwise and Cooper introduce a more robust and more efficient framework – generalized quantifiers. The main ideas of generalized quantifiers will be discussed in the next section.

1.1.1 NPs as sets of sets

The theory of generalized quantifiers brings a solution to both problems of predicate logic mentioned in the previous section – it is able to formalize the meaning of any natural language determiner (and moreover in a uniform fashion) and it assigns the non-discontinuous meaning to the determiners, making the formal language closer to the surface of the natural language. It achieves this goal by going beyond the boundaries of the first order logic: the intuitive meaning of the generalized quantifiers formalization of *most* in (4) is: *most* noun denotes the set of all properties which the most instantiations of noun bear. In other words, a generalized quantifier like *most sailors* denotes such set of properties which most sailors exemplify, e.g. the set of rum-drinkers, the set of swimmers and the set of scary songs singing individuals would be some of the sets in the set of sets denotation of the generalized quantifier *most sailors* (at least if we stick to the conventional image of a sailor). (4) (I follow the set notation which can be found in de Hoop (1992) e.g. as it seems to me more readable than the usual λ functional notation of generalize quantifiers) formalizes just this: $[\![mostN]\!]$ denotes such set of sets (X) over the universe of discourse ($X \subseteq E$) where each set member of X contains most Ns. The logical type of a generalized quantifier reflects this: its type is the $\langle\langle e,t\rangle,t\rangle$, the function from sets ($\langle e,t\rangle$) to the truth values ($\langle t\rangle$).

(4) $[\![Most\,\mathrm{N}]\!] = \{X \subseteq E : X\,\text{contains most Ns}\}$
(E stands for the domain of discourse)

Generalized quantifiers offer a natural unification for the denotation of all types of NPs – the format is so rich that any type of NP meaning can be treated like a set of sets. This goes pretty well with the old Montague's impetus for the uniform mapping of the syntactical categories to the semantic types. In the generalized quantifiers framework all NPs are treated at the $\langle\langle e,t\rangle,t\rangle$ type. This seems rather unintuitive at the first sight at least for the proper names, which were at least since Frege's (1892) seminal paper treated like entities (hence of the $\langle e\rangle$ type). But in generalized quantifiers the proper names can be represented as sets of properties which the respective entity instantiates.

If we accept a well established rule which constraints the conjunction only to the expressions of the same semantic type (and of course of the same syntactic category), we must admit that a proper name like *Peter* in (5) is of the same type as the generalized quantifier *some students.*

(5) I met Peter and some students.

Montague's solution to the conjunction problem was following from his uniform treatment of noun phrases semantics. As was already mentioned, it's straightforward to represent meaning of proper names as set of sets (type $\langle\langle e,t\rangle,t\rangle$), namely the as the set of all properties which the individual denoted by the proper name has. Then the logical type of proper name and quantifier like *some students* in (5) match and conjunction can apply. The Montague's strategy, even though formally coherent, was the generalization to the worst case: if some expression from natural language must be represented as a higher type in some context, then the expression must be represented as the higher type in all contexts. In that case, even the sentence *Peter smokes* is true if the set of smokers is one of the sets in the set of sets of properties which Peter has; and the sentence isn't formalized as a member-set relation between individual Peter and set of smokers. It is if course more natural to think about the denotation of a proper name like *Peter* as of an individual of the type $\langle e\rangle$ then as of set of sets of his properties but that doesn't make any argument against the Montague's theory; nevertheless we will see soon some real empirical problems which generalized quantifiers theory (following Montague in this respect) encounters. Partee and Rooth (1983) started a different tradition in dealing with this phenomena but I will introduce their type-shifting framework later.

Let's look at some examples of the generalized quantifiers treatment of the natural language determiners. (6-a) represents the meaning of *all* – *all N* is such set of sets, where each set contains all members of the N denotation ($[\![N]\!] \subseteq X$). (6-b) represents the meaning of *no*: *no N* is such set of sets which don't have any intersection with the denotation of N ($[\![N]\!] \cap X = \emptyset$). The generalized quantifier *no sailors* would denote set of sets like set denotation of the following VPs: *live on Mars*, *be a hamster*, *be a prime number*. The last example: numerical generalized quantifier in (6-c) denotes such set of sets which has the n-numerous intersection with the denotation of the N – a generalized quantifier like *at least two presidents of the Czech Republic* would represent a set of sets with the members like $\{x \in E :$ x's first name is Václav$\}$, $\{x \in E :$ x wears glasses$\}$, ... The generalized quantifier denotations in (6) correspond to total functions.

(6) a. $[\![\text{all N}]\!] = \{X \subseteq E : [\![N]\!] \subseteq X\}$
b. $[\![\text{no N}]\!] = \{X \subseteq E : [\![N]\!] \cap X = \emptyset\}$
c. $[\![\text{at least n N}]\!] = \{X \subseteq E : |[\![N]\!] \cap X| \geq n\}$
d. $[\![\text{most N}]\!] = \{X \subseteq E : |[\![N]\!] \cap X| > |[\![N]\!] - X|\}$

But the interpretation of some NPs in natural language is better treated as partial functions, the prime example are definite NPs such as *the N* or *both N*. Their denotation is given in (7): they are built on the semantics of generalized quantifier *all* but output undefined truth-value if the cardinality of the noun denotation doesn't meet the respective criterion. So NP like *the president of the Czech Republic* outputs undefined (unless the domain of quantification is contextually restricted to the present president or whoever else), because the Czech Republic had more than one representant of the role.

(7) a. $[\![\text{the n N}]\!] = [\![\text{all N}]\!]$ iff $|[\![\text{N}]\!]| = \text{n}$, otherwise undefined
b. $[\![\text{both N}]\!] = [\![\text{all N}]\!]$ iff $|[\![\text{N }]\!]| = 2$, otherwise undefined

Even if the generalized quantifiers framework works with sets of sets, there is a concept of witness sets introduced by Barwise and Cooper to go down in order: from sets of set to sets. Intuitively, we think about sentences like *John is a sailor* in terms of set membership: the sentence is true if John is the member of the set of sailors (formally: $\text{j} \in \{\text{x} \mid \text{x is a sailor}\}$). But Barwise and Cooper (1981), following Montague (1973), argue exactly for the opposite perspective with respect to what is the function and what is its argument: a sentence like *John is a sailor* is true in their framework if and only if the property of being a sailor is one of the properties (family of sets) which John has (formally: $\{\text{x} \mid \text{x is a sailor}\} \in \{\text{X} \subseteq \text{E} \mid \text{j} \subseteq \text{X}\}$). The idea of witnesses (or witness sets) can be understood as restoring the former intuition: the witness set for John is a singleton set $\{\text{j}\}$, and the sentence John is a sailor is true if and only if the witness set for John is a subset of the set of sailors. Similarly for quantifiers: the witness set of the quantifier *every sailor* is the set of sailors, the witness set of the quantifier two sailors is the set of sets containing as members sets of two sailors and so on.

1.1.2 Classification of determiners in the generalized quantifiers framework

The generalized quantifiers framework lead to many fruitful outcomes: one of them is the search for formally meaningful semantic universals. The basic idea defended by Barwise and Cooper is that natural language determiners are constrained to form just a subset of logically possible relations between sets. In other words, no natural language contains determiners which wouldn't satisfy all basic constraints as Extension, Conservativity and Quantity discussed in detail in Barwise and Cooper (1981) and sketched shortly below. Because the issue of semantic universals is tangential to the purposes of my book, I will just shortly mention two of the semantic universals: extension and conservativity.

The extension constraint is formalized in (8) and in a nutshell it says that enlarging the universe of discourse ($E \subseteq E'$) shouldn't change the truth value of the determiner ($D_E AB \leftrightarrow D_{E'} AB$). Consider a natural language sentence like (9). This sentence (if true) in a universe of discourse containing just entities in the Czech Republic should remain true even if we enlarge the universe of discourse to all European countries; this holds of course only if the denotation of A (sailors) and B (smokers) is kept fixed as stated in the formula ($D_E AB \leftrightarrow D_{E'} AB$).

(8) *Extension*
$\text{A, B} \subseteq \text{E} \subseteq \text{E'} \rightarrow (\text{D}_E\text{AB} \leftrightarrow \text{D}_{E'}\text{AB})$

(9) All sailors smoke.

Another universal of Barwise and Cooper is conservativity, as defined in (10), it says that the truth-values of any determiner remain the same, if we substitute its second argument for the intersection of the second argument with the first argument ($B \cap A$). It can be demonstrated in natural language with the equivalences in (11).

(10) *Conservativity*
$D_E AB \leftrightarrow D_E A(B \cap A)$

(11) a. Some students smoke.
$\approx$ Some students are smoking students.
b. All students are lazy.
$\approx$ All students are lazy students.
c. Two students are smart.
$\approx$ Two students are smart students.

Conservativity claims that we can ignore all entities outside of the intersection of A and B. Compare this with a focus sensitive particle like *only* in (12). For inspection of the truth conditions of (12) we must take into account individuals outside of A and B, because if (12) is true, then no other entity than sailors can smoke. From this it follows that *only* doesn't obey conservativity and isn't natural language determiner which is hardly surprising for a linguist, as *only* can modify any syntactic constituent, unlike regular determiners which can attach only to NPs.

(12) Only sailors smoke.

Besides the universal constraints on the denotation of natural language determiners as extension and conservativity, Barwise and Cooper examined some other formal properties of the binary relations between sets, which are satisfied only by some subsets of natural language determiners. These conditions thus yield classification of determiners into subclasses distinguished by these different semantic properties. I will discuss one such property: *Monotonicity.*

1.1.3 Monotonicity

The only property of generalized quantifiers which I will discuss in this book allows us to classify the natural language determiners according to their monotonicity. Monotonicity is imported to the natural language semantics from mathematics where monotone increasing are such functions which preserve the given ordering. For natural numbers, example can be a function like $f(x) = x * 2$, because for any x and y such as $x \leq y$, $f(x) \leq f(y)$. Monotone decreasing are such functions, which reverse the ordering, so if again $x \leq y$, $f(x)$ is monotone decreasing, if $f(x) \geq f(y)$, again an example from arithmetic would be a function like $f(x) = 10/x$.

In natural language and particularly in the generalized quantifiers framework, the monotonicity is determined with respect to both arguments of the determiner: nominal – A and verbal – B. The monotone increasing and monotone decreasing determiners with respect to the first argument are in (13) and monotone increasing and monotone decreasing determiners with respect to the second argument are defined in (14).

(13) a. MON↑: If D_EAB and A $\subseteq$ A', then D_EA'B
b. MON↓: If D_EAB and A' $\subseteq$ A, then D_EA'B

(14) a. MON↑: If D_EAB and B $\subseteq$ B', then D_EAB'
b. MON↓: If D_EAB and B' $\subseteq$ B, then D_EAB'

Let's demonstrate the monotonicity properties of some determiners on examples. In natural language the ordering is usually reducible to entailment and because if x is a dog, the we can entail that x is an animal, we can classify the determiner *some* as monotone increasing on its first argument, as witnessed by the validity of an implication in (15-a). The determiner *all* is monotone decreasing on its first argument, as the implication in (15-b) shows, because the implication goes in the opposite direction: from sets to subsets.

(15) a. Some dogs bark.
→ Some animals bark.
b. All animals sleep.
→ All dogs sleep.

Some preserves the ordering also on its second argument, see (16-a), as $[\![$long books$]\!] \subseteq [\![$books$]\!]$, but *no* reverses the ordering on its second argument, as $[\![$live in this town$]\!] \supseteq [\![$live in the suburbs of this town$]\!]$, see (16-b)

(16) a. Some linguists write long books.
→ Some linguists write books.
b. No linguists live in this town.
→ No linguists live in the suburbs of this town.

Besides the monotone increasing and monotone decreasing determiners, there is a lot of determiners which are non-monotone in any of their arguments, good example is the determiner *exactly two* in (17).

(17) a. Exactly two students came.
↛ Exactly two people came.
b. Exactly two people came.
↛ Exactly two students came.
c. Exactly two students came late.
↛ Exactly two students came.
d. Exactly two students came.
↛ Exactly two students came late.

The property of monotonicity has been famously first used by Ladusaw (1980) to describe the distribution of negative polarity items, expressions like English *ever* or *any* which occur primarily in the scope of negation and generally in the scope of monotone decreasing quantifiers (also called downward entailing quantifiers). This is the reason, why (18-a) is ungrammatical – *someone* is monotone increasing on both its arguments. (18-b) is grammatical, because *all* is monotone decreasing on its first argument, but monotone increasing on its second argument – see ungrammatical (18-c), unlike *no* which is monotone decreasing on both arguments, see (18-d).

(18) a. *Someone has ever been to Mars.
b. All students, who have ever been to Prague, love it.
c. *All students love anything.
d. No student loves anything difficult.

1.2 Formal framework

1.2.1 Language of plurality

In this section I will introduce the tool which I will use as the main formal instrument in the rest of the book. I presented the generalized quantifiers framework in the last section as an foreword to the main theoretical tool presented now for two reasons:

1. Generalized quantifiers framework represents a very robust and generally acclaimed framework which works pretty well in many cases. Although especially for indefinites it predicts behaviour not attested in natural language. And because I will describe Czech negative noun phrases which seem (at least in Slavic languages) to act as indefinites, I will comment on the generalized quantifier framework mostly critically. But if the generalized quantifiers didn't exist, then neither of the competing frameworks which are now so popular in formal semantics, wouldn't be on the market either. So I take generalized quantifiers to be a necessary step in our understanding of the noun phrases meaning. The step against which I will differentiate Landman's framework introduced below.

2. In this section I will introduce the framework of Fred Landman which he calls the Language of Plurality (hence LoP) – the details of the approach can be found in Landman (1989, 2000, 2004). And I think the main ingredients of LoP can be very well grasped just on the background of the generalized quantifiers (hence GQ) approach.

Landman's LoP is one of the frameworks which erode the uniform treatment of semantics of Noun phrases. So unlike GQ, where all noun phrases are represented as sets of sets (of course, there is a classification of NPs according to criteria like monotonicity, weak/strong force, . . . but this classification isn't reflected in the lexical entries and types of various determiners and NPs), LoP treats various types of NPs not uniformly. My motivation for using LoP is the following:

1. LoP offers a very restrictive interpretation of verbal and nominal negation in the full blown framework, where each step in the derivation is controlled by the formal

definition of the framework – see Appendix. So every formalization of a natural language sentence can be rigorously built step by step according to the rules of LoP. I consider this property of LoP very important as it offers a way how to control sometimes very subtle meaning differences expressed by different formulas. And I will provide the schematic derivations of the logical forms in LoP for the most important sentences under scrutiny.

2. LoP integrates formal semantics of number, unlike the GQ, where e.g. both denotation of singular universal and plural NPs like *every boy* and *all boys* get the same type and denotation – the set of all supersets of the set of boys. This is empirically wrong for many reasons – one of them is the incompatibility of singular universal quantified NPs with collective predicates like *gather*. Compare the unacceptability of sentence like **Every boy gathered* with grammaticality of a sentence like *All boys gathered*. It seems that the reason of ungrammaticality of the first sentence lies in semantics – intuitively collective predicate cannot be applied to atoms and singular universals quantifier like *every boy* cannot produce anything higher than atoms – GQ faces a problem if it represents the meaning of both quantifiers identically. Of course there are attempts to bring the semantics of number in Montague's framework (like Bennett (1976)) but I think that full integration of the plurality phenomena would lead to such dramatical changes in the GQ theory that the result would be (overall) quite close to LoP.

As I discussed above, LoP treats various types of NPs differently. We can distinguish three criteria which cut the landscape of NP semantics:

1. The distinction between scopal noun phrases and non-scopal noun phrases: non-scopal noun phrases can be entered into event types, scopal noun phrases not. It's the distinction between e.g. quantified NPs like *every boy* and indefinites like *a boy/three boys*. The former is obligatory quantified-in, resulting in a wide scope interpretation with respect to the event variable , the later can be quantified-in but can also be interpreted under the event variable resulting in a semantics close to the weak indefinites discussed above. I will address this distinction in detail in section 1.2.3.

2. The distinction between quantificational noun phrases, definites and indefinites: Landman (2004) distinguishes these three types according to their **starting type of interpretation**:

   a) quantificational noun phrases start out as type $\langle\langle d,t\rangle,t\rangle$. A short note on types: Landman differs from the traditional Montague typing because he uses his $\langle d\rangle$ type instead of Montague's $\langle e\rangle$ type for entities and $\langle e\rangle$ type for events. I usually use Landman's typing but if I do not, it should be clear from the context and hopefully will not confuse the diligent reader.

   b) definites start out at type $\langle d\rangle$

   c) indefinites start out at the predicative type $\langle d,t\rangle$.

So NPs (representing the three classes respectively) like *every boy*, *the boy* and *a boy* would have the same type in GQ framework: $\langle\langle d,t\rangle,t\rangle$ and the following interpretations:

a) *every boy* in GQ: {X ⊆ E: ⟦BOY⟧ ⊆ X }

b) *the boy* in GQ: {X ⊆ E: ⟦BOY⟧ ⊆ X } iff $|[\![BOY]\!]|$=1[1]

c) *a boy* in GQ: {X ⊆ E: ⟦BOY⟧∩ X ≠ ∅}

In LoP the three NPs would obtain the following interpretations (and the types discussed above):

a) *every boy* in LoP: λP.$\forall x \in$ BOY:P(x); the type $\langle\langle d,t\rangle,t\rangle$

b) *the boy* in LoP: $\delta(\lambda x.$BOY(x)) – δ is defined as the maximality operator picking up the supremum in the denotation: for singular NPs it is consequently defined only if there is one atom in the denotation of the predicate; the type $\langle d\rangle$

c) *a boy* in LoP: $\lambda x.$BOY(x); the type $\langle d,t\rangle$

3. The distinction in scalar maximalization properties of non-scopal noun phrases: the distinction between downward entailing maximalization triggers and other NPs. I will discuss this distinction in the following section.

Before I present the different interpretation of NPs in LoP, I will end this section by presenting the basic machinery of LoP. Let us assume a Boolean domain with three individuals in it, as shown in (19). The individuals at the bottom line are singularities, the atoms of the model; the entities above the singularities are plural entities. In the Boolean semi-lattice, the domain is partially ordered by ⊑, the part-of relation, and closed under ⊔, the sum or join operation. The formal axioms of the model can be found in the standard accounts of singular/plural distinction (Link (1983), Landman (1989)), where semi-lattices like (19) are used to model denotations of count expressions. Concerning the denotation of singular and plural nouns, the singular count nouns (like DOG) denote a set of atoms or, as in (19), the elements at the very bottom of the semi-lattice, hence, here a,b,c. The plurals (like DOGS) denote the set of atoms closed under the sum, that is the set of elements a,b,c, a ⊔ b, a ⊔ c, b ⊔ c, a ⊔ b ⊔ c in (19).

(19)

	a ⊔ b ⊔ c	
a ⊔ b	a ⊔ c	b ⊔ c
a	b	c

[1]In this book I don't aspire at solving the problem of the right formalization of definiteness. Nevertheless the logical form in b) raises a question (as correctly pointed out by J. Peregrin) of what happens when the cardinality of the extension of the predicate $|[\![BOY]\!]| \neq 1$. In that case according to the definition in b) the semantic calculation stops, a solution which is closer to Frege's presuppositional analysis of definite description than to Russell's.

In Link's semantics, a singular predicate like BOY denotes a set of singular individuals only, hence a set of atoms. Pluralization is a closure under sum: *BOY adds to the extension of BOY all the plural sums that can be formed from the elements of BOY, as formalized in (20). Besides the pluralization operator * (which is a theoretical tool for description of plural on nouns), let us assume the group-forming operation ↑, which is an operation that maps a sum onto an atomic (group) individual in its own right. Landman (2000)'s definition is shown in (21) and in the tables under I give mechanics for it to work. The group-forming operation packages pluralities into atoms. According to (21), ↑ operates in the domain of sums of individuals (assembled from individuals, henceforth called SUM-IND[2]), and its output belongs to the domain of groups (GROUP in (21)). The same process can be observed in the behavior of bunch denoting nouns like *team, committee* or *government.* Bunch nouns, despite their morphological singularity, denote plurality.[3]

(20) *BOY = d ∈ D: for some non-empty X ⊆ BOY: d = ⊔ X

(21) a. ↑ is one-one function from SUM into ATOM such that:
(i) ∀ d ∈ SUM-IND: ↑(d) ∈ GROUP
(ii) ∀d ∈ IND: ↑(d) = d
b. ↓ is function from ATOM onto SUM such that:
(i) ∀d ∈ SUM: ↓(↑(d)) = d
(ii) ∀d ∈ IND: ↓(d) = d

The framework is illustrated in two tables – (22) and (23), the first table (INDIVIDUAL) shows how sums are assembled from atoms, the second table (GROUP) demonstrates how group-atoms are closed under the sum operation too, the pluralization operation works in the same vein as in the INDIVIDUAL part, but this time it ranges over semantical opaque "impure" atoms to use Link's terminology.[4] The top row of both sub-domains represents kinds (more about that special ontological part of the universe later) which are basically taken as the maximal extension of a property (kind of dogs with three individuals would be their sum a ⊔ b ⊔ c). The second row (in the universe with three individuals) show sums of atoms and the bottom row is the level of atoms. Kinds of course belong to sums also but have the maximality distinguishing property unlike other sums.

[2]The domain SUM-IND contains only non-trivial = non-singular sums of individuals.

[3]The relationship of domains GROUP and IND is the following: both are domains of individuals but sortally different, GROUP domain is built from group-atoms and IND is built from singular atoms. GROUP atoms are not reducible to sums from the IND domain. The empirical motivation is the distinction between collective and distributive interpretation: the group agens of a collective interpretation of a sentence like *Three gangsters killed a president* is e.g. a group atom ↑ $(a \sqcup b \sqcup c)$, not a sum $a \sqcup b \sqcup c$). Thanks again to J. Peregrin for reminding me to explain the difference.

[4]In the table GROUP there are missing columns for (i) the group atom ↑ $(a \sqcup b \sqcup c)$ and (ii) all the sums resulting from the combination of this group atom with other group-atoms. The omission is dictated by the lack of space in the table.

(22)

	$a \sqcup b \sqcup c$		KIND
$a \sqcup b$	$a \sqcup c$	$b \sqcup c$	SUMS
a	b	c	ATOM
INDIVIDUAL			

(23)

	$\uparrow(a \sqcup b) \sqcup \uparrow(a \sqcup c) \sqcup \ldots$			KIND
$\uparrow(a \sqcup b) \sqcup \uparrow(a \sqcup c)$	$\uparrow(a \sqcup b) \sqcup \uparrow(b \sqcup c)$	$\uparrow(a \sqcup c) \sqcup \uparrow(b \sqcup c)$	...	SUMS
$\uparrow(a \sqcup b)$	$\uparrow(a \sqcup c)$	$\uparrow(b \sqcup c)$	...	ATOM
GROUP				

1.2.2 Maximalization of different NPs

In this section I will briefly discuss the relationship of LoP and pragmatics of implicatures. It is one of the established hypotheses of current formal semantics, that implicatures (like scalar implicatures connected to numerals) are cancelable unlike entailments and (at least some) presuppositions (see Portner (2005, 203) for a textbook overview). So the meaning of sentence like (24) comprises of at least two parts: asserted (semantical, entailed) and implicated (pragmatical) meaning. Both of them are paraphrased in (24-a) and (24-b). The asserted meaning is robust and cannot be changed without drastic revision of the whole discourse, implicatures on the other hand are defeasible and open to corrections. Both claims are again demonstrated below (the style of presentation follows Portner's textbook):

(24) I drank five beers.
- a. entailment: I drank at least five beers.
- b. implicature: I didn't drink six beers.
- a' ??I drank five beers, but I didn't drink four. (failed cancellation of entailment)
- b' I drank five beers and in fact I drank six. (cancellation of implicature)

The implicatures are derived Grice's Maxims and because speakers can obey different maxims, the implicatures are cancelable (see Grice (1989)).

How about LoP and implicatures? First notice that LoP delivers the basic meaning for sentences with numerical NPs without implicatures, so non-downward, non-upward entailing numerals are treated without maximalization and consequently their truth conditions are too weak. Sentence like (25) obtains logical form like (25-a) which claims that there was an event of leaving with a sum of three boys as its plural agent.

(25) Three boys left.
- a. $\exists e[LEFT(e) \wedge \exists x \in {}^*BOY \wedge Ag(e) = x \wedge |x| = 3]$

LoP is a neo-Davidsonian framework working with the explicit event variables (of type $\langle e \rangle$) and thematic roles (Agent, Patient, Theme, ... which are usually used in the shortcut form in the formulas) which are taken as functions from events to entities, see Appendix to the current chapter and Landman (2000) for details. Such sentence is compatible with four, five, six, ... boys leaving because in such a situation, there of course is an event of leaving with three boys as an agent. I will address this problem in the rest of the present section but let's look at another problem first.

It is a problem which faces any Davidsonian theory like Landman's LoP. It stems from the fact that existential closure over an implicit event variable (which is part of any Davidsonian theory) entails existence of something (event or set of some sort if the theory is translated into second-order logic). But downward entailing quantifiers are compatible with there being nothing. So e.g. (26) entails the existence of a leaving event, and there is no such entailment. There are at least two solutions of the problem: easy and hard solution. Easy solution follows the way of allowing null object into the semilattice denotation of thematic roles – see Landman (2004) for the implementation. The hard solution can be found in Landman (2000). As this issue of choosing between the two options will be not important in my investigations, I leave it aside and will tacitly assume the null object in the denotation of thematic roles.

(26) At most three boys left.
a.???$\exists e[LEFT(e) \wedge \exists x \in {}^{*}BOY \wedge |Ag(e)| \leq 3]$

But back to the problem with non-downward, non-upward entailing numerals, which will be important in the last chapter of the book where we will consider interpretation of negative manner and especially degree questions. (Landman, 2000, 231) discusses the issue and follows the established fact that implicatures are cancelable, so the maximality requirement shouldn't be part of the semantics proper. Landman's reasoning can be demonstrated by the following example. Imagine a scenario with departments competing for the most rigorous attitude to students – there is a threshold – if during examination period three professors reject ten students (cumulatively – for the definition of cumulativity see 1.2.3.1), the department is rigorous enough. In such a context you can say something like (27).

(27) Our department is rigorous. Three professors rejected ten students, in fact four professors rejected fifteen students at our department.

But for Landman the maximalization is local, not global as in the classical Grice's approach to implicatures. He builds his idea on examples like (28) which show that the global (Gricean) approach to implicatures results in an inadequate implicated meaning, especially if we take into account also sentences with numerical NPs in the scope of quantifiers like *every*. Gricean implicatures of (28) would mean (as shown in (28-a)), that there are some professors who didn't reject three students. (28) doesn't have such implicature which signals that the local approach to implicatures would be maybe more appropriate. In the next section we will see that quantifiers like *every* obligatory quantify-in over the event variable and if the implicatures are calculated at the event type, the local implicatures for (28) are (28-b) which seems to reflect our intuitions correctly.

(28) Every professor rejected three students.
  a. Grice (global) implicature: It is not true, that every professor rejected three students.
  = Some professors didn't reject three students.

b. Local implicature: for every professor x: x rejected not more then three students.

Landman (2000, 236) defines his maximality implicatures in form of the Implicature Construction Principle (ICP) – see (29). With respect to the local implicatures of numerical noun phrases, we apply the second point of ICP: in examples like (28) it delivers us the local negation of stronger alternatives on the scale.

(29) **Implicature Construction Principle**

1. The core of the *exactly*-implicature, triggered by a numerical noun phrase, is constructed at the event type that that noun phrase is in, relative to the scale constructed there.
2. From the core of the *exactly*-implicature, the actual implicature of the sentence asserted is built up, following the semantic composition of the sentence.
3. It becomes an implicature at the sentence level, unless, in the process of building up, there is a stage where the implicature built up at that stage is incompatible with or entailed by the semantic meaning built up at that stage.

But what is the most important point for the purposes of the current book is that the local approach to implicatures (coded via ICP) predicts that implicatures can be cancelled during the derivation of the sentence meaning (see point 3 of ICP). Consider a sentence like (30) where the numerical NP is in the scope of verbal negation. The schematic derivation of implicatures according to ICP is in (30-a-c). The most important part is (30-b) where negated entailed meaning contradicts the maximality implicature of numerical NP and because of that, the implicature vanishes. That again conforms the intuitions about meaning of sentences like (30), where I think nothing like the maximality implicature detected in the affirmative sentences arises. This finding will be crucial in the chapter about negative questions and also in the chapter about the interaction of scope between negation and other logical operators in the sentence.

(30) There weren't four boys at the party.

a. Local implicature (at the level of the event type):
meaning: There were four boys at the party.
implicature: There weren't more than four boys at the party.

b. we add negation scoping over event:
meaning: There weren't (at least) four boys at the party.
implicature: It is not the case that there weren't more than four boys at the party.
= There were more than four boys at the party.

c. the assertion is cancelled because it contradicts the meaning

1.2.3 Scopal and non-scopal NPs

Landman's theory treats non-quantificational noun phrases differently from the quantificational ones. In that respect it is again one of the theories which erode the uniform treatment of all types of NPs, as we know it from Generalized Quantifiers framework of Barwise and Cooper (1981). Beside the technical implementation of the cut between quantificational and non-quantificational NPs discussed below, the main empirical motivation for the non-uniformity is the empirical finding that genuine quantifiers like *every* or *no* are obligatory distributive, as witnessed by the ungrammaticality of sentences like (31) where the distributivity of the quantifier clashes with the collectivity semantics of the predicate.

(31) *Every student met in Prague.

Non-quantificational NPs like definites, indefinites, numeral headed NPs and proper names on the other hand are ambiguous between the distributivity and collectivity interpretation, consider sentence like (32): definites in (32-a), indefinites in (32-b), numerical noun phrases in (32-c) and proper names in (32-d) all allow both distributive and collective interpretation.

(32)
 a. The boy and the girl wrote the letter.
 b. A boy and a girl wrote the letter.
 c. Two boys and three girls wrote the letter.
 d. John and Mary wrote the letter.

Let's continue with the formal treatment of the non-quantificational/quantificational split. For Landman, non-quantificational NPs can shift their interpretation from the plural to the group freely. NPs like *John and Mary* and *three boys* have thus two interpretations: both non-quantificational NPs can be interpreted either as the set of properties that a sum of three boys (or the sum of John and Mary) have, or, alternatively, the NPs can be interpreted as the set of properties that a group of three boys (or group of John and Mary) has. The first interpretation is called sum interpretation and is responsible for the distributive reading of sentences containing such NPs; the second interpretation is called group interpretation and is the interpretation of the non-quantificational NPs in sentences with collective predicates. Unlike the non-quantificational NPs, quantifiers get their standard interpretation (as in (33)) and their standard interpretation is obligatory atomic, resulting in the obligatory distributive interpretation of the whole sentence.

(33) John and Mary
 a. $j \sqcup m$
 b. $\uparrow (j \sqcup m)$

(34) three boys
 a. $\lambda P.\exists x \in {}^*BOY : |x| = 3 \wedge P(x)$ (*sum*)
 The set of properties that a sum of three boys has.
 b. $\lambda P.\exists x \in {}^*BOY : |x| = 3 \wedge P(\uparrow (x))$ (*group*)

The set of properties that a set of three boys has.

Quantifiers get their standard interpretation, but in the process of composition with verb they must scope over the event variable. Negative noun phrases will eventually be interpreted as indefinites (because negation cannot scope over predicates in the full fledged LoP) but let us postpone that for a moment.

(35) every girl
a. $\lambda P.\forall x \in GIRL : P(x)$

(36) no girl
a. $\lambda P.\forall x \in GIRL : \neg P(x)$

In the next section I will show how LoP works on some model cases of sentences with plurality denoting NPs. For the full demonstration of the system see Landman (2000) and for the discussion how LoP can be fruitfully applied to various classes of Czech numerals see Dočekal (2012a).

1.2.3.1 Cumulativity, collectivity and distributivity

In LoP different types of NPs are more or less able to denote different plural meanings. But the indefinite numerical NPs are ceteris paribus able to denote all three types of meanings mentioned in the title of the current section. The literature on plurality unanimously distinguishes between the **distributive** and **collective** plurality interpretations. In some frameworks the distinction is further refined and the third reading called **cumulative** is established. Landman (2000) and Scha (1981) are proponents of the three way ambiguity, unlike Winter (2001) and Roberts (1987) who try to reduce the cumulative reading to the collective interpretation. I will show in further chapters that Czech negative noun phrases directly support the three way ambiguity. But before that let me demonstrate the three types of meanings along with their formalizations in LoP. Let's consider now nearly a classical type of sentence like (37) with the three logical forms in LoP formalizing the three readings. I will comment on each of them in the rest of the current section.

(37) Three boys kissed four girls.
a. cumulative:
$\exists e : {}^*KISS : \exists x \in {}^*BOY : |x| = 3 \wedge {}^*Ag(e) = x \wedge \exists y \in {}^*GIRL : |y| = 4 \wedge {}^*Th(e) = y$
b. distributive:
$\exists x \in {}^*BOY : |x| = 3 \wedge \forall a \in ATOM(x) : \exists y \in {}^*GIRL : |y| = 4 \wedge \forall b \in ATOM(y) : \exists e \in KISS : Ag(e) = a \wedge Th(e) = b$
c. collective:
$\exists e \in KISS : \exists x \in {}^*BOY : |x| = 3 \wedge Ag(e) =\uparrow (x) \wedge \exists y \in {}^*GIRL : |y| = 4 \wedge Th(e) =\uparrow (y)$

Let's first focus on (37-a) – **cumulative reading** – which in LoP can be paraphrased

```
a  ----- 1, 2

b  ----- 2, 4

c  ----- 3
```

as: there is a sum of kissing events that has a sum of three boys as plural agent and a sum of four girls as plural theme. The logical form (37-a) predicts that the reading should be the most natural and salient among the other readings when we consider such sentence out of the blue. The cumulative (scopeless) reading is basic reading of such sentences because no operator and no additional rule (quantifying-in and etc) is applied. One of the situations which would make such reading true is depicted below. By small letters a, b, c I symbolise different boys (one boy per each letter), by the numerals I symbolise different girls. As we see, this is scopeless reading in the sense that it's not true that for each boy there were four girls and also for no girl there were no three boys kissing her. The event is pluralized (as formalized by the * operator over event variable) and both Agent and Theme theta roles are pluralized as well. Although the number of kissing events isn't constrained as far as there were three boys and four girls involved in the pluralized event.

(37-b) is the **distributive reading** which in LoP arises due to scoping the object, then scoping the subject over it. And we can paraphrase the reading as: there are three boys such that for each boy there are four girls such that the boy kisses each of those four girls. This is the totally distributive reading in the sense that both numerical NPs are scoped over the event variable and they are scopally dependent with respect to each other – in this interpretation the subject scopes over the object. The reading is depicted below

```
a  ----- 1, 2, 3, 4

b  ----- 5, 6, 7, 8

c  ----- 9, 10, 11, 12
```

Last type of the reading is the (37-c) – **collective reading** – which can be paraphrased as: there is an event of a group of three boys kissing a group of four girls. This is again scopeless reading but this time the event isn't pluralized, its atomic arguments are two groups of three boys and four girls. One of the situations making such formulas true is depicted below. It's a bit hard to imagine a situation which would satisfy the truth conditions of (37-c) with the predicate like *kiss*. Maybe something like a scenario where a group kissing event of seven teenagers is taking place in a car would fit best.

```
(a+b+c) ----- (1+2+3+4)
```

So there are three basic types of readings for indefinite noun phrases (and numerical NPs as one of the major representatives of indefinites). Besides the three readings, we can also think (for the two NPs containing sentences) of their possible combinations: Landman (2000) distinguishes eight such readings. I will offer some arguments for distinguishing collectivity and cumulativity in later chapters, but let's demonstrate the distinction in further example. Recall that in LoP cumulativity isn't a kind of collectivity, it is a distributive reading without scoping the arguments. (38) sounds weird because its subject argument cannot be easily interpreted collectively (*give birth* is very distributive). But if cumulativity was a subcase of collectivity, then the sentence should be OK, because it would describe a scenario where a group of fifteen women gave birth to a group of seven children – this would make sense if we include into the group of women also nurses, women doctors, ... where the whole group would be responsible for giving birth to seven children. But even though I think (38) could be read in such a context, it's a bit weird, anyway. And that seems to show that the cumulative reading (being basic) here leads to the strange flavour of the most salient interpretation.

(38) ?Fifteen women gave birth to only seven children

The last remark in this section concerns the obligatory distributive interpretation of quantifiers. They are obligatory distributive with respect to the rest of their formula which doesn't mean that some other plurality NPs in the formula cannot be interpreted collectively or cumulatively. Such mixed reading can be one of the interpretations of (39) (and I assume it's the most salient interpretation). So because **quantifiers** like *every boy* are able to have only the distributive reading, depending on the interpretation of object argument, one of the situation verifying (39) is depicted below the formula.

(39) Every boy kissed four girls.
   a. $\forall x \in BOY : \exists e \in {}^*KISS : Ag(e) = x \wedge \exists y \in {}^*GIRL : |y| = 4 \wedge {}^*Th(e) = y$

```
a  ----- 1, 2, 3, 4

b  ----- 3, 4, 5, 6

c  ----- 5, 6, 7, 8
```

1.2.4 Negation in LoP

One of the reasons why I adopted LoP is that the scope of negation in LoP (like in any neo-Davidsonian theory – see e.g. Schein (1993)) is fixed. Negation must outscope the event variable, otherwise the sentences with negation would have tautological truth conditions. This can be seen in (40-b), the logical form for sentence like (40-a) which would arise if we allow negation to scope freely in LoP. The logical form in (40-b) describes a situation in which there is a walking event which doesn't have a girl as the agent, since this is most likely true in any situation, the result is a tautology. But of course (40-a) doesn't have tautological interpretation in natural language at all (compare it with prima facie tautologies like *Girls are girls. Either you sleep or you don't sleep, ...* This problem does not arise only if negation has wide scope, as in (40-c). This reading is scopeless (with respect to the interpretation of negative NP) which contradicts the empiry of English but let's ignore that aspect for now.

(40) a. No girl walked.
b. $\exists e[^{*}WALK(e) \wedge \neg\exists x[^{*}GIRL(x) \wedge^{*} Ag(e) = x]]$
c. $\neg\exists e[^{*}WALK(e) \wedge \exists x[^{*}GIRL(x) \wedge^{*} Ag(e) = x]]$

Let me conclude this section with a short comparison of LoP with predicate logic, the comparison with respect to how each of the theories handles negation. LoP is more restrictive as to the position of negation and also is different in the way it formalizes ambiguities of NPs and negation. In predicate logic the ambiguities of negation and NPs are formalized as various scopes of negation: the negation can scope either over the whole formula – the usual $\langle t, t\rangle$ type, or over a predicate – type-shifted variant of negation with the $\langle\langle d, t\rangle, \langle d, t\rangle\rangle$ type. In LoP it is the NP which scopes above or below the negation which remains before the existential closure of the event variable. Compare the different logical forms for an ambiguous sentence like (41).

(41) All students didn't come.
a. predicate logic:
(i) $\forall x[STUDENT(x) \rightarrow \neg COME(x)]$
(ii) $\neg\forall x[STUDENT(x) \rightarrow COME(x)]$
b. LoP:
(i) $\forall x \in STUDENT \rightarrow \neg\exists e[COME(e) \wedge Ag(e) = x]$
(ii) $\neg\exists e[COME(e) \wedge [\forall x \in STUDENT \rightarrow Ag(e) = x]]$

Note that both (i) readings in predicate logic and in LoP are the 'empty room' meanings, while (ii) – again in both frameworks – represent the everything between empty room and 99% of coming students scenario. The relative scopes in both frameworks are the same: $\forall > \neg$ means the empty room for sentences like (41) if you quantify over individuals as arguments of a predicate (as in predicate logic) or over events like in LoP. And similarly $\neg > \forall$ would be true/false in the same situations, irrespective of the framework.

1.2.4.1 Verbal negation

Now when we settled the issue of formal properties of negation in LoP, let's focus on how the natural language negation fits into the framework. Landman's answer is: auxiliary negation must take scope over the event type, while it syntactically is located on verb (V or T), its semantics is that of a sentence operator of type $\langle t, t\rangle$. That means that he dissociates the scope of the natural language negation in syntax and semantics. In other words, even if the verbal negation is outscoped by subject and some adverbials (in the syntactic structure of English), its semantic scope is different. This style of interpreting natural language negation is independently postulated in syntactico-semantic theories of negation and negative concord by Penka (2007) and Zeijlstra (2004). But even though

I don't want to compare the mentioned theories with LoP, one thing is pretty clear: Landman's motivation for treating natural language negation in this dissociation manner is different from the Penka/Zeijlstra reasoning. It follows from two independent sources: first source is the neo-Davidsonian framework which forces the scope of negation to be over the event variable despite its syntactic realization in the scope of subject NP. The second one is the maximal simplicity of negation – such solution can have negation with the only type $\langle t, t\rangle$, instead of multiple types for negation like in predicate logic or in type shifting theories like Partee (1987).

Technical implementation of the idea is then executed as follows: as the negation is of the $\langle t, t\rangle$ type, when it merges with verb (or auxiliary verb as in English), the local type mismatches (in case of verb: $\langle d, \langle e, t\rangle\rangle$). That leads to the type-driven scope mechanism which consists of a type-driven storage mechanism. The stored element is carried along in the derivation in a store and there is a type-driven retrieval mechanism:

(42) **Auxiliary negation** *niet (not)* $\rightarrow \neg$ of type $\langle t, t\rangle$

(43) **Storage of negation by type mismatch**: Negation gets stored if there is a type mismatch with its complement.

(44) **Retrieval of negation by type matching**: Negation gets retrieved from store **as soon as** the input type matches.

Little illustration of the system: consider a sentence like (45), where we negate a sentence containing manner adverbial *slowly.* LoP correctly predicts that the logical form for such a sentence should be (45-a) where negation outscopes the whole formula and consequently even the adverb. This has a welcome prediction that something like (45-b), as a logical form for (45), is impossible. (45-b) corresponds to the reversal of scope between negation and the adverbial – it would be true in a situation where Peter was an agent of some slow event which wasn't the event of walking, e.g. it was an event of swimming or driving a car. It's hard to judge only from intuition whether (45) has such a reading but at least for me this doesn't seem to be the case.[5]

(45) Peter didn't walk slowly.
a. $\neg\exists e[WALK(e) \wedge Ag(e) = p \wedge SLOW(e)]$
b. $*\exists e[\neg WALK(e) \wedge Ag(e) = p \wedge SLOW(e)]$

Note that in predicate logic nothing prevents both scopes and if we treat *slowly* as a predicate taking adjunct (probably the easiest and close to the empiry option), it's even surprising that negation should take wide scope with respect to the adverbial. Predicate logic formalizations of both scopes (if we would enrich predicate logic with type of events and use the second-order calculus) would be as in (46-a) and (46-b). This contrasts with the restrictiveness of LoP: in LoP manner adverbials must modify the event type, the negation on the other hand scopes over the existential closure of the event type, so (45-b)

[5]In predicate logic it would be possible (if the negation would be not only of the $\langle t, t\rangle$ type) to negate just predicate of events $SLOW$ but because LoP doesn't have such a logical type for negation, (45-a) and (45-b) are the only two possible readings of (45).

isn't an option unlike in predicate logic.

(46) a. $\neg SLOWLY(WALK(p))$
b. $SLOWLY(\neg WALK(p))$

LoP, as I use it here, predicts that generally all adverbs should scope under negation. This is a wrong prediction though, as Landman (2000) acknowledges and is invalid at least for subject/object oriented adverbials and also for speaker oriented adverbials. Consider (47) and subject oriented adverb in (47-a) and speaker oriented adverb in (47-b). While (47-a) is ambiguous, (47-b) is I think only interpretable with the wide scope of the adverbial. This shows that some adverbials can scope even over the negation and some of them must scope over the negation, unlike manner adverbials.

(47) a. Peter deliberately didn't kiss Jane.
b. Peter surprisingly didn't kiss Jane.

Landman (2000, 306) proposes a solution which relies on quantifying-in into scopal properties. In a nutshell he claims that subject oriented adverbials modify states which correspond to the events type shifted into states. So sentence like (47-a) would have logical form like (48) which we can paraphrase as: what Peter was deliberately about is his having the property/state of not kissing Jane. Because of this event to state type shifting possibility in LoP also the obligatory wide scope of negation with respect to manner adverbials weakens – I think we can interpret it as the default strategy: ceteris paribus (if linearity, focus, . . . doesn't say otherwise) negation scopes over the adverbial. But there is always the option of switching the events into states and then negation can be in the scope of adverbials e.g.

(48) $\exists s \in [\alpha] : A_1(s) = p \wedge DELIBERATE(p, s, C)$
where $\alpha = \lambda x.x \in AT \wedge \neg\exists e \in KISS : Ag(e) = x \wedge Th(e) = j$

1.2.5 Quantifiers and negation

Let's repeat: the scope of negation in LoP is fixed, ambiguities arise because of various scopes of NPs/adverbials. But because various types of NPs do have different treatment in LoP, scoping possibilities of various quantifiers depend on their type. So let's focus on different types of NPs, their predicted behaviour and let's see whether the theory and the empiry meet.

First, let's consider **indefinites**: indefinites in LoP can be interpreted with wide or narrow scope (corresponding to their sum/group status). That seems to work well – wide scope of the indefinite corresponds to a specific interpretation (there is a pipe which John didn't smoke), the narrow scope corresponds to a non-specific reading (John can be non-smoker in this scenario e.g.).

(49) John didn't smoke a pipe.
a. $\exists x[PIPE(x) \wedge \neg\exists e[SMOKE(e) \wedge Ag(e) = John \wedge Th(e) = x]]$

b. $\neg\exists e[SMOKE(e) \wedge Ag(e) = John \wedge PIPE(Th(e))]]$

Second class of NPs I consider in this section are unambiguous **quantifiers**. Recall that they must scope over the event variable, which results in their obligatory distributive interpretation. I think this prediction isn't totally right, at least for English *every* it seems that both scopes are available. But for *each* the prediction seems to be correct.[6] So while (50) can both have logical form (50-a) and (50-b), where the former represents the quantifying-in of the universal quantifier over negation (as expected) and the later represents the universal quantifier in situ (unexpected), (51) seems to have only the reading where *each* scopes over the negation leading to the obligatory wide scope interpretation of the quantifier.

(50) Every boy didn't come.

a. $\exists x[\sqcup(BOY(x)) \wedge \forall a \in ATOM(x) : \neg\exists e[COME(e) \wedge Ag(e) = a]]$

b. $?\neg\exists e[COME(e) \wedge Ag(e) =\uparrow (\sqcup(BOY(x)))]]$

(51) Each boy didn't come.

a. $*\neg > \forall$

b. $\forall > \neg$

It seems that obligatorily distributive quantifiers like *each* really scope only over negation but for *every* this isn't so clear. One of the options how to handle this problem in LoP is to weaken the obligatory distributive treatment of the quantifier *every*. This seems to be correct, because at least in object positions it's not hard to find examples of *every NP* being interpreted collectively, see (52), where the adverb *slowly* modifies the maximal event of the destruction of all shops in the neighborhood, so the object NP must be interpreted collectively, as in the LoP formalization in (52-a)

(52) TESCO slowly destroyed every shop in our neighborhood.

a. $\exists e[DESTROY(e) \wedge SLOW(e) \wedge Ag(e) = TESCO \wedge \exists x \in {}^*SHOP \wedge Th(e) =\uparrow (\sqcup(x))]$

1.3 Summary

This chapter provided the introduction into Language of plurality – the tool which I will use most often in the following chapters where I will look at particular problems concerning negation in different environments of Czech. The formal face of LoP is shown in the section 1.4, Appendix to the current chapter, and it literally follows the definitions from Landman (2000, 179-183).

[6]Thanks to Louise McNally (p.c.) for helping me to sort the data.

1.4 Appendix

1.4.1 The Language of Events and Plurality

1.4.2 Syntax of the Language of Events and Plurality

TYPES:
TYPE is the smallest set such that:

1. d,pow(d),e,pow(e),n,t $\in$ TYPE
2. if a, b $\in$ TYPE then <a,b> $\in$ TYPE

- d is the type of individuals, pow(d) of sets of individuals
- e is the type of events, pow(e) of sets of events
- n is the type of numbers
- t is the type of truth values
- <a,b> is the type of functions from a-entities into b-entities

EXPRESSIONS:
We start by specifying the special constants:
Constants
We have the following kinds of constants:

CONd: j, m, ...	individual constants
CONpow(d): BOY, GIRL, ...	nominal constants
INDd, GROUPd, SUMd, D	sortal constants
CONpow(e): WALK, KISS, ...	verbal constants
ATOMe, E	sortal constants
CONn: 0, 1, 2, ...	numeral constants
CON<e,d>: Ag, Th, ...	thematic constants

Variables: we have a countable set of variables VARa for every type a.
EXPa, the set of expressions of type a, is the smallest set such that:
EXPa:

1. **Constants and variables**:
   CONa $\cup$ VARa $\subseteq$ EXPa
2. **Functional abstraction**:
   If x $\in$ VARa and $\beta \in$ b then $\lambda x.\beta \in \langle a, b\rangle$

3. **Functional application**:
   If $\alpha \in \langle a, b\rangle$ and $\beta \in a$ then $(\alpha(\beta)) \in b$

4. **Connectives**:
   If $\phi, \psi \in t$ then $\neg\phi, (\phi \wedge \psi), (\phi \vee \psi) \in t$

5. **Identity, inequaility**:
   If $\alpha, \beta \in d$ then $(\alpha = \beta) \in t$
   If $\alpha, \beta \in e$ then $(\alpha = \beta) \in t$
   If $\alpha, \beta \in n$ then $(\alpha = \beta), (\alpha < \beta) \in t$

6. **Set formation**:
   If $x \in$ VARd and P $\in$ pow(d) and $\phi \in t$ then $\{x \in P : \phi\} \in pow(d)$
   If $x \in$ VARe and P $\in$ pow(e) and $\phi \in t$ then $\{x \in P : \phi\} \in pow(e)$

   With this we can introduce other sortal expressions like:
   SUMd - INDd, ATOMd = INDd $\cup$ GROUPd
   I will usually drop the type indices.

7. **Set application**:
   If $\alpha \in d$ and P $\in$ pow(d) then $(\alpha \in P) \in$ t
   If $\alpha \in e$ and P $\in$ pow(e) then $(\alpha \in P) \in$ t

8. **Quantification**:
   If x $\in$ VARd and P $\in$ pow(d) and $\phi \in t$ then $\forall x \in P : \phi, \exists x \in P : \phi \in t$
   If x $\in$ VARe and P $\in$ pow(e) and $\phi \in t$ then $\forall x \in P : \phi, \exists x \in P : \phi \in t$

9. **Plurality**:
   Part-of and sums:
   If $\alpha, \beta \in d$ then $(\alpha \sqsubseteq \beta) \in$ t
   If $\alpha, \beta \in e$ then $(\alpha \sqsubseteq \beta) \in$ t

10. If $\alpha, \beta \in d$ then $(\alpha \sqcup \beta) \in$ d
    If $\alpha, \beta \in e$ then $(\alpha \sqcup \beta) \in$ e

11. If P $\in$ pow(d) then $\sqcup(P) \in d$
    If P $\in$ pow(e) then $\sqcup(P) \in e$

12. If P $\in$ pow(d) the $\sigma(P) \in d$

13. **Groups**:
    If $\alpha \in d$ then $\uparrow \alpha, \downarrow \alpha \in d$

14. **Atoms and cardinality**:
    If $\alpha \in d$ then AT(α)$\in$ pow(d)
    If $\alpha \in e$ then AT(α)$\in$ pow(e)

15. If $\alpha \in d$ then $|\alpha| \in n$

16. **Singularization and pluralization**:
    If P $\in$ pow(d) then AT(P), *P $\in$ pow(d)
    If P $\in$ pow(e) then AT(P), *P $\in$ pow(e)

17. **Plural roles**:
    If R $\in \langle e, d\rangle$ then *R $\in \langle e, d\rangle$

(12), (13) and (15) do not have a corresponding event clause. These could of course be introduced, but at the moment we will have no need of them.

1.4.3 Semantics of the Language of Events and Plurality

MODELS:
A **model for the language of events and plurality** is a tuple
M=$< \mathbf{D}, \mathbf{E}, \mathbf{N}, R, \perp, i >$
where:

1. **D** is a domain $< D, \sqcup, ATOMd, INDd, GROUPd, \uparrow, \downarrow>$ of singular and plural individuals with groups. D is the domain of individuals.

2. **E** is a domain of $< E, \sqcup, ATOMe >$ of singular and plural individuals. E is the domain of events.

3. **N** is $< N, <>$, the set of natural numbers with the standard order $<$.

4. These domains don't overlap and $\perp$, the undefined object, is an object not in D, E or N.

5. i, the interpretation function, is a function from CONa into Da.

Domains based on model M:

- $Dd = D \cup \{\perp\}$
- $De = E \cup \{\perp\}$
- $Dn = N$
- $Dt = \{0, 1\}$
- $Dpow(d) = pow(D)$
- $Dpow(e) = pow(E)$
- $D < a, b >= (Da \rightarrow Db$, the set of all functions from Da into Db.

6. R, the set of thematic roles, is a subset of $D < e, d >$ (see below).

Constraints on interpretation function i:
Sortal constants:

- $i(INDd) = INDd$
- $i(GROUPd) = GROUPd$
- $i(D) = D$
- $i(SUMd) = [INDd]$, the i-join semilattice generated by IND.
- $i(ATOMe) = ATOMe$
- $i(E) = E$

Numerals:

- $i(n) = n$

Next we will be concerned with constraints on nominal constants, verbal constants and role constants. These constraints capture the assumptions about plurality and thematic role that I have discussed in the previous lectures:

Nominal and verbal constants are sets of atoms:

- Nominal constants: if $c \in CONpow(d)$ then $i(c) \subseteq ATOMd$
- Verbal constants: if $c \in CONpow(e)$ then $i(c) \subseteq ATOMe$

Finally, we constrain thematic role constants. Roles, thematic or non-thematic, are functions from $E \cup \{\perp\}$ into $D \cup \{\perp\}$, partial functions from events into individuals. Hence, I assume that **all** roles satisfy the Unique Role requirement:

Unique Role Requirement:
Thematic and non-thematic roles are partial functions from events into individuals.

We have sums both in the verbal domain (sums of events) and in the nominal domain (sums of individuals). In both domains, sums indicate plurality. I will assume that roles taking plural events as argument or plural individuals as value are **non-thematic**.

R is the set of thematic roles. I assume that **thematic** roles are only defined for **atomic events**, not for sum events. And I assume that **thematic** roles take only **atoms**, individuals or groups, as value, not sums. This is summarized as the Thematic Role Requirement:

Thematic Role Requirement:
if ROLE $\in$ R then:

1. If e $\notin$ ATOMe then ROLE(e)$=\perp$
2. if e $\in$ ATOMe and ROLE(e)$\neq\perp$ then ROLE(e) $\in$ ATOMd

Finally, thematic role constants are interpreted as thematic roles:

Thematic role constants:
if ROLE $\in$ CON$< e, d >$ then i(ROLE) $\in$ R

This completes the constraints on the interpretation function.
Assignment functions are functions from VARa into Da, and g[x:d] is, as usual, the assignment at most differing from g in assigning d to variable x.

SEMANTICS:
We define $[\![\alpha]\!]$M,g, the interpretation of α in M relative to g.

1. **Constants and variables**:
   If c $\in$ CONa then $[\![c]\!]$M,g $=$ i(c)
   If x $\in$ VARa then $[\![x]\!]$M,g $=$ g(x)
2. **Functional abstraction**:
   $[\![\lambda x_a.\beta]\!]M,g=\lambda d \in Da.[\![\beta]\!]M, g[x_a : d]$
3. **Functional application**:
   $[\![(\alpha(\beta))]\!]M, g = [\![\alpha]\!]M, g([\![\beta]\!]M, g)$
4. **Connectives**:
   $[\![\neg\phi]\!]M, g = 1$ iff $[\![\phi]\!]M, g = 0$; 0 otherwise.
   $[\![\phi \wedge \psi]\!]M, g = 1$ iff $[\![\phi]\!]$M,g $=$1 and $[\![\psi]\!]M, g = 1$; 0 otherwise
   $[\![\phi \vee \psi]\!]M, g = 1$ iff $[\![\phi]\!]$M,g $=$1 or $[\![\psi]\!]M, g = 1$; 0 otherwise
5. **Identity and inequality**:
   $[\![\alpha = \beta]\!]M, g$ iff $[\![\alpha]\!]M, g = [\![\beta]\!]M, g$ and $[\![\alpha]\!]M, g, [\![\beta]\!]M, g \neq\perp$; 0 otherwise
   $\alpha < \beta M, g$ $=$ 1 iff $[\![\alpha]\!]$ $<$ $[\![\beta]\!]$, 0 otherwise
6. **Set formation**:
   $[\![\{x \in P : \phi\}]\!]M, g = \{d \in [\![P]\!]M, g : [\![\phi]\!]M, g[x : d] = 1\}$
7. **Set application:**
   $[\![\alpha \in P]\!]M, g = 1$ iff $[\![\alpha]\!]M, g \in [\![P]\!]M, g$; 0 otherwise
8. **Quantification**:
   $[\![\forall x \in P : \phi]\!]M, g = 1$ iff for every $d \in [\![P]\!]M, g : [\![\phi]\!]M, g[x : d] = 1$; 0 otherwise
   $[\![\exists x \in P : \phi]\!]M, g = 1$ iff for some $d \in [\![P]\!]M, g : [\![\phi]\!]M, g[x : d] = 1$; 0 otherwise

Plurality:
Part of and sums:

9. $[\![\alpha \sqsubseteq \beta]\!] M, g = 1$ iff $[\![\alpha]\!] M, g \sqsubseteq [\![\beta]\!] M, g$; 0 otherwise

10. $[\![\alpha \sqcup \beta]\!] M, g = [\![\alpha]\!] M, g \sqcup [\![\beta]\!] M, g$ if $[\![\alpha]\!] M, g \neq \perp, [\![\beta]\!] M, g \neq \perp$; $\perp$ otherwise

11. $[\![\mathtt{u}(P)]\!] M, g = \mathtt{u}([\![P]\!] M, g)$ if $[\![P]\!] M, g \neq \emptyset$; $\perp$ otherwise

12. $[\![\sigma(P)]\!] M, g = \mathtt{u}([\![P]\!] M, g)$ if $\mathtt{u}([\![P]\!] M, g) \in [\![P]\!] M, g$; $\perp$ otherwise

Groups

13. $[\![\uparrow \alpha]\!] M, g = \uparrow ([\![\alpha]\!] M, g)$ if $[\![\alpha]\!] M, g \in SUM$; $\perp$ otherwise
$[\![\downarrow \alpha]\!] M, g = \downarrow ([\![\alpha]\!] M, g)$ if $[\![\alpha]\!] M, g \in ATOM$; $\perp$ otherwise

Atoms and cardinality:
Let $\alpha \in d$ or $\alpha \in e$:

14. $[\![AT(\alpha)]\!] M, g = AT([\![\alpha]\!] M, g)$ if $[\![\alpha]\!] M, g \neq \perp$; $\emptyset$ otherwise
Where AT(x)=$\{a \in ATOM : a \sqsubseteq x\}$

15. $[\![|\alpha|]\!] M, g = |[\![AT(\alpha)]\!] M, g|$

Singularization and pluralization:

16. $[\![AT(P)]\!] M, g = AT([\![P]\!] M, g)$ where $AT(X) = ATOM \cap X$
$[\![{}^*P]\!] M, g = [[\![P]\!] M, g]$ where [X] is the i-join semilattice generated by X (and [X]=$\emptyset$ if X = $\emptyset$).

All this is completely as before. The new part comes with the plural roles:
Plural roles

17. $[\![{}^*R]\!] M, g = \lambda e. \begin{cases} \sqcup(\{[\![R]\!] M, g(a) : a \in AT(e)\}) \text{ if } \forall a \in AT(e) : [\![R]\!] M, g(a) \neq \perp \\ \perp \; otherwise \end{cases}$

If e is an event in E, and for every atomic part a of e, **thematic role** R is defined for a, then **plural role** ${}^*R$ is defined for e, and maps e onto the sum of the R-values of the atomic parts of e.

If thematic role R is not defined for every atomic part of e, then ${}^*R$ is not defined for e, and ${}^*R$ maps e onto $\perp$.

2 The nature of negative noun phrases

2.1 Introduction

The goal of this chapter is to argue that in contrast to n-words in English, Czech n-words are not quantifiers but they should be analyzed as indefinites in the scope of sentential negation. One of the most reliable diagnostics for determination of quantifier status in natural language expression is the ability to appear in so called predicative position. In contrast to APs and PPs only some nominals may appear in the predicative position; quantifiers are generally banned from this position (for one of the early formulation of this constraint see Doron (1983)) as is exemplified in (1) and (2):

(1) John is $[_{AP}$ tall$]/[_{PP}$ in the room$]/[_{NP}$ a teacher$]$

(2) a. *John is every member of the club.
b. *John is each man.
c. *John and Mary are most students.
d. *John is exactly one teacher.

This ban on quantifiers in predicative positions can be explained quite easily if we assume classical Montague typing of quantifiers and proper names: quantifiers are of the $\langle\langle d,t\rangle,t\rangle$ type and proper names are also of the same type (proper names denote principal ultrafilters, sets of properties which a given individual has). We cannot combine these two types $\langle\langle d,t\rangle,t\rangle$ X $\langle\langle d,t\rangle,t\rangle$ by functional application as neither of them can be a function or an argument of the other type.

What is crucial for my argumentation is that we can use the predicative position as a test for whether something is a quantifier. Interestingly, there are exceptions to this generalization. Notably, *no*-NP ('n-words') may be predicative as in (3).

(3) John is no friend of mine.

According to Partee (1987) quantifiers can appear in predicative position if reanalyzed as involving lowering of the standard generalized quantifier (e.g. *no friend of mine* $\rightarrow$ set of entities disjoint from the set of my friends). The type-lowering operation is realized by the type-shifting operator BE: $\langle\langle d,t\rangle,t\rangle \rightarrow \langle d,t\rangle$.

(4) BE$[\alpha]$=$\lambda y.\alpha(\lambda x.x = y)$ $\quad (= \lambda y.\alpha(\{y\}))$

Consequently, the shifted quantifier can appear as a predicative NP. The meaning of (3) in Partee's system is that John doesn't have the property BE_FRIEND_OF_MINE among the set of his properties, which seems to fit.

(5) John is no friend of mine.

What I want to show is that this type shifting solution gives wrong predictions and we will get better results if we assume that (at least for Czech and probably generally Slavic) n-words are not quantifiers but their semantic type is predicative ($\langle d, t \rangle$ type).

This chapter is organized as follows. Sections 2.2 to 2.5 outline the basic assumptions concerning type shifting mechanisms, choice functions and the syntactic structures corresponding to the different semantic types. Sections 2.6, 2.7 and 2.8 discuss predictions made by the introduced assumption for the analysis of different phenomena, including n-words in the predicative and argument positions, the collective interpretation of n-words and their semantics in the scope of intensional predicates. In section 2.9 I discuss some open questions. Finally, the section 2.10 offers a review of the arguments presented in the paper.

2.2 The puzzle

As it stands, Partee's proposal makes some incorrect predictions. Mainly, as it is clear from the data, only some quantifiers can appear in predicative position but the proposal predicts that BE could apply to *any* quantifier. Partee herself acknowledges this problem and proposes a remedy in terms of pragmatic restrictions on type-shifting. For a general critique of her account see Winter (2001) and the next section. As we will see, however, Partee's solution cannot account for data from negative-concord languages. Crucially, the original type shifting strategy overlooks the fact that quantifiers banned from the predicate position cannot have a collective interpretation and an opaque reading under intensional predicates (among other things). Czech n-words (as well as English negative quantifiers as in (3)) are grammatical as predicate nominals:

(6) *Petr není žádný můj student.*
Petr not-AUX no my student
'Petr is no student of mine.'

But (at least in Czech and at least not in English, although the distinction probably holds between Slavic and Germanic languages generally) they can have a collective interpretation:

(7) a. *Žádní mí studenti nejsou dobrá parta.*
no my students not-AUX good team
'#No students of mine are good team.'
b. *No students are a good team.

A de dicto reading in the scope of an intensional verb is grammatical for them which holds for both Germanic – (8-b) from Landman (2004) – and Slavic – (8-a) and (9) from

Błasczak (2001, p. 224) – languages.

(8) a. *Petr nehledá žádné jednorožce.*
Petr not-seeks no unicorns
'Petr is seeking no unicorn.'
b. *Dafna zoekt geen griffioens.*
Dafna seeks no griffins.
'Dafna doesn't seek any griffins.'

(9) *Janek nie szuka żadnego jednorożca.*
Janek NEG seek-3.SG.PRES no-ACC unicorn-ACC
'Janek does not seek any unicorns.'

Moreover Slavic n-words in the scope of intensional verbs allow only de dicto readings but Germanic languages allow both de dicto and the de re readings. I will show more about this prediction in next sections. Beside that, uncontroversial quantifiers like *ani jeden student* 'not a single student', despite having the same truth-conditional import, contrast with n-words in the way they behave in the mentioned contexts (no collective reading, ungrammatical in predicative position and only the de re reading in intensional contexts).

(10) *Petr není ani jeden můj student.
'*Petr is not a single student of mine.'

(11) *Petr nehledá ani jednoho jednorožce.*
Petr not-seeks not one unicorn
'Petr is seeking not a single unicorn.'

This shows that there are systematic differences between n-words and quantifiers in Slavic languages (more differences than in Germanic languages) and moreover that the difference between n-words and quantifiers cannot stem from semantics only, as clear from the minimal contrast between quantifier *ani jeden student* and negative noun phrase *žádný student.* In the section 2.3 and 2.4 I will introduce some generally shared assumptions about types of different noun phrases first and then present two frameworks formalizing the type-shifting machinery.

2.3 Type shifting

The canonical view on the syntax and semantics of NPs can be summarized as follows: NPs denote properties (they are semantically of $\langle d, t\rangle$ type) type and as such cannot be straight arguments of predicates. On the other hand they can pretty well stand in the predicative position and as set denoting expressions can be used to assign some property to the argument in subject position:[1]

[1]English example in (12-b) is a bit misleading because better would be an example from a language where in predicative position it's possible to use bare NP, e.g. Spanish sentence *Es profesor de griego* 'He is professor of Greek' would be a better illustration. Thanks to J. Peregrin for drawing

(12) a. *[$_{\text{NP}}$ Dog] was sleeping.
b. Fido is [$_{\text{NP}}$ a dog].

DPs denote generalized quantifiers (they are semantically of $\langle d\rangle$or $\langle\langle d,t\rangle,t\rangle$type. Because of that they can be of course arguments but they usually aren't well in predicative positions:

(13) a. [$_{\text{DP}}$ Every dog] was sleeping.
b. *Fido is [$_{\text{DP}}$ every dog].

In languages like Czech where the distinction between NP and DP isn't morphosyntactically coded by determiners, it's not so easy to say when some phrase is really NP or DP if no determiner is a part of it. I will have more to say about that later but for now let's assume that indisputable quantifiers are usually ungrammatical in predicative positions and grammatical in argumental ones:

(14) a. *[$_{\text{DP}}$Každý pes] spal. (=(13-a))*
Every dog slept
'Every dog was sleeping'
b. **Fido je [$_{\text{DP}}$každý pes]. (=(13-b))*
Fido AUX every dog
'Fido is every dog.'

Usual picture which connects syntax and semantics (see Longobardi (1994, 1996)) follows an intuition that somehow nouns need determiners to be made into arguments. For determinerless language like Czech that means that syntactic structure of bare NPs depends on their function in sentence. If they are arguments then their phrasal status must be DP and we must postulate some silent determiner turning denotation of $< d,t >$ type into the right argumental type (either $\langle d\rangle$ or $\langle\langle d,t\rangle,t\rangle$ type). If they are in predicative position then their type can remain basic $\langle d,t\rangle$.

(15) a. [$_{\text{DP}}$ Pes] spal. pes … $\langle\langle e,t\rangle,t\rangle$
'The dog was sleeping.'
b. Fido je [$_{\text{NP}}$ pes]. pes… $\langle e,t\rangle$
'Fido is a dog.'

We can propose that bare NPs in languages like Czech are ambiguous with respect to definiteness/indefiniteness also. The hypothesis would be then that bare NP like *pes* is three ways ambiguous:

(16) $\|pes\|=$
a. DOG(x)… predicate of $\langle d,t\rangle$ type
b. $\lambda P\exists x[DOG(x)\wedge P(x)]$… indefinite NP, quantifier of the $\langle\langle d,t\rangle,t\rangle$ type
c. $\sigma DOG(x)$ … definite NP of the $\langle d\rangle$ type;

my attention to this point.

2.4 Two Theories of Type Shifting between Arguments and Predicates

Let me briefly introduce two frameworks which systematically map different types of noun phrases depending on their argument/predicate position in the sentence and also depending on their determiner type shifting capabilities (especially in determiner heavy languages like English, where the second option is deeply grammaticalized). The two frameworks are Barbara's Partee type shifting approach as describe in Partee (1987) and Landman's adjectival theory of indefinites as defined in Landman (2004).

2.4.1 Partee's Type Shifting Triangle

First type shifting theory was proposed by Barbara Partee in her influential Partee (1987) paper. It departs from the uniform treatment of noun phrases semantics (discussed in the first chapter) in one very important aspect – Partee claims that the basic type of noun phrases is the simplest (lowest) type which fits the type demands of the sentence, where the noun phrase occurs. She basically proposes that the three types for noun phrases we discussed in the previous section – two for argument positions: $\langle d \rangle$ (singular and plural) individuals and $\langle\langle d,t\rangle,t\rangle$ of generalized quantifies; the third type available for the interpretation of noun phrases in predicative positions is type $\langle d,t\rangle$ of sets of individuals. The three types are demonstrated in (17) respectively.

(17) a. **Peter** was sleeping. …type $\langle d \rangle$
b. **Three girls** were sleeping. …type $\langle\langle d,t\rangle,t\rangle$
c. The visitors were **three girls**. …type $\langle d,t\rangle$

Landman (2004, 20) summarises Partee's position by the following postulate (the name reminds us that Partee in fact builds her theory of predication on top generalized quantifiers theory reaching back to Montague (1973) and Barwise and Cooper (1981)).

(18) **Montague–Partee (MP)**:
MP-principle A – the Generalized Quantifier Theory of determiners:
All noun phrase interpretations are born at argument types.

That means that in Partee's framework quantificational and indefinite determiners start their type at $\langle\langle d,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$ type and quantificational and indefinite noun phrases are born at the argument type $\langle\langle d,t\rangle,t\rangle$ without any need for type-shifting. Schematic derivation of the meaning of noun phrases like *every dog* and *three dogs* follows in (19) and (20).

(19) a. *every* $\rightarrow \lambda Q\lambda P.Q \subseteq ATOM \wedge \forall x[Q(x) \rightarrow P(x)]$… type $\langle\langle d,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$
b. *dog* $\rightarrow DOG$ …type $\langle d,t\rangle$
c. *every dog* $\rightarrow \lambda P.DOG \subseteq ATOM \wedge \forall x[DOG(x) \rightarrow P(x)]$
type $\langle\langle d,t\rangle,t\rangle$

(20) a. *three* $\rightarrow \lambda Q\lambda P.\exists x \in Q : |x| = 3 \wedge P(x)$… type $\langle\langle d,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$

b. *dogs* $\rightarrow {}^{*}DOG\ldots$ type $\langle d,t\rangle$
c. *three dogs* $\rightarrow \lambda P.\exists x \in {}^{*}DOG : |x| = 3 \wedge P(x)\ldots$ type $\langle\langle d,t\rangle,t\rangle$

The same holds also for Partee's analysis of definite noun phrases which are semantically composed by the application of the definite determiner to the predicate meaning of NP, see (21).

(21) *the* $\rightarrow \lambda Q.\sigma(Q)$
The function that maps Q onto the sum of its elements if that is in Q, and is undefined if not.

The overall principle behind Partee's analysis is that noun phrases are born at argument types and if we find them in predicative positions, this results from their type-shifting into the set type. Landman (2004, 20) subsumes this line of reasoning as MP-principle-B, here in (22).

(22) **MP-principle B – the Partee triangle**
Predicate interpretations of noun phrases are derived from argument interpretation with type lowering operation BE.

ARGUMENTS *PREDICATES*

$$\begin{tikzcd} \langle\langle d,t\rangle,t\rangle \arrow[dr, "BE"] & \\ & \langle d,t\rangle \\ \langle d\rangle \arrow[uu, "LIFT"] \arrow[ur, "IDENT"'] & \end{tikzcd}$$

There are three type-shifting operations used by Partee:

(23) a. LIFT: LIFT$[\alpha]$=$\lambda P.P(\alpha)$
b. IDENT$[\alpha]$=$\lambda x.x = \alpha$ $(= \{x\})$
c. BE$[\alpha]$=$\lambda y.\alpha(\lambda x.x = y)$ $(= \lambda y.\alpha(\{y\}))$

Noun phrases can shift from $\langle d\rangle$ to $\langle\langle d,t\rangle,t\rangle$ with type raising operation LIFT – e.g. when $\langle d\rangle$ denoting proper name conjoins with a generalized quantifier. They can shift from $\langle d\rangle$ to $\langle d,t\rangle$ with type raising operation IDENT – e.g. if proper names are used predicatively as in sentences like *Peter is **Napoleon** in his office.* And finally if we find quantificational or indefinite noun phrases in predicative position, for Partee that necessarily means that it was type lowered with the operation BE.

2.4.2 The Adjectival Theory of Indefinites

The second approach to type shifting is proposed by Fred Landman in Landman (2004). This is the framework which I will use heavily in this chapter. There are many other approaches to type shifting, see Chierchia (1998) for a neo-Carlsonian approach, Winter (2001) for choice function approach and discussion of its merits, and of course Partee and Rooth (1983) and Partee (1987), where the ideas of type-shifting were laid. I cannot compare the differences of these frameworks here, so let me pragmatically choose the Landman's, because for the purposes of my book it fits best.

Landman modifies Partee's type shifting framework in one important aspect. His main idea with respect to the type shifting of noun phrases is explicated in his Adjectival theory principle (see Landman (2004, 21)) where he reverses the type shifting strategy for indefinites as proposed by Partee. He calls his approach to type shifting adjectival theory because his main idea is to treat indefinite determiners and numerals similar to adjectives. As he acknowledges, this idea isn't particularly new in formal semantics and various pieces of inspiration can be found in Link (1983), van Geenhoven (1998), Krifka (1999) among others. But as far as I can see, Landman is the first to seriously incorporate the idea into full fledged framework. His adjectival theory principle is stated in (24).

(24) **The Adjectival Theory (AT)**:
AT=principle A – the adjectival semantics of indefinites:
Indefinite noun phrases are born at the predicate type.

So quantificational and definite determiners are interpreted identically in MP and AT, as relations between sets and functions from sets to individuals respectively. But as for indefinites, they start at type $\langle d,t\rangle$ in AT, the type of sets of individuals, instead of $\langle\langle d,t\rangle,t\rangle$ type of MP. And also indefinite determiners, as well as numerals are interpreted at type $\langle d,t\rangle$, the same type as the type of adjectives and bare nouns. The composition of indefinite determiners/numerals with nouns proceeds via intersection operation defined below in (25). The illustrative derivation of (predicative) meaning for noun phrase like *three girls* is in (26).

(25) $[_{\text{NP}}$ ADJ NP$] \rightarrow$ ADJ $\cap$ NP $(\lambda x.ADJ(x) \wedge NP(x))$

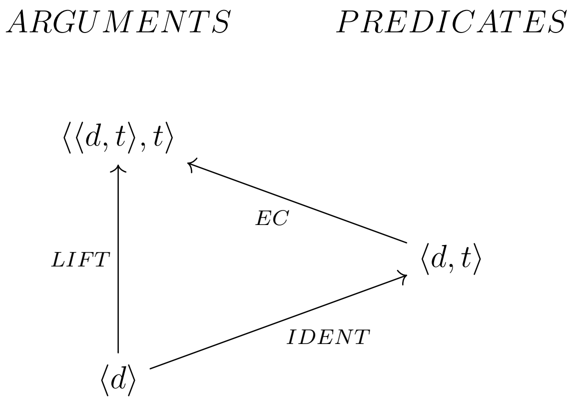
(26) a. *three* $\rightarrow \lambda x.|x| = 3$ of type $\langle d,t\rangle$
The set of plural individuals consisting of three atoms.
b. *girls* $\rightarrow$ *GIRL of type $\langle d,t\rangle$
The set of all plural individuals that consist solely of girls.
c. *three girls* $\rightarrow \lambda x.{}^*GIRL(x) \wedge |x| = 3$
The set of all sums of girls each consisting of three individuals.

That means that unlike quantificational and definite noun phrases, indefinites (and numerical noun phrases as a subkind of indefinites) must undergo type shifting when they occur in argument positions. This is core of **Principle B** of AT:

(27) **AT-principle B – the Existential Closure Triangle**
Argument interpretations of indefinite noun phrases are derived from predicative interpretations through type lifting with Existential Closure.

AT comprises of three operations, where two are identical to MP (LIFT and IDENT) but instead of BE, there is the Existential Closure (EC) operation which reverses the shifting – instead of type-lowering the argument, we type raise the basic $\langle d, t\rangle$ indefinite type.

(28) a. LIFT: LIFT$[\alpha]{=}\lambda P.P(\alpha)$
b. IDENT$[\alpha]{=}\lambda x.x = \alpha$ $(= \{x\})$
c. EXISTENTIAL CLOSURE$[\alpha]{=}\lambda P.\exists x[\alpha(x) \wedge P(x)]$



In AT then indefinite noun phrases have two basic interpretations: basic which reveals in the predicative positions and type raised (via existential closure) which appears in argument positions – see (29-a) and (29-b) respectively.

(29) a. *three girls* $\rightarrow \lambda x.{}^{*}GIRL(x) \wedge |x| = 3$
the predicative interpretation
b. *three girls* $\rightarrow \lambda P.\exists x[{}^{*}GIRL(x) \wedge |x| = 3 \wedge P(x)]$
the argument interpretation

2.4.3 Partee's pragmatic restriction on type shifting

In this section I will only briefly repeat Partee's pragmatic argumentation which should restrict the application of the BE operator. Her argument is aimed at the inability of *every* quantifier to appear in predicative position. I think that Winter (2001) quite conclusively shows that this cannot work, but let's repeat Partee's proposal first.

Partee (1987) claims that applying the BE operator to generalized quantifier semantics of a DP like *every student* would produce a trivial interpretation (an empty set) unless the interpretation of the noun *student* is a singleton set. Partee argues that this clashes with the presupposition of universal quantifiers in natural language. As according to her DPs of the form *every* NP presuppose that their NP complements denote non-singleton sets. This looks like a plausible interpretation of the ungrammaticality of sentences like

(30) where the BE operator cannot be used to lower the generalized quantifier to set interpretation for the following reasons. DP *every student of mine* presupposes non-singleton interpretation of the set denoted by the NP *student of mine*, so applying the BE to the DP *every student of mine* would lead to presupposition failure (if we cancel the presupposition) or to a trivial interpretation (if the presupposition is accepted and the BE operator is applied anyhow). A generalized quantifier is of incorrect type to combine with a proper name, so not applying the BE operator leads to a semantic incompatibility in a third imaginable scenario.

(30) *Peter is every student of mine.

The trouble with this account, as Winter (2001) shows, is that it isn't able to explain the argument/predicate asymmetry of the presupposition defeasibility. As the following example (31) shows, in argument position the non singleton presupposition of the *every* NP phrase is defeasible but in predicate position the same presupposition cancellation doesn't work. The example shows the singleton interpretation of *every* NP is available (even if pragmatically strange) when the DP is in subject position. Moreover both sentences denote the same situation but the acceptability of (31-a) is based solely on the argument syntactic position of the quantifier. That means that the non singleton meaning constraint for the big quantifier is probably only conversational implicature, not from the presupposition, as presuppositions cannot be generally suspended this way as in (31-a).

(31) a. If John and Mary failed entry exams, and Peter didn't, then every student of mine is Peter.
b. *If John and Mary failed entry exams, and Peter didn't, then Peter is every student of mine.

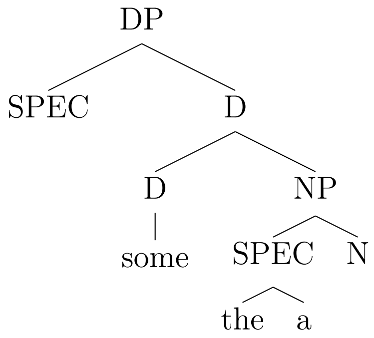
The grammaticality of (31-a) is predicted if we assume that in predicative position the proper noun can be type lifted to set type ($\langle d, t\rangle$ – the set of all things called 'Petr') which is then fed as an argument to a generalized quantifier in the subject position. This strategy isn't available when the proper noun is in subject position.

I will show in the next section how the ungrammaticality of *every* NP in predicative positions can be explained without the type shifting operator BE. The solution will also explain the puzzles mentioned at the beginning of section 2.2.

2.5 Linking Syntax and Semantics of Type Shifting

In the rest of the current chapter I will mix Landman's general approach to type shifting with Winter's Flexible Boolean Semantics. The motivation for this move is the sensitivity to syntactic status of the determiner in noun phrase. Such sensitivity is built into Flexible Boolean Semantics (hence FBS further). Recall the different behaviour of *žádný* and *ani jeden* in (6) and (10) – the first type of determiner can head noun phrase occurring in predicative position, the later not. The reason for this lies in the syntactical complexity of two types of determiners. But let me introduce FBS now. FBS is developed in papers Winter (2001) and Winter (2005), a.o.,FBS uses ideas about the semantic layers within DP that distinguish between a predicate denoting layer and a quantifier denoting layer. My main assumptions are the following: there are three syntactic layers in DP, for English from Winter (2005, Figure 1), see (32).

(32)



Nominals are classified into three types according to the portion of the NP/DP structure they fill:

1. Nominals that contain a full spec-DP position. These nominals can only be analyzed as DPs. They appear only in *argument* positions.

2. Nominals that contain an empty spec-DP and a full D position. These nominals can be analyzed as either DPs or D′s. They can only appear in predicate positions with overt copula.

3. Nominals where both spec-DP and D are empty. These nominals can be analyzed as DPs, D′s or NPs. They can appear only in predicate positions.

There is syntax-semantics matching for these layers:

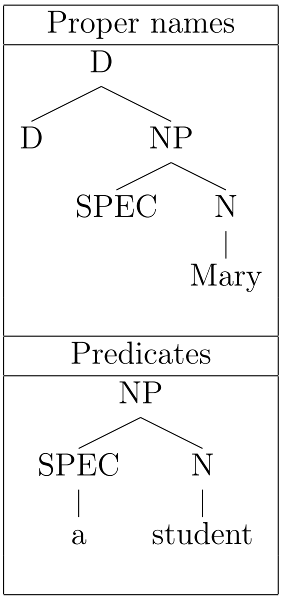
1. Under their NP analysis, nominals unambiguously denote predicates (type $\langle d, t\rangle$).

2. Under their DP analysis, nominals unambiguously denote generalized quantifiers (type $\langle\langle d, t\rangle, \langle\langle d, t\rangle, t\rangle\rangle$ before adding a NP argument to a determiner and $\langle\langle d, t\rangle, t\rangle\rangle$ after applying the determiner to the NP argument).

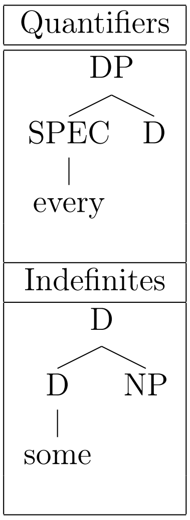
3. Under their D′ analysis, the interpretation of nominals is free to move back and forth between predicates and quantifiers. The example (34), table *Indefinites*, represents an instance of such a D′-level predicate (a good example from English is e.g. an NP headed by an unstressed determiner *some*).

Some illustrations of the system are the following:

(33)

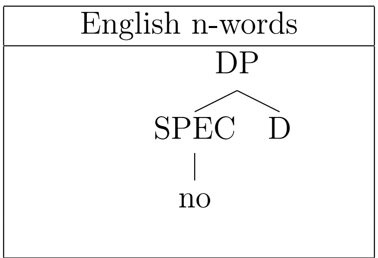


(34)



For English n-words Winter (2001) assumes that in argument positions they are negative quantifiers (generalized quantifiers) and that they are syntactically rigid nouns. Their syntax and semantics is the following:

(35)



no'(X)(Y) iff X $\cap$ Y $= \emptyset$
$= \neg\exists x[X(x) \wedge Y(x)]$

Compare this with Landman's treatment of English negative noun phrases in chapter

1. For now I will simply assume that it's right to assume that English negative noun phrases are quantifiers, but see Penka (2007) for careful discussion pointing to another solution.

2.5.1 Choice functions

The flexible interpretation of the D′ level is by virtue of phonologically covert operators that apply at this level and map predicates to quantifiers and vice versa. These operators are called category shifting principles.

Winter (2001) proposes two such principles: the *choice function* (CF) operation that maps predicates to quantifiers, and the *minimum* operator that maps quantifiers to predicates. Let's assume the following common definition of CFs, where they are used as category shifting principles from predicates to entities (Winter (2001) proposes a more general framework where CFs are operators from predicates to generalized quantifiers, but for simplicity I adopt a more intuitive definition from Winter (2005, def. 1)):

(36) For any set E, a *choice function* over E is a function that maps every non-empty subset A of E to a member of A.

The opposite of the choice function is the Minimum operator which maps quantifiers to predicates (it produces e.g. the minimal set from conjunction of two principal ultrafilters – min(M⊓J) = {{**m**',**j**'}}):[2]

(37) **Minimum sort**
$\min_{(\tau t)(\tau t)} = \lambda Q_{\tau t}.\lambda A_{\tau}.Q(A) \wedge \forall B \in Q[B \sqsubseteq A \rightarrow B = A]$

The main motivation for using CFs is more systematic treatment of the wide scope behavior of indefinites.

(38) If some relative of mine dies, I will inherit a house.
a. $[\exists f[CH(f) \wedge DIES(f(RELATIVE\_OF\_MINE))]] \rightarrow INHERIT(I, HOUSE)$
b. $\exists f[CH(f) \wedge [DIES(f(RELATIVE\_OF\_MINE)) \rightarrow INHERIT(I, HOUSE)]]$

As is well known, indefinites give the appearance of scoping out of syntactic islands, as in the example (38), cited in Reinhart (1997) with two readings: in (38-a) the existential closure takes place withing the antecedent of the conditional and we get the „narrow scope" reading, but in (38-b) the existential closure takes scope over the conditional and this results in a „wide scope" reading.

Existential closure is a mechanism for interpreting indefinites in argument positions and the logic behind it is a second order quantification over choice functions. According

[2] I use the polymorphic conjunction symbol ⊓ from Winter (2001): ⊓ conjoins propositions and generalized quantifiers (as in this case) too.

to Reinhart (1997) and Winter (2001) this closure can take place at any level of syntactic structure. This leads to apparent wide scope effects with indefinites.

If we compare Landman's AT with Winter's FBS right now, we see that FBS is more liberal – there is the minimum sort operator which maps quantifiers to predicates, in this respect it is parallel to Partee's BE type lowering operator. Unlike Partee, Winter restricts the usage of minimum sort syntactically as we will see immediately. I will use Landman's Existential Closure type shifting operator instead of the mechanism of choices functions, because the power and the glory of choice functions lies in its ability to describe wide scope reading of indefinites. And as the issue of wide scope reading isn't main topic of my investigation, I will use more conservative Existential Closure formalisation further.

2.5.2 Czech n-words

For Czech (and I assume generally for Slavic but that would need of course careful research) I assume basically an indefinite structure for n-words and corresponding to that indefinite semantics. In the Flexible Boolean Semantics of Winter there's a question if Czech n-words are more like English *some* indefinites (D′) or like (NP) *a/the* (in)definites.

Winter (2005) proposes a criterion to distinguish between the D′ and the NP level: conjunctions of singular D′ are plural, whereas conjunctions of singular NPs inherit their number features. This is parallel to conjunctions of other predicative categories such as VP/TP, PP and AP. In (39) we see that Czech negative noun phrases can be conjoined in argument position with singular agreement on the verb and that they both can be interpreted as attributes of one individual (unlike *jeden* indefinites in (39-b) which are parallel to *some* indefinites in English).[3] We can interpret (39-a) as (40), which shows that Czech n-words are NP indefinites.[4]

(39) a. *Žádný velký básník a žádný národní hrdina dnes nepronesl řeč.*
No big poet and no national hero today not-gave speech
'#no big poet and no big national hero gave a speech today.'

b. *Jeden velký básník a jeden národní hrdina dnes *pronesl/pronesli řeč.*
one big poet and one national hero today *give-sg/give-pl speech

[3](39-a) can be interpreted as attributing two properties to one individual but this interpretation isn't necessary: (39-a) can mean that we are talking about two different individuals too. In that case I would prefer plural agreement though which would point at the shift of the n-words to the *D'* level.

[4]The singular agreement with conjoined NPs is a suggestive piece evidence but not a sufficient argument for NP nature of n-words. One of the tests which would offer insight into the DP/NP status of n-words is opaqueness for extraction: DPs are usually taken as opaque for left branch extraction but NP's are transparent in this respect, see Bošković (2005) for Slavic languages. But as Abels (2003) convincingly shows, the left branch extraction data can be explained by remnant movement analysis, which unfortunately means that locality effects cannot be used as test for DP/NP status of n-words. And as I'm not aware of any other syntactic tests which can prove or refute the NP status of n-words, I will stick to the assumption that n-words are NPs even if we are still missing conclusive evidence for this claim.

'A big poet and a national hero gave a speech today.'

(40) $\neg\exists x[BIG\_POET(x) \wedge NATIONAL\_HERO(x) \wedge GIVE\_SPEECH(x)]$

Let's start with a hypothesis that Czech n-words have indefinite NP syntax and the indefinite semantics of a determiner is simply zero; the only semantics is set denotation contributed by NP and see how far this can lead us. There is of course the need of Czech n-words to be licensed by verbal negation and I assume that some version of syntactic agreement theory of n-words in the style of Penka (2007) is on the right track.

Under Winter's approach indefinites are flexible nominals (predicates) and as such can be type-shifted into quantifiers in some syntactic constructions. This shifting is obligatory every time when n-words are in argument positions, as their set $\langle d, t\rangle$ type would lead to type incompatibility in any argument position. As said at the end of 2.3, I will use Landman's Existential Closure type shifting operation for this purpose, instead of Winter's choice function approach, because as far as I can see, both approaches give the same truth conditions at least for the cases I will consider in this chapter. And because Landman's Existential Closure is lighter in terms of formal machinery involved, I prefer it for simply parsimonious reasons.

As predicates we would expect n-words to appear in predicate positions. In contrast, quantifiers of the 'not a single one' type are rigid nominals and cannot be shifted into predicates in Winter's framework. There is no type lowering operator in Landman's framework, so both approaches give the same predictions with respect to the *ani jeden/žádný* distinction. The distinction between n-words and 'not a single one' quantifiers is at least partially syntactic, as n-words belong to the flexible nominals type and quantifiers to the rigid nominals type in Winter's system. I think that this is the right hypothesis as there's no semantic distinction between both types in Generalized quantifiers theory. From the point of view of truth conditions, both n-words and negative quantifiers of the 'not a single one' type can be correctly represented as an operation of an noninteresction of any two sets. But if we look more carefully at the syntactic and semantic behavior of n-words in different environments, we will see that predicate semantics and NP syntax, as is depicted in (41), predicts their properties much more correctly. And this is exactly what I will show in sections 2.6, 2.7 and 2.8.

(41)

Czech n-words
[NP [SPEC žádný] [N]]

2.6 Prediction I: predicative positions

Let's repeat my main assumption: n-words in the negative concord languages are restriction predicates ($\langle d, t\rangle$ type) and their type does not change in predicative position.

From that it follows that their appearance in predicative position is expected as their type is similar to other predicates like syntactic APs, PPs, etc. If n-words were be generalized quantifiers (sets of sets), it would be predicted that they shouldn't appear in predicative positions.

N-words in argument position are interpreted through type shifting via Existential Closure into the type of generalized quantifiers. So n-words are indefinites of a special sort (for a closely related proposal see Penka (2007); Zeijlstra (2004); Błasczak (2001)).

N-words can appear in the predicative nominal constructions (they are not quantifiers there) but the question is why quantifiers of the *every* type cannot occur in this position as well if the flexible Boolean semantics has the minimum operator as in (37). In Winter's system this follows from a syntactic ban on type shifting rigid DPs. The min operator can shift quantifiers to predicates (e.g. principal ultrafilter) if they are flexible. In Landman's framework the possibility of lowering quantifiers to predicates is entirely absent.

On the other hand, quantifiers of the 'not a single one' type are rigid nominals, so in predicative position they would need min operator to turn them into set type; but this type shifting is forbidden as they are rigid nominals, they are DPs and their logical type cannot be shifted.

Czech n-words are grammatical in predicative positions and moreover they can have a distributive reading there as in the following example. As they are interpreted as predicates, they can be conjoined by boolean conjunction and the proper name *Petr* in the subject is interpreted as a set of sets (type shifted by the LIFT type raising operator from the simple $\langle d \rangle$ type to the $\langle\langle d, t\rangle, t\rangle$) and is applied to them.[5] The result then is logically equivalent to the conjunction of two predicates applied to a term denoting the atom individual Petr. If the n-words in (42) would be quantifiers, then the boolean conjunction of them would assemble the set of properties common to both quantifiers and this set would be applied to the subject. This would lead to the same type problems discussed in Section 2.2 for simple quantifiers in predicative position.

(42) *Petr není žádný můj kamarád ani žádný můj soused.*
Petr not-AUX no my friend neither no my neighbor
'Petr is no friend of mine and no neighbor of mine.'

a. $\neg\lambda P.P(Petr)(FRIEND\_OF\_MINE \wedge MY\_NEIGHBOUR)$
$\iff \neg FRIEND\_OF\_MINE(petr) \wedge \neg MY\_NEIGHBOUR(petr)$

2.7 Prediction II: collectivity

My basic hypothesis is that n-words in negative concord languages like Czech are

[5] The conjunction $\wedge$ in (42) is not of the standard type $\langle\langle t, t\rangle, t\rangle$ type but it is a predicate conjoining operator. In the example it joins two sets and outputs their intersection: $\lambda x.[friend(x) \wedge neighbour(x)]$. The whole sentence is then true if the set of sets (set of Peter's properties – formalizing the proper name Petr) doesn't contain as one of the sets, the intersection. For the definition of such polymorphic conjunction see Winter (2001:36). Thanks to J. Peregrin for reminding me of the difference between the predicate conjunction and the propositional conjunction.

simply indefinites which must syntactically agree with verbal negation and this negation is the locus of the logical negation interpretation.

As indefinites, n-words denote set(s) of objects (depending on their morphological number) and we should expect them to be grammatical with collective predicates which demand plural arguments. On the other hand if n-words would be generalized quantifiers (at least in classical Montague typing) we wouldn't expect them to be grammatical with genuine collective predicates. Recall that in LoP unambiguous quantifiers like *every/each* must scope over the event variable which leads to the obligatory distributive interpretation.

In this section I will look at behavior of n-words with collective predicates. There are two sentence types which are important in this respect. The first one (example (43)) will be dealt with in the subsection 2.7.1. (43) is an interesting sentence because predicates like *be a good team* are a good testing ground for the quantifier/set type of their arguments. Basically all quantifiers are banned as their arguments, as (44-b) shows, which is behavior not shared by all collective predicates (e.g. the collective predicate *meet* allows as its arguments quantifiers if they are plural – see (44-a)).

(43) Žádní mí studenti nejsou dobrá parta.
no my students not-AUX good team
'#None students of mine are good team.'

(44) a. All the students are meeting in the hall.
b. *All the /exactly four/between four and ten/at least ten/many/no/most of the students are a good team.

The second sentence type (example (45)) will be treated in the subsection 2.7.2. Once the empirical claim that Czech n-words are capable of collective and cumulative interpretation is established, I will further explore the differences between English and Czech negative NPs and also formalize the distinction in LoP – see 2.7.3.

(45) *Žádný můj student a žádný můj učitel se v Praze nesešli.*
no my student and no my teacher REFL in Prague not-met
'No student of mine and no teacher of mine met in Prague.'

2.7.1 Groups

Recall that Landman (1989) proposes that nouns referring to sets can be shifted to group denoting atoms in a way that the former plurality is interpreted as an atom element representing the relevant group of objects, and as such they can be arguments of collective predicates, as in (7-a). Their denotation then is similar to singular noun phrases like *the group of students* or *the committee*. Formally this is represented by $\uparrow$ operator in LoP.

As everybody working on plurality agrees, predicates in natural language vary as to what kinds of plural objects they take in their extension. Let's first look at what Landman's framework predicts in this respect. Then I will focus on the question how the basic picture can be refined by Winter's ideas.

First, let's look at three basic types of predicates in singular number, reflecting the singular number of their arguments if they appear in syntactically predicative position:

1. distributive predicates like *sleep*, *have blue eyes* or *walk* take only individual atoms;

2. collective predicates like *gather* or *meet* take only group-atoms;

3. mixed predicates like *write the book* or *touch the ceiling* take both individual atoms and group atoms, which results in their ambiguous distributive/collective interpretation depending on the semantics of argument they take;

As for nominals, their denotation can be divided into individual atoms and group atoms:

1. nominals like *student* or *boy* denote only individual atoms;

2. nominals like *team*, *crowd* or *library* denote only group atoms;

This classification is quite intuitive and is able to explain basic incompatibilities of predicates and their arguments in sentences like #*The crowd had blue eyes* (group atom as an argument of individual atom taking predicate) or #*The boy gathered* (individual atom as an argument of group atom taking predicate).

I assume (again with most of the researcher, see Sauerland (2003) for discussion of this issue) that the grammatical number on nouns is interpreted semantically (I use Landman's pluralization star * operator for this purpose) but the grammatical number of verbs is purely a syntactical reflex of agreement between the subject and the verb. So if we pluralize the arguments of three mentioned predicates, the closure under sum assembles pluralities depending on the former type of the arguments. And that must be reflected also in the denotation of the predicate. Let's illustrate the working of the system on some sample denotations of the mentioned classes of predicates and nominals. First let's look at singular predicates and nominals:

(46) a. *sleep* $= \{a,b,c\}$
b. *gather* $= \{\uparrow(a\sqcup b),\uparrow(b\sqcup c)\}$
c. *write the letter* $= \{a,b,\uparrow(a\sqcup c)\}$

(47) a. *student* $= \{a,b\}$
b. *team* $= \{\uparrow(a\sqcup b\sqcup c),\uparrow(a\sqcup b)\}$

Now let's look at the plural version of the predicates and nominals:

(48) a. **sleep*$=\{a,b,c,a\sqcup b,a\sqcup c,b\sqcup c,a\sqcup b\sqcup c\}$
b. **gather*$=\{\uparrow(a\sqcup b),\uparrow(b\sqcup c), \uparrow(a\sqcup b)\sqcup \uparrow(b\sqcup c)\}$
c. **write the letter*$=\{a,b,\uparrow(a\sqcup c),a\sqcup b,a\sqcup \uparrow(a\sqcup c),b\sqcup \uparrow(a\sqcup c),a\sqcup b\sqcup \uparrow(a\sqcup c)\}$

(49) a. *student* $= \{a,b,a\sqcup b\}$
b. *team* $= \{\uparrow(a\sqcup b\sqcup c),\uparrow(a\sqcup b), \uparrow(a\sqcup b\sqcup c)\sqcup \uparrow(a\sqcup b)\}$

Now, when the basic assumptions behind the plurality interpretation of predicates and nominals were introduced, let me continue to Winter's ideas about refining this hypothesis (note that Winter (2001) doesn't agree with Landman's two domains approach – Winter tries to do without group subdomain of pluralities, that will be reflected by different formalizations below).

The basic assumptions about collective predicates like *be a good team* in Winter's flexible Boolean semantics is that they are atom predicates where each atom denotes a plural entity. And according to him, these predicates are genuine collective predicates. The distinction between collective predicates like *be a good team* and distributive predicates like *laugh* is that distributive predicates are atom predicates as well but in their uninflected denotations they range only over regular individuals.

Winter's typology of semantic number classifies predicates according to their behavior in sentences like the following.

(50) a. all the/no/at least/many students/committees PRED
b. every/no/more than one/many a student/committee PRED

PRED is a predicate (verb, noun or adjective) like *be a good team* or *laugh.* If the sentences in (50-a) and (50-b) are equally acceptable and, if acceptable, are furthermore semantically equivalent, then PRED is called an *atom predicate.* If the sentences differ in either acceptability or truth-conditions, then PRED is called a *set predicate.*

According to this criterion, a collective predicate like *meet* is a set predicate but collective predicate like *be a good team* is an atom predicate, compare (51-a) and (51-b) with different acceptability and (52-a) and (52-b) with similar (un)acceptability. All distributive predicates (like *laugh*, *smile*, *sleep*) are of course atom predicates. What is the crucial distinction between Landman's and Winter's typology of plurality denoting expressions? From the point of view of collective nouns, it's Winter's observation that not all collective predicates behave similarly – while both *be a good team* and *meet* would be classified as group denoting nominals by Landman, only the first is genuine collective predicate for Winter, because the second nominal can take also sums in its denotation (next to group atoms).

(51) a. All the/no/at least two/many students met.
b. *Every/*no/*more then one/*many a student met.

(52) a. *All the/*no/*at least two/*many students are a good team.
b. *Every/*no/*more then one/*many a student is a good team.

Winter's system builds on the distinction between the semantic number of a predicate (the atom/set distinction) and the morphological number of the predicate (the sg./pl. distinction), see (53) and (54). In (55) are some lexical entries for illustration. The first two principles are analogical to Landman's pluralization star operator plus the basic categorization of individual atom and group atom denoting classification. Winter's innovations are of two kinds: first Winter doesn't assume that there is a totally productive mapping between sums and groups – see the lexical entry for *committee*; second he allows also sums into the extension of predicates like *meet.* This comes from his test for atomic/set type of predicate mentioned above. I think this is right move, as quantifiers are really sensitive to the semi-collective/genuine collective distinction as we saw in (44-a).

(53) **Principle 1** *When uninflected for number, atom predicates denote sets of atomic entities. Uninflected set predicates denote sets of sets of atomic entities.*

(54) **Principle 2** *Number features change the semantic number of predicates so that all singular predicates denote sets of atoms whereas all plural predicates denote sets of sets.*

(55) a. **student**'={**j**',**m**',**p**'}
b. **students** = {{**j**'},{**m**'},{**p**'},{**j**',**m**'}...,{**j**',**m**',**p**'}}
c. **committee**'={**c**'$_A$,**c'**$_B$}
d. **is_a_good_team**={**c**'$_A$,**c**'$_B$}
e. **meet**'={{**j**',**m'**},{**c**'$_B$}}

If we accept classical Montague's treatment of quantifiers then there's a type problem because there is no semantic difference between the singular and plural determiner quantifiers (*all, every,* no_{sg}*,* no_{pl}*, ...*). All of them are of the type $\langle\langle d,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$ but in Winter's system (following Bennett) singular predicates are of the $\langle d,t\rangle$ type although plural predicates are of the $\langle\langle d,t\rangle,t\rangle$ type. Given these assumptions, plural marked arguments of a quantificational determiner yield a type mismatch and should yield prima facie uninterpretability.

The situation is rescued via a special interpretation rule called „determiner-fitting“ triggered by the presence of morphological plurality. The working of 'dfit' is a bit complicated but let's say that it can explain the distinction between (57-a) and (57-b).[6]

An important prediction of the system is that quantifiers are incompatible with genuine collective predicates like *be a good team* (even if the quantifiers are in plural). They are compatible with set predicates like *meet* via the dfit strategy but this strategy is unavailable to rescue grammatically for collective atom predicates.

(56) **Determiner fitting**
$dfit = \lambda D_{(et)(ett)}.\lambda\mathcal{A}_{ett}.\lambda\mathcal{B}_{ett}.D(\cup\mathcal{A})(\cup(\mathcal{A}\cap\mathcal{B}))$

(57) a. All students met in the hallway.
b. *All students are a good team.

Nevertheless some at first sight quantifiers can be subjects of these atom collective predicates like *be a good team*, see (58), they are quantifiers of the flexible type (their

[6]Dfit is a type shifting operator which essentially allows combination of otherwise distributive quantifiers (like *exactly five boys*, which is of two-sets of individuals input type: $\langle d,t\rangle$) with a collective predicate like *gather* (of type $\langle\langle d,t\rangle,t\rangle$). The semantical composition has two steps: first the NP and VP argument denotations are intersected (for a sentence like *Exactly five students gathered there* the output would set of sets of gathered students). In step two, the NP denotation and the output of the intersection from step one are unionized. Both arguments of the distributive quantifier are now pure sets ($\langle d,t\rangle$ type), so the quantifier can apply to them without any problems.

syntactic projection is only D′, not a full DP), so they can be type shifted into a set type and then turned into groups.

(58) a. The students are a good team.
b. Some students I know are a good team.
c. Five students I know are a good team.

As groups they are eligible arguments for genuine collective predicates like *be a good team*. The sample derivation of denotation of NP like *the students* is shown below. In (59-a) the bare plural *students* denotes set of atoms and sums, in (59-b) application of the maximalization σ-operator (the meaning of the definite article) turns the denotation into the supremum – the maximal entity in the denotation of plural NP *students*, in (59-c) we type-shift the supremum into a group using Landman's ↑-operator, and in (59-d) we apply the genuine collective predicate to the group. Winter (2001) generalizes that for rigid nominals the mapping to group-atoms is not available but for flexible ones it is, this is the reason of ungrammaticality of (57-b) and grammaticality of (58-a-c).

(59) a. *students*={a,b,c,a⊔b,a⊔c,b⊔c,a⊔b⊔c}
b. *the students*={a⊔b⊔c}
c. *the students* (as a group)={↑(a⊔b⊔c)}
d. BE_GOOD_TEAM(↑(a⊔b⊔c)) (=meaning of (58-a))

If we return to the example (43), repeated below as (60), we can say that the system predicts that it can be grammatical only if the n-word isn't a generalized quantifier and rigid nominal. So this is another piece of puzzle which points at the predicate nature of n-words.

(60) can be formalized as (61), which in LoP says, that there is no plurality in the denotation of plural nominal *students*, which could be true group-shifted argument of the genuine collective predicate BE_GOOD_TEAM.

(60) *Žádní mí studenti nejsou dobrá parta.*
no my students not-AUX good team
'#No students of mine are good team.'

(61) $\neg\exists x \in {}^{*}STUDENT : BE\_GOOD\_TEAM(\uparrow(x))$

The corresponding English sentence in (62) is ungrammatical. That shows that English n-words are at least syntactically rigid nominals, read DPs, and because of that unlike Czech n-words they cannot be mapped to impure atoms.

(62) No students are a good team.

2.7.2 Coordination of n-words

The next important piece of data is exemplified by sentence (63) which shows that with set predicates n-words can assemble a plural entity with a property assigned to them by the set predicate. This property is then negated because of the propositional negation (signalized by negative concord both on the n-words and on the verb).

The generalized quantifiers approach cannot explain this sentence interpretation because the basic denotation of negative quantifiers in GQ theory is a disjoint operation on sets (*no student of mine* would denote a set of sets disjoint from my students) and the only meaning which GQ theory can assign to (63) would be that some intersection of a set of entities disjoint from my students and teachers met in Prague. That is of course a very implausible reading for (63).

In Partee's type shifting system the truth conditions would be similar to the GQ treatment. (63) would mean that some non-student of mine and some non-teacher of mine met in Prague, again a wrong meaning for the sentence (63). This also supports the syntactic theory of negative concord phenomena, as proposed in Penka (2007), because the scope of negation is interpreted at the propositional level and the scope of n-words is interpreted under the collective predicate *meet* (first there is summation of the two indefinites which is type shifted into a group – about the group consisting of any atom of student with any atom of teachers, it is said that the group doesn't belong to the denotation of the collective predicate *meet*).

But if we follow the main line of argumentation here and treat n-words as indefinites, the intuitive meaning of (63) is that for any chosen pair consisting of my student and my teacher, this pair don't have a property MET_IN_PRAGUE which is exactly what (64) formalizes. As the grammatical judgment in English translation shows, this sentence is either ungrammatical in English or it has the peculiar meaning discussed in the preceding paragraph, which probably leads to its unacceptability.

(63) *Žádný můj student a žádný můj učitel se v Praze nesešli..*
no my student and no my teacher REFL in Prague not-met
'#No student of mine and no teacher of mine met in Prague.'

(64) $\neg\exists x \in STUDENT : \exists y \in TEACHER : MEET(\uparrow (x \sqcup y))$

2.7.3 Negative NPs in Czech and English and their formalization in LoP

As was demonstrated in the previous sections, 2.7.1 and 2.7.2, Czech and English differ in the way they distribute (English) or don't allow to distribute (Czech) the pluralities denoted by their negative NPs. Czech negative NPs are always interpreted cumulatively (and allow the shift to groups), while English negative NPs are interpreted only distributively. Let's consider English sentence (65) and its Czech translation in (66).

(65) No women gave birth to twins.

(66) *#Žádné ženy neporodily dvojčata.*
no women not-gave_birth twins
'No women gave birth to twins.'

Predicate *give birth to twins* is extremely distributive, its singular and plural denotation would be e.g. sets in (67-a) and (67-b). There is no group element either in the singular or the plural denotation, because even if today the act of childbirth is carried out by many nurses and doctors helping the mother, we still at least linguistically (and quite naturally) credit the main responsibility to the mother only. Let's assume that plural *women* (in both languages has the denotation as in (67)), then the English sentence in (65) is true in such a model (let's assume that individuals *a,b,c* are cows e.g.).

(67) a. *give birth to twins* = {a,b,c}
b. **give birth to twins* = {a,b,c,a⊔b,a⊔c,b⊔c,a⊔b⊔c}

(68) **women* = {d,e,d⊔e}

Czech sentence like (66) should be true in such a scenario but it is ungrammatical. Why? There are two options for its interpretation: cumulative and collective. I will discuss both in details now. The cumulative interpretation is formalized in (69). The trouble with the cumulative interpretation is that it forces us to understand the Czech sentence as we would understand an English sentence like (70) which in the cumulative reading would ascribe one baby from the twins to each mother. (70) is of course totally natural in the distributive reading, but it lacks the cumulative reading for biological reasons.

(69) $\neg\exists ex[{}^{*}WOMAN(x) \wedge {}^{*}GIVE\_BIRTH(e) \wedge {}^{*}Ag(e) = x \wedge {}^{*}TWINS(Pat(e))]$

(70) Jane and Mary gave birth to twins.

The second interpretative option for Czech negative NPs would be to shift the plurality into group atom. But again, we cannot interpret such a reading for biological reason. Compare English sentence like (71) which sounds just weird. To sum up: Czech n-words are of the predicative $\langle d, t\rangle$ type and in LoP they scope under the event variable, their reading is hence cumulative or collective but never truly distributive. But what about singular n-words? Czech sentence like (72-a) is perfectly acceptable and has the meaning corresponding to the English plural negative NPs. I assume that this is simply an effect of grammatical number: as in singular the cumulative reading and the distributive reading cannot be distinguished, we have here the illusion of distributivity but in fact, the singular n-word is still under the closure of the event variable, so we don't have the genuine distributivity – see the formalization in (71-b).

(71) Jane and Mary as a group gave birth to twins.

(72) a. *Žádná žena neporodila dvojčata.*
no woman not-gave_birth twins
'No women gave birth to twins.'
b. $\neg\exists ex[WOMAN(x) \wedge GIVE\_BIRTH(e) \wedge Ag(e) = x \wedge TWINS(Pat(e))]$

English negative NPs on the other hand obligatorily scope over the event variable, it carries the logical negation along the way and their interpretation in LoP is (73). I formalize the plural negative NP as $\neg\exists x \in WOMAN$, because it is originally composed from ${}^{*}WOMAN$ and Landman's scopal quantifying-in rule which ranges over all atoms in the plurality which can be collapsed into $\neg\exists x \in WOMAN$ – see the next section for the explicit account of the composition.

(73) $\neg\exists x \in WOMAN(x) : \exists e[GIVE\_BIRTH(e) \wedge Ag(e) = x \wedge TWINS(Pat(e))]$

2.7.3.1 English negative NPs in LoP

In this section I will demonstrate how English negative noun phrases compositionally contribute to the meaning of the sentences in which they occur. The formal treatment is done LoP and draws heavily from the chapter 8 of Landman (2004). Landman (2004, p. 176) proposes the following interpretation for nominal negation – see (74). Nominal negation (of the type $\langle\langle\langle d,t\rangle,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$) is stored and retrieved as soon as the derivation reaches one of the admissible types for negation – in this case the type of generalized quantifiers ($\langle\langle d,t\rangle,t\rangle$). As the consequence of its types, nominal negation is interpreted differently in argument and adjoined/predicative positions and allows the collective interpretation for English NPs in case they occur in the adjoined/predicative positions. But in the argument positions the negation is a noun phrase modifier interpreted as $\lambda T\lambda P.\neg T(P)$ – its logical type is $\langle\langle\langle d,t\rangle,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$. In adjunct positions the nominal negation is incorporated auxiliary negation which scopes in the moment when the derivation reaches the type $\langle t\rangle$, its starting type is then $\langle t,t\rangle$. In Landman's system there is no no type shifting of negation (compare with Partee (1987) where neg NP is interpreted as ATOM - $[\![NP]\!]$) in a sense that there is a complement interpretation for negative NPs – negation is always interpreted as classical logical negation but its different interpretation is a result of different scopes where it occurs. Sample derivation of English sentence (75) follows next. The negative NP starts its interpretation as a simple plural predicate in LoP and the negative part of its meaning is stored – (75-a), because the type of the NP ($\langle d,t\rangle$) doesn't fit any of the admissible types for nominal negation.

(74) **nominal negation**
no $\rightarrow \neg_n$ where n is $\langle t,t\rangle$ or $\langle\langle\langle d,t\rangle,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$

(75) No girls slept.
a. *no girls* $\rightarrow {}^*GIRL$, STORE $\neg_n$

Because the negative NP is in argument position, it must undergo argument shift to $\langle\langle d,t\rangle,t\rangle$ type and because $\langle\langle d,t\rangle,t\rangle$ is one of the input types for nominal negation, $\neg_n$ must be retrieved from the store – (76-a). This is the scopal version of negative NP and as such scopes over the predicate – (76-b) – and over the event variable.

(76) a. $\lambda P.\neg\exists x[{}^*GIRL(x) \wedge P(x)]\ldots$ type $\langle\langle d,t\rangle,t\rangle$
b. $\lambda x\lambda e.SLEEP(e) \wedge Ag(e) = x\ldots$ type $\langle d,\langle e,t\rangle\rangle$

The types of the negative NP and the predicate are incompatible in this step of derivation, so we apply maximalization (closure of the event variable) – (77-b) and next we abstract over variable x, turning its type $\langle t\rangle$ into the type $\langle d,t\rangle$ – (77-c).

(77) a. $\lambda P.\neg\exists x[{}^*GIRL(x) \wedge P(x)]\ldots$ type $\langle\langle d,t\rangle,t\rangle$

b. $\exists e[SLEEP(e) \wedge Ag(e) = x] \ldots$ type $\langle t \rangle$
c. $\lambda x.\exists e[SLEEP(e) \wedge Ag(e) = x] \ldots$ type $\langle d, t \rangle$

Then we quantify-in the negative NP and according to Landman (2000, 194) we must use the rule of scopal quantifying-in which ranges over atoms of the quantified plurality (the part $\forall x_n \in ATOM(x)$ in (78)). SQI quantifies α into ϕ – λ-abstraction is part of the SQI in fact, α is the scoped operator. Obligatory distributive interpretation of scoped operators is consequence of this. After application of SQI to (77-a) (α) and (77-b) (ϕ) we obtain (79). For easier reading I will use the formalization in (78-a) which simply substitutes the negation of existential quantifier with universal quantification over the negated formula (this follows from the predicate logic equivalence of $\neg\exists x Px$ and $\forall x \neg Px$).

(78) SQI$_n$: **scopal quantifying-in**.
SQI$_n$=APPLY$[\lambda x.\forall x_n \in ATOM(x) : \phi, \alpha\ ]$

(79) $\neg\exists x[{}^*GIRL(x) \wedge \forall x_n \in ATOM(x) : \exists e[SLEEP(e) \wedge Ag(e) = x_n]]$
a. $\forall x[{}^*GIRL(x) \wedge \forall x_n \in ATOM(x) : \neg\exists e[SLEEP(e) \wedge Ag(e) = x_n]]$

The obligatory distributive interpretation of quantified NPs (and English negative NPs seem to behave in all respects like ordinary quantifiers like *every NP*) is the theoretical explanation of ungrammaticality of such operators as arguments of cumulative or collective predicates. So English negative NPs are treated like obligatorily quantified-in indefinites with stored negation. Their behaviour follows from that and it explains the ungrammaticality of the following examples – (80-a) and (80-b) are ungrammatical, because both NPs must scope over the event variable in LoP and as such must be interpreted distributively but this of course clashes with the collective interpretation of the predicate *gather*.

(80) a. #Every student gathered in the hall.
b. #No students gathered in the hall.

As for the **negative NPs in predicative or adjoined positions** – the derivation doesn't go through the $\langle\langle d, t\rangle, t\rangle$ type of NP, so negation is retrieved later, after the existential closure of event variable. An immediate prediction of this assumption is that cumulative and collective reading of Germanic negative NPs is possible in non-argumental positions – see Landman (2004, p.177) – which seems to be the case at least for Dutch. So Dutch allows in its *there is* constructions the negative NPs to have the cumulative and collective reading as demonstrated in (81-a) and (81-b) respectively.

(81) a. Er spelt geen meisje in de tuin.
'There was no girl playing in the garden.'
$\neg\exists e[PLAY(e) \wedge GIRL(Ag(e)) \wedge IN(e) = \sqcup(GARDEN)]$
b. Er kwamen drie jongens en geen meisjes samen.
Three boys and no girls gathered.

What we seem to see is that there is a correlation between the predicative interpretation of NP and its collective/cumulative reading. The tentative hypothesis can have a form of an empirical generalization: distributive interpretation disallows predicative type of NP and conversely cumulative/collective interpretation is the only plural interpretation of the predicative NPs. Whether such hypothesis should have deeper explanation and whether it's empirically correct is something I hope to examine in a future work.

2.7.3.2 Czech negative NPs in LoP

The same semantics as in (74) would give totally incorrect predictions for Czech negative NPs. This is so for two main reasons: (i) negative force – Czech n-words don't carry any real negative semantics (so there is no double negative reading in Czech) and (ii) no distributive interpretation of Czech negative NPs – there is no distributive reading of Czech n-words. Basically then we can assume that Czech n-words don't have the $\langle\langle\langle d,t\rangle,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$ type and their type is $\langle d,t\rangle$. Moreover they don't store the negation. Negative force comes from the verbal negation. To formalize this we can use Landman's auxiliary negation rule as repeated here in (82) (after Landman (2004, p.174))

(82) **Auxiliary negation**
niet(not) $\rightarrow \neg$ of type $\langle t,t\rangle$

The obligatory presence of verbal negation can be formalized as in (83). So let's assume that negation on Czech n-words is simply signal that the argument shift for Czech negative NPs in argument positions must be done no later then at the point of negating the existential closure of the event variable.

(83) Czech n-words: argumental shift of Czech n-words is possible only under negated event variable.

This is a sort of predicative analysis of negative NPs, close to syntactic proposals like Zeijlstra (2004) but I think this simple rule explains the behaviour of Czech negative NPs quite well. It explains that lack of negative verb with n-words leads to ungrammaticality: (84) is ungrammatical because $\langle d,t\rangle$ type cannot occur in argument position and because the predicative NP isn't existentially closed, the verb and the argument cannot be combined because of type mismatch: verb is of the type $\langle d,\langle e,t\rangle\rangle$, NP of type $\langle d,t\rangle$ and there is no type shifting rule which can repair this. Let's look now at the derivation of (85) and the ingredients in (85-a) – negative NP, (85-b) – the predicate and (85-c) – the verbal negation.

(84) **Žádný chlapec přišel.*
no boy came
'No boy came'

(85) *Žádní chlapci nepřišli.*
no boys not-came
'No boys came.'

a. žádní chlapci . . . $\lambda x.^{*}BOY(x)\ldots\langle d,t\rangle$
b. přišli . . . $\lambda x.\lambda e.COME(e)\wedge Ag(e)=x\ldots\langle d,\langle e,t\rangle\rangle$
c. ne-. . . $\neg\ldots\langle t,t\rangle$

The derivation continues as: the interpretation of negated verb is predicative with the event argument (the negation cannot apply and is stored in this moment because of the type incompatibility) – (86). We apply the argument shift (check whether negation is in the store) to the argumental negative NP – (86-a). And we lift the predicate, so it can apply in situ to NP – (87-b).

(86) a. ne-přišli . . . $\lambda x.\lambda e.COME(e)\wedge Ag(e)=x\ldots$ STORE $\neg$

(87) a. $\lambda P.\exists x[^{*}BOY(x)\wedge P(x)]\ldots\langle\langle d,t\rangle,t\rangle$
b. $\lambda T.\{e\in COME: T(\lambda x.e\in COME(e)\wedge Ag(e)=x)\}\ \ldots\langle\langle\langle d,t\rangle,t\rangle,\langle e,t\rangle\rangle$

Next, we apply the predicate to argument (88-a), then do the maximalization (existential closure of the event variable – (88-b)) and then retrieve the negation because we reach the $\langle t\rangle$ type –(88-c).

(88) a. $\{e\in COME:\exists x[^{*}BOY(x)\wedge Ag(e)=x]\}$
b. $\exists e[COME(e)\wedge\exists x[^{*}BOY(x)\wedge Ag(e)=x]]$
c. $\neg\exists e[COME(e)\wedge\exists x[^{*}BOY(x)\wedge Ag(e)=x]]$

The obligatory cumulative interpretation explains why Czech n-words occur as arguments of cumulative and collective predicates. As arguments of collective predicates, they undergo the group-shift but they remain in the scope of the existential closure of the event variable. On the other hand, they resist to be arguments of distributive predicates as the following examples show: (89-a) is ok under the cumulative interpretation. (89-b) is the pure collective interpretation. And (89-c) again demonstrates that Czech negative NPs resist to be arguments of strictly distributive predicates.

(89) a. *Žádní pohřebáci nepohřbili víc jak 15 lidí za den.*
no undertakers not-buried more than 15 people in day
'??No undertakers buried more than 15 people per day.'
b. *Žádní chlapci neutvořili pyramidu.*
no boys not-formed pyramid
'??No boys formed a pyramid.'
c. #*Žádní chlapci neměli modré oči.*
no boys not-have blue eyes
'No boys had blue eyes.'

2.8 Prediction III: intensional predicates

Let's repeat: n-words are indefinites and without additional structure they denote sets. From it follows that they should be grammatical in environments selecting for sets or properties. Intensional predicates were argued to be property selecting and we will see that this works well with the indefinite status of Czech n-words.

Indefinites in the scope of intensional verbs are generally able to have two readings, the de dicto and the de re, as (90) illustrates, which can mean either that there are two criminals such that the inspector must arrest them or that there is a norm for the inspector to arrest two criminals per week, irrespective of their identity.[7]

(90) The inspector must arrest two criminals this week.

a. de dicto: norm for the inspector per week is two criminals

b. de re: there are two criminals such that the inspector must arrest them

N-words in negative concord languages like Czech can be interpreted only de dicto in these constructions as I want to show in this section. Let's look at (91) and first it's the de dicto reading.

(91) *Petr nehledá žádného jednorožce.*
Petr not-searches no unicorn
'Petr doesn't seek any unicorn.'

In Montague's classical analysis, the de dicto reading would be analyzed as a relation SEEK between Petr and the intension of a generalized quantifier as in (92-a), in other words, intensional verbs denote relations between individuals and quantifier intension, i.e. they are of type $\langle s, \langle\langle d,t\rangle,t\rangle\rangle, \langle d,t\rangle\rangle$. This reading is very weak. It expresses that Petr stands in the SEEK relation to the function which assigns to every possible world the set of properties that no unicorn has.

It's because on Montague's analysis of the de dicto reading, the negation is sitting in the wrong place. For Montague, the only alternative is to scope it out. But that gives the de re reading, which is also wrong.

Zimmermann (1993) argues against Montague's analysis of quantifiers in the scope of intensional verbs, in favor of an analysis where the complement of SEEK is an intensional property, rather than the intension of a generalized quantifier.

This is exactly in accordance with the analysis which postulates an indefinite analysis for n-words and is also one of the main arguments for separating negative and indefinite part of n-words (irrespective of the negative concord status of the examined language), as Landman (2004) and Penka (2007) show, because otherwise we would end up with the same problems as in (92-a) because at the level of properties, the only plausible analysis of negation is as complementation as in (92-b).That would mean that Petr is seeking non-unicorns and not that Peter is not searching for unicorns. The most plausible meaning of (92) is (92-c) where negation takes scope over whole formula

(92) Petr nehledá žádného jednorožce.

a. $SEEK(\hat{}\lambda P.\neg\exists x[UNICORN(x) \wedge P(x)])(p)$

b. $SEEK(\hat{}(ATOM - UNICORN)(p))$

[7]The problem of the de dicto/de re interpretation in the scope of modal verbs is one of the big topics of formal semantics going back at least to Montague (1973). For the discussion of Germanic n-words and their semantics in the scope of intensional verbs see Penka (2007, chap. 3).

c. $\neg SEEK(\hat{}UNICORN)(p))$

Let's return to the de re reading of Czech sentences with n-words. It's easier to test them when embedding the n-word under modal verbs than under an intensional verb like *seek*. Sentence (93) under the de dicto reading means that there's no obligation for the inspector to arrest two criminals this week.

But what would be the de re reading? The de re reading would be true in situations in which the de dicto reading is false. If the norm of work for inspectors says that there are no criminals, say a murderer and a burglar, which have to be arrested this week, but only that two criminals must be arrested per week, then (93) under the de dicto reading is false but under the de re reading is true.

This is so because in the de re reading an indefinite would scope over modal verb but under negation. This reading is unavailable for the sentence (93), so I conclude that n-words in Czech don't have the de re readings. This follows from the predicate semantic type of Czech n-words. On the other hand in Germanic languages, negative noun phrases as quantifiers can quantifier raise over the modal verb, which is the reason for their ability to have the de re reading as well.

(93) *Inspektor nemusí tento týden zavřít žádné dva zločince.*
inspector not-must this week arrest no two criminals
'The inspector need not arrest two criminals this week.'

a. $\neg$ must $>$ $\exists$
b. *$\neg$ $>$ $\exists$ $>$ must

2.9 Open questions

I have analysed Czech negative noun phrases as indefinites with the need to be licensed by negation. Indefinites are generally peculiar in their wide scope behaviour (see e.g. Fodor and Sag (1982),Kratzer (1998), ...). Let's remind ourselves of the contrast between universal quantifier in (94) and an indefinite in (95)

(94) *Jestliže Petr koupí každou knihu v tomhle knihkupectví, tak přijde na buben.*
If Petr buys every book in this bookshop then will-be-he on drum
'If Petr buys every book in this book shop, then he will be broke.'

a. $[\forall x[BOOK(x) \rightarrow BUY(p,x)]] \rightarrow BROKE(p)$
b. *$\forall x[[BOOK(x) \rightarrow BUY(p,x)] \rightarrow BROKE(p)]$

(95) *Jestliže Petr koupí jednu knihu v tomhle knihkupectví, tak přijde na buben.*
If Petr buys one book in this bookshop then will-be-he on drum
'If Petr buys one book in this book shop, then he will be broke.'

a. $[\exists x[BOOK(x) \wedge BUY(p,x)]] \rightarrow BROKE(p)$
b. $\exists x[BOOK(x) \wedge [BUY(p,x) \rightarrow BROKE(p)]]$

It would be appropriate to check the behavior of Czech n-words whether it shows something similar in this respect. That means, if the n-words demonstrate any wide scope phenomena similar to the regular indefinites. At first sight this is not true as we see from (96) with the only grammatical reading in (96-a) and with the logically possible, very weak, but in the natural language totally ungrammatical reading in (96-b).

(96-b) can be paraphrased as: there is such an x (book) which if Peter doesn't buy the x, then he will remain rich. This would be true in a situation where one very expensive book in the bookshop would make Peter poor, although buying other books would be harmless for his wallet, but the sentence (96) is much more strong – it says that any book in this bookshop would ruin Petr.

(96) *Jestli si Petr nekoupí žádnou knížku v tomhle knihkupectví, tak*
If REFL Petr not-buy no book in this bookshop then
zůstane bohatý.
remain-will-he rich
'If Petr buys no book in this book shop, then he will remain rich.'
a. $\neg[\exists x[BOOK(x) \wedge BUY(p,x)]] \rightarrow REMAIN\_RICH(p)$
b. $\exists x[BOOK(x) \wedge \neg[BUY(p,x) \rightarrow REMAIN\_RICH(p)]]$

Let's follow an old practice and describe the fact by a stipulatively named rule and because it's just the opposite of the specificity marking of *certain*, let's call it unspecificity marking rule.

(97) **Unspecificity marking rule**
The n-words in Czech denote a predicate that must be existentially closed under the scope of verbal negation and also under the scope of any other logical operator.

The scope possibilities of Czech n-words are very restricted: they must be interpreted in the scope of negation and moreover in the scope of any other logical expression in their sentence. This again formally follows from the status of negation in Landman's framework. Negation scopes over the event variable, if some expression (noun phrase, adverbial, ...) wants to be scopally interpreted it must undergo quantifying-in which raises it over the negation. If Czech n-words are interpreted necessarily under the scope of negation, then by transitivity, they must be interpreted under all scope taking expressions in their sentence. The following examples demonstrate this claim.

(98) *Petr si nechtěl vzít žádnou řeznici.*
Petr REFL not-wanted marry no she-butcher
'Petr wanted to marry no woman butcher.'
a. $\neg$ > want > $\exists$ woman butcher
b. *$\exists$ woman butcher > $\neg$ > want

c. * $\neg > \exists >$ want

(99) *Dva řezníci nezabili žádného vola.*
Two butchers not-killed no ox
'Two butchers killed no ox.'

a. 2 butchers $> \neg > \exists$ ox
b. *$\exists$ ox $>$ 2 butchers $> \neg$

(100) *Petr často nejedl žádný řízek.*
Petr frequently not-ate no schnitzel
'Petr frequently ate no schnitzel.'

a. frequently $> \neg > \exists$ schnitzel
b. *$\exists$ schnitzel $>$ frequently $> \neg$

Last remark: the reason why n-words are incompatible with modifiers of the *certain* type is maybe semantic: *certain* wants to have widest scope but *no* goes in the opposite direction. From this it follows that no closure is available and ungrammatically arises.

(101) **Petr si nechce vzít žádnou jistou studentku.*
Petr REFL not-wants marry no certain student
'Petr wants to marry no certain student.'

2.10 Summary

The present analysis of n-words has shown that Czech n-words are of the set type ($\langle d, t\rangle$) and their type does not change in predicate position. N-words in argument position are interpreted as other indefinites through existential closure. The negative morphology of n-words is only an agreement feature which signals propositional negation (negative n-words in Slavic languages must be accompanied by a negated verb, where negation is high enough to have scope over the event variable). So n-words are indefinites of a special sort.

As predicates of the set type, n-words can be interpreted in opaque contexts selecting for properties; they can appear in the predicative nominal constructions (they are not quantifiers there); they can be mapped to the atom element representing the relevant group of objects and as such they can be arguments of collective predicates; and they can form summation of their arguments in coordination which is then interpreted as a generalized quantifier ranging over collective predicates.

Summary

The starting point of the investigations in this book was the model-theoretic approach to negation in natural language, particularly the application of the Language of Events and Plurality to Czech negation. In this framework I examined four different areas of natural language where negation leads to non-trivial (and hence linguistically interesting) problems – especially when we attempt to explicitly model the compositional building of the truth-conditions of the whole sentences.

The four areas were: interpretation of morphological negation occurring on verb and/or on noun phrases simultaneously (Chapter 2), interpretation of apparent aspectual properties of negation (Chapter 3), prediction of the scope possibilities of negation and other quantified noun phrases in natural language – especially universal quantifiers (Chapter 4) and finally the cross-linguistic variation with respect to negative manner and degree questions ungrammaticality.

All these problems surely require more research by linguists and the certainty of my conclusions holds only relatively to the data I examined. Nevertheless, I think it's safe to conclude that the semantics of natural language negation corresponds to the truth-reverting function of formal logic. All the apparent counterexamples to such a claim can be explained away if we take into account syntactic agreement and the logical type of negation which lead to its interpretation at the appropriate place in the formula (which can be pretty far from its surface position in natural language). The alleged aspectual shifting properties of negation are simply reducible to its inference reversal property which makes the telic environments homogeneous. The mysterious wide scope interpretation of negation with respect to the universal quantifier follows from the competence between universal NPs and negative NPs, which (with the negation on verb caused by the negative concord in languages like Czech) express the opposite scope of negation and the universal quantifier more economically. And finally the negation as the source of negative manner and degree questions ungrammaticality in English results from the independent focus-related properties of English and their different distribution in Czech.

At a more general level, I tried to solve all empirical puzzles of Czech negation which I came across during my investigation in the most conservative manner (relative to the framework I have chosen) as I was able to do. All the complications were blamed on the independent parts of natural language. This is just one of the ways to go, which is clear from the alternative hypotheses I mentioned in the previous chapters. But it's the one which strikes me as the best because of its elegance and simplicity, as no additional machinery was postulated beyond the tools which were independently needed in other areas of the natural language semantics.

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