Formal approaches to number in Slavic and beyond

Edited by

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To the memory of Joanna Błaszczak

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Preface

Mojmír Dočekal & Marcin Wągiel
Masaryk University

This collective monograph is one of the outcomes of the research project *Formal Approaches to Number in Slavic* (GA17-16111S; https://sites.google.com/view/number-in-slavic/home) funded by the Czech Science Foundation (GAČR) and carried out at the Department of Linguistics and Baltic Languages at Masaryk University in Brno in cooperation with researchers from the Center for Language and Cognition at the University of Groningen, the Department of German Studies at the University of Vienna, and the Center for Experimental Research on Natural Language at the University of Wrocław. The project examined the ways in which number, as a cognitive category, as well as various numerical operations are incorporated into grammars of Slavic in comparison with other languages.

Early versions of many of the contributions making up this book were first presented as papers at the Number, Numerals and Plurality workshop organized at the 12th conference on Syntax, Phonology and Language Analysis (SinFonIJA 12), which was held at Masaryk University in Brno on September 12–14, 2019 (the program of the conference can be found online: https://sites.google.com/phil.muni.cz/sinfonija12/program). The workshop aimed at a maximum of theoretical diversity and broad empirical coverage, features that we hope are maintained in this book. Encouraged by the success of the workshop and the quality of the papers presented, we invited selected authors as well as other researchers to address four coherent topics within the study of number in natural language: (i) plurality, number and countability, (ii) collectivity, distributivity and cumulativity, (iii) numerals and classifiers, and (iv) other quantifiers. The proposed collective monograph gathers peer-reviewed contributions exploring those themes both in Slavic and non-Slavic languages. Each of the chapters completed the two-round double-blind review process in which every paper was evaluated and commented on by two reviewers.

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This book would not have been possible without our extremely helpful reviewers: Boban Arsenijević, Joanna Błaszczak, Lisa Bylinina, Pavel Caha, Lucas Champollion, Luka Crnič, Flóra Lili Donáti, Kurt Erbach, Suzana Fong, Jovana Gajić, Ljudmila Geist, Scott Grimm, Piotr Gulgowski, Andreas Haida, Nina Haslinger, Dorota Klimek-Jankowska, Heidi Klockmann, Ivona Kučerová, Caitlin Meyer, Olav Mueller-Reichau, Rick Nouwen, Roumyana Pancheva, Lilla Pintér, Wiktor Pskit, Magdalena Roszkowski, Viola Schmitt, Yasutada Sudo, Balázs Surányi, Peter Sutton, Yuta Tatsumi, Barbara, Tomaszewicz-Özakın, Tue Trinh, Hanna de Vries, Kata Wohlmuth and Eytan Zweig. The whole book was reviewed by Jakub Dotlačil. Many thanks for your reviews! Furthermore, we would also like to most sincerely thank the OSL handling editors Berit Gehrke and Radek Šimík for their continuous and extensive help and support in making this book happen. We are also grateful to Chris Rance for proofreading the English text. Finally, we wish to acknowledge the technical support of the entire Language Science Press editorial team as well as the help of everyone else who contributed by type-setting and proofreading parts of the contents of this book. We hope that the readers will find it interesting and inspiring. This book is dedicated to the memory of Joanna Błaszczak who passed away shortly before its publication. She will be missed.

Mojmír Dočekal & Marcin Wągiel
Brno, 8 July 2021

Introduction

Chapter 1

Number in natural language from a formal perspective

Marcin Wągiel & Mojmír Dočekal
Masaryk University

In this introduction, we provide a general overview of a variety of phenomena related to the encoding of the cognitive category of NUMBER in natural language, e.g., number-marking, collective nouns, conjunctions, numerals and other quantifiers, as well as classifiers, and show how Slavic data can contribute to our understanding of these phenomena. We also examine the main strands of the study of number in language developed within formal lingusitics, linguistic typology, and psycholinguistics. Finally, we introduce the content of this collective monograph and discuss its relevance to current research.

Keywords: number, plurality, numerals, quantifiers, formal linguistics

1 Introduction

The goal of this monograph is to explore the relationship between the cognitive notion of NUMBER and various grammatical devices expressing this concept in natural language. The book aims at investigating different morphosyntactic and semantic categories including plurality and number-marking, individuation and countability, cumulativity, distributivity and collectivity, numerals, numeral modifiers and classifiers, as well as other quantifiers. It gathers contributions tackling the main themes from different theoretical and methodological perspectives in order to contribute to our understanding of cross-linguistic patterns both in Slavic and non-Slavic languages.

In this chapter, we will provide a brief introduction to various approaches to the study of the concept of number in natural language. We will mainly focus on

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the issues whose better understanding this book directly contributes to. First, in §2, we will discuss a variety of phenomena related to the expression of number in language. Then, in §3, we will review the major strands in linguistic research dedicated to explaining these phenomena. Finally, in §4 we will introduce the content of this book and briefly explain its contribution.

2 Number in language

The nature of the relationship between number as a cognitive category and language is highly complex, and thus the literature on the topic is vast. In this section, we will introduce a number of topics that are of relevance for the linguistic phenomena explored in this book and briefly discuss why they are important for a better understanding of how humans conceive of quantity and number.

2.1 Number sense

It is well-documented that humans possess what is often called NUMBER SENSE, i.e., an intuitive understanding of numbers and their magnitude as well as various numerical relations and operations (see, e.g., Dehaene 1997 for an overview). The human number sense involves two distinct cognitive systems, namely the object tracking system, which enables an immediate enumeration of small sets, and the approximate number system, which supports the estimation of the magnitude of a collection of objects without relying on symbolic representations (see, e.g., Hyde 2011 for an overview). This mental ability is argued to provide an endowed predisposition for developing the concept of exact number and simple arithmetic and to facilitate the acquisition of lexical categories related to quantity, such as numerals (e.g., Gelman & Gallistel 1978, Wynn 1990). Therefore, it seems that already in early childhood the language faculty interacts with that part of human mind that generates number sense.

2.2 Linguistic expression of the cognitive notion of number

Most languages of the world have formal means to express the conceptual distinction between 'one' and 'more than one'. A cross-linguistically widespread morphosyntactic device dedicated for that purpose is the category of GRAMMATICAL NUMBER (e.g., Corbett 2000). This category is typically expressed by an affix on the noun and/or by the agreement it triggers on other lexical items. The overall range of its values includes singular, dual (for two), trial (for three), paucal (for few, as opposed to many), plural and greater plural (for an excessive number).

Though languages typically encode only two or three of those values, there are also languages with more complex number systems as well as ones that do not mark those distinctions morphologically at all. An example of a language with a rich number system is Bayso, see (1), which distinguishes between number-neutral, singular, paucal and plural forms of the noun.

(1) a. lúban foofe
lion.GNRL watched.1.SG
'I watched a lion/lions.'

b. lubán-titi foofe
lion-SG watched.1.SG
'I watched a lion.'

c. luban-jaa foofe
lion-PAU watched.1.SG
'I watched a few lions.'

d. luban-jool foofe
lion-PL watched.1.SG
'I watched (a lot of) lions.' (Bayso, Cushitic; Corbett 2000: 11, adapted)

In Slavic, a complex number system including singular, dual and plural is attested in certain dialects of Slovenian as well as in Lower and Upper Sorbian, see (2).

(2) a. hród
palace.SG
'palace/castle'

b. hrod-aj
palace-DU
'two palaces/castles'

c. hrod-y
palace-PL
'palaces/castles' (Upper Sorbian; Corbett 2000: 20, adapted)

In these languages, dual triggers obligatory agreement with determiners, adjectives and verbs, as demonstrated in (3). Its semantic relationship with the singular and plural as well as its interplay with the meaning of numerals have been subject to important theoretical considerations (e.g., Dvořák & Sauerland 2006, Martí 2020).

(3) T-a dv-a stol-a st-a
these-DU.M.NOM two-DU.M.NOM chair-DU.M.NOM be-3.DU.PRS
polomljen-a.
broken-DU.M.NOM
'These two chairs are broken.' (Slovenian; Derganc 2003: 168, adapted)

Though in Slavic and other Indo-European languages grammatical number is typically marked through suffixation and inflection, other cross-linguistically common means include apophony, i.e., a word-internal sound change, as in the English pair *man* ~ *men*, and suppletion, e.g., *čelovek* 'man' ~ *ljudi* 'men' in Russian. Yet another frequent grammatical device employed for number marking across languages is reduplication (e.g., Moravcsik 1978, Corbett 2000). For instance, the repeated initial syllable in (4) functions as a morphological plural marker.

(4) a. kuna
husband
'husband'

b. kuu-kuna
RED-husband
'husbands' (Papago, Uto-Aztecan; Moravcsik 1978: 308, adapted)

A related phenomenon attested cross-linguistically is known as syntactic reduplication (e.g., Travis 2001, Pskit 2021 [this volume]), where the repeated material preceding and following the proposition gives raise to a plural interpretation, as illustrated in (5).

(5) Jon washed plate after plate for hours after the party. (Travis 2001: 457)

Though grammatical number often expresses the semantic concepts of SINGULARITY and PLURALITY, there are many well-studied mismatches between the two notions. First, the plural does not always mean 'more than one' (e.g., Sauerland 2003, Spector 2007, Zweig 2009). For instance, (6a) does not mean that only carrying multiple guns is illegal in Illinois. Similarly, (6b) cannot be true in a scenario where a single alien has walked the earth.

(6) a. Carrying guns is illegal in Illinois.

b. No aliens have ever walked the earth. (Nouwen 2016: 267)

Furthermore, there is an intriguing relationship between bare singular nominals and NUMBER NEUTRALITY (e.g., Rullmann & You 2006, Dayal 2011, Fong 2021 [this volume]). For instance, the bare direct object in (7) is not specified with respect to whether it refers to a single individual or to a plurality of individuals.

(7) anu bacca sambhaaltii hai
Anu child look-after-IPFV be-PRS
'Anu looks after (one or more) children.' (Hindi; Dayal 2011: 127, adapted)

Furthermore, a question arises whether the semantics of bare noun phrases in languages with articles like English and German is the same as in articleless languages such as most Slavic languages (e.g., Geist 2010, Heim 2011). Though it has been proposed that articleless languages employ other morphological or syntactic devices in order to express definiteness, e.g., word order, aspect and number marking, novel evidence suggests the meaning of bare nouns in Slavic is different than expected under standard theories of uniqueness and maximality (e.g., Šimík & Demian 2021 [this volume]).

The grammatical category of plural marking is closely related to COUNTABILITY, often known also as the mass/count distinction illustrated by the contrast in (8). While standard theories of mass and count tend to model this distinction in binary terms (e.g., Link 1983, Chierchia 1998, 2010), there is convincing evidence that nouns can be countable to various degrees forming a scale of the mass/count spectrum (e.g., Allan 1980, Grimm et al. 2021 [this volume]).

(8) a. Thirty three {tables/stars/pieces of that pizza}.
b. * Thirty three {bloods/waters/golds}. (Chierchia 2010: 104, adapted)

Naturally, what counts as 'one' and what counts as 'many' relates to a deep philosophical problem of individuation, i.e, a criterion of numerically distinguishing the members of a kind (e.g., Grimm 2012, Wągiel 2018). The problem of individuation becomes even more perplexing if we consider the class of abstract entities, e.g., *fact* and *information* (e.g., Grimm 2014, Sutton & Filip 2020), and belief objects, e.g., imaginary individuals such as monsters (e.g., Geach 1967, Haslinger & Schmitt 2021 [this volume]).

Across languages, there is also a distinct class of nominal expressions known as COLLECTIVE NOUNS, e.g., *committee* and *pile*.[1] Though such nouns are singular in terms of their morphosyntax, they denote a plurality of objects (e.g., Landman 1989, Barker 1992, Pearson 2011, Henderson 2017). This is evidenced by the fact that similar to plurals, but unlike singulars, collectives are compatible with predicates calling for plural arguments such as *meet*, see (9).

[1] Sometimes they are also referred to as group or bunch nouns.

(9) a. The {men/#man} met on Tuesday.

b. The committee met on Tuesday. (Barker 1992: 80, adapted)

Interestingly, Slavic languages with their rich nominal systems have many types of derived collectives, e.g., Czech *list* 'leaf' → *listí* 'foliage'.[2] This fact makes them an especially valuable source of data regarding the ways in which the semantic notion of plurality can be encoded in derivational morphology (e.g., Wągiel 2021 [this volume]).

Another class of expressions designating number consists of QUANTIFIERS such as *some*, *most* and *all*. The nature of the lexical representations of their meanings as well as the psychological mechanisms involved in the interpretation of those meanings have been a puzzling question not only in linguistics but also in cognitive science (e.g., Pietroski et al. 2009, Lidz et al. 2011, Tomaszewicz-Özakın 2021 [this volume]).

A well-known property of quantifiers is that they give rise to scalar implicatures, i.e., implicit inferences suggesting that the speaker had a reason for not using a stronger, i.e., more informative, term on the same scale (e.g., Horn 1984). For instance, uttering (10) implies that the addressee did not eat all of the cookies.

(10) You ate some of the cookies. (Horn 1984: 14)

In this context, what is of particular interest is children's understanding of quantifiers and their computation of scalar implicatures, which seem to differ from what we find in adults (e.g., Noveck 2001, Papafragou & Tantalou 2004, É. Kiss et al. 2021 [this volume]).

Yet another intriguing feature of quantifiers is that some of them enter nontrivial interactions with other phenomena such as negative polarity (e.g., Israel 1996, Solt 2015, Giannoula 2021 [this volume]). For instance, items like *much* can only appear in specific environments, such as negation, and are incompatible with affirmative contexts, as demonstrated by the contrast in (11).

(11) a. Albert didn't get much sleep.

b. * Albert got much sleep. (Israel 1996: 620)

A unique subset of lexical items dedicated to expressing quantity are CARDINAL NUMERALS. Though traditionally they were assumed to form a natural class with quantifiers such as *some* and *all*, there are good reasons to believe that in fact numerals are linguistic objects of a different type (e.g., Landman 2004: Ch. 2,

[2]Note that the form *listí* 'foliage' is not the plural of *list* 'leaf', which is *listy* 'leaves'.

Rothstein 2017: Ch. 2). As witnessed in (12), nominals modified by numerals can appear in predicate position while nominals involving other quantifiers cannot (on a non-partitive reading). Furthermore, numerals can also co-occur with the definite article and *every*, e.g., *the four cats* and *every two students*, respectively.

(12) a. The inhabitants of the barn are four cats.
b. # The guests are {some/most} students. (Rothstein 2017: 18, adapted)

The internal syntax and semantics of cardinal numerals as well as relationships between basic and complex numerals have been an important topic in the study of these expressions (e.g., Rothstein 2013, Ionin & Matushansky 2018, Wągiel & Caha 2020, Klockmann 2021 [this volume], Tatsumi 2021 [this volume]). One of the questions is whether the meaning and syntactic status of *six* is the same also in *sixty* and *six hundred.*

Though for a long time the mainstream research has been mostly focused on cardinals, like the ones described above, in recent years some attention has also been dedicated to puzzling semantic properties of numerals referring to numbers that are not positive integers like *zero* (e.g., Bylinina & Nouwen 2018) as well as fractions such as *one third* (⅓) and decimals like *two point five* (2.5) (e.g., Salmon 1997, Haida & Trinh 2021 [this volume]). A deeper understanding of how the mechanism responsible for quantification over parts of entities might also shed light on more general issues of individuation discussed above.

Furthermore, numerals can be modified by various modifiers including comparative modifiers such as *more than* as well as superlative modifiers such as *at least.* Though at first sight these two seem entirely synonymous only the latter give rise to ignorance inferences (e.g., Krifka 1999, Nouwen 2010, Donáti & Sudo 2021 [this volume]). To illustrate, consider the contrast in (13) in the scenario when the speaker knows that a hexagon has exactly six sides.

(13) a. A hexagon has more than three sides.
b. # A hexagon has at least three sides. (Nouwen 2010: 4, adapted)

Interestingly, in many languages across the world numerals cannot combine with nouns directly. For this purpose a special category of CLASSIFIERS is required, see (14) (e.g., Aikhenvald 2000, Bale & Coon 2014). Classifiers sort nouns based on the type of their referents and provide means of the individuation thereof.

(14) liǎng *(zhāng) zhuōzi
two CL table
'two tables' (Mandarin Chinese; Bale & Coon 2014: 695)

A puzzling property of some classifier systems is their optionality (e.g., Schvarcz & Nemes 2021 [this volume]). For instance, the classifier in (15) can but need not be used, which raises questions with respect to its semantic contribution.

(15) sa(-tangkai) bungo
one-CL flower
'one flower' (Minangkabau, Malayic; Aikhenvald 2000: 190, adapted)

Though classifiers are a rather marginal category in Slavic, there are a small number thereof in languages such as Bulgarian and Russian (e.g., Cinque & Krapova 2007, Khrizman 2016). For instance, the Russian classifier *čelovek* for counting persons can appear optionally in constructions like (16).

(16) pjat' (čelovek) stroitelej
five CL builders.GEN
'five builders' (Russian; Khrizman 2016: 4, adapted)

Another grammatical device dedicated to encoding plurality is CONJUNCTION. Interestingly, coordinated phrases as well as other plurality-denoting expressions give rise to an ambiguity between the collective, the distributive and the cumulative interpretation (e.g., Scha 1981, Link 1983, Beck & Sauerland 2000, Landman 2000, Haslinger et al. 2021 [this volume], Roszkowski 2021 [this volume]). For instance, (17) on the collective reading is true if John and Bill together gave one flower to Mary, Sue, Ann and Jane as a group. On the distributive reading, John gave a flower to the girls and so did Bill. Finally, the cumulative scenario could look like this: John gave a flower to Mary and Ann, whereas Bill gave a flower to Sue and Jane.

(17) John and Bill gave a flower to Mary, Sue, Ann and Jane.
(Beck & Sauerland 2000: 362)

In this respect Slavic languages have proved to be a valuable source of data since they grammaticalized a special category of collective numerals, which rule out the distributive reading (e.g., Dočekal 2012, Wągiel 2015). For instance, while (18a) receives both the collective and the distributive interpreation, (18b) allows only for the collective reading, i.e., the total of written letters is one.

(18) a. Tři chlapci napsali dopis.
three boys wrote.PL letter.ACC
'Three boys wrote a letter.'

b. Troj-ice chlapců napsala dopis.
three-COLL.F boys.GEN wrote.SG.F letter.ACC
‘A group of three boys wrote a letter.’
(Czech; Dočekal 2012: 113, adapted)

So far, we have discussed various ways in which the cognitive distinction between ‘one’ and ‘more than one’ is expressed by nouns and their modifiers. However, the expression of number is by no means restricted to the nominal domain. Many languages display the category of verbal number often termed as PLURACTIONALITY (e.g., Lasersohn 1995: Ch. 13). This grammatical device indicates that the action designated by the verb was performed more than once or that there is more than one participant involved in that action. For instance, the contrast in (19) shows that the semantic contribution of the pluractional marker, realized here as *tu*, is that the agent and the theme were involved in a plurality of pushing events.

(19) a. ʔiʃa-ʔ ʔinanta-siʔ ʔi=tuɗɗuur-ay
he-NOM girl-DEF 3=push-PFV
‘He pushed the girl.’

b. ʔiʃa-ʔ ʔinanta-siʔ ʔi=tu-tuɗɗuur-ay
he-NOM girl-DEF 3=PLU-push-PFV
‘He pushed the girl more than once.’
(Konso, Cushitic; Orkaydo 2013: adapted)

Verbal number is also related to ASPECT, which expresses how an event or a state denoted by the verb extends over time. Since Slavic languages are renowned for their rich aspectual systems, they have attracted a lot of attention in this area (e.g., Filip 1999, Borik 2006). For instance, morphologically marked iterative forms of verbs in West Slavic express repetitive events, as illustrated in (20).

(20) Irenka (często) chadz-a-ła do biblioteki.
Irenka often walk-ITER-PST to library.GEN
‘Irenka often walked to the library.’ (Polish; Piñón 1997: 469, adapted)

Moreover, it is known that the grammatical number of the noun phrase interacts non-trivially with the telicity of the entire verb phrase (e.g., Verkuyl 1972, Krifka 1998, de Swart 2006, Wągiel & Dočekal 2021 [this volume]). While in sentences with a singular indefinite object the predicate gets a telic interpretation, see (21a), its counterpart with a plural indefinite object is atelic, see (21b).[3]

[3]Notice, however, that not all predicates behave like this, e.g., *find* and *kill* do not.

(21) a. # Koos and Robby ate a sandwich for hours.
b. Koos and Robby ate sandwiches for hours. (Verkuyl 1972: 49–50)

The discussion of various grammatical and lexical devices dedicated to expressing the cognitive notion of number presented above by no means exhausts the potential of natural language. There are also various complex numerical expressions such as *two-fold* and *double* (e.g., Wągiel 2018), frequency adjectives such as *occasional* and *frequent* (e.g., Gehrke & McNally 2015), quantificational adverbials such as *two times* (e.g., Landman 2004: Ch. 11, Dočekal & Wągiel 2018) and *often* (e.g., Doetjes 2007) and many more. Nonetheless, we believe that this short presentation gives an overall idea of how elusive and multi-layered the relationship between number sense and grammar is. In the next section, we will briefly discuss various linguistic approaches that attempt to shed more light on the relationship in question.

3 Approaches to number

The phenomena described above have puzzled linguists, philosophers and psychologists for a long time. In this section, we briefly introduce three main research traditions that attempt at explaining the relationship between number and grammar.

In the last thirty years, formal linguistics has been heavily influenced by studies addressing the vexing questions concerning the proper treatment of grammatical number, conjunction, numerals, the mass/count distinction and a number of other related topics that can be vaguely summarized under the label THEORIES OF PLURALITY. The usual starting point is referenced as Link (1983), but of course, there are many influential pre-runners such as Bennett (1979), ter Meulen (1980), and Scha (1981). If we focus on the last three decades of the research on pluralities, we can identify several central frameworks which address the issues in question and offer heuristically intriguing paths to follow. At the end of the previous century, there appeared first proposals of the formalization of various interpretations of plurality-denoting noun phrases. Since then the study of number and plurality has become one of the central topics in linguistics.

The theories of plurality proposed so far differ in many respects. While some are more semantically oriented and develop models grounded in lattice-theory (e.g., Krifka 1989, Landman 1989, 2000, Champollion 2017), others take a more pragmatic stance and base their formalizations on sets (e.g., Schwarzschild 1996, Winter 2001). Furthermore, after the seminal work of Link (1983) the mainstream research has agreed upon a more parsimonious approach to ontological domains, though authors diverge in the way they formalize the cognitive distinction between objects and substances (see, e.g., Krifka 1989, Chierchia 1998, 2010, Rothstein 2010, Landman 2011, 2016). Moreover, already in the early years of semantic research the notion of plurality was extended to the domain of eventualities (e.g., Bach 1986) and then expanded to even more abstract categories. Another significant strand of the research pursued in formal theories of plurality focuses on the proper treatment of numerals and classifiers (e.g., Krifka 1995, 1999, Landman 2004, Ionin & Matushansky 2006, 2018, Bale et al. 2011, Bale & Coon 2014, Rothstein 2017). Finally, a growing body of literature concerns bounded and unbounded interpretations of numerals and the semantic contribution of numeral modifiers (e.g., Geurts 2006, Nouwen 2010, Kennedy 2015).

Independently to the research pursued in formal linguistics, the distribution and grammar of number and numerals has received a lot of attention in the typological literature (e.g., Corbett 1978, 2000, Greenberg 1978, Hurford 1987, 1998). Similarly, significant work has been carried out in the domain of classifiers (e.g., Dixon 1982, Aikhenvald 2000). What these broad cross-linguistic inquiries have revealed is that across languages there is a surprisingly rich diversity in meaning-form correspondences related to number and plurality. Yet, the exact nature of these correspondences remains unclear and the discovered variation often poses a challenge for the theoretical work described above.

Finally, for a couple of decades the way in which plurality and numerosity are linguistically expressed and cognitively processed has been a topic of interest for psycholinguists and cognitive scientists. This strand of research investigates experimentally different ways in which speakers refer to quantities in natural language. The key issues relate to countability, pluralization, quantity comparison and the mental representation of number magnitude (see, e.g., Henik & Tzelgov 1982, Shipley & Shepperson 1990, Dehaene et al. 1993, Barner & Snedeker 2005, Melgoza et al. 2008). Another important topic concerns the nature of the lexical representations of quantifiers alongside the psychological mechanisms involved in their interpretation (e.g., Pietroski et al. 2009, Lidz et al. 2011). Finally, acquisition studies have pursued to understand how children acquire the capacity to perceive, comprehend and use those parts of language that are dedicated to expressing quantity (e.g., Noveck 2001, Papafragou & Tantalou 2004). Despite intriguing experimental results, it is often still unclear how to account for the psycholinguistic findings in formal models.

Though all of these traditions are very insightful and have produced significant results, so far to a great extent they seem to be developing independently, and thus many important more general issues related to number and plurality remain elusive. We feel it is time to attempt to shed more light on the topic by proposing a monograph whose aim is to combine different empirical, methodological and theoretical perspectives. We hope that as a result the field will gain a better understanding of the relationship between the cognitive notion of number and different ways it is reflected in grammar. The research pursued in the course of the last decade proves that focusing on Slavic is a good place to start (see, e.g., Dočekal 2012, Wągiel 2015, Matushansky 2015, Khrizman 2016, Arsenijević 2017).

4 The contribution of this book

This monograph consists of four parts covering coherent topics within the study of number in natural language: (I) *Plurality, number and countability*, (II) *Collectivity, distributivity and cumulativity*, (III) *Numerals and classifiers* and (IV) *Other quantifiers*. Each part includes 3–6 chapters investigating different aspects of the main subject. In sum, the book consists of 19 chapters (including this introduction) related to each other by virtue of the general topic as well as formal linguistic frameworks adopted as their background. While being part of a broader whole, each chapter focuses on a particular problem from a different perspective, be it formal morphology, syntax or semantics, linguistic typology, experimental investigation or a combination of these. Concerning the empirical coverage, 11 out of the total of 19 chapters focus on Slavic data, often in comparison with other languages. The remaining 8 contributions either explore more general theoretical issues or investigate relevant linguistic phenomena in non-Slavic languages, which could also shed new light on the research on number and plurality in Slavic.

The first part, *Plurality, number and countability*, is dedicated to the study of grammatical number and its correspondence to the semantic notion of plurality including the mass/count distinction. Empirically, it covers Slavic as well as Germanic, Turkic, Afro-Asiatic and Niger-Congo languages. The contribution by Piotr Gulgowski & Joanna Błaszczak opens the volume by investigating experimentally the conceptual representation of grammatical and lexical number. This is pursued from the perspective of the perceptual processing of singular, plural and collective nouns in Polish. Subsequently, Scott Grimm, Ellise Moon and Adam Richman argue for a more fine-grained theory of countability by investigating strongly non-countable nouns in English such as *fatherhood* and *eyesight*. Based on the evidence from an extensive corpus search carried out on the COCA, they present a challenge for current approaches to the mass/count distinction, pointing to the need for a more general theory. Wiktor Pskit investigates (primarily) syntactic properties of English and Polish reduplicated constructions such as *goal after goal.* A Slavic perspective is insightful since it allows the correlation of grammatical aspect with the pluractional interpretation of the expressions in question. Dorota Klimek-Jankowska & Joanna Błaszczak relate plurality in the domain of objects and events. The experiment discussed in their chapter brings evidence in favor of the underspecification approach to the imperfective morphological aspect in Slavic. Suzana Fong explores the syntax of plural marking by examining bare nouns in Wolof. Her results suggest that the number interpretation of such nominals arise as a result of syntactic structures of a different size. Finally, Radek Šimík & Christoph Demian examine the correlation in Polish and German between uniqueness and maximality on the one hand, and grammatical number on the other. Based on a production experiment, they argue that Polish word order alternations are not semantic correlates of German articles.

The second part, *Collectivity, distributivity and cumulativity*, brings together contributions investigating distributive and non-distributive, i.e., cumulative and collective, interpretations of different types of nominals from a broad cross-linguistic perspective. Marcin Wągiel investigates the morpho-semantics of two different types of Slavic collective nouns arguing that the manner in which parts are related to the whole is often grammaticalized. The discussed data call for a mereotopological approach under which spatial collectives are interpreted as properties of spatial clusters, whereas social collectives are treated as properties of social clusters. Magdalena Roszkowski provides novel evidence from Polish concerning non-distributive interpretations of (allegedly) obligatorily distributive conjunction particles. The data are challenging for current theories of distributivity and demonstrate how careful exploration of Slavic data can help us to fine-tune the theories of plurality. Nina Haslinger, Eva Rosina, Magdalena Roszkowski, Viola Schmitt & Valerie Wurm test the cross-linguistic predictions of different theories of cumulativity with respect to morphological marking. Based on a typological sample covering 22 languages from 7 language families (including Slavic), they conclude that no obligatory markers for cumulative readings were attested. Finally, Nina Haslinger & Viola Schmitt explore contextual restrictions on intentional identity. Their research tackles an intriguing question, namely when are two intensions treated as distinct in natural language, by examining evidence from cumulative belief sentences.

The third part, *Numerals and classifiers*, explores theoretical challenges related to the categories in question and discuss data from a wide variety of languages including Slavic and Germanic as well as Hungarian and obligatory classifier languages such Mandarin Chinese and Japanese. Andreas Haida & Tue Trinh open this part of the book by convincingly showing that traditional theories of numeral denotations break down once we move beyond the usual examples including cardinals. They propose a more inclusive theory of numerals that could also account for decimals like *two point five* (2.5) by postulating a mereological subpart counting component. Heidi Klockmann investigates the syntactic status of base numerals in Polish and English. Her analysis provides an account for different types of numeral bases as well as insights concerning language change in the domain of numerals. On the other hand, Yuta Tatsumi provides a syntactic analysis of complex cardinals by building on parallels between multiplicands and numeral classifiers in a number of languages (including Slavic). The data discussed pose a challenge for mainstream theories of complex numerals while the developed analysis proposes a unified account for numeral constructions in both classifier and non-classifier languages. Flóra Lili Donáti & Yasutada Sudo explore the problem of defining alternatives for modified numerals from a theoretical perspective. Their account for the unacceptability of sentences with superlative numeral modifiers accompanied with scalar particles such as *even* brings a novel piece of evidence concerning the nature of such alternatives and provides insight into the strength of the additivity presupposition. Finally, Brigitta R. Schvarcz & Borbála Nemes investigate sortal individuating classifiers in Hungarian and their relationship with plurality and kind denotation. Their findings support analyses postulating that nouns are born as kind-denoting expressions and then can undergo a shift to predicates.

As already indicated by the title *Other quantifiers*, the last part of the book focuses on other types of quantifying expressions. Barbara Tomaszewicz-Özakın discusses how the verification procedure of an agent parsing sentences containing quantifiers is directly determined by the particular formal properties of the respective quantifiers. The findings of an eye-tracking experiment on four Polish quantifiers extend the results of previous behavioral studies on the topic. Katalin É. Kiss, Lilla Pintér & Tamás Zétényi present new evidence stemming from an acquisition study on Hungarian children's grasp of an existential plural determiner corresponding to English *some*. The reported results of their experiments seem to corroborate previous studies suggesting that at least some pragmatic interpretative resources are acquired later in the course of language acquisition. Finally, Mina Giannoula brings some intriguing data concerning a previously observed fact that in some languages *much* behaves in certain contexts as a weak negative polarity item. Based on a grammaticalized distinction in Greek, she argues that one of the two Greek equivalents of *much* behaves like a strong negative polarity item in the sense of veridicality-based approaches.

We believe that the broad multi-dimensional empirical and methodological perspective of this collective monograph will be of interest to researchers focusing on how certain cognitive distinctions concerning number and related issues are represented in grammar, be it linguists, philosophers or cognitive psychologists. The reader will find data not only from Slavic languages, which constitute the main empirical focus of the book, but also from a number of typologically and genetically diverse languages including, e.g., English, German, Spanish, Greek, Japanese, Mandarin Chinese, Hungarian, Turkish as well as Wolof. Thus, we believe the book will be valuable not only to linguists working on Slavic, but also to those interested in broader cross-linguistic research and typology.

Abbreviations

1	first person	ITER	iterative aspect
3	third person	M	masculine gender
ACC	accusative case	NOM	nominative case
CL	classifier	PAU	paucal number
COLL	collective marker	PFV	perfective aspect
DEF	definite marker	PL	plural number
DU	dual number	PLU	pluractional marker
F	feminie gender	PRS	present tense
GEN	genitive case	PST	past tense
GNRL	general number	RED	reduplication
IPFV	imperfective aspect	SG	singular number

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Part I

Plurality, number and countability

Chapter 2

Conceptual representation of lexical and grammatical number: Evidence from SNARC and size congruity effect in the processing of Polish nouns

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The goal of the present study was to investigate the numerical representation of the referents of collective singular nouns in comparison with non-collective singular and plural nouns. Specifically, we asked whether the representation of collective singulars is influenced by the grammatical number (singularity) or the lexical specification (plurality of collection elements). This question was addressed in two psycholinguistic experiments using a technique based on two number-related phenomena: the spatial-numerical association of response codes (SNARC) effect and the size congruity effect. Participants performed semantic (Experiment 1) or grammatical (Experiment 2) number judgments for collective and non-collective Polish nouns, while the response hand, grammatical number and font size of the words were manipulated. A weak SNARC effect was found in the form of faster responses for grammatically singular nouns with the left hand and for grammatically plural nouns with the right hand. Collective singulars patterned with non-collective singulars suggesting that the primary representation of collective referents does not include conceptual plurality. The numerical interpretation seems to be driven more by grammatical than lexical factors. The SNARC effect was present only in Experiment 1, which points to its dependence on the task type. No size congruity effect occurred in either experiment, so the size of the denoted set does not appear to be a salient property of the conceptual representation of linguistic number.

Keywords: collectivity, number, plurality, size congruity effect, SNARC

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1 Introduction

In many languages number has the status of a grammatical category as illustrated by contrasts like *dog* vs. *dogs* in English. These contrasts are linked with certain conceptual distinctions, specifically with communicating whether the speaker has in mind one thing or multiple things. Linking number form with number meaning is not always a straightforward task. Collective nouns are a class of words characterized by an inherent plurality. A grammatically singular collective noun, like the English word *committee*, is lexically specified as a collection with multiple elements. Proper comprehension of a singular collective noun requires the ability to reconcile those two sources of numerical information and to construct the correct interpretation. The goal of the present study is to shed more light on how language comprehenders represent the denotation of collective singular nouns (e.g., *army*) and how those representations compare to non-collective singular nouns (e.g., *soldier*) and plural nouns (e.g., *soldiers*). We were particularly interested in whether the numerical construal of a collective referent is primarily affected by the lexical or the grammatical factors. Past research (Bock & Eberhard 1993, Bock et al. 2006, Nenonen & Niemi 2010) revealed that the plural reading of collective nouns is less common than the singular reading, which might suggest that the reading of such words is determined mostly by their grammatical number. However, the methods used in past studies may not have been able to capture the way in which the participants actually construed the objects denoted by collective nouns (as discussed below). To investigate this issue we used a technique based on two phenomena known to be related to general numerical cognition: the spatial-numerical association of response codes (SNARC) effect and the size congruity effect. Both effects belong to the class of interference phenomena in which two dimensions (e.g., conceptual number and size) collide resulting in a conflict detectable in reaction times. Employing these effects as diagnostics of conceptual singularity and plurality allowed us to investigate the numerical representations built automatically by language users as they encounter singular, plural and collective nouns.

2 Past research

The semantics of grammatical number has long been an important topic of formal linguistic analyses. Notable work has been done within the framework which applied mereological tools to extend the ontological domain of language in order to include plural objects and groups as well as singular atoms (Link 1987, Landman 1989).[1] Since grammatically singular nouns naming a collection (e.g., *army*) can refer to the collection as a whole (a collective or singular reference) or to its elements (a distributive or plural reference), a proper description of their semantics has been challenging. Consequently, collectivity has been the subject of multiple theoretical accounts (for an overview, see Levin 2001: Section 1.2). The problem of singular nouns denoting multiple entities also attracted the attention of experimental researchers. Some of the empirical findings are discussed below.

Bock & Eberhard (1993) showed participants a list of English nouns (collective and non-collective) that were either singular or plural. The participants were asked to indicate how many things each word represented. The results revealed that collective singulars were significantly more likely to be associated with the "more than one thing" answer (41% of responses) than non-collective singulars (10% of responses). In contrast, this answer constituted around 90% of responses for grammatically plural nouns. Nenonen & Niemi (2010) conducted a similar judgment test for several classes of Finnish nouns, including derivationally created collectives. The results showed again that participants allowed plural referents for grammatically singular collective nouns, though less commonly than in Bock & Eberhard's English study: the "more than one thing" answers constituted around 20% of responses in this condition. Overall, a plural interpretation of collective singulars was available, although it was clearly not the dominant one. Additionally, the authors reported a considerable variability for individual collective nouns, which ranged from 0% to around 40% of the "more than one thing" responses, suggesting that not all nouns commonly treated as collective by linguists may in fact have this status for the majority of speakers.

In some varieties of English, grammatically singular collective subjects can appear with both singular and plural agreement morphology on the verb. This is known as conceptual (or notional) agreement.

(1) The committee has/have finally made a decision.

An investigation of the agreement patterns for collectives in two major varieties of English can be found in Bock et al. (2006). In a sentence completion study, participants (British English and American English speakers) were instructed to turn simple definite noun phrases containing different types of nouns into full sentences. Collective singular nouns were followed by plural verbs in around 20% of continuations for BE speakers and in around 2.3% of continuations for AE speakers. This was in contrast to the near lack of plural agreement continuations following ordinary singular nouns and nearly 100% of plural agreement

[1] For a more recent discussion of the semantics of number, see Moltmann (2016).

continuations following plural nouns for both language varieties. A similar pattern was found in a corpus survey of American and British financial press also presented in Bock et al. (2006). In the studied sample, collective singular nouns were followed by plural verbs in around 26% of cases in the British corpus and in around 7% of cases in the American corpus. The study confirmed that plural verb agreement for collective singular subjects is available as an option for the speakers of contemporary British English, although it is chosen less frequently than singular agreement.

That singular nouns can denote multiple objects has also been demonstrated with words known as object-mass nouns (e.g., *furniture*, *jewelry*, *clothing*), which have been argued to individuate their meaning despite being morphosyntactically uncountable (Barner & Snedeker 2005). Object-mass nouns resemble collective nouns, the main difference being that the former disallow plural forms (e.g., **furnitures*) whereas the latter can be pluralized (e.g., *armies*).

A phenomenon similar to lexical collectivity also exists at the level of predicates. Sentences with plural subjects, like in the example below, can be ambiguous.

(2) Three students lifted a piano.

The sentence can be understood as referring to a situation where all three students lifted the piano together (collective reading) or to separate events of piano lifting (distributive reading). In an eye-tracking experiment, Frazier et al. (1999) presented participants with sentences containing conjoined subjects that were ambiguous between a collective and a distributive reading (e.g., *Jane and Martha weighed 220 pounds…*). The sentences contained also a disambiguating adverb located in different places depending on the condition. If the disambiguating adverb appeared after the predicate, participants needed more effort (longer fixation times, more regressions) to process the disambiguation when the adverb was distributive (*each*) than when it was collective (*together*). This indicates that a collective reading of a sentence might be the preferred interpretation. An ambiguous predicate is by default assumed to be collective and the comprehender needs some time to recover if this initial assumption turns out to be wrong.

The studies discussed above extended our understanding of collectivity by providing more information about the likelihood of the singular (collective) and plural (distributive) reading of such words. The results indicate that the dominant interpretation associated with a collective noun is singular. It is not clear, however, whether the observed effects reflect the way in which the referents of collectives are truly conceptualized when they are encountered. The number judgment studies by Bock & Eberhard (1993) and Nenonen & Niemi (2010) or the sentence completion study by Bock et al. (2006) did not control for the possibility that participants used (at least partially) the response strategy of deliberately following the grammatical number marking on the noun, so the preponderance of singular responses in those studies may not correspond to the basic representation of collective referents. The eye-tracking experiment of Frazier et al. (1999) suggests a general tendency to represent collections primarily as wholes instead of focusing on the individual elements. However, the materials used in that experiment contained conjoined noun phrases instead of collective nouns. Additionally, a preference at the sentence level might not generalize to the level of words.

Three possibilities exist. The first possibility is that the singular construal (the collection as a whole) is indeed the primary representation of the referents of collective nouns, as suggested by the results of past research. The plural reading under this scenario must be derived from this default singular interpretation by some process, perhaps by highlighting constituent parts through a kind of profiling mechanism described by Lagnacker (1991). The second possibility is that conceptual plurality following from lexical semantics is primary for collectives. In this case, the predominant singular judgments and agreement patterns reported in the past studies could result from a deliberate response strategy and should be absent in measures of more automatic processes. One more possibility is that both construals of a collective word (conceptual singularity and plurality) are activated simultaneously leading to a competition.

Distinguishing between those three possibilities requires applying a tool sensitive to number-related concepts and capable of capturing early mental construals. For this reason, the method chosen for the present study depended on measuring reaction times, which may reveal aspects of the numerical representations not reflected in the elicited judgments. The method was based on two interference phenomena well documented in the literature on numerical cognition. The following section introduces both phenomena and discusses their suitability for studying grammatical number in general and collectivity in particular.

3 Number interference effects

Numerical cognition is the name for the psychological mechanisms responsible for processing numbers and quantities. It has been established that humans share with many other animal species the ability to quickly determine the exact number of elements in a set of up to four things and to estimate the approximate numerosity of larger sets (Feigenson et al. 2004). Another finding has been that processing a numerical quantity (expressed, for instance, by a digit or a number word) can be disrupted by processing other types of information, like spatial relations or size (Dehaene et al. 1993, Henik & Tzelgov 1982, Fitousi et al. 2009, Cohen Kadosh et al. 2007). Such interference can be used to find out whether a specific stimulus activates a numerical concept in the mind of an experiment participant.

3.1 Number and space: The SNARC effect

In a series of experiments designed to test the representation and extraction of number-related information (parity and numerical magnitude) associated with number symbols, Dehaene et al. (1993) asked participants to determine whether numbers (single digits in the range 0–9) appearing individually on the screen are odd or even by pressing a button with the left hand or the right hand. The assignment of the correct response to the hand was manipulated. There was a significant interaction between the magnitude of the displayed numbers and the response hand, with faster responses to small numbers using the left hand and to big numbers using the right hand. The effect was sensitive to relative, rather than absolute, numerical values (numbers 4 and 5 received faster responses with the right hand when they were tested in the range 0–5 and with the left hand in the range 4–9) as well as to reading and writing habits (it was much weaker or even reversed for Iranian subjects more familiar with a right-to-left writing system). The phenomenon has been labeled the SPATIAL-NUMERICAL ASSOCIATION OF RESPONSE CODES (SNARC) effect.

The SNARC effect has been found in auditory as well as visual modality, for Arabic digits and for number words (Nuerk et al. 2005). The existence of the SNARC effect has been used as an argument in favor of the mental number line hypothesis, i.e., the idea that magnitudes associated with numbers are represented mentally as if on an imaginary line, typically with small numbers on the left and large numbers on the right (Dehaene et al. 1993, Göbel et al. 2011, Pavese & Umiltà 1998). The effect has also been found for tasks involving determining the size (Fitousi et al. 2009) or color (Keus & Schwarz 2005) of number symbols. Performing those tasks does not require accessing the number value of the symbols, so numerical information seems to be activated automatically even if participants do not pay attention to it. However, the kind of task does matter. Röttger & Domahs (2015) carefully tested the influence of the task demands on the SNARC effect. They gave participants four kinds of tasks using written German numerals as stimuli. No SNARC effect was found for the tasks focusing on visual features (type of font) or lexical features (real word or pseudoword), however the effect was present for two semantic tasks (parity and magnitude determination).[2]

Although the numerical concepts associated with grammatical number (singularity vs. plurality) are less precise than the values encoded by numerals, they too can give rise to the SNARC effect, as demonstrated by Röttger & Domahs (2015). Singular and plural German nouns were used as stimuli in an experiment resembling closely the experiment with numerals described above. The task once again probed four levels of processing: visual features (font type), lexical features (real word or pseudoword), non-numerical semantics (animacy) and numerical semantics (singular or plural meaning). The analysis of response times indicated that participants exhibited a left hand facilitation for singular nouns and a right hand facilitation for plural nouns. This pattern resembled the classic SNARC effect for small and large numbers and was consistent with the possibility that singular nouns (denoting a small amount) are linked with the left end of the mental number line, while plural nouns (activating the concept of a large quantity) are linked with the right end. The effect was statistically significant only for the task requiring direct access to number semantics (i.e., deciding whether a given noun names one or more than one entity).

3.2 Number and size: The size congruity effect

A different mental mechanism in the form of SIZE CONGRUITY EFFECT (SCE) connects numerical cognition with the processing of size. The non-numerical variant of the effect was originally demonstrated by Paivio (1975). Participants in that study were shown pairs of pictures of animals and objects. The pictures differed in sizes. In the incongruent condition, the entity smaller in real life was represented as visually larger (e.g., a lamp bigger than a zebra). In the congruent condition, the depicted objects were of the expected proportions. Participants were asked to indicate which object is larger in real life while ignoring the sizes of the pictures. The responses were faster when the picture sizes matched the real life sizes. A numerical version of the effect was described by Henik & Tzelgov (1982). Pairs of Arabic digits of varying font sizes were used in a magnitude comparison experiment. The numerical and visual magnitudes were either congruent (e.g., 3 vs. **5**) or incongruent (e.g., **3** vs. 5). The average response times in the congruent condition were faster than in the incongruent condition. This interference effect has been replicated in subsequent studies both with digits and number words (Besner & Coltheart 1979, Cohen Kadosh et al. 2007, Foltz et al. 1984).[3] To our

[2] Number words seem more sensitive to the type of task than digits, as demonstrated in phoneme monitoring experiments (Fias 2001, Fias et al. 1996).

knowledge, a size congruity effect for grammatical number (or lexical collectivity) has not yet been demonstrated. However, given that interpreting number in language gives rise to a mental representation of quantity (Patson 2016, Patson et al. 2014), it should also activate set size information.

3.3 Combining SNARC with SCE

An experimental design combining the two phenomena has been presented in Fitousi et al. (2009). In order to find out whether the SNARC effect and the SCE would interact, participants were asked to determine the font size of numbers displayed on the screen (Arabic digits 1–9 except 5) by responding with the right or left hand for large font or small font digits (the assignment of correct responses to the left or right hand varied between blocks). The number value and size of stimuli were thus independently manipulated. Participants were asked to ignore the numerical value of the digit. There was a clear size congruity effect and a significant SNARC effect. The authors found no statistical evidence in the data for any interaction between the two effects, but the study showed that the two effects can be elicited simultaneously in a single experiment. The same was also attempted in the present work. We decided to combine both effects in order to create a more sensitive tool for detecting the activation of numerical concepts and, consequently, to provide a more comprehensive picture of how the referents of collective nouns are numerically represented and of the role of grammatical and lexical factors. Additionally, by using a SNARC-SCE technique we hoped to determine whether the numerosity representations constructed from nouns resemble the representations evoked by numerals and digits in terms of relations with both size and space.

[3] SCE can be used as an argument for the existence of a general magnitude processing mechanism where a common, modality-independent representation is assigned to all kinds of quantity. However, critics of this hypothesis (Van Opstal & Verguts 2013) point out that the observed interaction between number and physical magnitude may take place at a relatively late decision-making stage where the outputs of completely or partially distinct systems compete for response selection (e.g., *small* from number magnitude interpretation competing with *big* from visual size analysis). Similarities in the processing of discrete (number) and continuous (size) quantities may result from similar task demands or the limitations of the basic cognitive systems, like working memory. See also the discussion in Santens & Verguts (2011).

4 Experiment 1

4.1 Research questions and predictions

The goal of Experiment 1 was to investigate whether the numerical representations associated with collective singular nouns depend more on the grammatical singularity or lexical plurality of those words. This was done by comparing collective singulars with non-collective singular and plural nouns. The number concepts activated by each noun type were measured by the capacity of the words to produce the SNARC effect and the size congruity effect. The design consisted of a semantic number judgment task (determining how many things a word denotes) combined with manipulating the response hand, grammatical number and font size of collective and non-collective (henceforth UNITARY) Polish nouns.

The predictions for unitary singulars and plurals were straightforward, based on the results from previous studies of the SNARC effect (e.g., Röttger & Domahs 2015) and the size congruity effect (e.g., Henik & Tzelgov 1982). Unitary singular nouns were predicted to activate the concept of 'one', congruent with the left side (SNARC) and with small font (SCE). Plural nouns were predicted to evoke the notion of 'more than one', congruent with the right side and with big font. The congruent conditions were expected to result in a facilitation in the form of faster responses.

The results for collective singulars were of particular interest. If the primary representation of their meaning is determined by the lexical information about the multiplicity of constituent elements, they should pattern with grammatically plural nouns. If the referent of collectives is conceptualized primarily as singular, in accordance with their grammatical number designation, then they should behave like unitary singular nouns. If both construals (conceptual singularity and plurality) are initially activated resulting in a conflict and competition, collective singular nouns could fall somewhere between unitary singular and plural nouns in terms of their capacity to elicit the SNARC effect and the SCE.

4.2 Design

4.2.1 Materials

Thirty unitary singular nouns (e.g., *wilk* 'wolf') were selected for the experiment. Thirty plural forms were created from the singulars (e.g., *wilki* 'wolves').

Additionally, 20 collective singular nouns (e.g., *ławica* 'shoal') were chosen. Although collective singular nouns in Polish do not allow for a plural subject-verb agreement, the collective status of Polish nouns can be demonstrated by their compatibility with predicates which normally require plural subjects (e.g., *zebrać się* 'to gather'). This was used as a criterion for the selection of collective nouns for the experiment from a candidate set prepared based on the authors' intuition.

Plural equivalents of collective singulars were not created by simply pluralizing them. Instead, a plural form of a closely semantically related unitary noun was selected for each collective singular (e.g., plural *śledzie* 'herrings' for collective singular *ławica* 'shoal'). This was done for two reasons. First, many Polish collective nouns show case syncretism across grammatical number (e.g., *grup-y* 'group-NOM.PL' or 'group-GEN.SG'). Such number ambiguity is easily disambiguated with context, but, in the present experiment, words were shown in isolation and the results hinged on a fast recognition and activation of number values. None of the plural forms used in the study was ambiguous in this way. The second reason was to avoid the possible difficulties with processing "doubly plural" forms like *teams*.

Overall, there were 100 nouns (60 unitary and 40 collective), 50 singular and 50 plural, each occurring in a big font and a small font condition as well as in a left response hand and a right response hand condition. This design resulted in 400 trials presented in two blocks. Every participant saw every item. The presentation order was fully randomized across blocks for every participant.

4.2.2 Procedure

The experiment was conducted on a standard PC computer using a 23.6 inch monitor (LG 24M35D-B) with a 1920×1080 resolution. With the distance of a participant from the screen of approximately 60cm, a single character in the small font condition (50 pixels) subtended $\sim 0.45°$ (horizontally) by $\sim 0.75°$ (vertically) of visual angle, while a single character in the big font condition (150 pixels) subtended $\sim 1.62°$ (horizontally) by $\sim 2.39°$ (vertically) of visual angle.

The experimental procedure was based on the techniques presented in Röttger & Domahs (2015) and Fitousi et al. (2009), who used a pure SNARC effect and a combination of the SNARC effect with the SCE, respectively. At the beginning of each trial, five asterisks appeared at the center of the screen. The symbols were automatically replaced after 300ms by an experimental stimulus. The stimulus was a singular or plural Polish noun displayed either in small font or big font. The participant's task was to determine whether the noun referred to one or more than one thing (semantic number judgment) while ignoring the visual size of the stimulus. The stimulus remained on the screen until the participant made a decision by pressing the "z" or "/" key on a standard QWERTY keyboard corresponding to the answers "one" or "more than one". There was a 300ms blank screen between trials.

The experiment consisted of two blocks. The assignment of keys to responses changed after the first block (e.g., if "z" in Block 1 meant "more than one", in Block 2 it meant "one"). A message before each block informed the participant about the current assignment of keys. The order of key assignments in blocks was counterbalanced across participants. There were three breaks within each block. During a break the participant was encouraged to rest and resume the experiment by pressing a button. In each block, the experiment proper was preceded by a training session with 24 trials. The set of training items consisted of nouns balanced in terms of grammatical number, font size and response hand. None of the items used in the training session appeared later in the experiment proper. Feedback was provided if the participant made a mistake in the form of a message (*źle* 'incorrect') that stayed on the screen for 1 second. In the training session a message appeared also after correct responses (*dobrze* 'correct'). During the experiment proper, feedback was provided only for incorrect responses. The main purpose of the feedback was to facilitate learning the correct assignment of keys.

The experiment was designed and presented using the PsychoPy software (version 1.84.2) (Peirce 2007, 2009).

4.2.3 Participants

Twenty-two students of the Institute for English Studies of the University of Wrocław (9 women, 13 men) took part in the experiment. Participants were all native speakers of Polish. The average age was 20.8 (SD = 2.5).

4.3 Results: Number judgments

To determine the general availability of a plural reading of collective nouns in Polish, the first analysis looked at the judgments the participants made regarding the semantic number of the nouns (determining whether a word named one or more than one thing).

The percentage of "more than one thing" responses for collective singulars (M = 20.7%, SD = 31.2) was considerably lower than for plurals (M = 97.4%, SD = 2.7), but it was higher than for unitary singulars (M = 2.4%, SD = 2.9). The participants regarded grammatically plural nouns as almost always referring to multiple entities. Unitary singular nouns were almost always interpreted as denoting a single thing. The answers for collective singulars were less consistent. Nouns in this condition were predominantly interpreted as referring to one thing, but around a fifth of responses indicated a plural reading. A pair of one-way ANOVA tests (by subjects and by items) with the percentage of plural responses as the dependent variable and the type of number (collective singular, unitary singular, plural) as the independent factor confirmed that the difference was statistically significant ($F_1(2, 42) = 172.990, p < 0.001, \eta^2 = 0.892; F_2(2, 97) = 12209.997, p < 0.001, \eta^2 = 0.996$).

The variance among collective singulars was larger than for the other conditions. The most plural-like collectives (*armia* 'army', *brygada* 'brigade') received the "more than one thing" answer in 26% of cases, while for the most singular-like collective (*zbiór* 'set', the only collective noun used in the experiment that was not clearly animate) the singular answer was given in 13% of cases.[4]

Some variance existed also among the participants. Four participants never chose the "more than one thing" answer in the collective condition, meaning that they treated collective nouns as exclusively singular. On the other end of the scale, two participants chose the "more than one thing" response for 92% of collectives, meaning that nouns from this group were predominantly plural for them. For the majority of the participants, the "more than one thing" answers in this condition did not exceed 35% of responses. See Table 2 for percentages in individual conditions.

4.4 Results: Reaction time

The data were cleaned first by removing all incorrect responses (with the exception of answers to collective singulars) and then eliminating all trials with reaction times (RT) 3 standard deviations above and below the mean for every participant.[5] This resulted in eliminating 184 data points, which constituted 2.1% of correct responses. The remaining trials were subjected to tests performed with the SPSS software (version 22).

A pair of 3×2×2 ANOVA tests (by subjects and by items) were conducted with RT as the dependent variable and the following independent factors and all their interactions:

- Number Type (collective singular, unitary singular, plural)
- Font Size (small, big)
- Response Hand (left, right)

[4] A high variance for collectives has been reported before by Nenonen & Niemi (2010).

[5] Because no response could be considered objectively wrong for collective singulars, all answers in this condition were included in the final analysis.

Results of the ANOVA tests are given in Table 1. Mean reaction times and accuracy in each condition are given in Table 2.

Table 1: ANOVA test results for Experiment 1. NT: Number Type; FS: Font Size; RH: Response Hand.

Source	df		F		*p*		Partial η^2	
	F1	F2	F1	F2	F1	F2	F1	F2
NT	2, 42	2, 97	18.67	35.35	<0.001*	<0.001*	0.47	0.42
FS	1, 21	1, 97	0.26	0.05	0.615	0.942	0.01	0.00
RH	1, 21	1, 97	0.54	1.17	0.471	0.283	0.03	0.01
NT×FS	2, 42	2, 97	0.66	0.19	0.520	0.828	0.03	0.00
NT×RH	2, 42	2, 97	1.25	6.06	0.296	0.003*	0.06	0.11
FS×RH	1, 21	1, 97	0.45	0.14	0.508	0.712	0.02	0.00
NT×FS×RH	2, 42	2, 9	0.22	0.11	0.802	0.893	0.01	0.00

Table 2: Mean reaction times (ms) and number judgment answers (percent of plural responses) in all conditions in Experiment 1. Standard errors in parentheses

	Response Hand					
	Left		Right		Congruity (Left – Right)	
Num Type Font Size	RT (ms)	Answ (% of pl)	RT (ms)	Answ (% of pl)	RT (ms)	Answ (% of pl)
Col Sg						
Small	854(47)	19.3%(7.0)	910(54)	23.0%(6.7)	−56	−3.7%
Big	853(45)	19.5%(6.7)	902(59)	21.1%(6.9)	−49	−1.6%
Unit Sg						
Small	772(41)	2.0%(0.8)	784(42)	2.1%(0.8)	−12	−0.1%
Big	776(38)	2.6%(1.0)	789(43)	3.0%(0.7)	−13	−0.4%
Plural						
Small	821(47)	97.5%(0.6)	802(35)	97.0%(0.7)	19	0.5%
Big	818(46)	97.5%(0.7)	779(32)	97.6%(0.6)	39	−0.1%

4.4.1 Number Type effect

The main effect of Number Type was significant, see Table 1. Responses to collective singular nouns were on average longest (M = 880ms, SE = 45), followed by responses to plural nouns (M = 805ms, SE = 38) and unitary singular nouns (M = 780ms, SE = 38). However, this significant main effect has to be considered in the context of a significant (by items) interaction between Number Type and Response Hand. No other main effect was significant.

4.4.2 SNARC effect

The interaction of Number Type×Response Hand was not significant by subjects but it was significant by items, see Table 1. For unitary singulars and plurals the interaction was consistent with the predicted SNARC effect. Responses for unitary singular nouns were faster with the left hand than with the right hand. The opposite was true for plural nouns. Collective singulars patterned with unitary singular nouns. The left hand preference for collectives was numerically even bigger than for unitary nouns. See Table 3 for reaction times and number judgments.

Table 3: Congruity of response hand and number type (SNARC) in Experiment 1 measured in reaction times (ms) and number judgment answers (percent of plural responses). Standard errors in parentheses

	Response Hand					
	Left		Right		Congruity (Left − Right)	
Num Type	RT (ms)	Answ (% of pl)	RT (ms)	Answ (% of pl)	RT (ms)	Answ (% of pl)
Col Sg	853(45)	19.4%(6.8)	906(55)	22.0%(6.7)	−53	−2.6%
Unit Sg	774(39)	2.3%(0.7)	787(42)	2.6%(0.7)	−13	−0.3%
Plural	820(46)	97.5%(0.6)	791(33)	97.3%(0.6)	29	0.2%

4.4.3 Size congruity effect

The Number Type×Font Size interaction was not significant either by subjects or by items, see Table 1. There was, therefore, no statistically valid evidence for any size congruity effect. See Table 4 for reaction times and number judgments.

Table 4: Congruity of font size and number type (SCE) in Experiment 1 measured in reaction times (ms) and number judgment answers (percent of plural responses). Standard errors in parentheses

	Font Size					
	Small		Big		Congruity (Small – Big)	
Num Type	RT (ms)	Answ (% of pl)	RT (ms)	Answ (% of pl)	RT (ms)	Answ (% of pl)
Col Sg	882(45)	21.1%(6.7)	877(46)	20.3%(6.6)	5	0.8%
Unit Sg	778(39)	20.0%(0.7)	783(38)	28.0%(0.7)	−5	−8.0%
Plural	812(40)	97.3%(0.6)	798(36)	97.5%(0.6)	14	−0.2%

4.5 Discussion

4.5.1 Plural interpretation of collectives

The judgment data showed that participants chose the "more than one thing" answer in 20.7% of responses in the collective singular condition, compared to just 2.4% in the unitary singular condition and 97.4% in the plural condition. This outcome is similar to the number judgment results for collectives obtained in earlier studies with speakers of English (Bock & Eberhard 1993) and Finnish (Nenonen & Niemi 2010). Polish speakers participating in the experiment were aware that collective nouns can refer to multiple objects despite their grammatical singularity, even though they were more likely to treat nouns from this category as semantically singular.

4.5.2 SNARC effect

The interaction of the type of number (collective singular, unitary singular, plural) and the response hand was significant, although only in a by-items analysis.

For unitary singular nouns, participants responded faster with the left hand than with the right hand. The opposite was true for plural nouns. This pattern resembled the SNARC effect observed for small and large numbers (Dehaene et al. 1993, Gevers et al. 2006, Göbel et al. 2011) and the findings for grammatical number in German (Röttger & Domahs 2015). Polish comprehenders in the experiment automatically associated grammatically singular nouns with the left side of the mental space, while grammatically plural nouns were linked with the right side. This is consistent with the idea that processing numerical magnitudes engages representations arranged on a mental number line (Dehaene et al. 1993, Göbel et al. 2011, Pavese & Umiltà 1998). Crucially for the main research question, collective singulars behaved like unitary singulars. This suggests that overall collective singulars were automatically conceptualized as referring to the collection as a whole, which is consistent with the semantic number judgments in the present experiment and the results of past research (Bock & Eberhard 1993, Nenonen & Niemi 2010, Bock et al. 2006). Thus, the primary factor determining the conceptual representation of the objects denoted by collective nouns appears to be their grammatical number.

4.5.3 Size congruity effect

The interaction between the type of number and the visual size of the font was not significant. There was, therefore, no evidence that either grammatical number or collectivity can cause a size congruity effect. In particular, grammatical singularity and plurality did not activate small size and big size representations, respectively, despite giving rise to a SNARC effect. This result is surprising. A group of individuals is typically larger than a single individual of this category, yet the group size does not seem to be part of the mental representation of number for language comprehenders. Perhaps this underrepresentation in terms of size is due to the fact that plurals can easily refer to very small groups, possibly of just two individuals. The lack of a size congruity effect for grammatical number may also suggest that understanding the semantic contribution of grammatical number depends on the part of numerical cognition linking numerosities with the processing of space (hence the observed SNARC effect), but not with the processing of continuous magnitudes, like size.

It is also possible that the emergence of a size congruity effect was blocked by certain design features of Experiment 1. Experiment 2 tested this possibility.

5 Experiment 2

Experiment 1 showed no sign of a size congruity effect. The SNARC effect was present, but it was statistically significant only in a by-items analysis. The lack of an SCE and a statistically weak SNARC effect may have been due to design choices, so another experiment was conducted addressing some of the possible problems. Changes were introduced in three areas: the selection of nouns for the collective singular condition, the choice of plural counterparts for collective singulars and the choice of the task.

5.1 Research goal and predictions

As in Experiment 1, the research problem investigated in Experiment 2 concerned whether the primary numerical representation of the referents of collective singular nouns is driven by their grammatical or lexical status. If collective singulars are associated primarily with the conceptual singularity based on their grammatical number, they should behave more like unitary singular nouns. If collective singulars are linked with conceptual plurality through the lexical emphasis on the elements of the collection, they should pattern with grammatically plural nouns in terms of the SNARC effect and, possibly, the SCE. If both representations are automatically activated early on (competing for selection), the results for collective singulars should fall somewhere between unitary singulars and plurals.

5.2 Design

5.2.1 Materials

Collective nouns for Experiment 1 were chosen based on the authors' intuition. For Experiment 2, a pretest was organized to select nouns whose collective reading is most salient. A questionnaire with a list of words was presented to participants, who evaluated how often every word was used to refer to more than one entity. Participants made their decision on a scale from 1 (very rarely) to 5 (very often). The list contained 188 words of which 62 were singular nouns with a potentially collective reading (e.g., *ekipa* 'squad'). The remaining words were unitary singulars (e.g., *wilk* 'wolf'), *pluralia tantum* (e.g., *nożyce* 'scissors'), mass nouns (e.g., *błoto* 'mud') and ordinary plurals (e.g., *drzewa* 'trees'). The questionnaire was distributed online through Google Forms. Ten native speakers of Polish took part. Responses for each item were averaged over all participants. Thirty collective nouns with the highest scores were selected for the experiment. Of the selected nouns, the lowest rated item (*sztab* 'military headquarters') received 3.6 points and the highest rated (*trzoda* 'lifestock') received 4.7 points ($M = 4.22$, $SD = 0.27$). In Experiment 1, instead of pluralizing collective singulars (e.g., *armie* 'armies' for *armia* 'army'), plural forms of related unitary nouns (e.g., *żołnierze* 'soldiers' for *armia* 'army') were used. While this was done to avoid a potential effect of number syncretism and "double plurality", it may have introduced more variance among items. In Experiment 2, plural forms were created from collective singulars. In addition to the collective nouns, 30 unitary singular nouns and their plural forms were selected.

Overall there were 60 singular and 60 plural nouns. Each noun was presented in big font and small font as well as with a left hand and right hand response. Every participant saw all items. This resulted in 480 trials distributed over two blocks. The presentation order was fully randomized for every participant.

5.2.2 Procedure

Experiment 2 was conducted on the same standard PC and 23.6 inch monitor as Experiment 1. The design was mostly the same as in Experiment 1, the only difference being the task. The task used in Experiment 1 (semantic number judgment) was chosen to make the results comparable with past number judgment studies (Bock & Eberhard 1993, Nenonen & Niemi 2010) and to follow closely the design of Röttger & Domahs (2015), where a SNARC effect for grammatical number was demonstrated. However, that task may have drawn the participants' attention to the number ambiguity of collectives, thereby affecting the outcome. Experiment 2 addressed this problem by encouraging participants to focus on the grammatical number instead. The participants were instructed to determine whether the noun is grammatically singular or plural (grammatical number judgment) while ignoring the visual size of the stimulus. The font sizes in the two size conditions and the resulting visual angles for stimuli were the same as in the previous experiment.

Experiment 2 again consisted of two blocks, with the assignment of keys to responses changing after the first block. There were three breaks within each block (every 60 trials). In each block, the experiment proper was preceded by a training session with 22 trials. The set of training items consisted of nouns balanced in terms of grammatical number, font size and response hand. None of the items used in the training session appeared later in the experiment proper. If the participant made a mistake, feedback was provided in the form of a message (*źle* 'incorrect') that stayed on the screen for 1 second. In the training session a message also appeared after correct responses (*dobrze* 'correct'). The main purpose of the feedback was to facilitate learning the correct assignment of keys.

The experiment was designed and presented using the PsychoPy software (version 1.84.2) (Peirce 2007, 2009).

5.2.3 Participants

Twenty-three students of the Institute for English Studies of the University of Wrocław (15 women, 8 men) took part in the experiment. Participants were all native speakers of Polish. The average age was 22.4 (SD = 5.5).

5.2.4 Results: Accuracy

In Experiment 2, participants were required to focus on the grammatical number of words and decide whether each noun is gramatically singular or plural. The accuracy measure, therefore, did not reflect the numerical semantics of the nouns. This time the differences between the types of number were very small. Participants were on average most accurate with unitary singular nouns (M = 98.5%, SE = 0.6) and slightly less accurate with collective singulars (M = 97.3%, SE = 0.6) and plurals (M = 97%, SE = 0.4). A pair of one-way ANOVA tests (by subjects and by items) with Accuracy as the dependent variable and Number Type (collective singular, unitary singular, plural) as the independent factor showed that these differences were significant by subjects ($F_1(2, 44) = 5.46$, $p = 0.008$, $\eta^2 = 0.20$) but not by items ($F_2(2, 117) = 1.34$, $p = 0.27$).

5.3 Results: Reaction times

The data were cleaned first by removing all incorrect responses. After that, all trials with reaction times (RT) 3 standard deviations above and below the mean for every participant were removed. This resulted in eliminating 215 data points which constituted 2% of correct responses. The remaining trials were subjected to tests performed with the SPSS software (version 22).

In order to test the research hypotheses, a pair of 3×2×2 ANOVA tests (by subjects and by items) were conducted with RT as the dependent variable and the following independent factors:

- Number Type (collective singular, unitary singular, plural)
- Font Size (small, big)
- Response Hand (left, right)

Results of the ANOVA tests are given in Table 5. Mean reaction times and accuracy in each condition are given in Table 6.

5.3.1 Number Type effect

The main effect of Number Type was significant. Responses to collective singular nouns were on average longest (M = 828ms, SE = 33), followed by responses to plural nouns (M = 801ms, SE = 29) and to unitary singular nouns (M = 760ms, SE = 24). No other main effect was significant.

Table 5: ANOVA test results for Experiment 2. NT: Number Type; FS: Font Size; RH: Response Hand.

Source	df		F		*p*		Partial η^2	
	F1	F2	F1	F2	F1	F2	F1	F2
NT	2, 44	2, 117	20.31	9.82	<0.001*	<0.001*	0.48	0.14
FS	1, 22	1, 117	0.02	0.06	0.893	0.815	0.00	0.00
RH	1, 22	1, 117	0.47	1.17	0.499	0.281	0.02	0.01
NT×FS	2, 44	2, 117	2.57	1.03	0.088	0.361	0.11	0.02
NT×RH	2, 44	2, 117	0.07	0.22	0.932	0.803	0.00	0.00
FS×RH	1, 22	1, 117	2.35	1.16	0.140	0.283	0.10	0.01
NT×FS×RH	2, 44	2, 117	2.86	1.55	0.068	0.216	0.12	0.03

Table 6: Mean reaction times (ms) and accuracy (percent correct) in all conditions in Experiment 2. Standard errors in parentheses

	Response Hand					
	Left		Right		Congruity (Left – Right)	
Num Type Font Size	RT (ms)	Acc (% corr)	RT (ms)	Acc (% corr)	RT (ms)	Acc (% corr)
Col Sg						
Small	830(34)	96.2%(1.1)	834(39)	97.4%(7.0)	−4	−1.2%
Big	818(31)	97.1%(7.0)	830(36)	98.6%(6.0)	−12	−1.5%
Unit Sg						
Small	765(27)	98.8%(4.0)	743(24)	98.7%(4.0)	22	0.1%
Big	755(26)	98.1%(5.0)	776(28)	98.3%(5.0)	−21	−0.2%
Plural						
Small	794(31)	97.0%(4.0)	808(30)	97.5%(6.0)	−14	−0.5%
Big	798(32)	96.4%(5.0)	802(30)	97.0%(4.0)	−4	−0.6%

5.3.2 SNARC effect

The Number Type×Response Hand interaction was not significant either by subjects or by items. There was no statistically valid evidence for a SNARC effect.

5.3.3 Size congruity effect

The Number Type×Font Size interaction was not significant either by subjects or by items. There was no statistically valid evidence for a size congruity effect.

5.4 Discussion

Experiment 2 introduced some changes to the design of Experiment 1 as an attempt to strengthen the SNARC effect and elicit a size congruity effect. However, this time both effects were absent. The results showed no interaction of number with either the response side or visual size.

The main change in Experiment 2 with respect to Experiment 1 was a change in the task. The semantic number judgment task of deciding whether the word named one or more than one thing from Experiment 1 was replaced with the grammatical number judgment task of deciding whether the word was grammatically singular or plural. The change was intended to turn the participants' attention away from the number ambiguity of collective singulars while keeping the task in the domain of number. However, it is possible that the fact that conceptual number in Experiment 2 was irrelevant for the task meant that it was not extracted fast enough to affect the performance and produce a SNARC effect. This would be in line with the results of Röttger & Domahs (2015), who found a SNARC effect for singular and plural German nouns only for the task requiring the processing of semantic number but not for tasks related to other types of information (animacy semantics, lexical status, visual features). In the present study, the SNARC effect remained absent for a task involving paying attention to grammatical number.

6 General discussion

The two experiments reported here investigated the numerical representation of the referents of collective singular nouns. The main research problem concerned the question whether language comprehenders construe the entities denoted by collective singular nouns primarily in terms of conceptual singularity (determined by their grammatical number) or conceptual plurality (determined by their lexical semantics). In Experiment 1 collective singular nouns behaved overall like unitary singular nouns and differed from plural nouns in terms of the SNARC effect. Plural nouns received faster responses with the right hand than with the left hand. In contrast, collective and unitary singulars showed a clear preference for the left hand. This fits the hypothesis that the reference of a collective noun is initially construed as a single entity (the whole group), consistent with the grammatical singularity of the word, and the plural interpretation is secondary to this initial singularity, resulting from the highlighting of component parts.

Some tentative conclusions for models of grammatical number processing can be offered based on our findings. For words with a conflict between the grammatical and lexical number, like collective nouns, the number mismatch seems to be resolved in favor of the grammatical information. The data obtained in the present experiments suggests that such words initially activate numerical concepts consistent with their grammatical number. Comprehenders seem to expect grammatical number to be a reliable cue for the numerosity of the objects under discussion. This is true even if the lexical specification of a noun is at odds with its morphosyntactic marking. This independence of the primary number representation from lexical factors like collectivity suggests that the extraction of grammatical number information is automatic and happens soon after a noun is encountered, possibly before or in parallel to the lexical semantics. This may follow from the status of number as a grammatical category. Electrophysiological studies show the separability of semantic and morphosyntactic processes in the form of separate early ERP components, with signs of interaction between the two types of information visible in relatively late time windows (Friederici 2002). Effects of semantic manipulations are commonly observed as amplitude modulations of the N400, which is a component peaking around 400ms after stimulus onset (Kutas & Federmeier 2011). Processes that require access to the syntactic category of a word are reflected in the amplitude of the eLAN, an early component peaking around 150–300ms after stimulus onset (Hahne & Friederici 1999), which has been found for word-category violations even in meaningless "jabberwocky" sentences (Hahne & Jescheniak 2001). Manipulations involving specifically grammatical number affect the amplitude of the LAN, a component related to morphosyntactic processes (Münte et al. 1997, Friederici 1995) peaking around the same time as the N400 (Barber & Carreiras 2005, Lück et al. 2006).[6] Thus ERP evidence points to lexical and grammatical information being processed independently at an early stage of comprehension. This is consistent with the present findings.

[6]Even though the N400 and the LAN are both negative going components peaking around the

There was no evidence from either Experiment 1 or Experiment 2 that the conceptual representation of number in language can lead to a size congruity effect. This null result may indicate the limits of mental simulations based on linguistic information (Barsalou 1999, Zwaan 2009, Patson et al. 2014). It seems that the size of the denoted set is not a salient property of the conceptual representations of grammatical number. In the original study by Paivio (1975) participants had problems comparing real life sizes of depicted objects if the image sizes were incongruent (e.g., the image of a lamp bigger than the image of a zebra). Given the results of Paivio's study, it is possible that participants in the present study focused more on the size of typical individuals constituting a given group than the size of the group itself. The nouns used in the two experiments were not matched for average sizes of the denoted individuals. The items included words naming relatively small objects (e.g., *pasek* 'belt') as well as names for bigger things (e.g., *stół* 'table'). Perhaps a more careful choice of items is necessary to detect a size congruity effect related to grammatical number or collectivity.

From a methodological perspective, the results of Experiment 1 confirm the suitability of the SNARC effect elicited by semantic number judgments as a tool for studying the conceptual representation of number in language. However, the complete absence of the effect in Experiment 2, which used grammatical number judgments, points to the task-sensitive nature of this effect, consistent with the results of Röttger & Domahs (2015). The lack of the size congruity effect in both experiments means that more research is needed to determine whether it can be a suitable diagnostic of number interpretation for grammatical number studies.

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same time, they can be distinguished by the distributions of the electrodes picking them at the scalp. Whereas the distribution of the N400 is centro-parietal, the LAN is most prominent at the left-anterior sites.

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Chapter 3

Strongly non-countable nouns: Strategies against individuality

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Studies in countability have uncovered a range of ontological entities which permit counting, including natural concrete individuals, discrete events, and taxonomic subkinds. Identifying the reasons why nominal referents may *not* be counted has been less successful, however, and remains controversial. This paper examines nouns that are "strongly non-countable", those nouns for which combination with the plural marker, quantifiers, and nearly all other forms of determination is a vanishingly rare event. This paper develops a data set of nearly 500 such nouns, adducing their strongly non-countable status from usage over a 350 million word corpus (Davies 2009). Through further internet searches, we attest rare, but possible, patterns of coercion available to these nouns. We then develop a classification of the different notional categories that these nouns belong to. Finally, we examine broad distributional patterns and argue that these strongly non-countable nouns contrast with countable nouns as to their patterns of usage, in particular, being less discourse-salient and less referential than their count noun counterparts.

Keywords: countability, non-countable nouns, coercion, abstract nouns

1 Introduction: Assessing the varieties of non-countable nouns

When a noun has a countable interpretation, it is often intuitively clear why the countable interpretation comes about: The noun references some sort of unit which permits counting. The nature of this unit may be different depending on

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the noun, whole objects of the natural kind sort (*dogs*) or measurement units (*kilos*) to give just two examples among many, but it appears reasonably straightforward to identify that there is a unit and that that is what is being counted.

When a noun fails to permit a countable interpretation, the situation is usually far less clear. Much research over the last two decades has gone into distinguishing two types of non-countable nouns: SUBSTANCES, those nouns traditionally considered to be "mass" such as *water* or *clay*, and AGGREGATES, including *furniture*, the most famous example, along with other nouns such as *jewelry* or *mail*. The non-countability status of substances has traditionally been supported by the strong intuition that neither *water* nor *clay* in their primary uses make reference to individual units, more technically speaking 'atoms', which would serve as a basis for quantification. In contrast, *furniture* and other nouns of the aggregate type *do* refer to individuals, despite their grammatical non-countability status. Theoretical models of countability have mostly been content to account for these three types of nouns: individuals, substances and aggregates (see, for instance, Bale & Barner 2009, Chierchia 2010, or Deal 2017). Most agree that the grammatical contrasts among these noun types reflect an ontological contrast although it is a matter of controversy as to how tight the relation is.

This paper contends that the challenge of accounting for non-countable nouns is far greater than typically assumed in the literature and establishes some basic results on the diversity of non-countable nouns in English.[1] We will have little to say about the different virtues or short-comings of any particular theoretical account of non-countable nouns in this paper, instead we limit ourselves to establishing empirical baselines as to what types of non-countable nouns there are and how they behave contextually and grammatically.

The structure of the paper is as follows. In §2, we establish our methodology and, through corpus work, isolate close to 500 nouns that are rigidly non-countable or nearly always so. §3 asks if these nouns *ever* are counted and examines the different patterns of coercion observed through further internet-based searches and categorizes them. In §4, we elaborate a classification of the different notional categories that these nouns belong to, which themselves fall into four super-categories: Entities, Eventualities, Phenomena, and Abstract. We then examine the correlation between the different notional categories and the different types of coercion observed in §3. §5 examines broad distributional patterns of these nouns at the level of clauses and nominal phrases, demonstrating that, on

[1]See also Allan (1980) and Kiss et al. (2016) for other larger-scale studies which help establish the diversity of countable and non-countable nouns, as well as Sutton & Filip (2019) and Sutton & Filip (2020), which provide recent empirical work on certain domains of abstract nouns.

average, the non-countable nouns of our data set show behavior consistent with less discourse-salient and less referential uses. We conclude in §6.

Our aim is that this study will facilitate the investigation of non-countability in several directions. First, establishing, initially for English, what the lexical variation is among non-countable nouns, viz. what types of nouns have non-countable readings? Answering this question with a systematic approach will hopefully open up avenues for cross-linguistic comparison: Do the countability statuses of different notional categories co-vary across languages? Clearly, answers to these questions will help test the predictive power of current theories: What would a theory look like that not only explains the non-countability of *water* and *furniture* but also of *coriander*, *parenthood*, *fun*, or *sportsmanship*? Ultimately, this effort contributes to understanding the causal foundations of non-countability.

2 Methodology: Discovering strongly non-countable nouns

To assess the spectrum of non-countable nouns, we extracted a large set of nouns which, based on several measures, showed the lowest degree of countability. We chose those with the lowest degree of countability in part to exclude polysemous nouns, also known as "dual-life" or "flexible" nouns, and to minimize interference from nouns lending themselves to secondary interpretations through coercion. In all, we assess nearly 500 nouns, a sufficient quantity to deliver insight into potential classes of non-countable nouns while remaining of a manageable size.

The non-countable nouns were selected from the database described in Grimm & Wahlang (2021), derived from a 350 million word portion of the Corpus of Contemporary English (Davies 2009). This was subsequently processed via a natural language processing (NLP) pipeline, parsing and annotating each occurrence of each noun with all relevant dependencies in which the noun stood (using Universal Dependencies from De Marneffe et al. 2014). This process captured a vast amount of distributional information about each noun, permitting further analytical investigation of nouns' behaviors. (See Grimm & Wahlang 2021 for further details on the corpus processing and database development.)

We filtered this database to extract strongly non-countable nouns. Occurrence in bare plural was found in Grimm & Wahlang (2021) to be the strongest predictor of countable nouns in the database, so we filtered the data most tightly on this feature, requiring a noun's percentage of occurrences in the bare plural to be lower than 2% of all occurrences and, additionally, occurrence with numeric modifiers to be lower than 20%. We allowed for some amount of flexibility in these constraints to account for possible noise in the corpus data, due to parsing or other processing errors, as well as to not exclude rare coerced occurrences of the noun. We allowed for more flexibility in the occurrence with numeric modifiers since, for our purposes, there is a larger amount of noise due to how De Marneffe et al. (2014) treat numeric modifiers, since they include under numeric modifiers not only cardinal numbers and the like but also measure terms such as *2 kilos* (which do not discriminate between countable and non-countable nouns).[2]

To select the best candidates, the data was sorted first by the lowest bare plural noun percentage (giving preference to nouns with the least noise in that category), then by lowest proper noun percentage (that is, those nouns which were very rarely, if at all, tagged as proper nouns, thereby excluding proper nouns, like *William* or *Cincinnati*, which would have almost no occurrences in the plural), and then highest value of overall occurrences (to preference nouns that we had the most data for). The resulting data was further filtered to only include nouns coded as uncountable in the CELEX database (Baayen et al. 1996) as another measure to narrow our scope. Finally, we selected only nouns for which there were greater than 200 example sentences in our data, giving us sufficient data from which to generalize. From this sorted list, we selected the top 550 nouns as the starting point for our research, assuming that around 50 of these would ultimately be excluded due to noisiness in the data or ambiguity between multiple senses.

This list of 550 nouns was then further pared down by hand during the process of analyzing nouns for rare and contextual count examples using Google searches (see §3). A number of these searches returned established countable uses of the noun (e.g. *prospects*, *writings*) which led us to remove that noun from our list. In total, 26 nouns had enough count examples to be excluded from the data and 42 nouns had multiple distinct senses (some of which were highly countable), gerund uses, or appeared almost exclusively in fixed phrases (*in spite of*) and so were also excluded. With the final list of 482 nouns, we built a dataset containing distributional information with the data from Grimm & Wahlang (2021) for each noun, as well as additional data compiled from COCA example sentences. This provided us with not only summary statistics for the behavior of each noun (e.g., the percentage of occurrences with the definite article or as the subject of the verb phrase) but also lists of the unique modifiers (e.g., adjectives, case modifiers, possessive constructions) compiled from every example in our data pulled from

[2]The settings for these filters are not the only ones possible, and are proposed based on our (subjective) experiments with different percentages for both of the filters and examining the resulting sets of nouns. These settings were felt to be optimal for permitting some level of noise or ambiguity while also narrowing down the set to truly non-countable nouns.

COCA. For the comparison between the grammatical distribution of strongly non-countable nouns and countable nouns in §5, this data set was also extended with a set of core countable nouns, grouped separately, from data in Grimm & Wahlang (2021) (clusters 7 and 8, containing 799 count nouns).

In addition to this distributional information, our final dataset also contains data on each noun's countability as well as derivational morphology from CELEX (Baayen et al. 1996), hand-annotation of each noun's notional category (see §4), and the possible count coercion contexts that noun was found to appear in (as discussed in §3). A separate file contains examples demonstrating each type of coercion found for each noun. We have made the final dataset and accompanying files publicly available at https://quantitativesemanticslab.github.io/.

3 The contexts of coercion

While our data set contains a large number of occurrences for each noun considered (at least 200), this is not sufficient to determine if a noun which is normally non-countable *ever* gets counted, and if so, upon which basis that counting is carried out. To examine valid, albeit rare, countable examples of these nouns, we performed a battery of Google searches for each of the 482 nouns. For each noun, we searched for occurrences with the definite article *the*, plural demonstratives *these* and *those*, numerals *two* and *three*, as well as quantifiers *some*, *many*, and *multiple*. We limited ourselves to inspecting the first five pages of results per search (~50 results per search), which in practice was sufficient to turn up any countable uses.[3]

We collected a number of example sentences demonstrating each type of countability coercion observed with a given noun. Table 1 lists the different countable uses, which we will refer to as COERCION TYPES, observed of the 482 nouns in the data set and provides the number of nouns observed for each coercion type. While no countable examples were found for 262 of the nouns, the remaining nouns had examples that could be attributed to one or more coercion types.

The coercion types were determined by the authors and a research assistant who separately annotated the collected examples.[4] They discussed the annotations and agreed upon a final set of labels on a small training portion of the

[3]We ignored a range of occurrences with plural forms that arose in uses with proper nouns, in typos, translations, non-native uses, or misuses.

[4]This was carried out on a portion of the data for Jargon and Archaic had already been excluded.

Table 1: Types of countable uses of non-countable nouns. *Note*: As some nouns were found to have more than one type from multiple example sentences, the "Number of nouns observed" column does not sum to 482.

Coercion type	Number of nouns observed
Entity Type	96
Event	67
Possessor	35
Relational	29
Event Type	24
Packaging	8
Value	6
Modificational	4
Countable only in specific contexts[a]	126
Archaic[b]	59
No countable uses observed	137

[a] I.e. jargon.
[b] All count uses predate 1880.

data (150 example sentences). Then two of this group served as annotators independently annotated the remaining 377 example sentences and compared their annotations. Inter-annotator agreement was 'moderate' (Cohen's $\kappa = 0.56$) when calculated on the entire test dataset (527 sentences). Agreement was even higher on two subsets of the data. One subset excluded even more archaic or jargon uses and the inter-annotator agreement was 'substantial' (Cohen's $\kappa = 0.65$), and similarly for a different subset which excluded a specific error pattern from one of the annotators who over-labeled with the Packaging coercion type (Cohen's $\kappa = 0.66$).[5]

Since the theoretical understanding of different types of coercions possible – beyond the familiar contexts discussed in the literature under "packaging" and "grinder" – is still limited, despite a growing literature which describes some of the lesser-studied countability shifts (Payne & Huddleston 2002, Grimm 2014, Husić 2020, Zamparelli 2020), we now detail with examples the different coercion types we observed for these nouns.

[5] See full data set at https://quantitativesemanticslab.github.io/.

Entity Type: These count uses refer to multiple classifications, compositions, severities, etc. of the entity designated by the lexicon. As a heuristic diagnostic, *type of* or a similar phrase may be felicitously added to clarify the contrast evoked.

(1) **Twines** can differ by their material and strength, which changes how they should be used. Some **twines** are ideal for cooking since they can withstand heat and don't impart flavor onto your food, while other **twines** are perfect for decoration or more heavy-duty use.[6]

(2) We now face two **agricultures**. The long-term model is exploitive and degenerative, while the new model is regenerative and more profitable.[7]

Event: These count uses refer to multiple occurrences or iterations of the event designated by the noun. If the events *are not* simultaneous, ordinal numerals or lexical items denoting temporal location may stand in to distinguish the events, as in (3). If the events *are* simultaneous, other modifiers such as locations may be used to distinguish the events, as in (4).

(3) The **automations** are not necessarily run at the top of the hour, and it may not be exactly one hour between executions of an automation. (Google Books)

(4) Most important of the **minings** were those of the Gotthard and Simplon tunnels. (Google Books)

Possessor: These count uses make reference to distinct agents displaying the property, often implicitly.

(5) The management team understands how individualized the recovery process is and that no two **sobrieties** look the same.[8]

Relational: These count uses arise from distinguishing multiple types in terms of their relation to, e.g., other event participants. In example (6), different types of *contentment* are established with respect to the different things with which one may be content, i.e., different stimuli.

[6] https://www.webstaurantstore.com/guide/880/types-of-twine.html
[7] https://www.farmprogress.com/management/we-now-face-two-agricultures
[8] https://m.yelp.ca/biz/the-district-recovery-community-huntington-beach

(6) Those **contentments** have come to include housing, healthcare, schooling and employment as well as freedom from intimidation.[9]

Event Type: While countable Event uses refer to multiple, specific occurrences of the event designated by the noun, Event Type uses do not refer to specific events, but more abstractly, contrasting different types of the event in question.

(7) Again, this is not to hold equivalence between either the types of violence or particular **violences** in each category. (Google Books)

Packaging: These count uses evoke a bundling or containment of the noun's referent as a single unit, often assuming a standard measure or container.

(8) Six quarts of milk, two **buttermilks**, two chocolates, and three pints of cream. (Google Books)

Value: These count uses refer to varying levels or numerical values of a scale associated, perhaps implicitly, with the noun. This use differs from Entity Type coercions as this relies on a value or degree. Explicit values may be added to distinguish between the singular units.

(9) Low **latitudes** are those locations found between the Equator (0 degrees N/S) and 30 degrees N/S. The middle **latitudes** are found between 30 degrees N/S and 60 degrees N/S. And the high **latitudes** are found between 60 degrees N/S and the poles (90 degrees N/S). [10]

(10) Barley was germinated in soils of two **moistures** (40 and 50 per cent). (Google Books)

Modificational: These count uses are of (typically) adjectives, where the head noun is absent and the modifier or distinguishing property is actually what bears the plural morphology.

(11) If there really were 6 vanilla and 6 peanut butter candies in the box, what is the probability that you would have picked three **vanillas** in a row?[11]

[9] https://reader.exacteditions.com/issues/59737/page/10

[10] https://www.shsu.edu/~dl_www/bkonline/131online/f02latitude/02index.htm

[11] https://www.slader.com/discussion/question/someone-hands-you-a-box-of-a-dozen-chocolate-covered-candies-telling-you-that-half-are-vanilla-cre-2/

Jargon: These are count uses that occur only within specific contexts, primarily technical jargon. The example in (12) is a commonly found example of jargon occurring in chemistry and physics contexts that describe atoms and molecules.

(12) However, at the oxygens bridging two **aluminums**, oxygens were swapped only about once every 13 hours.[12]

Archaic: These count uses occur only in poetic uses or examples predating 1880, and current countable uses are not found outside of these contexts.

(13) The capytle doth shew of the **fortitudes** of the planetes.
(Google Books)

No countable uses observed: These nouns had no occurrences of count uses.

In summary, this data set leads us to observe a wide range of possible shifts from non-countable to countable interpretations, many of which have been little explored at this point. For Type coercions, while there is some discussion and even controversy about (the lack of) subtype coercions (see Grimm & Levin 2017 and Sutton & Filip 2016 and references therein), it has primarily revolved around nouns describing liquids or substances (*wines*) and artifactual aggregates lacking subtype readings (*furniture*), yet there are many other domains to check to see how type coercion is effected, as exemplified in (2). The interpretational shifts we list under Event and Possessor have to date only received brief treatments (Grimm 2014, Zamparelli 2020, Husić 2020) and similarly for Relational (Grimm 2014) (although a more sophisticated treatment has begun to be developed for informational nouns in the line of work of Sutton & Filip 2019 and Sutton & Filip 2020), while the observation of Value-based and Modificational count shifts is novel to the best of our knowledge. Again, it is possible that this classification stands in need of revision and, for instance, Relation or Value could be grouped under Type if understood more broadly, but we have erred on the side of being more explicit to bring out some of more unusual cases of coercion observed. A related issue is if all of the examples examined are truly cases of coercion as opposed to polysemy – again we have erred on the side of inclusion as coercion when a plausible case can be made.

[12]https://www.ucdavis.edu/news/oxygen-swapping-offers-clues-toxics-management/

4 The notional varieties of strongly non-countable nouns

A major theme of countability research is the relation between contrastive grammatical countability classes and corresponding contrasts, or lack thereof, of notional, or ontological, types of the corresponding referents of the grammatical classes. As mentioned, several authors propose that the referential types of individuals, aggregates, and substances are those that are responsible for countability contrasts (Bale & Barner 2009, Chierchia 2010, Deal 2017). It is therefore critical to examine the relation between the strongly non-countable nouns and their corresponding notional types. The different notional types brought forth by the strongly non-countable data demonstrate that those referential types may be necessary to account for the grammatical behavior related to countability, but those three types are far from sufficient. Instead, we observed rich variation in the notional types that correspond to strongly non-countable nouns, transcending the contrasts typically posited to explain grammatical countability patterns, as in those between, e.g., substances vs. individuals vs. aggregates or events vs. states.

4.1 Notional categories of strongly non-countable nouns

This section puts forth a classification of the 482 nouns into 27 separate "notional" categories, such as LIQUIDS or DISEASE. While the categorization presented here no doubt reflects some core aspects of the nouns' meaning, we hasten to emphasize that this classification is preliminary – nearly all of these nouns have never been systematically analyzed and we do not pretend to have been able to fully analyze them here. That said, even this initial categorization establishes that the range of notional noun types which show strongly non-countable behavior is far greater than one would suppose from the discussions in the literature.

Table 2 (page 68) displays the categorization. The 27 categories are broadly grouped into four super-categories: Entities, Eventualities, Phenomena, and Abstract. These are organized in terms of the apparent ontological commitments of the nominal descriptions falling under each category: Entities includes nouns describing entities rooted in physical existence ("concrete entities"); Eventualities includes those entities rooted in a temporal dimension, here using the term "eventualities" in the sense of Bach (1986) for both events and states; Phenomena – such as diseases or natural forces – while having a connection to the physical world are more abstract than the concrete objects found in Entities; and Abstract contains nouns that are, at least on their primary reading, detached from the physical world, comprised of nouns describing, e.g., atemporal, non-physical qualities (*cleanliness*) or domains of knowledge (*geology*). In the following, we discuss the different categories and their nouns and note their particularities against the background of the expectations from the countability literature.

These proposed categories can also often be distinguished via contrasting grammatical properties, often those related to the argument structure considerations. For instance, unlike pure substances, the BY-PRODUCTS category contains nouns that allow a *from* argument which specifies from where the substance originated (*refuse from the facility*). Similarly, MENTAL STATES differ from GENERAL STATES in that the former, such as *awe* require a participant who is mentally engaged in the event. While these grammatical contrasts have informed our categorization, we only discuss them in passing as they do not directly map onto countability contrasts.

4.1.1 Entities

The Entities super-category includes some representatives of "classic" non-countable noun types, such as SUBSTANCES (*dirt*), MATERIALS (*asphalt, hemp, latex*), GRAINS AND FLOURS (*bran, cornstarch, flax*), and LIQUIDS (*booze, kerosene, oil*). Although these notional categories are the most typical ones used to exemplify non-countable nouns (e.g. *water*, a liquid) in our data, these categories are somewhat sparsely populated compared to the number of other categories (e.g., mental state nouns). No doubt this results from the high number of nouns in these categories which are "dual-life" nouns, that is, nouns which also manifest a countable use and thus were excluded from our set of strongly non-countable nouns. At the same time, other instances of liquids and substances do arise, namely those that have been processed or manufactured, falling under the categories of CHEMICALS & ELEMENTS and DRUGS.

Better represented are AGGREGATE nouns, for which nearly all the examples from the literature are found in our data set (*footwear, furniture, luggage, silverware*) along with nouns which have some claim to "aggregate" status, even if most likely possessing some different characteristics than *furniture*, such as *bedding*, *homework*, *merchandise*, *paperwork*, *parking*, *traffic*, *weaponry*, and *wildlife*. Thus, our methodology is able to replicate the observation made at several points in the literature that aggregate nouns like *furniture* are less flexible and therefore more strongly non-countable than typical substance or liquid nouns.

The category BY-PRODUCTS collects nouns that either designate materials which result from some prior activity (*rubble*, *sawdust*, *sewage*, *smoke*, *soot*) or designate collections of entities or materials deemed worthless (*garbage*, *refuse*, *trash*, *filth*). While the cause for the first group's non-countability status may

Table 2: Notional classes of non-countable nouns

Category	Examples
Entities (108)	
aggregates (27)	footwear, furniture, glitter, traffic
by-products (10)	garbage, rubble, sawdust, soot
chemicals & elements (20)	ammonia, glucose titanium, uranium
drugs (7)	cocaine, morphine, nicotine
meat (3)	pork, poultry, venison
grains/flours (4)	bran, flax, oatmeal
herbs and spices (11)	cumin, nutmeg, paprika, parsley
materials (11)	carpeting, denim, plywood
liquids (11)	bile, buttermilk, oil, rainwater
natural substances (4)	dirt, driftwood, flesh, quartz
Eventualities (109)	
events (8)	atonement, bribery, legalization
multi-participant events (6)	acclaim, applause, bloodshed, gunfire
coming-into-/going-out-of-exist. (13)	abolition, emergence, eradication
mental states (28)	awe, bewilderment, remorse, unease
general states (17)	illiteracy, prosperity, puberty
activities (25)	banking, espionage, gardening
gradual/repeated processes (12)	conservation, enforcement
Phenomena (21)	
diseases (6)	arthritis, flu, hepatitis, herpes
disorders (7)	alcoholism, amnesia, anorexia
natural force (8)	antimatter, electricity, momentum
Abstract (212)	
domains (16)	agriculture, geology, journalism
social ideas (27)	communism, conservatism
general quality (52)	cleanliness, permanence, resiliency
human quality (55)	cynicism, sportsmanship, stardom
asymmetric relations (25)	abstinence, paucity, precedence
symmetric relations (11)	coexistence, companionship, peace
sports (16)	archery, golf, soccer
location/time (10)	airspace, dawn, latitude
unclassified (32)	fun, haste, parenthood

be similar to that of materials or aggregates, for nouns such as *trash* the seeming cause of non-countability is more indirect: Even if a use of *trash* designates entities that would otherwise be countable individuals, designating (and evaluating) them with the nominal description *trash* avoids identifying or individuating elements.

Food terms such as *chicken* are well-known as "dual-life" nouns, but the nouns of the MEATS category here are those that describe classes of meat (*poultry, pork, venison*) for which reference to the animal is named separately. While *chicken* is often used as an example of a noun with both a count and non-count use to exemplify the claim that many nouns in the lexicon are "flexible" nouns (e.g. Bale & Barner 2009: 241), this is not to be taken for granted, since, for instance, *pork* and *pig* (or *mutton* and *sheep*) are not "flexible", that is, do not, in typical circumstances, display both a count and non-count use. This is clearly due to the fact that the reference to the animal and the meat are accomplished by two distinct nouns, whereas in the case of *chicken*, a single noun lexicalizes both types of referents.

HERBS AND SPICES, such as *coriander*, *cumin*, *fennel*, *incense*, and *nutmeg* provide another interesting puzzle. In their physical form, many members of this class (e.g. a parsley plant or sprig, or a fennel bulb) are just as easy to individuate as many other small plants or bulbs which are described by countable nouns in English (*dandelion, onion*), as well as countable nouns which are similarly able to divide their reference, such as *twig* or *branch*. Yet, it is presumably their use, typically as processed bits or powders, that accounts for their strongly non-countable behavior (Wierzbicka 1988).

In sum, the now-common notional contrast between individual, aggregate and substance nouns is not sufficient to explain the variety of types of non-countable nouns observed even in the domain of physical entities: Evaluativity, interaction/use, and lexical contrast all may play a role in why a given noun may be (non-)countable.

4.1.2 Eventualities

The Eventualities super-category contains nominal forms designating various events, activities, processes or states. As one might expect from previous work linking countability and aktionsart (see Mourelatos 1978, Grimm 2014 and references therein), the non-countable nouns in this category are imbalanced among types of eventualities. More nouns refer to activities, processes or states than to events and, further, the strongly non-countable nouns that do refer to events have very particular semantics.

MULTI-PARTICIPANT EVENTS enforce reference to multiple individuals or events, thus *applause* normally comprises clapping from more than one member of an audience, and *bloodshed* is used to describe the killing or wounding of multiple people.[13] Similarly, *centralization* requires bringing multiple elements together while *dissemination* requires distributing multiple elements in multiple locations. The intrinsic plurality in these nominal descriptions most likely inhibits the use of a plural form.[14]

The category of COMING-INTO-/GOING-OUT-OF-EXISTENCE contains nouns which describe the beginning or the end or demise of an entity, which typically is an argument of the noun, such as *abolition*, *emergence*, *eradication*, *incineration*, or *regeneration*. Thus, *eradication* designates the end of some entity's or set of entities' existence, as in *the eradication of smallpox*, while *emergence* is the beginning of the existence of some entity or the appearance at a location. While these eventualities designate precise points in time where the entity in question passes into or out of existence, the grounds for canonical non-countability would appear to stem from the uniqueness of the events, as entities do not typically pass into or out of existence more than once.

The category of EVENTS contains a rather miscellaneous set of eventive nouns which do not fit into the categories discussed above. Those such as *atonement* or *reclamation* would also appear to be rather unique occurrences and as such resist pluralization.

The remaining categories in the Eventuality super-category are the more expected non-countable eventualities: ACTIVITIES, GRADUAL/REPEATED PROCESSES and STATES. We distinguish two types of states. In addition to MENTAL STATES, which are often cited as non-countable nouns, we include GENERAL STATES (*mayhem*, *poverty*, *unemployment*), by which we indicate nouns that refer to a general situation, equally able to be predicated of individuals and groups, and unlike the category of GENERAL QUALITY, are straightforwardly compatible with temporal localization. Many of these nouns manifest what has been termed in Grimm (2016) a "non-particularized use," that is, the nouns refer to instances of, e.g., *poverty*, but without making any claims to these instances being spatiotemporally located or being of a particular number.

[13] Some lexicographical resources note the multiple-participant facet of *bloodshed*'s meaning, as in the definition from the Oxford lexicography website lexico.com: "The killing or wounding of people, typically on a large scale during a conflict."

[14] An anonymous reviewer suggests that this class could constitute a morphologically singular counterpart to pluralia tantum nouns like *scissors* or *entrails*, which have been argued to be lexically plural (Acquaviva 2008), differing in that the lexical plurality is not overtly marked.

4.1.3 Phenomena

These nouns lack reference to any specific temporal or spatial location, the vagueness and unbounded nature of which is most likely the cause of their non-countability. For instance, DISEASES includes nouns which have meanings charged with physical and temporal aspects, e.g., *smallpox* or *tuberculosis* have physical causes and manifestations, but these are not the same as nouns which describe a (potentially) bounded physical entity, like *table*. Similar observations apply to DISORDERS, such as *autism* or *vertigo*, which are related to events, but cannot be reduced to particular events or states, as well as to NATURAL FORCES, such as *magnetism* or *sunshine*.

4.1.4 Abstract

The nouns in ABSTRACT are those which are not necessarily interpreted as connected to spatial or temporal dimensions. DOMAINS OF KNOWLEDGE (*forestry*, *psychoanalysis*, *voodoo*) or SOCIAL IDEAS (*federalism*, *materialism*) describe bodies of knowledge, ideas or cultural practices which are not embodied by one particular act or event. Qualities, both HUMAN QUALITIES (*chastity*, *foolishness*) and GENERAL QUALITIES (*health*, *toughness*), may be exemplified by acts or events, but are not co-extensional with those events. That is, the meaning of *chastity* or *foolishness* is not equivalent to the set of chaste or foolish acts. Nouns which designate relations are found in this class, too. These are distinct from nouns most often discussed under "relational nouns" such as *brother* or *neighbor*, which designate an entity in terms of the relation it stands in with respect to another entity. The nouns, whether in the SYMMETRIC RELATIONS (*accordance*, *relatedness*) or ASYMMETRIC RELATIONS (*governance*, *subordination*) category, designate the relation itself.

The nouns in the category of LOCATION/TIME describe or reference some aspect of spatial or temporal experience, as in *horseback*, *midair*, or *sundown*, but again cannot be reduced to a specific location or event. The category of SPORTS too shares the aspect of at once having physical and temporal aspects while also transcending them.

4.1.5 Unclassified

The inclusion of this category reinforces a point made at the beginning of this section, that this classification is incomplete and many unresolved issues remain. This varied group includes nouns such as *postage*, *slang*, *eyesight*, and *firepower*, which fit poorly in any of the categories discussed so far. No doubt a larger sample would help to establish even more fine-grained categories in which these nouns could be located. Some interesting cases are still worth pointing out.

Manslaughter appears to be rigidly non-countable, which is odd if one takes it to be analogous to, for instance, *murder*; however, the observed uses of *manslaughter* do not appear to be directly referencing acts or events, but rather offer a classification of acts or events as falling under manslaughter or not – that is, the noun provides a second-order property, a property of properties. In a similar vein, the nouns *conduct* or *haste* do not refer an event itself, but serve as a secondary predication over an event, referring to the manner in which an event or set of events was carried out.

Another interesting case is the small group of nouns derived by *-hood*, including *fatherhood*, *motherhood*, and *parenthood*.[15] Here *-hood* combines with a relational noun to derive some more abstract quality or property associated with participating in that relation. These nouns do not appear to be stative, as evidenced by their infelicitous combination with temporal modifiers (*his homelessness*/?*fatherhood lasted two years*), nor do they straightforwardly fit with human qualities (*composure*), which depict a quality that humans can possess or not, nor with general qualities (*cleanliness*), which characterize a situation.

In sum, the wide variation in different notional categories of non-countable nouns vividly demonstrates the challenge awaiting theories of (non-)countability. It is unlikely that there is a single, monolithic source of non-countability for which the semantics of *glitter*, *homelessness* and *archery* interact in the same way. To the contrary, it appears that many of the principles by which something is deemed non-countable, in English and across languages, have yet to be fully understood.

4.2 Notional types and coercion types

We now turn to examine if correspondences can be found between the notional categories of nouns laid out in this section and the coercion types discussed in §3. Figure 1 presents a heatmap that maps the number of nouns in each notional category manifesting each type of coercion shift. Several trends are visible upon inspecting this visualization of the data. First, as one would expect, Packaging and Event coercions are effectively in complementary distribution, with Packaging being found among nouns of the Entities super-category and Event being

[15] *Womanhood* is also included in this group, although it differs semantically from those derived from a relational noun. Derivations with *-hood* are not semantically transparent, as the countable nouns *childhood*, which is temporally grounded, or *neighborhood*, which is spatially grounded, attest.

found across the rest of the notional super-categories. Second, Type coercions are robustly found across the different super-categories, although are unobserved for some of the categories, such as AGGREGATES, ELEMENTS, or LOCATION/TIME. The Jargon and Archaic coercions are primarily found with the more eventive and abstract nouns. The None column, which tracks the number of nouns for which no coercions were observed, shows that across the different categories there are almost always some nouns which are rigidly non-countable, while certain notional categories, such as SPORTS or NATURAL SUBSTANCES, appear to be mostly comprised of rigidly non-countable nouns.

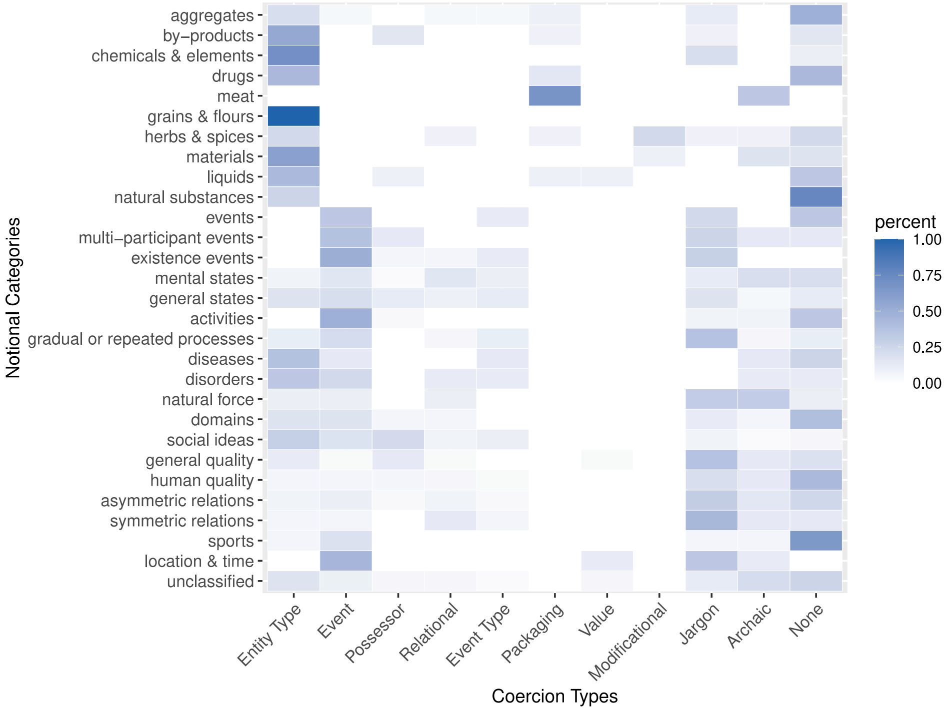

Figure 1: Heatmap showing the proportion of observed coercions in each coercion type for each notional category

A major effort for future research is to understand which types of nominals allow which types of coercions. We expect that contributing this explicit data set of coercions will help systematize this effort.

5 Variation in grammatical behavior of strongly non-countable nouns

This section investigates the general distributional characteristics of these nouns, beyond those solely concerned with countability. We ask if it is possible to detect any broad scale contrasts in grammatical environments between these strongly non-countable nouns and a group of "standard" countable nouns and hypothesize that these sets of nouns which already differ in countability status will also differ in two other aspects of their grammatical distribution. First, we expect them to differ in their propensity for occurrence in different grammatical positions, i.e. if they are more frequently governed by verbs or prepositions and what position they have in those structures, e.g. verbal subject or object. Measuring the nouns' distribution in clausal position, e.g., use as subject, serves as a proxy for understanding their typical discourse salience (see Kaiser 2006 and references therein): Verbal subjects tend to be more salient in the discourse as a whole than nouns occurring in the object position, and similarly for nouns occurring as a nominal head modified by a prepositional construction (*the **ire** of parents*) as opposed to being in the complement of a preposition (*the ire of **parents***). Second, we measure the "referential weight" of the nouns' uses, tracking the amount of determination, especially definite determiner usage, the noun manifests across its occurrences. We expect countable nouns to have a higher proportion of referential (definite) uses and we use the occurrence of the definite determiner as a proxy for referential uses (while noting that this is clearly a simplification, given the complexity of the uses of the definite determiner, see Lyons 1999 i.a.). For countable nouns, on the whole, we expect more occurrences with the definite determiner and in salient argument positions (*The **vase** is on the table.*) while strongly non-countable nouns will occur less often with definite determiners and in non-argument positions (*The stoppages of work could not be justified by the standards of arbitral **jurisprudence**.*)

Together, if validated, these hypotheses would indicate that countable nouns tend toward greater discourse salient and referential uses while strongly non-countable nouns, and perhaps non-countable nouns more generally, have fewer discourse salient and referential uses. This is intuitively plausible insomuch as countable nouns describe entities for which it is useful to regularly pick out, or individuate, the referents. To explore these hypotheses, we expanded our data set to include countable nouns with which we could contrast the 482 non-countable nouns. We selected the Core Countable nouns of Grimm & Wahlang (2021), a set of 799 nouns identified through a clustering experiment based on distributional properties shown to be predictive of countability status.[16]

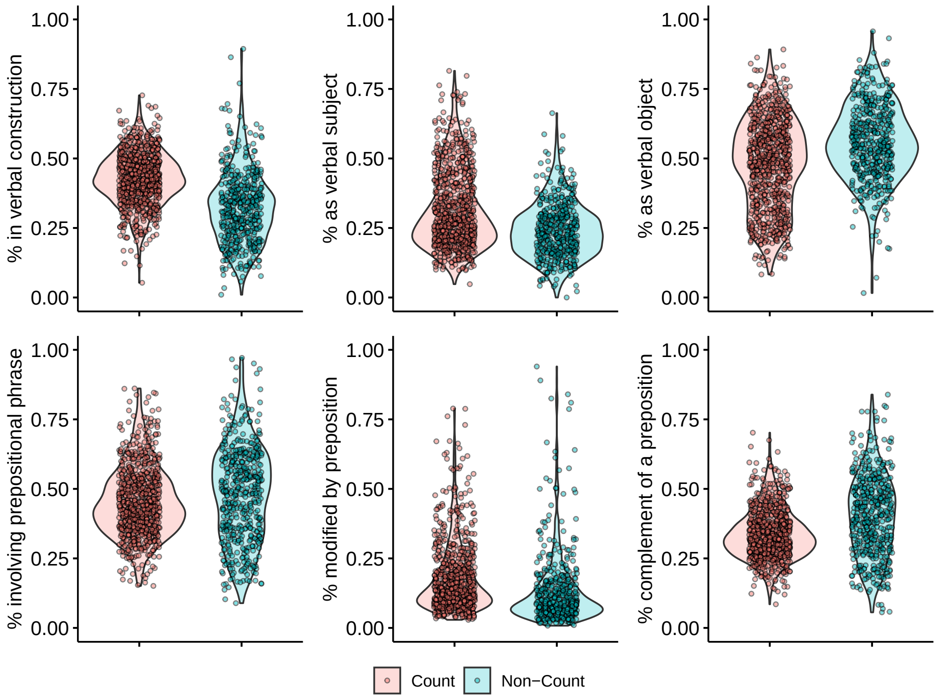

Figure 2: Comparison of distributional properties of non-count and count nouns: Percentage of occurrence of each noun in each environment

Figure 2 presents plots displaying the distribution of the grammatical positions of the countable and non-countable nouns examined. The violin plots include each noun as an individual point and the probability density of the distribution of the sample showing the general distributional trends. The upper half of Figure 2 shows in the leftmost panel the nouns' occurrence in verbal constructions generally and then the proportion of a noun's verbal occurrences as verbal subject and as object. The lower half shows their occurrence with prepositions generally, and then, relative to the total number of prepositional occurrences, the proportion as nominal head modified by a preposition and the proportion as complement of a preposition. As can be seen, countable nouns have a greater

[16]These properties were occurrence in the bare Plural, the bare singular, and with "unit", "fuzzy" and "other" denumerators. See Grimm & Wahlang (2021) for further discussion.

propensity to be in verbal constructions and to be the subject of those constructions more often than non-countable nouns do, and conversely, non-countable nouns have a greater tendency to be in object position.[17]

The behaviors of the different types of nouns in prepositional phrases is more variable, especially for non-countable nouns: Non-countable nouns have a greater propensity to occur generally in prepositional phrases and to occur in the complement of prepositional phrases than countable nouns do, but what is most striking is the far greater variability among non-countable nouns than among countable nouns. Countable nouns can be seen to vary from approximately 25%–75% of occurrence in prepositional phrases with a mean tendency of 45.4%. Non-countable nouns range from hardly ever occurring in prepositional phrases (*parking, bowling*) to nearly always (*entirety, lack, emergence*), and the central tendency, at 47.7%, is far less pronounced. The same contrast occurs in measuring occurrence in prepositional complement positions, with some non-countable nouns hardly ever occurring as a complement to a preposition (*shopping, gripe*) and some nearly always doing so (*manslaughter, colonialism, disgust*). The rate of occurrence as the head of the prepositional phrase is similar for countable and non-countable nouns, although less frequent for non-countable nouns.

Figure 3 presents violin plots which display the distributional traits hypothesized to correspond to the different degree of determination and referential uses among countable and non-countable nouns. For this study, we consider the singular and plural occurrences of nouns separately, since their ability to occur without determiners differs: Plural nouns, like non-countable nouns may be bare (that is, have a "null determiner"), while this is disallowed for countable nouns.

The plots in the left panels display coarse-grained information about determination patterns. The upper-left panel shows the percentage of nouns' occurrences *not* as bare nouns, that is, occurrences that lack any sort of quantifiers, determiners or modifiers. The lower-left panel displays the proportion of determiners found with a given noun. Here we observe a trend that holds across all the plots. There is an ordering among the mean proportion of determination for the different groups: Singular count nouns have the highest proportion of determiner or non-bare use, plural count nouns next highest and non-count nouns lowest. In the upper-left panel, non-countable nouns display a high degree of variation as to whether they occur bare, with some exclusively occurring bare (*peacetime, photosynthesis*) and some most always occurring with some sort of determination or modification (*fondness, nakedness, woodwork*). In contrast, countable nouns

[17] All significance tests were carried out using simple t-tests, and all result reported as "significant" are of $p < 0.001$. For comparisons between the distributions of singular and plural occurrences of nouns, paired t-tests were used. See further details in the data and code repository.

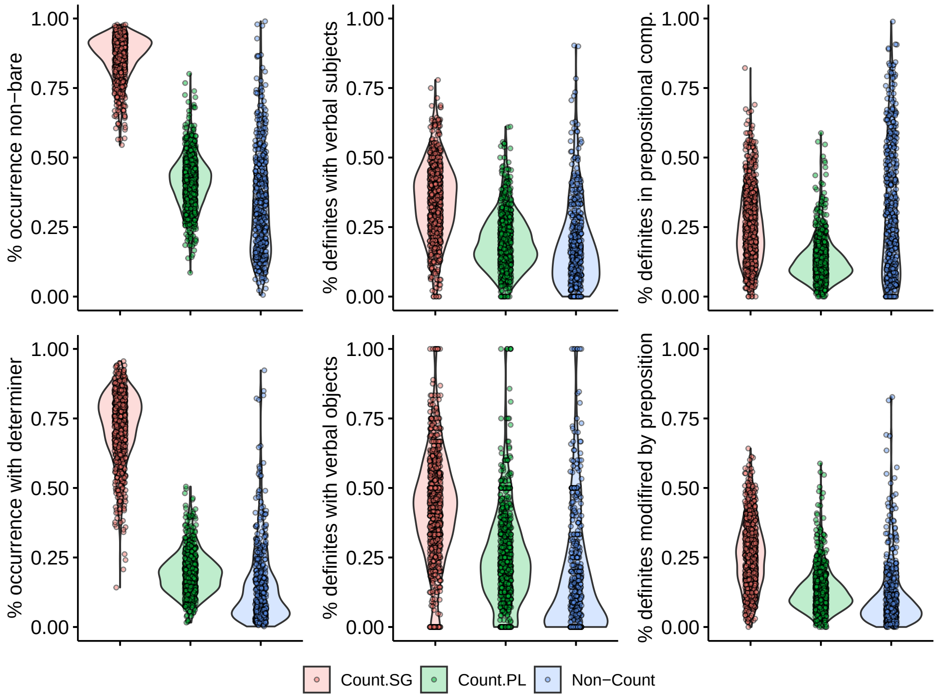

Figure 3: Comparison of determiner distributions of non-count and count nouns: Percentage of occurrence of each noun in each environment

are more tightly grouped for singular and plural occurrences, with a substantial proportion of plural uses occurring bare, no doubt largely due to generic uses.

The four middle and right-hand side panels track the occurrence of definite determiners in different syntactic positions. We calculate the proportion of definite uses among all uses of a given noun. For the mid-upper panel, the proportion of definite uses of count nouns, both in singular and plural uses, and non-count nouns are given for all occurrences in subject position. Count singular uses have the greatest proportion of definite uses (ranging from 0%–77% of their occurrences, mean tendency of 34.6%), while count plural uses and non-count nouns have a lower proportion of definite occurrences (0%–61%, mean 19.7%, and 0%–90%, mean 18.6%, respectively). While non-count nouns have the lowest proportion of definites in subject position, the distribution of plural uses of count nouns does not differ significantly in subject position from that of non-count nouns, although both differ significantly from the distribution of the singular uses of the count nouns.

Turning to nouns in the verbal object position (lower-mid panel) and those in the complement of a prepositional phrase (upper-right panel), the occurrences of definites among singular and plural uses of count nouns and non-count nouns all do differ significantly. While each type has nouns that have no or all occurrences as definites, making the ranges of proportions from 0% to 100% for all three, their central tendencies differ: count singular 34.6%, count plural 24.2% and non-count 17.6%.[18]

The general trend holds for the distribution of definite determiners with prepositions as well, with count singular nouns having a higher proportion than count plural nouns which is itself higher than non-count nouns. The definite uses of non-countable nouns in the complement of prepositions, as would be expected from Figure 2, show a large range of variation, although the central tendencies of count singular, count plural and non-count nouns differ significantly in the expected directions. The lower-right panel shows that many non-countable nouns show a high proportion of their definite uses when the noun is modified by a preposition, which appears to primarily occur when the non-countable noun is related to another referent, e.g. *the acidity of the soil*, i.e., the non-countable noun has a particular referent, here an acidity value, in relation to another referent (*soil*).

Overall, we are able to observe that the strongly non-countable nouns have a greater tendency to occur in syntactic positions which correspond to lesser discourse salience – in particular as verbal objects and complements of prepositions. Further, on average, they occur more often bare, that is, with less determination overall and, in particular, fewer definite uses, especially in argument positions. This is to be expected if countable nouns are more individuated, easily identified, and referred to, while non-countable nouns are those that are less individuated and less easy to establish as referents (see Grimm 2018 and references therein).

6 Outlook

This paper has presented a systematic study of a large number of non-countable nouns, tracking various aspects relevant for the ongoing discussions in the countability literature, including notional categories, as well as contextual and grammatical behavior. While this data set is to date far larger than any collected for

[18] These figures exclude copular constructions, although there too we found similar (statistically significant) trends. Count singulars have a higher proportion of definites in subject position than count plurals which in turn have a higher proportion than non-count nouns. However, for copular objects, while count singulars had a greater proportion of definite uses overall, this only contrasted significantly with count plurals, but not with non-count nouns.

this purpose, we must again emphasize the preliminary nature of the results here. Within the confines of this paper, we have only be able to bring forth a number of contrasts present in this data set, but certainly not all of them, nor have we *explained* these contrasts in detail beyond contributing some informal remarks.

It remains to be seen how current models of the count/non-count contrast need to be extended or revised to account for the various non-countable nouns examined here. Most of the countability literature has delivered analyses from the perspective of part-structures, such as mereology, a natural enough approach for nouns falling under entities or eventualities. Yet, for many of the nouns observed in the data set, such as *fatherhood*, *eyesight*, or *eloquence*, pressing them into the mould of a part-structure analysis seems far less convincing, pointing to the need for a more general theory of countability contrasts.

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Chapter 4

Syntactic reduplication and plurality: On some properties of NPN subjects and objects in Polish and English

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University of Lodz

This paper is concerned with selected properties of noun–preposition–noun (NPN) clausal subjects and objects (e.g. *day after day/dzień po dniu*) in English and Polish. At the descriptive level, the relevant phenomena include NPN subject-verb agreement and the aspectual features of verbs co-occurring with NPN subjects and objects. The phenomena are discussed in the light of the "internal" properties of NPN structures derived by the mechanism of iterative (syntactic) reduplication developed in Travis (2001, 2003) where a reduplicative head (Q) copies the complement of the preposition. The copy of the noun moves to SpecQP. Both nouns are treated as "defective" nominals (*n*Ps) due to the absence of the DP-layer since the presence of determiners is excluded (arguably cross-linguistically). The whole NPN is syntactically singular though semantically it encodes plurality (a sequence or succession of entities or events). In both English and Polish the singular character of NPN subjects is manifested by their co-occurrence with singular rather than plural verbs. Whenever such NPNs are subjects or objects, they only occur with imperfective verbs in Polish. While this is not morphologically marked in English, English clauses with NPN subjects or objects only allow imperfective interpretation too.

Keywords: reduplication, iteration, plurality, agreement, aspect

1 Introduction

Although the key characteristics of the syntax and semantics of NOUN–PREPOSITION–NOUN (NPN) structures (e.g. *day after day* in English, *dzień po dniu* in

Wiktor Pskit. 2021. Syntactic reduplication and plurality: On some properties of NPN subjects and objects in Polish and English. In Mojmír Dočekal & Marcin Wągiel (eds.), *Formal approaches to number in Slavic and beyond*, 83–98. Berlin: Language Science Press. DOI: 10.5281/zenodo.5082456

Polish) are discussed in a number of studies (see Pi 1995, Travis 2001, 2003, Beck & von Stechow 2007, Jackendoff 2008, Dobaczewski 2009, 2018, Rosalska 2011, Haïk 2013, Pskit 2015, 2017), the properties of NPNs functioning as clausal subjects and objects have not yet been investigated.

§2 presents the basic internal properties of NPNs in English and Polish, mainly based on what is reported in earlier studies. It also proposes an account of the mechanism responsible for the derivation of NPNs, which is a revised version of an earlier proposal in Travis (2001, 2003). §3 is concerned with the behaviour of argument NPNs: their status as subjects and objects, NPN subject-verb agreement patterns, and aspectual characteristics of the verb with NPN subject or object in Polish. §4 summarises the discussion, offers some tentative conclusions, and remarks on prospects for further research on the topic.

The current study constitutes but a preliminary look at the relevant problems and the observations made below need to be confronted with data from other languages.

2 The structure and internal properties of NPN structures

2.1 NPNs and related structures

What comes to be called NPN in the relevant literature represents a heterogeneous inventory of structures. Thus, there are idiomatic NPNs with a restricted selection of different nouns (e.g. *cheek by jowl*, *hand over fist*) and more regular NPN patterns with several prepositions but without lexically constrained nominals (e.g. *day by day*, *bumper to bumper*, *layer upon layer*). The latter category includes a number of highly lexicalised instances, such as *face to face/twarzą w twarz* 'face.INS in face.ACC'. The productive pattern involves the English prepositions *by*, *for*, *to*, *after* and *upon* (Pi 1995, Jackendoff 2008) and the Polish prepositions *w* 'in', *po* 'after', *za* 'behind/for/after/by', *przy* 'next to/close to' and *obok* 'next to' (Rosalska 2011, Pskit 2015, Dobaczewski 2018). Thus understood NPN structures are distinguished from PNPN constructions with identical (e.g. *from cover to cover/od deski do deski* 'from board.GEN to board.GEN', *from door to door*) or different nominals (e.g. *from mother to daughter*, *from shelf to floor, z ojca na syna* 'from father.ACC to son.ACC') (cf. Zwarts 2013). In particular, (P)NPN with the optional initial *from* in English can give an impression of being NPN, as in Jackendoff's (2008: 12) examples below (cf. also Zwarts 2013: 70):

(1) a. Adult coloration is highly variable (from) snake to snake.
    b. (From) situation to situation, conditions change.

An important characteristic of NPN structures with identical nouns is that they seem to involve some combination of the doubling of language form (identical nominals "surrounding" the preposition) and the plurality (or iteration) in terms of interpretation.[1] As Quirk et al. (1985: 280) observe, in such NPNs "two nouns are placed together in a parallel structure".

The present paper focuses on the productive subtype of NPNs with the English prepositions *after* and *upon* and the Polish prepositions *po* 'after' and *za* 'after/by' (lit. 'behind'), because only such NPNs occur as clausal arguments. As observed in other studies, while some NPNs allow dual (in Jackendoff's (2008) terms: the sense of juxtaposition of two entities or matching of two entities or sets of entities) or plural readings (succession in Jackendoff 2008), those with *after/upon* in English and with *po/za* in Polish have invariably plural readings.

2.2 Constraints on NPN-internal nominals

In both Polish and English, there are similar constraints on the nominals in NPNs. There is preference for countable singular nouns in both N_1 and N_2 position in N_1PN_2. As a result, uncountable (2) and plural countable nominals (3) appear to be ruled out (English data from Jackendoff 2008):

(2) a. * water after water, * dust for dust

b. * odzież za odzieżą
clothes.SG.NOM after clothes.SG.INS
Literally: 'clothes after clothes'

(3) a. * men for men, * books after books, * weeks by weeks

b. * książki za książkami
books.PL.NOM after books.PL.INS
Literally: 'books after books'

c. * tygodnie po tygodniach
weeks.PL.NOM after/by weeks.PL.LOC
Literally: 'weeks by weeks'

An obvious counterexample to the ban on mass nouns (2a) and plurals (3a) is the expression found in the Anglican burial service:

(4) … earth to earth, ashes to ashes, dust to dust …

[1]For more on different approaches to the semantics of NPN structures see Beck & von Stechow (2007) and Jackendoff (2008).

However, it is an instance of formulaic language and the NPNs *ashes to ashes* and *dust to dust* – whether used separately or together – have attained the status of idiom(s) rather than given rise to a productive pattern. It is also possible to interpret the data in (4) as elided versions of their clausal counterparts. The English NPNs with the preposition *upon* provide further problems with regard to the aforementioned constraint on nominals. What turns out to be relatively productive is the occurrence of mass nouns that undergo the well-known process of semantic recategorisation (mass / uncountable → countable):

(5) Absurdity upon absurdity. (Internet)

Its Polish counterpart (though unattested) would definitely have a countable reading ('a number of instances of absurdity following one another'):

(6) absurd za absurdem
absurdity.SG.NOM after/upon absurdity.SG.INS
'absurdity upon absurdity'

A semantically related and well-attested clausal counterpart also involves the doubling of the nominal that is countable, but such clausal structures are beyond the scope of the present analysis:

(7) Absurd goni absurd.
absurdity.3SG.NOM chase.3SG.PRS absurdity.3SG.ACC
'It is absurdity upon absurdity.'

The English *upon* turns out to be a "troublemaker" in the context of NPNs that permit plurals such as *millions* below:

(8) … there are millions upon millions who support your decision …
(Internet)

While *millions* has morphological plural marking, its plural sense is non-specific: a very large but non-specific number/amount. One way to account for this apparent exception to the ban on plural nominals in NPNs is to rely on Acquaviva's (2008) notion of lexical plurals. In spite of their plural inflectional marking, the English *hundreds*, *thousands* or *millions* are instances of number neutralisation, in the sense of neutralisation of the singular-plural opposition (Acquaviva 2008: 23, 26), or in Link's (1998: 221) wording they "have the *form* of a plural, but their reference is *transnumeral*" (emphasis in original). Then the ban on mass nouns and plurals should perhaps be rephrased in terms of number-neutrality or in terms of an unvalued number feature: bare nominals occur as N_1 and N_2, because they are number-neutral or their number features are unvalued.[2] The doubling of the nominals is responsible for the plural interpretation. This makes the presence of *millions* in (8) somewhat redundant from a semantic point of view.

The "bareness" of N_1 and N_2 is also reflected by the absence of any kind of determinative material: articles (in English), demonstratives and indefinite determiners (in Polish and English):

(9) a. * the man for the man, * a day after a day

b. * some inch by some inch (Jackendoff 2008: 9)

c. * ten dzień po tym / tamtym dniu
this.SG.NOM day.SG.NOM after this that.SG.LOC day.SG.LOC
Literally: 'this day after this/that day'

d. * jakiś dzień po jakimś dniu
some.SG.NOM day.SG.NOM after some.SG.LOC day.SG.LOC
Literally: 'some day after some day'

All in all, the doubling of the nominals seems to yield the meaning of plural. Obviously, the identical nominals – though with different morphological case markings in Polish – capture identity of sense rather than identity of reference.

2.3 Modification of NPN-internal nominals

Usually the nominals cannot be modified (10) (examples from Jackendoff 2008), although *after* and *upon* allow premodification and postmodification (11) (examples from Jackendoff 2008 and Haïk 2013). Interestingly, in English both premodifiers and postmodifiers occur either on both N_1 and N_2 (11a) or just on N_2 (11b–11c). Moreover, both *after* and *upon* allow iteration (11e).

(10) a. * father of a soldier for father of a soldier

b. * day of rain to day of rain

(11) a. tall boy after tall boy

b. day after miserable day

c. day after day of rain

d. layer upon layer of mud

e. day after day after day of unending rain

[2] As pointed out by an anonymous reviewer, the notion of unvalued feature seems to be more appropriate than that of number-neutrality, esp. if the latter is understood as general number.

By contrast, Polish NPNs with relatively productive *po* 'after' and *za* 'after/upon/behind' exhibit lower acceptability of modification (12), and if modification is marginally acceptable, which is more likely in the context of premodification, then it is found on either both N_1 and N_2, as in English, or only on N_1, as opposed to the English data in (11).

(12) a. ? deszczowy dzień za deszczowym dniem
rainy.sg.nom day.sg.nom after rainy.sg.ins day.sg.ins
Literally: 'rainy day after/upon rainy day'

b. ? deszczowy dzień po dniu
rainy.sg.nom day.sg.nom after day.sg.loc
Literally: 'rainy day after day'

c. ?? dzień deszczu za dniem deszczu
day.nom rain.gen after day.ins rain.gen
Literally: 'day of rain after day of rain'

d. * dzień deszczu za dniem
day.nom rain.gen after day.ins
Literally: 'day of rain after day'

e. * dzień za dniem deszczu
day.nom after day.ins rain.gen
Literally: 'day after day of rain'

While the availability of modification does not seem to directly affect the issue of number in NPNs, the nominal concord involving morphological marking of number, gender and case on the noun and its premodifier in Polish does have implications for the account of the structure and derivation of NPNs, as is made clear in §2.4 below.

2.4 The structure of NPN via syntactic reduplication

Following Travis (2001, 2003), I assume that NPNs are derived by the mechanism of iterative (syntactic) reduplication, where a reduplicative head (Q) copies the complement of the preposition. The copy of the noun moves to SpecQP as in Figure 1 below.

Importantly, the mechanism of iterative reduplication developed by Travis (2001, 2003) permits some subdomains to be copied into specifier positions. The kind of copying in question substantially differs from the copying in the "classical" movement since in the case of syntactic reduplication it is copying without

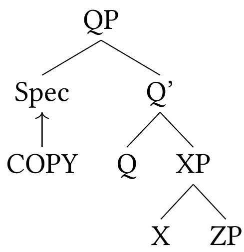

Figure 1: Syntactic (iterative) reduplication (Travis 2001, 2003)

deletion. Given the modification patterns in (11–12), and in particular considerable variation concerning the presence of modifiers on both nominals or only N_1 or only N_2, Travis's approach needs to be reconsidered: the whole *n*P is copied, and modifiers can undergo PF deletion on either N_1 (in English) or N_2 (in Polish). The distribution of modifiers in NPNs could be regulated by Fanselow & Ćavar's (2002) distributed deletion mechanism, but it is not to be elaborated on here.

Travis (2001, 2003) does not take it to be a settled matter whether the Q head selects a PP as its complement, or it is lexically realised as the preposition. In the latter case, the preposition would be an overt realisation (or at least the guise) of the reduplicative head. As a result, there are two possible structures for NPNs derived via syntactic reduplication: see Figures 2 and 3.

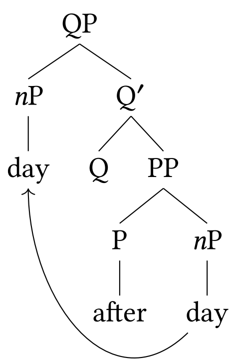

Figure 2: A variant of syntactic reduplication where the Q head selects a PP as its complement

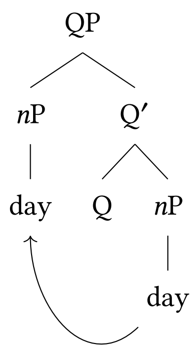

Figure 3: A variant of syntactic reduplication where the Q head is morpho-phonologically realized as a preposition in languages such as English or Polish

The structure in Figure 2 has a somewhat un-Minimalist flavour as it is based on a head (Q) that would probably be morpho-phonologically empty in all languages. Apart from this, the mechanism involving movement of a nominal complement out of a PP in non-P-stranding languages such as Polish poses another difficulty. If Abels (2003) is right regarding the phasal status of P in non-P-stranding languages, then Figure 3 would involve the crossing of a phase boundary.

The configuration in Figure 3 seems to capture the facts from languages where NPNs have no preposition, as illustrated for Kazakh (Turkic) in (13) (Turkish would follow the same pattern, Dilek Uygun Gokmen p.c.):[3]

(13) a. kunen kunge
day.ABL day.DAT
'day by day'

b. elden elge
country.ABL country.DAT
'country by country'

c. sureten suretke
picture.ABL picture.DAT
'picture after picture' (Kazakh)

The major theoretical disadvantage of the structure in Figure 3 is that – by allowing the copying of the content of the complement of Q into its specifier – it violates anti-locality (Abels 2003, Grohmann 2003): the movement is too local. In particular, Abels (2003) argues against movement from the complement to the specifier of the same head.[4] This analysis can be saved by stipulating that the syntactic reduplication is distinct from the "classical" movement: copying without deletion – licensed by the reduplicative head – is allowed to be that local.[5]

For languages like Kazakh or Turkish, the structure in Figure 2 would entail the presence of two empty heads: the Q head triggering reduplication, and the adposition-like case assigner heading the complement of Q, which is quite an

[3]The Kazakh examples were provided by native speakers of the language who participated in comparative morphosyntax seminars I taught at the University of Lodz (Poland) 2016–2019.

[4]According to an anonymous reviewer, the only solution to the problem of anti-locality in the case of NPN structures would be to treat this kind of movement as a non-syntactic operation. I leave it for further research to decide whether the original idea of syntactic reduplication in Travis (2001, 2003) can be maintained.

[5]Another problem pointed out by an anonymous reviewer with respect to movement without deletion is that this kind of operation overgenerates. However, if we assume that this sort of movement is only triggered by the reduplicative head that has some selectional restrictions (as illustrated in §2.2 above), the operation becomes restricted, though obviously by stipulation.

unwelcome result. According to the structure in Figure 3, the Q head would be morpho-phonologically realised as a preposition in languages such as English or Polish, and it would be phonologically null in languages such as Kazakh.[6]

As regards case assignment in Polish or Kazakh NPNs (and possibly in other languages with a rich system of morphological case), it would have to take place after the reduplication occurs. The nominal following the preposition is copied before it is assigned case by P: in Polish the case-marking of N_2 is determined by the preposition. This would involve post-syntactic realisation of case inflection (Sigurðsson 2012) or delayed movement to the appropriate position in KP as in Caha (2009). The details of case assignment are not going to be elaborated on here, however.

Based on the idea of cross-categorial symmetry between the nominal and the verbal/clausal domains, there has been a long-standing tradition of assuming the presence of an outer *n*P shell headed by a light noun and serving as the complement for some other higher functional heads (cf. Radford 2000, 2009, Alexiadou et al. 2007) as a nominal counterpart of the vP projection in the clausal domain. Following this tradition, I assume that the bare nominals in NPNs are "defective" in the sense that they lack the DP-layer in English (and other languages with articles) and in Polish if one assumes the universality of DP (see e.g. Progovac 1998, Willim 1998, Pereltsvaig 2007, Jeong 2016). The NPN-internal nominals also lack projections hosting demonstratives and other determinative heads in both English and Polish, which I expect to be valid cross-linguistically, but it obviously remains a tentative hypothesis to be tested in the course of further research. They resemble Pereltsvaig's (2006) small nominals, as argued for in Pskit (2017). Alternatively, the "defective"/small nominals inside NPNs can also be viewed as *n*Ps in the sense of roots with a categorising *n* head, as in Distributed Morphology (cf. Halle & Marantz 1993, Harley & Noyer 1999, Acquaviva 2008). Whether there are any higher functional projections dominating *n*P is a questionable issue. Given the number-neutral status of N_1 and N_2, they most probably do not include NumP, though this may seem problematic from the point of view of subject-verb agreement facts discussed in 3 below, and is perhaps even more controversial in the context of plural agreement as in (8) above, reproduced in (14) below for convenience:

(14) … there are millions upon millions who support your decision …

(Internet)

[6] This needs to be corroborated by analysing the behaviour of NPNs in clauses in Kazakh or Turkish.

Acquaviva (2008) argues that plurality that is inherent in nouns such as *hundreds*, *thousands* or *millions* is encoded in the categorising *n* head, making the nouns in question [*n* [ROOT]] complexes in the spirit of Distributed Morphology. If NumP is absent, the fact that the case endings on N_1 and N_2 in Polish are for the singular results from the treatment of these number-neutral bare nominals as singular by default. The same "singular-by-default" explanation would have to work in the context of premodifiers of the bare nominals, if they are found licit in Polish (cf. the data in (12) above), as such premodifiers necessarily agree with the head noun in terms of number, gender and case. As regards gender, the absence of the relevant functional head could be explained based on the assumption in Alexiadou et al. (2007): gender is an inherent part of the lexical entry of each noun rather than the matter of a dedicated functional head in the syntax.[7]

If NPNs are actually QPs, it naturally follows that the properties – including the quantificational properties – of the whole NPN are determined by the Q head.

3 The external properties of NPN subjects and objects

In both English and Polish, NPNs with all the prepositions in question can occur as adjuncts in typical adjunct positions in the clausal architecture. Consider the English data in (15) (from Jackendoff 2008 and Huddleston & Pullum 2002) and the Polish examples in (16):

(15) a. Page for page, this is the best-looking book I've ever bought.
b. John and Bill, arm in arm, strolled through the park.
c. We went through the garden inch by inch.
d. She worked on it day after day.

(16) a. Szli łeb w łeb.
go.3PL.PST head.SG.NOM in head.SG.ACC
'They went/ran neck and neck.'
b. Dzień po dniu zbliżaliśmy się do celu.
day.SG.NOM after day.SG.LOC approach.1PL.PST to goal
'Day after day we were approaching our goal.'
c. Wertował książkę kartka po kartce.
leaf.3SG.PST.through book page.SG.NOM after page.SG.LOC
'He leafed through a book page after page.' (Dobaczewski 2018: 249)

[7] As an anonymous reviewer aptly observes, this may mean that both plurality and gender are encoded in the categoriser. An alternative would be to assume that – given data such as (13) – the NPN-internal nominals contain the NumP projection, which requires investigating more cross-linguistic data on NPN subjects and objects.

English NPNs can also be DP-internal premodifiers (17a), and those with *after* and *upon* can function as complements of prepositions (17b) or possessive determiners (17c) (Jackendoff 2008: 19), though such patterns are not available in Polish:

(17) a. Your day-to-day progress is astounding.
b. We looked for dog after dog.
c. Student after student's parents objected.

A selected set of NPNs – with *after* and *upon* in English and with *po* and *za* in Polish – can become clausal subjects or objects.

(18) a. Day after day passed.
b. I drank cup after cup (of coffee).

(19) a. Mijał dzień za dniem.
pass.3SG.PST day.SG.NOM after day.SG.INS
'Day after day passed.'
b. Czytał wiersz za wierszem.
read.3SG.PST poem.SG.ACC after poem.SG.INS
'He read poem after poem.'
c. Mówiła studentowi za studentem …
tell.3SG.PST student.SG.DAT after student.SG.INS
'She told student after student …'

An interesting subject-verb agreement pattern emerges from the data in (18–19): in both English and Polish the verb is invariably singular in spite of the plural semantics of the whole NPN, which is corroborated by (20) below:

(20) a. Day after day passes …
b. * Day after day pass …
c. Mija dzień za dniem.
pass.3SG.PRS day.SG.NOM after day.SG.INS
'Day after day passes.'
d. * Mijają dzień za dniem
pass.3PL.PRS day.SG.NOM after day.SG.INS
Intended: 'Day after day passes.'

Given the derivation of NPNs as QPs via syntactic (iterative) reduplication, I assume – as suggested in §2.4 above – that the quantificational properties of NPNs are determined by the Q head. The agreement data prove that subject NPNs are syntactically singular. In addition, Polish NPN subjects agree with the verb also in terms of grammatical gender; see (21a) vs. (21b):

(21) a. Mijał dzień za dniem.
pass.3SG.M.PST day.SG.M.NOM after day.SG.M.INS
'Day after day passed.'

b. Mijała noc za nocą.
pass.3SG.F.PST night.SG.F.NOM after night.SG.F.INS
'Night after night passed.'

The data in (20) and (21) suggest that the relevant agreement relation is established in one of the two ways: either the T head may look into the features of N_1 or the feature valuation takes place between T and Q, with the Q head inheriting the phi-features of N_1.

Whenever NPNs are subjects or objects, they only occur with imperfective verbs in Polish as in (22). While this is not morphologically marked in English, English clauses with NPN subjects or objects would only allow imperfective interpretation too. Note that morphologically perfective verbs in Polish are fine with non-NPN plural objects (22c):

(22) a. Strzelał bramkę za bramką.
score.3SG.M.PST.IPFV goal after goal
'He scored goal after goal.'

b. * Strzelił bramkę za bramką.
score.3SG.M.PST.PFV goal after goal
Literally: 'He has scored goal after goal.'

c. Strzelił wiele bramek.
score.3SG.M.PST.PFV a.lot.of goals
'He has scored a lot of goals.'

One possible – though stipulative – account of the co-occurrence of imperfective verbs with NPN objects and subjects is based on the mechanism of valuation of the relevant feature of the Asp head in the extended verbal projection and the Q head of the NPN. An alternative is to relegate the issue to the level of LF interface as this property of NPN subjects and objects is shared with NPN adjuncts.

Indeed, irrespective of the grammatical function of NPNs, their plural semantics (iteration of entities or events) seems to match the morphological manifestation of the outer (grammatical) aspect in the verbal domain. The lack of such morphological aspectual marking in English points to the semantic licensing of the phenomenon.

4 Conclusion

The aim of the paper was to discuss the properties of subject and object NPNs in the light of the internal characteristics of NPN structures derived via a revised version of syntactic reduplication, originally proposed in Travis (2001, 2003).

The investigation is preliminary in nature and awaits corroboration by further research on NPNs in English, Polish and beyond.

The singular syntax of NPNs in both languages is reflected by the singular subject-verb agreement, whereas the plural semantics of NPNs corresponds to the imperfective characteristics of the verb with all types of NPNs.

The modification data discussed in §2.3 above suggest the following hypothesis with possible typological implications. While they encode the plurality of entities or events, NPNs are structures that are formally "abbreviatory": the mechanism of syntactic (iterative) reduplication yields expressions with minimal structure. The NPN is a structure with as little material (both in terms of "surface" morpho-phonological material and in terms of the articulation of the underlying syntactic structure) as possible. Ideally, there are two bare nominals "linked" by a preposition. Hence, in a language such as Polish, with rich nominal-internal agreement between the head noun and its modifiers, the amount of the morpho-phonological material resulting from establishing the agreement makes it too "heavy" for the Q head to accept modification within the NPN. But this remains a hypothesis to be tested empirically in other languages, especially beyond Germanic and Slavic and indeed beyond Indo-European, and also to be further pursued on theoretical grounds.

If the internal and external properties of NPNs discussed above turn out to be cross-linguistically valid, as expected based on fragmentary data from other languages, the lines of reasoning suggested above may gain further empirical support.

Abbreviations

3	third person	M	masculine
ABL	ablative	NOM	nominative
ACC	accusative	PFV	perfective
DAT	dative	PL	plural
F	feminine	PRS	present
INS	instrumental	PST	past
IPFV	imperfective	SG	singular
LOC	locative		

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Chapter 5

Implications of the number semantics of NP objects for the interpretation of imperfective verbs in Polish

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Languages differ in the range of readings of imperfective aspect but its single ongoing and plural event readings are cross-linguistically licensed. In this study we focus on the role of the number of NP objects on the disambiguation of Polish imperfective verbs. The crucial observation is that a singular object may block whereas a plural NP object creates a strong preference for the plural event reading of imperfective verbs. However, in the right context, the plural event reading of imperfective verbs is also available with singular NP objects. In order to account for these observations, we combine underspecification and number approaches to imperfective aspect and we propose that imperfective is underspecified for number and this information is specified via a coercion template mainly on the basis of the number semantics of nominal objects of imperfective verbs.

Keywords: imperfective aspect, semantic underspecification, number, contextual cues, gradual specification process

1 Introduction

It is known from the literature on English that the number of an (indefinite) NP object has an impact on the VP interpretation. For example, while in a sentence with a singular indefinite object a predicate like *eat* receives a telic interpretation (cf. *John ate an apple*), the use of a plural indefinite object results in an atelic interpretation (cf. *John ate apples*). The readings in question are associated with

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lexical aspect (ibidem).[1] What is less known is the role of the number of an NP object on the interpretation of the verbal predicate in languages with grammatical aspect such as Polish (or other Slavic languages).[2] In the present paper we will focus on the role of the number of an NP object on the interpretation of an imperfective verb in Polish. The usual assumption is that imperfective predicates reflect the perspective of an "insider", who sees a portion of an event from the inside and is oblivious to its endpoints (Kazanina & Phillips 2003). In more formal terms, the imperfective introduces the inclusion relation between the event time interval and reference time interval, where the former includes the latter, leaving the potential endpoints of an event from view; cf. (1) (for more discussion see, among others, Borik 2003, Comrie 1976, Kamp & Reyle 1993, Klein 1994, Reichenbach 1947, Smith 1997).

(1) $[\![\textsc{ipfv}]\!] = \lambda P.\lambda t.\exists e : \tau(e) \supseteq t \wedge P(e)$

It has been noticed in the literature that in those languages which distinguish between perfective and imperfective aspect, imperfective is multiply ambiguous (see Rivero et al. 2014, Cipria & Roberts 2000, Deo 2009, 2015, Hacquard 2015, de Swart 1998). However, what seems to be the case is that even if languages differ in the range of possible readings of imperfective, two meanings of imperfective aspect can be identified as standard cross-linguistically. The readings in question are single ongoing and plural event readings, illustrated by the Polish examples in (2) and (3), respectively.

(2) *Single ongoing*
Anna czytała gazetę, kiedy ktoś
Anna read.IPFV.PST.3SG.F newspaper.ACC when someone
wszedł do domu.
enter.PFV.PST.3SG.M into house
'Anna was reading a newspaper when someone entered the house.'

[1] For space reasons, we will not go into the discussion of the composition of semantic aspect in English. The reader is referred to Filip (1993/1999), Krifka (1989, 1992, 1998), Rothstein (2004), Verkuyl (1972, 1993, 1999). For further discussion, see Dowty (1979), MacDonald (2008), Tenny (1994), Willim (2006), and the references cited there.

[2] Semantic/lexical aspect (also referred to as "situational aspect" or "situation type," "eventuality type," "Vendlerian aspect," "inner aspect," or "Aktionsart") is lexically encoded in a verbal predicate. Grammatical/morphological aspect (also referred to as "viewpoint aspect" or "outer aspect"), on the other, is conveyed by "a grammatical morpheme, usually verbal" (Smith 1997: 2).

(3) *Plural event reading*
Maria prasowała ubrania córki wieczorami.
Mary iron.IPFV.PST.3SG.F clothes.ACC daughter.GEN evenings.INS
'Mary ironed her daughter's clothes in the evenings.'

On its single ongoing reading (ex. 2), the imperfective verb refers to an event which is incomplete at the asserted interval Willim (2006: 200–201). By contrast, on the plural event reading, the imperfective verb most typically refers to a series of delimited events happening on several occasions, as in (3). Interestingly, it seems to be the case that the availability of a given reading of the imperfective verb in Polish might be blocked or facilitated depending on what kind of object, singular or plural, is used. Examples in (4) and (5) illustrate this point.

(4) Rubens malował kobietę.
Rubens paint.IPFV.PST.3SG.M woman.SG.ACC
'Rubens was painting a woman.'

(5) Rubens malował kobiety.
Rubens paint.IPFV.PST.3SG.M woman.PL.ACC
'Rubens painted women.'

In (4), in which a singular (indefinite NP object) is used, the imperfective predicate denotes a single ongoing eventuality.[3,4] Crucially, the plural event reading is blocked in this case. However, when we change the grammatical number of the NP object in (5) to plural, the plural event reading becomes available. The above examples demonstrate that the number of an NP object plays an important role for the interpretation of an imperfective verb in Polish. But this is not the end of the story yet since in the right context, the plural event reading of imperfective verbs is also available with singular NP objects. Take (6) as an example.

(6) Audrey Hepburn paliła fajkę.
Audrey Hepburn smoke.IPFV.PST.3SG.F pipe.SG.ACC
'Audrey Hepburn smoked a tobacco pipe.'

[3]In Polish, there is no indefinite marking in NPs but the indefinite/definite reading of bare singular nouns is determined by the information structure. More precisely, under normal intonation the sentence stress falls on the final element, that is, the default placement of the focus exponent in Slavic is in the right periphery of a sentence (see Junghanns 2002).

[4]In principle it is pragmatically possible that one paints the same woman again and again but in the context with Rubens, who is well known for painting different women on different occasions, the reading that he painted the same woman on different occasions is pragmatically implausible. According to our intuitions and the intuitions of the native speakers consulted the plural event reading in this context is not available. Moreover, even if you use a different subject in (4), e.g., Peter, still the plural event reading is very hard (if not impossible) to obtain.

In (6) the most natural interpretation is that she smoked a tobacco pipe (possibly the same tobacco pipe) on several occasions. In order to account for these observations, we will rely on Ferreira's (2004, 2005) number approach to imperfective aspect, according to which it selects for either a singular or plural VP. Kagan's (2008, 2010) treatment of imperfective aspect as plural on events will also be discussed in this connection. We will also adopt de Swart's (2006) notion of bijection, which allows for a dependent reading between pairs of individuals and events in plural sets. We will argue that imperfective is underspecified for number and this information is specified via Dölling's (2014) coercion template mainly on the basis of the number semantics of nominal objects of imperfective verbs.

The paper is organized in the following way. First, in §2 we will present the underspecification approach to imperfective aspect. We will argue that the underspecification approach alone is not able to capture some crucial facts related to the interaction of imperfective aspect and the number of the NP objects. Next, §3 presents the results of an online questionnaire testing meaning preferences for imperfective verbs in Polish. The results of the questionnaire will speak in favor of the number theory of imperfective aspect proposed by Ferreira (2004, 2005) and presented in §4. However, it will be shown that this theory is too rigorous and it does not capture the fact that the interaction of the number semantics of imperfective aspect with the number of NP objects clearly relies on pragmatics. Based on the results of these studies and observations regarding the underspecified nature of imperfective aspect, we will argue that imperfective aspect is underspecified for number and we will present our account in §5. §6 will conclude the paper.

2 The underspecification approach to imperfective aspect

In Polish and in most languages which manifest the distinction between perfective and imperfective aspect, the former is semantically more marked (it has a more specific meaning and a more constrained distribution) and the latter is semantically less marked (it has a wider, more general meaning and occurs in a wider set of contexts). Perfective aspect has a very specific meaning in that it denotes an episodic bounded event. In contrast, imperfective aspect has a wider meaning in that it can be used to describe episodic unbounded, iterative or habitual eventualities. Consequently perfective aspect has a more restricted distribution than imperfective aspect.[5] Additionally, there is a gap in the distribution of perfective aspect. Perfective aspect can be used to talk about past and future events while imperfective aspectual forms can be used to talk about past, present and future events, as shown in Table 1.

Table 1: The distribution of perfective and imperfective aspect for past, present and future reference

Past time reference	Present time reference	Future time reference
imperfective aspect perfective aspect	imperfective aspect	imperfective aspect perfective aspect

Importantly, imperfective verbs in Polish can describe events as completed in what are know as general factual contexts, presented in (7).

(7) Podczas zwiedzania Barcelony jeden z turystów pyta przewodnika:
while visiting Barcelona one of tourists asks guide
Jaka spektakularna budowla. Kto ją budował /
what spectacular building who her build.IPFV.PST.3SG.M
zbudował?
build.PFV.PST.3SG.M
'While visiting Barcelona, one of the tourists asks the guide: What a spectacular building. Who built it?'

This fact is challenging for all the theories of imperfective aspect since it is not clear why imperfective is used to describe event completion even though this meaning could be better expressed by means of perfective aspect. This indicates that under some circumstances the meanings of perfective and imperfective aspect overlap. For this reason different linguists treat imperfective aspect as non-aspect, non-perfective, semantically underspecified, semantically unmarked or default (see Battistella 1990, Borik 2003, Comrie 1976, Dahl 1985, Filip 1993, Forsyth 1970, Kagan 2008, 2010, Klein 1995, Paslawska & von Stechow 2003, Willim 2006).

The semantically underspecified status of imperfective aspect in Polish, as described above, is compatible with the observation made in Aikhenvald & Dixon (1998) that in many languages only semantically underspecified aspect can be

[5] Sometimes it is assumed that unmarked forms lack the specific meaning a marked form has (cf. Borik 2003, who assumes that the meaning of imperfective aspect is non-perfective).

used in negative statements. In Polish, negation does not always force the use of the unmarked imperfective aspect but imperfective aspect is preferred in negative contexts with necessity modals (see Klimek-Jankowska et al. 2018).[6] More precisely, in positive contexts Polish speakers use two different forms, perfective and imperfective, to distinguish between single completed and repetitive events, as shown in (8a) and (9a). In contrast, in negative contexts this distinction is neutralized in the sense that one and the same form, i.e., imperfective, is used to describe single completed and repetitive eventualities, as shown in (8b) and (9b). Using perfective aspect in a negative context with a necessity modal sounds much less natural than using the imperfective form; see (8c).

(8) a. Musiałeś wstać.
must.PST.2SG.M get.up.PFV.INF
'You had to get up (once).'

b. Nie musiałeś wstawać.
not must.PST.2SG.M get.up.PFV.INF
'You did not have to get up (once).'

c. Nie musiałeś wstać.
not must.PST.2SG.M get.up.PFV.INF
'You did not have to get up (once).'

(9) a. Musiałeś wstawać.
must.PST.2SG.M get.up.IPFV.INF
'You had to get up (repeatedly).'

b. Nie musiałeś wstawać.
not must.PST.2SG.M get.up.IPFV.INF
'You did not have to get up (repeatedly).'

These observations suggest that perfective aspect is semantically specific in Polish and imperfective is semantically underspecified. How to account for the semantic underspecification of imperfective aspect in a more formal way? Hacquard (2015) argues that imperfective aspect has no meaning at all and its single ongoing or plural readings are realized by covert operators PROG or HAB. Imperfective marking is then taken to be the reflex of the presence of these covert operators in the syntactic structure. A similar view is proposed by Frąckowiak (2015), who following Hacquard (2015) claims that imperfective is a semantically vacuous morpheme whose distinct meanings are introduced by distinct, phonologically null operators.

[6] See Kagan (2008, 2010) for discussion of the use of the imperfective aspect (in Russian) in downward entailing environments.

One problem for the approach proposed by Hacquard (2015) is that in Polish, imperfective aspect is used to express plural event readings in contexts whose meaning is not necessarily habitual, as shown in (10):

(10) a. Jan spotykał dzisiaj ludzi z wielu zakątków
Jan met.IPFV.PST.3SG.M dzisiaj people.ACC from many parts
świata.
world.GEN
'John kept meeting people from different parts of the world today.'

b. Jan dwa dni czytał różne książki.
Jan two days read.IPFV.PST.3SG.M different books.ACC
'John read different books for two days.'

c. Zawsze kiedy mężczyźni wracali z łowów, cała
always when men return.PST.3PL.M from hunts whole
wioska zbierała się przy ognisku.
village gather.IPFV.PST.3SG.F REFL by fire
'You did not have to get up (once).'

In (10a) there were several occasions of John's meeting people from different parts of the world on a specific day (not habitually). In (10b) John read different books on several occasions for two days (not habitually). Finally, in (10c) on every occasion of the men returning from hunting, the whole village gathered by the fire. In (10a) and (10b), imperfective is used to express a plurality of events but the events in the plural set are distributed over a relatively short temporal interval and they do not constitute a habit. In (10c), the plural event reading results from the universal quantification over events by means of the adverbial quantifier *zawsze* 'always' and it has been convincingly argued by Ferreira (2004, 2005) that contexts with adverbs of quantification have a different semantics than bare habitual contexts. This shows that there are several plural event readings of imperfective aspect which cannot be captured by the semantics of the HAB operator. Additionally, under this approach it is not immediately clear how to account for the observation that singular NP objects create a strong preference for the single ongoing interpretation of imperfective verbs and plural NP objects create a strong preference for the plural event reading of imperfective verbs as in (4) vs. (5) in Polish.

In the next section, we present the results of our online questionnaire, which indicate that the number of NP objects has a significant impact on the interpretation of imperfective verbs in Polish. Next, in §4 it will be shown how the observed facts can be accounted for using Ferreira's (2004, 2005) number approach to imperfective aspect and de Swart's (2006) notion of bijection. However, it will be demonstrated that there is an important role of pragmatics in the interaction of the number of NP objects and the number semantics of imperfective verbs which can be better accounted for if the number approach is combined with the underspecification approach.

3 An online questionnaire on the role of the NP object number on the interpretation of imperfective verbs

3.1 Description

The goal of the reported online questionnaire was to establish whether the number of an NP complement of an imperfective verb has an impact on its preferred single ongoing or plural event meaning in Polish. We wanted to determine if there are significant differences between the interpretations for different verbal conditions: (i) imperfective verbs without any complements; (ii) imperfective verbs with singular complements; (iii) imperfective verbs with plural complements. The participants were asked to decide whether a given verb or a verb phrase referred to one event in the past or many events in the past. There was an additional option 'It is hard to say as both meanings are possible'. The participants could choose only one of the following answer types: (i) *jednokrotnie* 'one time'; (ii) *wielokrotnie* 'many times'; (iii) *trudno powiedzieć (obydwa znaczenia są możliwe)* 'difficult to say (both meanings are acceptable)'. The exact instruction to the questionnaire is given below.[7]

> W kwestionariuszu należy zdecydować, czy dany czasownik lub fraza czasownikowa odnosi się do jednego wydarzenia ciągłego w przeszłości, czy wyraża zdarzenie, które wydrzyło się wiele razy w przeszłości. Jest też do wyboru opcja "trudno powiedzieć, obydwa znaczenia są możliwe". Należy zawsze wybrać tylko jedną odpowiedź.

The questionnaire was filled in by twenty two participants (native speakers of Polish, students from the University of Wrocław (non-linguists), age 19–24). Each participant saw 10 bare imperfective verbs (without a sentential context),

[7]The task instruction translates as follows: "In the questionnaire you should decide whether a given verb or a verb phrase refers to one ongoing event in the past or to an event which happened many times in the past. There is also an option 'difficult to say as both meanings are possible'. You should chose only one option at a time."

10 imperfective verbs followed by a plural NP object and 10 imperfective verbs followed by a singular NP object, as summarized in Table 2. All the verbs had a past tense third person singular masculine morphology. All the items in our questionnaire study involved imperfective verbs (belonging to a lexical aspectual class of accomplishments) but the imperfective aspect places the perspective time inside the temporal trace of an event and hence it excludes the endpoints from view.

Table 2: Polish imperfective verbs and verb phrases used in our online questionnaire

imperfective verb	imperfective verb + NP_{SG}	imperfective verb + /NP_{PL}
ratował ‘(he) rescued’	testował maszynę ‘(he) tested (a) machine’	zamiatał korytarze ‘(he) swept corridors’
drukował ‘(he) printed’	rysował portret ‘(he) painted (a) portrait’	wyceniał działki ‘(he) priced plots of land’
nagrywał ‘(he) recorded’	wystawiał ocenę ‘(he) gaved (a) grade’	podlewał trawniki ‘(he) watered lawns’
pakował ‘(he) packed’	podrabiał podpis ‘(he) counterfeited signature’	sporządzał raporty ‘(he) made reports’
rozliczał ‘(he) calculated’	usuwał usterkę ‘(he) removed (a) failure’	podrywał dziewczyny ‘(he) picked up girls’
oceniał ‘(he) evaluated’	uszczelniał okno ‘(he) waterproofed (a) window’	wygłaszał wykłady ‘(he) gave lectures’
montował ‘(he) installed’	wysyłał paczkę ‘(he) shipped (a) package’	wypełniał formularze ‘(he) filled in forms’
wycinał ‘(he) cut out’	malował obraz ‘(he) painted (a) painting’	ozdabiał wnętrza ‘(he) decorated interiors’
omawiał ‘(he) discussed’	szkicował budynek ‘(he) sketched (a) building’	szacował straty ‘(he) estimated losses’
poprawiał ‘(he) corrected’	wyłudzał łapówkę ‘(he) extorted (a) bribe’	naprawiał rowery ‘(he) repaired bikes’

3.2 Results

Statistical analysis was conducted in the R program on a Windows compatible PC (R Core Team 2020). To determine the existence of the differences in the reading choices of imperfective verbs in three experimental conditions: (i) verb not followed by an object (ipfv), (ii) verb followed by an object in singular number (ipfv+$\mathrm{NP}_{\mathrm{SG}}$) and (iii) verb followed by an object in plural number (ipfv+$\mathrm{NP}_{\mathrm{PL}}$) a loglinear analysis using loglm function (MASS package, Venables & Ripley 2002) was performed. This analysis was chosen because the response variable (reading) was nominal. A two-way loglinear analysis produced the final model, which retained all the main effects (Condition and Reading) and a two-way interaction effect (Condition × Reading). The likelihood for this model was $\chi^2(0) = 1, p = 1$. Removing the interaction effect resulted in a significantly poorer model fit ($\chi^2(4) = 337.463, p < 0.0001$), which indicated that the two-way interaction effect was significant. To break-down the interaction effect, standardized residuals were examined; see Table 3 (residuals which indicate significant differences, i.e. outside the −1.98 to 1.98 range, are marked in bold).

Examination of standardized residuals have shown the following differences:

1. If the verb is not followed by any object NP (ipfv), respondents preferred to choose the meaning when both ‘one time’ and ‘many times’ interpretations were possible. They also avoided selecting the ‘one time’ interpretation.

2. If the verb is followed by an object in singular number, the preferred reading is the one in which action is carried only once, i.e., the ‘one time’ reading. Moreover, conceptualizing the action as occurring multiple times, i.e., the ‘many times’ reading, is dispreferred.

3. If the verb is followed by an object in plural number, the ‘many times’ reading is the only one preferred, as both ‘one time’ and ‘difficult to say’ readings are were avoided.

The results are graphically represented in Figure 1. The summary of all the participants’ responses is given in the Appendix.

3.3 Discussion

Taken together, when imperfective verbs were presented out of context, the answer ‘it is hard to say (both meanings are possible)’ was chosen more often than the remaining two answers ‘one time’ and ‘many times’. Only the difference

Table 3: Statistics for reading choice counts with respect to experimental conditions

Condition	Reading	Response		
		one time	hard to say	many times
IPFV	count	36	104	110
	expected count	76.667	63.333	112
	standardized residuals	**−4.475**	**5.110**	−0.189
IPFV+NP_{SG}	count	155	51	190
	expected count	67.2	57	100.8
	standardized residuals	**10.711**	**−0.795**	**−8.148**
IPFV+NP_{PL}	count	33	35	207
	expected count	82.133	69.667	123.2
	standardized residuals	**−5.421**	**−4.153**	**7.550**

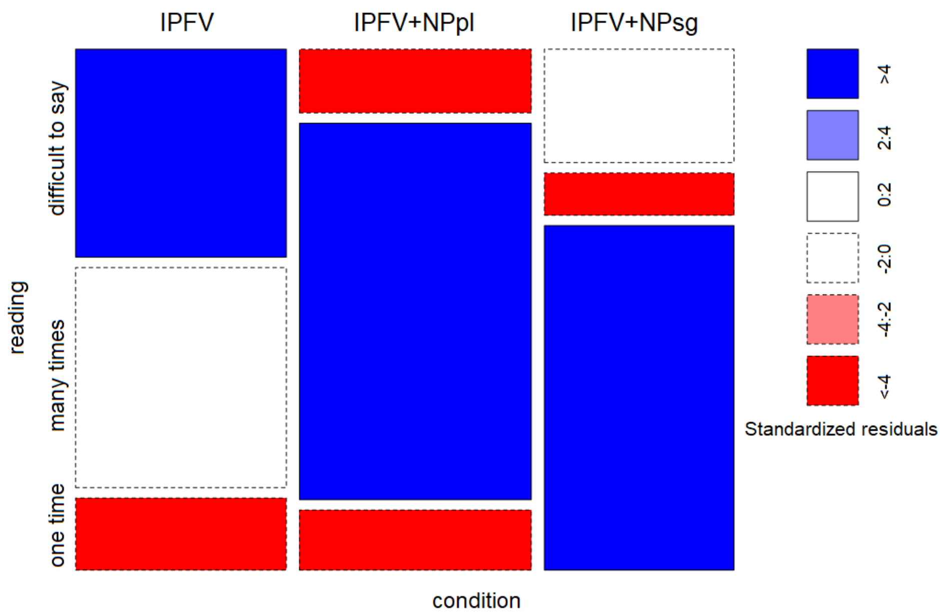


Figure 1: Standardized residuals for three kinds of answers 'one time', 'many times', 'it is hard to say as both readings are possible' in three Conditions: IPFV, IPFV+NP_{SG}, IPFV+NP_{PL}.

between the number of 'it is hard to say (both meanings are possible)' and 'one time' readings was statistically significant. Additionally, the answer 'many times' was chosen significantly more often than the answer 'one time', which may suggest that the plural reading of imperfective aspect is dominant (more frequent). In contexts in which imperfective verbs were followed by a singular NP object, there was a significant preference for the 'one time' interpretation. Additionally, there was a significant preference for the 'many times' interpretation in contexts in which imperfective verbs were followed by a plural NP object. These data provide support for the claim that plural readings of imperfective verbs are obtained via a dependent reading between events described by a verb and individuals described by an NP object. Most importantly, the results of this study indicate that many respondents did not have a clear preference for any of the meanings of imperfective verbs presented out of context. For those respondents who had preferences, the plural event reading of bare imperfective verbs was preferred over the single ongoing reading. Additionally, the results indicate that the grammatical number of NP complements of imperfective verbs can serve as a contextual cue pointing to either the single ongoing or plural meaning of imperfective verbs. In order to account for the observations made in our online questionnaire study, in the following section we will adopt Ferreira's (2004, 2005) number approach to imperfective aspect (which is compatible with Kagan's 2008, 2010 view of imperfective aspect) and de Swart's (2006) notion of bijection.

4 The number approach to imperfective aspect

4.1 Ferreira's (2004, 2005) number approach to imperfective

Ferreira (2004, 2005) extends Link's (1983) original idea that the domain of individuals is formed by singular as well as plural objects (where singular objects are atomic entities and have no proper parts while plural objects are mereological sums having proper parts) and argues that a similar mereology can be extended to the domain of events. More precisely, Ferreira (2004, 2005) argues that the singular/plural opposition used by Link (1983) to distinguish between atomic and non-atomic individuals in the domain of objects applies to events as well with plural events being characterizable as mereological sums having singular events as their minimal parts. Ferreira (2004, 2005) argues that imperfective aspect is an operator which selects for either plural or singular VPs: IPFV [VP_{SG}/VP_{PL}]. The single ongoing interpretation of an imperfective verb is derived from the logical form with the imperfective selecting for VP_{SG}, as presented in (11).

(11) $[\![\textsc{ipfv}_{\textsc{sg}}]\!] = \lambda P_{\mathrm{SG}}.\lambda t.\exists e : \tau(e) \supseteq t \wedge P(e)$

The plural event reading of an imperfective verb is derived from the logical form with the Imperfective selecting for $\mathrm{VP}_{\textsc{pl}}$, as formally represented in (12).

(12) $[\![\textsc{ipfv}_{\textsc{pl}}]\!] = \lambda P_{\mathrm{PL}}.\lambda t.\exists e : \tau(e) \supseteq t \wedge P(e)$

Ferreira (2004, 2005) accounts for the unbounded interpretation of imperfective aspect by assuming Klein's (1995) time relational semantics, where the perspective time t is included in the temporal trace of an event $\tau(e)$. This means that while interpreting imperfective aspect we take the perspective of an "insider", who sees a portion of an event from the inside and is oblivious to its endpoints (see Kazanina & Phillips 2003).

In order to formally capture the fact that under the plural event reading of imperfective each of the events in the plural set is distributed over separate time intervals, Ferreira (2004, 2005) assumes that the domain of intervals D_i contains singular and plural intervals and there is a homomorphism τ between the structured domain of events and the structured domain of intervals, so that for any events e, e', $\tau(e \oplus e') = \tau(e) \oplus \tau(e')$ where $\tau(e)$ is the time of the event e.

4.2 Kagan's (2008, 2010) number approach to the perfective/imperfective opposition

Kagan (2008, 2010) also proposes a number approach to aspect but she draws an analogy between the singular/plural opposition in the nominal domain to the perfective/imperfective opposition in the verbal domain.[8] Following Sauerland (2003a), Kagan (2008, 2010) assumes that the semantics of plural NPs is essentially neutral with respect to number, that is, the denotation of a bare plural NP contains both pluralities of objects and singular objects while the denotation of singular NPs which is restricted to atomic individuals, as shown in (13) and (14).

(13) $[\![\textsc{sg}]\!] = \lambda P.\lambda x.P(x) \wedge \textsc{sng}(P)$

(14) $[\![\textsc{pl}]\!] = \lambda P.\lambda x.P(x)$

Kagan (2008, 2010) applies this semantics proposed for singular and plural morphology in the nominal domain to the perfective versus imperfective opposition, as demonstrated in (15) and (16).

[8] See also Rothstein (2020) who, following Kagan (2010), treats "imperfective root verbs as plural predicates denoting sets of plural events, with singular events the borderline case of plurality" (p. 156).

(15) $[\![\text{PFV}]\!] = \lambda P.\lambda e.P(e) \wedge \text{SNG}(P)$

(16) $[\![\text{IPFV}]\!] = \lambda P.\lambda e.P(e)$

More precisely, it is assumed that just like singular NPs denote singular object (atomic individuals), perfective predicates denote atomic events.[9] In a similar vein, just like the denotation of bare plural NPs contain both pluralities of objects and singular objects, the denotation of the imperfective aspect encompasses both atomic and non-atomic events. Thus, the imperfective aspect, just like the plural number, are treated as default in the proposed analysis.[10,11]

What is crucial in Kagan's (2008, 2010) approach is that the imperfective is number neutral and its interpretation is determined on the basis of Gricean maxims while Ferreira (2004, 2005) claims that the imperfective operator selects either a singular or a plural VP. Ferreira (2004, 2005) does not specify which factors determine the selection. We think that his approach leaves more room for capturing the role of the grammatical number of NP objects in the selection of a plural or singular event.

4.3 A preliminary proposal

In our study we adopt Ferreira's (2004, 2005) number approach to imperfective aspect and we extend it by adopting Dölling's (2014) underspecification approach (which will be discussed later in this section). We argue that imperfective verbs are underspecified for number (they are underspecified for whether they denote singular or plural eventualities). When combined with time-relational semantics, perfective verbs refer to single bounded eventualities and imperfective verbs refer to single or plural temporally unbounded eventualities. As revealed by the

[9] Following Krifka (1992), Filip (2000) and Rothstein (2004), among others, it is assumed that atomicity or singularity involves quantization.

[10] As Kagan (2010) points out, the view of the imperfective as a default aspect is by no means new. Similar observations can be found in the literature already in Forsyth (1970).

[11] The choice of a specific aspect form of a verb in a given context is claimed to be pragmatic in nature. More precisely, it is assumed to be subject to the Gricean maxim of quantity, which Kagan (2008, 2010) is defined following Sauerland (2003b) as follows: a. maximize assertion: Use the most informative assertion that is true. b. maximize presupposition: Use the most informative presupposition that is satisfied. Since, as revealed in (16), a perfective form is more restricted in meaning than its imperfective counterpart, whenever the former is appropriate (as contributing an entailment that the event described by the speaker is atomic), the use of the latter is ruled out by the above principles. The choice of the less restricted imperfective form thus triggers a conclusion on the part of the hearer that the perfective form was not appropriate. In other words, the hearer can conclude in this case that "atomicity requirement is not satisfied, or at least that the speaker does not have sufficient evidence that the event she has encoded is indeed atomic" (Kagan 2008: 10–12).

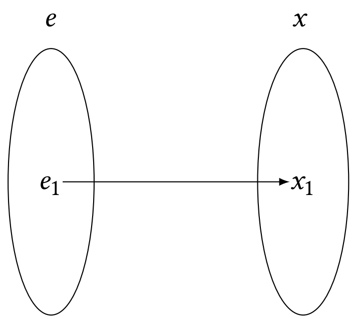
results of the online questionnaire reported in §3, the grammatical number of NP complements of imperfective verbs can serve as a contextual cue pointing to either the single ongoing or plural meaning of imperfective verbs. Consider examples (4) and (5) presented earlier in the introduction and repeated here for convenience as (17) and (18).

(17) Rubens malował kobietę. = (4)
Rubens paint.IPFV.PST.3SG.M woman.SG.ACC
'Rubens was painting a woman.'

(18) Rubens malował kobiety. = (5)
Rubens paint.IPFV.PST.3SG.M woman.PL.ACC
'Rubens painted women.'

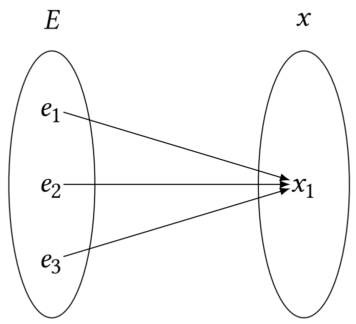
Assuming following Ferreira (2004, 2005) that an imperfective operator selects for either singular or plural VPs, the sentences in (17) and (18) have two possible contextual interpretations each, one with a singular event e and one with a plural event E (note that x is used to represent singular individuals and X is used to represent plural individuals), as presented in Figures 2–5.

This means that the sentence in (17) with an imperfective verb and a singular NP object is in principle ambiguous between the interpretations represented in Figures 2 and 3. However, the interpretation in Figure 3 where there is a plural event of Ruben's painting the same woman is pragmatically implausible, therefore the interpretation in Figure 2 is strongly preferred. Similarly, the sentence in (18) is ambiguous between the interpretations represented in Figures 4 and 5 but the interpretation in Figure 4 where there is a single event of Rubens' painting



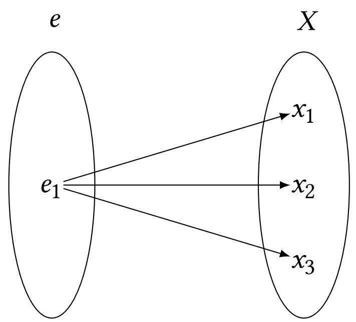
$$\exists e \exists x[\textsc{paint}(e) \land \textsc{agent}(\textsc{Rubens}, e) \land \textsc{woman}(x) \land \textsc{theme}(e) = x]$$

Figure 2: Contextual single event interpretations of the sentence in (17)



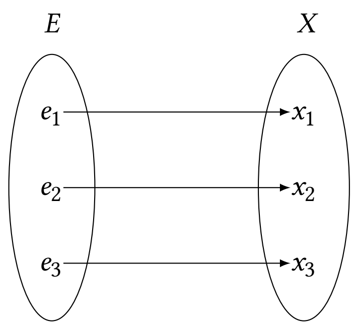
$\exists E \exists x[\textsc{paint}(E) \wedge \textsc{agent}(\textsc{Rubens}, E) \wedge \textsc{woman}(x) \wedge \textsc{theme}(E) = x]$

Figure 3: Contextual plural event interpretations of the sentence in (17)



$\exists e \exists X[\textsc{paint}(e) \wedge \textsc{agent}(\textsc{Rubens}, e) \wedge \textsc{woman}(X) \wedge \textsc{theme}(e) = X]$

Figure 4: Contextual single event interpretations of the sentence in (18)



$\exists E \exists X[\textsc{paint}(E) \wedge \textsc{agent}(\textsc{Rubens}, E) \wedge \textsc{woman}(X) \wedge \textsc{theme}(E) = X \wedge f : E \leftrightarrow X]$

Figure 5: Contextual plural event interpretations of the sentence in (18). *Note*: $E \leftrightarrow X$ represents a bijection (one-to-one) relation between members of the plural event E (understood as a sum of events) and the members of the plural entity X (understood as a sum of individuals).

multiple women is pragmatically implausible, therefore the interpretation in Figure 5 is strongly preferred. The configuration in Figure 5 is the only one in which there are two plural sums and it is possible to establish a bijection (one-to-one) relation between members of the plural event *E* (understood as a sum of events) and members of the plural entity *X* (understood as a sum of individuals) giving rise to a dependent reading between pairs of individuals (denoted by an NP_{PL}) and events (denoted by a VP_{PL}). Given the results of our questionnaire study, it appears to be the case that in most scenarios it is pragmatically more plausible that plural events involve different entities which disfavors or even blocks the use of singular NP objects under the plural event reading of imperfective. However, there are contexts in which it is not impossible, as shown in (19).

(19) Audrey Hepburn paliła fajkę.
Audrey Hepburn smoke.IPFV.PST.3SG.F pipe.SG.ACC
'Audrey Hepburn smoked a tobacco pipe.'

(20) Audrey Hepburn paliła fajki.
Audrey Hepburn smoke.IPFV.PST.3SG.F pipe.PL.ACC
'Audrey Hepburn smoked tobacco pipes.'

(19) can be exceptionally interpreted as describing a plural event of Audrey's smoking the same pipe on each occasion because it is pragmatically possible to smoke the same pipe several times. By contrast, in (21) Sherlock's smoking the same cigarette on different occasions is pragmatically odd, therefore the plural event reading in this scenario is more naturally expressed in (22) with a plural NP object allowing for a bijection relation between the set of events in the denotation of an imperfective verb and the set of individuals in the denotation of a plural NP object.

(21) Sherlock Holmes palił papierosa.
Sherlock Holmes smoke.IPFV.PST.3SG.M tobacco-pipe.SG.ACC
'Sherlock Holmes smoked a cigarette.'

(22) Sherlock Holmes palił papierosy.
Sherlock Holmes smoke.IPFV.PST.3SG.M cigarettes.PL.ACC
'Sherlock Holmes smoked cigarettes.'

It thus appears to be the case that the number approach to imperfective aspect alone is insufficient to account for the interaction between imperfective aspect and the number of NP objects as it is to a large extent a result of the interaction of semantics and pragmatics. For this reason we would like to propose that the two independent approaches to imperfective aspect: the underspecification approach (see §2) and the number approach (as presented in the present section) should be combined and that is reasonable to assume that imperfective aspect is underspecified for number. This can be elegantly captured in more formal terms by adopting the model of interpretation of aspectually underspecified representations proposed by Dölling (2014) and Egg (2005), which is presented in the next section.

5 The proposed model of interpretation of imperfective aspect

A theoretical approach to resolving semantically underspecified expressions, also in the aspectual domain, has been proposed by Dölling (1995, 1997, 2001, 2003b,a, 2014) and Egg (2005), among others. In a nutshell, it is assumed that the computation of a fully specified meaning takes place in two steps (see also the two-level semantic approach by Bierwisch 1983, 1997, 2007, Bierwisch & Lang 1989, Bierwisch & Schreuder 1992, Lang 1994). The first step consists in the computation of an underspecified representation in a strictly compositional fashion. Crucially, in the first step everything which needs further disambiguation is left open. More specifically, Egg (2005) proposes that semantic representation introduces particular gaps or blanks which can be filled in with relevant aspectual operators in order to buffer aspectual conflicts. Dölling (2014) claims that in the first stage an abstract, underspecified coercion operator is mandatorily inserted in semantic composition. The disambiguation of an underspecified representation is part of the second computational step. It is based on pragmatic information such as discourse context or conceptual knowledge. In Egg's work aspectual mismatches, for example, are resolved by inserting an appropriate operator (e.g., iteration, add preparation etc.) into the underspecified representation, whereby the choice of an operator is determined on pragmatic grounds. In Dölling (2014), in the second step an aspectual coercion can be realized by pragmatically enriching it. However, as Bott (1989: 47) points out, "[l]ike the previous accounts, Egg (2005) does not provide a theory of how and when pragmatic information is brought into the specification process."

Inspired by the works of Dölling (2014) and Egg (2005), we propose that upon encountering an imperfective predicate, the ipfv operator is added to the semantic representation and it is underspecified for number. Importantly, we assume, following Tatevosov (2011, 2015), that the aspectual operators ipfv and pfv act at the level of AspP (and are phonologically null) and their morphological exponents merge lower in the syntactic hierarchy. We adopt Dölling's (2014: 34–35) formalism, according to which each verbal predicate is added to the representation with a template called COERCE, which has the form $\lambda P \lambda e.Qe' : R(e', e)[P(e')]$ (an abstract coercion operator) and which denotes a mapping from properties of eventualities of a certain sort onto properties of eventualities of some other sort. More precisely, properties P are mapped onto properties $\lambda e.Qe' : R(e', e)[P(e')]$ where some quantifier Q (which can be instantiated as $\exists$ or $\forall$) ranging over e' has as its restriction an inter-sortal relation R between e' and e, and its scope is the proposition that e' is P. The symbol R can be instantiated by any inter-sortal relation between eventualities understood as shifts from one aspectual type to another. In Dölling's (2014: 34–35) formalism the fixation of the parameter R is left to context and it involves a pragmatic enrichment mechanism. As a consequence, the template COERCE leaves room for different specifications at the pragmatics-semantics interface. Dölling (2014: 34–35) illustrates the use of the COERCE template in the VP *play the sonata* (see 23), which can be coerced into a repetitive action of playing the same sonata over and over again when combined with a temporal adverbial specifying a long temporal interval.

(23) $[\![\text{play the sonata}]\!]$: $\lambda e.\textsc{play}(e) \wedge \textsc{theme}(\textsc{the sonata}, e)$

(24) COERCE: $\lambda P \lambda e.Qe' : R(e', e)[P(e')]$

(25) $[\![\text{play the sonata}]\!]$: $\lambda e.Qe' : R(e', e)[\textsc{play}(e') \wedge \textsc{theme}(\textsc{the sonata}, e')]$

We would like to propose that Dölling's (2014) COERCE template is an obligatory element of the semantics of the imperfective operator, as represented in (24):

(26) $[\![\textsc{ipfv}]\!] = \lambda P.\lambda t.\lambda e.\exists e'[\textsc{numb}(e, e') \wedge t \subseteq \tau(e') \wedge P(e') = 1]$

The COERCE template involves a number operator NUMB, which maps singular or plural eventualities to their plural or singular counterparts. Inspired by the insights of recent psycholinguistic studies related to the processing of polysemous lexical items (Klein & Murphy 2002, Pylkkänen et al. 2006, Frisson 2015), we assume that the plural and singular readings of events are listed as separate senses of verbal lexical entries. More precisely, we think that these senses (singular/plural) are connected to the same abstract lexical representation of a given verbal predicate but the senses themselves are distinctly listed and some of them may be more dominant (more frequent) than others. Most predicates such as *palić* 'smoke', *gotować* 'cook', *sprzątać* 'clean', *uczyć* 'teach', *myć* 'wash', *jeść* 'eat' (and the predicates used in our questionnaire) have a more dominant (more frequent) plural event sense because they are more often used in plural event contexts. In the case of such predicates, when the context supports the singular event reading, the number operator in the COERCE template takes as its input a more dominant plural eventuality and it switches it to a singular event reading. However, there are also predicates which describe eventualities which normally do not happen regularly such as *rodzić* 'give birth', *umierać* 'die' because they are more often used as episodic events. The dominant sense of such predicates is a singular event. In the case of these predicates, when the context supports the plural event reading, the number operator in the COERCE template maps a singular eventuality to a plural one. In psycholinguistic research, it has been shown that sense frequency has an impact on the interpretation process of polysemous words. It has been shown that switching between word senses under the influence of context is costly (see Frisson 2015 and the references mentioned therein). We think these context-dependent switches between singular and plural event senses of verbal predicates can be nicely captured formally by applying Dölling's (2014) COERCE template, which acts at the semantics–pragmatics interface.

It may happen however that the dominant meaning (plural or singular) of an imperfective verb is consistent with context and no coercion is necessary. In such cases, we assume following Dölling (2014) that the representation involves an equation between e and e' which results in removing the NUMB operator as it involves an identity relation, as shown in (25):

(27) $[\![\text{IPFV}]\!]$
$$= \lambda P.\lambda t.\lambda e.\exists e' : e' = e[t \subseteq \tau(e') \wedge P(e') = 1] \equiv \lambda P.\lambda t.\lambda e.[t \subseteq \tau(e') \wedge P(e')]$$

Depending on the interaction with the surrounding context, the imperfective operator IPFV can thus be specified (via coercion) to a singular or plural event reading. The number of an NP object plays a crucial role in this specification process. As the results of our online questionnaire indicate, without any context, an imperfective verb can be interpreted as denoting a single event or multiple events, though its plural reading seems to be the dominant (more frequent) one. A plural event interpretation is strongly preferred with imperfective verbs followed by a plural NP object. By contrast, when an imperfective verb is followed by a singular NP object, there is a strong preference for a single event interpretation. This is especially the case with consumption verbs, as, for example, *jeść jabłko* 'to eat.IPFV an apple', which cannot receive a 'many times' interpretation since with strong incremental theme verbs the participants of repeated events cannot be identical. In contrast, with verbs like, for example, *podlewać ogród* 'to water.IPFV a/the garden' or *reparować rower* 'to repair.IPFV a/the bike', a plural event interpretation, involving one and the same participant, is possible. This shows that the role of the number of NP objects is not deterministic in the specification process as it interacts with the information about the specific lexical semantics of a given imperfective verb. Furthermore, as we have seen in §4, the information about the number of an NP object also interacts with pragmatics or world knowledge.[12] While a single unbounded event interpretation of an imperfective verb followed by a singular object might be more plausible in one case (recall the Rubens example in (17)), in another case it might in fact be more plausible to assume that the imperfective verb followed by a singular object denotes a plural event (recall the Audrey Hepburn example in (19)).

6 Conclusion

To sum up, there is solid evidence that imperfective aspect is semantically underspecified (recall §2). However, we have shown that the underspecification approach alone is not able to capture some crucial facts related to the interaction of imperfective aspect and the number of the NP objects, as revealed by the results of our online questionnaire study (§3). We have also argued that although these observations could potentially be accounted for by applying Ferreira's (2004, 2005) number approach to imperfective aspect, this theory is too rigorous and it does not capture the fact that the interaction of the number semantics of imperfective aspect with the number of NP objects clearly relies on pragmatics (§4). In the present paper we propose a model of interpretation of imperfective aspect which in some sense combines the underspecification approach and the number approach to imperfective aspect as it takes imperfective aspect to be underspecified for number (§4.3). More precisely, following the ideas put forward by Dölling (2003a,b, 2014) and Egg (2005), we argue that the imperfective operator that is added to the representation contains a COERCE template with

[12] As pointed out by an anonymous reviewer, it is very difficult to propose a theory of how and when pragmatic information is brought into the specification process of IPFV. The weak point of the present analysis is that there is a thin line between cases in which the "switching mode" of COERCE (from a dominant plural sense to a singular one) is activated (as in Rubens painting the same woman again and again, which is pragmatically implausible since it is common knowledge that he painted different women on different occasions). In contrast to Audrey's smoking the same pipe again and again, which is claimed to be pragmatically possible and leaves COERCION in the "identity mode". We think that it is necessary to investigate the role of singular/plural sense dominance of different imperfective verbs in the specification process to sort out the exact interplay of the COERCE function of IPFV, sense dominance, the number of an NP object and pragmatics (world knowledge).

a number operator in it and it is specified for number on the basis of the interaction between the number semantics of the NP object, the imperfective aspect and context (§5). Our account leaves room for the interaction between the grammatical number of the NP object, pragmatics and plural and singular senses of verbs, which all play a nontrivial role in the specification process of imperfective aspect, which in our view is underspecified for number. However, this proposal should be treated as a pathway for further research as there are still many interesting questions left open. For example, it would be interesting to extend the proposed analysis with questions related to the role of different lexical aspectual classes of verbs, the interaction of the plural and singular readings of IPFV with quantifiers. What is also nonstandard in our analysis is the proposal that the selection of singular and plural meanings of IPFV is preceded by the activation of plural and singular senses of verbal predicates. Finally, the psychological plausibility of the existence of the COERCE operator leading to meaning shifts between singular and plural readings of IPFV should be experimentally investigated, for example in relation to sense dominance.

Abbreviations

2	second person	M	masculine
3	third person	NEG	negation
ACC	accusative	PFV	perfective
F	feminine	PL	plural
GEN	genitive	PST	past tense
INF	infinitive	REFL	reflexive
INS	instrumental	SG	singular
IPFV	imperfective		

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Appendix: Summary of the responses of all the participants for all the tested items

Table 4: Items: Conditions and contents

No.	Condition	Source	Translation
1	IPFV	ratował	'[he] rescued'
2	IPFV	drukował	'[he] printed'
3	IPFV	nagrywał	'[he] recorded'
4	IPFV	pakował	'[he] packed'
5	IPFV	rozliczał	'[he] calculated'
6	IPFV	oceniał	'[he] evaluated'
7	IPFV	montował	'[he] installed'
8	IPFV	wycinał	'[he] cut out'
9	IPFV	omawiał	'[he] discussed'
10	IPFV	poprawiał	'[he] corrected'
11	IPFV+NPsg	testował maszynę	'[he] tested (a) machine'
12	IPFV+NPsg	rysował portret	'[he] drew (a) portrait'
13	IPFV+NPsg	wystawiał ocenę	'[he] gave (a) grade'
14	IPFV+NPsg	podrabiał podpis	'[he] counterfeited (a) signature'
15	IPFV+NPsg	usuwał usterkę	'[he] removed (a) failure'
16	IPFV+NPsg	wysyłał paczkę	'[he] shipped (a) package'
17	IPFV+NPsg	malował obraz	'[he] painted (a) painting'
18	IPFV+NPsg	szkicował budynek	'[he] sketched (a) building'
19	IPFV+NPsg	wyłudzał łapówkę	'[he] extorted (a) bribe'
20	IPFV+NPsg	uszczelniał okno	'[he] sealed (a) window'
21	IPFV+NPpl	zamiatał korytarze	'[he] swept corridors'
22	IPFV+NPpl	wyceniał działki	'[he] priced plots of land'
23	IPFV+NPpl	podlewał trawniki	'[he] watered lawns'
24	IPFV+NPpl	sporządzał raporty	'[he] made reports'
25	IPFV+NPpl	podrywał dziewczyny	'[he] picked up girls'
26	IPFV+NPpl	wygłaszał wykłady	'[he] delivered lectures'
27	IPFV+NPpl	naprawiał rowery	'[he] repaied bikes'
28	IPFV+NPpl	wypełniał blankiety	'[he] filled in forms'
29	IPFV+NPpl	ozdabiał wnętrza	'[he] decorated interiors'
30	IPFV+NPpl	szacował straty	'[he] estimated losses'

Table 5: Responses: p = participant, 1 = one time, 2 = difficult to say (both meanings are possible), 3 = many times

No.	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	p13	...
1	3	1	3	3	3	2	2	1	3	3	3	3	3	...
2	1	1	2	2	3	1	1	3	3	3	2	1	3	...
3	3	1	2	2	2	3	2	1	3	3	1	1	3	...
4	1	1	2	2	3	2	2	1	1	3	2	3	3	...
5	2	3	2	2	3	2	2	2	3	3	2	3	3	...
6	2	1	2	2	3	2	2	2	1	3	2	3	3	...
7	2	1	2	2	3	2	2	3	1	2	1	3	3	...
8	1	1	2	2	3	2	2	2	1	2	1	1	3	...
9	2	1	2	2	3	2	2	2	3	3	1	1	3	...
10	2	1	2	2	3	2	2	2	3	3	1	1	3	...
11	1	2	2	1	2	1	1	1	1	3	1	1	1	...
12	1	1	2	1	2	1	1	1	1	1	1	1	1	...
13	1	3	2	1	1	2	1	3	3	3	1	1	1	...
14	1	1	2	2	2	1	1	1	1	1	1	1	1	...
15	1	1	1	1	1	1	1	1	1	3	1	1	1	...
16	1	1	1	1	1	1	1	1	1	3	1	1	1	...
17	1	1	1	1	1	1	1	1	1	2	1	1	1	...
18	1	1	2	1	1	1	1	1	1	2	1	1	1	...
19	1	3	2	1	1	1	1	1	1	3	1	1	1	...
20	1	1	1	1	1	1	1	1	1	2	1	1	2	...
21	3	2	3	3	3	3	2	3	2	3	3	3	3	...
22	3	2	3	3	3	3	3	3	3	3	1	3	3	...
23	1	3	3	3	2	3	3	3	3	3	3	3	3	...
24	3	1	3	3	3	3	3	3	3	3	3	3	3	...
25	3	3	3	3	3	3	3	3	3	3	2	3	3	...
26	3	3	3	3	3	3	3	3	3	3	3	3	3	...
27	3	3	3	3	3	3	3	3	3	3	3	3	3	...
28	3	3	2	3	3	1	2	3	3	3	3	3	3	...
29	3	3	2	3	3	3	3	3	3	3	3	3	3	...
30	3	1	2	2	3	1	1	2	3	3	2	1	3	...

Table 6: Responses (*continued*): p = participant, 1 = one time, 2 = difficult to say (both meanings are possible), 3 = many times

No.	p14	p15	p16	p17	p18	p19	p20	p21	p22	p23	p24	p25
1	3	3	3	2	3	3	3	2	3	3	3	3
2	3	3	2	2	3	2	3	2	2	3	3	3
3	2	3	2	2	3	2	3	2	2	2	3	3
4	1	3	2	2	3	2	3	2	2	2	3	3
5	1	3	3	2	3	3	3	2	2	3	3	3
6	2	3	2	3	3	2	2	2	2	2	3	3
7	2	3	2	3	3	2	3	2	2	3	3	3
8	1	3	2	2	3	2	3	2	2	3	3	2
9	2	3	2	2	3	2	3	1	2	3	3	3
10	2	3	2	2	3	2	2	1	2	3	3	3
11	3	2	2	3	3	1	1	2	2	1	2	3
12	1	2	2	1	1	1	1	1	1	1	1	2
13	1	1	2	2	1	1	1	3	2	2	1	2
14	1	1	2	2	1	3	1	2	1	3	1	3
15	1	3	2	2	1	1	1	2	2	2	1	2
16	1	1	2	1	1	1	1	1	1	2	1	2
17	1	3	1	1	1	1	1	1	1	1	1	2
18	1	2	2	2	1	2	1	2	1	2	1	1
19	1	2	2	1	1	2	1	2	1	2	1	1
20	1	1	1	1	1	2	1	2	1	2	1	2
21	3	3	3	3	3	3	3	2	3	3	3	3
22	3	3	1	3	3	3	3	2	3	3	3	3
23	3	3	3	2	3	1	3	2	3	3	3	3
24	3	3	3	3	3	3	3	2	3	3	3	3
25	3	3	3	2	3	2	3	2	3	3	3	3
26	3	3	3	3	3	3	3	3	3	3	3	3
27	3	3	3	3	3	3	3	2	3	3	3	3
28	3	3	3	3	3	2	3	1	3	3	3	3
29	3	3	3	3	3	3	3	2	3	3	3	3
30	1	2	3	2	3	2	3	1	2	3	1	2

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Chapter 6

The syntax of plural marking: The view from bare nouns in Wolof

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A cross-linguistically stable property of bare nominals is number neutrality: they do not imply any commitment to a singular or plural interpretation. In Wolof, however, BNs are singular when unmodified and a plural interpretation only becomes available when a nominal-internal plural feature occurs. The generalization is that BNs in Wolof are singular, unless plural morphology is exponed. I propose that, while both a singular and plural NumP are available in Wolof, only the former leads to a convergent derivation. This is caused by the stipulation that the plural Num must lower onto *n*, combined with the assumption that BNs lack an *n*P. Number morphology becomes available when a relative clause is merged with the BN. The licensing of a RC implies the addition of an *n*P, which allows a plural Num to satisfy its lowering requirement. Some nominal modifiers, however, do not have number morphology and they do not require the projection of *n*P. As such, the plural Num cannot satisfy its requirement.

Keywords: Wolof, bare nominal, number neutrality

1 Introduction

Wolof (Niger-Congo, Senegal) has a rich set of overt determiners (see Tamba et al. 2012).

(1) a. Xale y-i lekk-na-ñu gato b-i.
child CM.PL-DEF eat-NA-3PL cake CM.SG-DEF
'The children ate the cake.'

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b. Xadi gis-na a-b sàcc.
Xadi see-NA.3SG INDEF-CM.SG thief
'Xadi saw a thief.'

c. Awa jàpp-na a-y sàcc.
Awa catch-NA.3SG INDEF-CM.PL thief
'Awa caught some thieves.'
(Tamba et al. 2012: (2a/32a/33b); glosses adapted for uniformity)

The determiner contains a class marker (CM; see Babou & Loporcaro 2016) affix. The class marker also encodes number information (singular or plural): *sàcc* 'thief' remains constant in (1b) and (1c). Whether the DP it heads is interpreted as singular or plural is correlated with the class marker used, *b* and *y*, respectively.

Wolof also has BARE NOMINALS (BNs).

(2) Gis-na-a ndonggo darra senegalee.
see-NA-1SG student Senegalese
'I saw a Senegalese student.'

I assume that BNs are nominals that lack the morphology displayed by their overt counterparts like those in (1). BNs in Wolof lack a(n overt) determiner and the class marker attached to it. Because of the absence of a class marker, there is also no overt number morphology.

BNs in Wolof seem to be narrow scope indefinites. They can be licensed in an existential construction, which displays definiteness effects:

(3) a. Am-na a-b / a-y xaj ci biti.
have-NA.3SG INDEF-CM.SG INDEF-CM.PL dog PREP outside
'There is/are a/some dog(s) outside.'

b. * Am-na xaj b-i ci biti.
have-NA.3SG dog CM.SG-DEF PREP outside
Intended: 'There is the dog outside.'

c. Am-na xaj ci dool b-i.
have-NA.3SG dog PREP garden CM.SG-DEF
'There is a dog in the garden.'

Furthermore, they seem to take narrow scope.

(4) Mareem séy-aat-na ak fécckat.
Mareem marry-ITER-NA.3SG CONJ dancer
'Mareem married a dancer again.'

a. ✗ ‘Mareem married the same dancer several times (e.g. marriage, followed by divorce, followed by another marriage).’

b. ✓ ‘Mareem has a very specific preference and she has married several, different dancers.’

Several, unrelated languages have BNs too. Among them is Mandarin.

(5) Zuotian wo mai le shu.
yesterday I buy ASP book
‘Yesterday, I bought one or more books.’
(Mandarin; Rullmann & You 2006: (1))

As can be gleaned from the translation, the BN in (5) has a number neutral interpretation, that is, it lacks a commitment to a singular or plural interpretation. This property is also known as “general number” (Corbett 2000).

Conversely, BNs in Wolof seem to be exclusively singular. This can be demonstrated by the fact that BNs cannot saturate a collective predicate (6) or be the antecedent of plural discourse anaphora (7).

(6) * Jàngalekat b-i dajeele-na xale ci bayaal b-i.
teacher CM.SG-DEF gather-NA.3SG child PREP park CM.SG-DEF
Intended: ‘The teacher gathered child in the park.’

(7) Gis-na-a jàngalekat. Maymuna bëgg-na ko / *leen.
see-NA-1SG teacher Maymuna like-NA.3SG OBJ.3SG OBJ.3PL
‘I saw teacher yesterday. Maymuna admires her.’

One may compare the Wolof data above with the behavior of BNs in Mandarin with respect to the same properties:

(8) Zuotian wo mai le shu. Wo ba ta / tamen dai hui jia le.
yesterday I buy ASP book. I BA it them bring back home ASP
‘Yesterday, I bought one or more books. I brought it/them home.’
(Mandarin; Rullmann & You 2006)

(9) Laoshi zai gongyuan-li jihe-le xuesheng.
teacher at park-in gather-PERF student
‘The teacher gathered the students in the park.’
(Mandarin; Fulang Chen, p.c.)

In order to account for the singular (and not number neutral) interpretation of BNs in Wolof, I will propose that the source of the singular interpretation of unmodified BNs in Wolof is nominal-internal. Compared to full nominals, BNs will be proposed to have a truncated structure. Specifically, they include only a Number Phrase (NumP) above the root. Wolof must have both a singular and a plural NumP. The NumP in BNs could in principle be plural too. But I stipulate that the plural Num must obligatorily lower onto *n*. Because BNs lack a *n*, the requirement that Num lower onto *n* cannot be fulfilled. As such, the only convergent derivation is one where Num is singular. The correlation between the size of the structure and the number interpretation of a BN will be shown to be consistent with the effects that different modifiers may have on the number interpretation.

2 BNs in Wolof are singular (when unmodified)

In this section, we will examine data that suggest that BNs in Wolof are singular. We will first examine the behavior of full nominals to establish a baseline to compare BNs with.

First, (10) demonstrates that *dajeele* is a collective predicate and thus requires a plural object.

(10) Jàngalekat b-i dajeele-na *a-b xale / a-y
teacher CM.SG-DEF gather-NA.3SG CM.SG-INDEF child CM.PL-INDEF
xale ci bayaal b-i.
child PREP park CM.SG-DEF
'The teacher gathered some children in the park.'

(6) above has already showed that a BN cannot saturate this predicate.

Second, a pronoun that refers back to a full nominal must match its number feature:

(11) a. Gis-na-a a-b jàngalekat. Maymuna bëgg-na ko /
see-NA-1SG INDEF-CM.SG teacher Maymuna like-NA.3SG OBJ.3SG
*leen.
OBJ.3PL
'I saw a teacher yesterday. Maymuna admires her.'

b. Gis-na-a a-y jàngalekat. Maymuna bëgg-na *ko / leen.
see-NA-1SG INDEF-CM.PL teacher Maymuna like-NA.3SG OBJ.3SG OBJ.3PL
'I saw some teachers yesterday. Maymuna admires them.'

We saw in (7) above that, if a BN is the antecedent, discourse anaphora can only be singular.

Third, only a plural full nominal can be the antecedent of a reciprocal.

(12) a. * Jàngalekat b-i wanale-na a-b ndonggo darra mu xam-ante.
teacher CM.SG-DEF introduce-NA.3SG CM.SG-INDEF student 3SG know-RECIP
Intended: 'The teacher introduced a student to each other.'

b. Jàngalekat b-i wanale-na a-y ndonggo darra ñu xam-ante.
teacher CM.SG-DEF introduce-NA.3SG CM.PL-INDEF student 3PL know-RECIP
'The teacher introduced some students to each other.'

If a BN is the antecedent, the resulting sentence is ungrammatical (13).

(13) * Jàngalekat b-i wanale-na ndonggo darra mu / ñu xam-ante.
teacher CM.SG-DEF introduce-NA.3SG student 3SG 3PL know-RECIP
Intended: 'The teacher introduced student to each other.'

A similar effect can be seen with plural reflexives. As expected, a reflexive and its antecedent must have the same number features.

(14) a. Kadeer sang-aloo-na xale y-i seen bopp.
Kadeer wash-CAUS-NA.3SG student CM.PL-DEF POSS.3PL head
'Kadeer made the children wash themselves.'

b. Kadeer sang-aloo-na xale b-i bopp=am.
Kadeer wash-CAUS-NA.3SG student CM.SG-DEF head=POSS.3SG
'Kadeer made the child wash themselves.'

c. * Kadeer sang-aloo-na xale b-i seen bopp.
Kadeer wash-CAUS-NA.3SG student CM.SG-DEF POSS.3PL head
Intended: 'Kadeer made the child wash themselves.'

Following the pattern that we have seen so far, a BN cannot be the antecedent of a plural reflexive.

(15) * Jàngalekat b-i sang-aloo-na ndonggo darra seen bopp.
teacher CM.SG-DEF wash-CAUS-NA.3SG student POSS.3PL head
Intended: 'The teacher made student wash themselves.'

But it can be the antecedent of a singular reflexive. As such, (15)'s ill-formedness cannot be caused by the BN's inability to be an antecedent.

(16) Jàngalekat b-i sang-aloo-na ndonggo darra bopp=am.
teacher CM.SG-DEF wash-CAUS-NA.3SG student head=POSS.3SG
'The teacher made some student wash himself/herself.'

To summarize what we have seen so far, BNs in Wolof exhibit the same behavior as that showcased by their singular, full nominal counterparts. A generalization that can be drawn from these data is that BNs in Wolof are singular. This contrasts with what is usually considered to be a crosslinguistic stable property of BNs, namely, a number neutral interpretation (Dayal 2011). The question that we must then ask is the following: how can we account for the exclusively singular interpretation (and not number neutral) interpretation of BNs in Wolof? Before proceeding to an analysis that tries to address this question, we will see data that indicate that the generalization arrived at above is too strong. More precisely, we will see that, if we add a modifier to the BN, if the modifier contains plural morphology, the BN can indeed have a plural interpretation. This is going to be the case of relative clauses, which display complementizer agreement in Wolof. In contrast, if the modifier does not contain any number exponent, a BN retains its exclusively singular interpretation.

3 Adding a modifier: Relative clauses vs. plain modifiers

3.1 Relative clause

In Wolof, a relative clause contains a class marker (Babou & Loporcaro 2016) attached to the relative complementizer *u* (Torrence 2013). The class marker of the relative clause and that of the determiner outside the relative clause must match.

(17) a. Samba tej-na palanteer [b-u tilim] b-i / *y-i.
Samba close-NA.3SG window CM.SG-COMP dirty CM.SG-DEF CM.PL-DEF
'Samba closed the window that is dirty.'

b. Samba tej-na palanteer [y-u tilim] y-i / *b-i.
Samba close-NA.3SG window CM.PL-COMP dirty CM.PL-DEF CM.SG-DEF
'Samba closed the windows that are dirty.'

BNs can be modified by either a relative clause with either a singular (18a) or a plural (18b) class marker.[1]

(18) a. Samba tej-na palanteer [b-u tilim].
Samba close-NA.3SG window CM.SG-COMP dirty
'Samba closed some window that is dirty.'

b. Samba tej-na palanteer [y-u tilim].
Samba close-NA.3SG window CM.PL-COMP dirty
'Samba closed some windows that are dirty.'

What we saw in the previous section is that BNs are singular. We also saw that they behave like a singular full DP. We may ask then how they can be able to be modified by a relative clause with a plural class marker (*y*, 18b), while their singular full DP counterpart cannot (17a). In fact, the behavior of BNs now resembles that of plural DPs (17b). We may ask additionally if BNs modified by a plural relative clause may behave like full plural DPs in other aspects as well. In this section, we will see that the answer to this question is positive.

Specifically, the data below show us that a BN modified by a plural relative clause (i.e., a relative clause which contains a plural class marker like *y* prefixed to the complementizer) behaves like its plural full nominal counterpart: the BN can now saturate a collective predicate, as well as act as the antecedent of a plural pronoun, reciprocal, and plural reflexive.

[1]At least in the Wolof dialect investigated in this paper, the relative complementizer *-u* (and the class marker prefixed to it) can occur with overt determiners (of both the definite and indefinite varieties), which are placed outside of the relative clause. This is the reason why I consider (17a) and (17b) to be instances of BNs modified by a relative clause.

(19) a. * Jàngalekat b-i dajeele-na xale [b-u Samba
teacher CM.SG-DEF gather-NA.3SG child CM.SG-COMP Samba
xam] ci bayaal b-i.
know PREP park CM.SG-DEF
Intended: 'The teacher gathered child who Samba knows in the park.'

b. Jàngalekat b-i dajeele-na xale [y-u Samba
teacher CM.SG-DEF gather-NA.3SG child CM.PL-COMP Samba
xam] ci bayaal b-i.
know PREP park CM.SG-DEF
'The teacher gathered some children who Samba knows in the park.'

(20) a. Gis-na-a jàngalekat [b-u Roxaya xam]. Maymuna
see-NA-1SG teacher CM.SG-COMP Roxaya know Maymuna
bëgg-na ko / *leen.
like-NA.3SG OBJ.3SG OBJ.3PL
'I saw a teacher who Roxaya knows. Maymuna admires her.'

b. Gis-na-a jàngalekat [y-u Roxaya xam]. Maymuna
see-NA-1SG teacher CM.PL-COMP Roxaya know Maymuna
bëgg-na *ko / leen.
like-NA.3SG OBJ.3SG OBJ.3PL
'I saw some teachers who Roxaya knows. Maymuna admires them.'

(21) a. * Jàngalekat b-i wanale-na ndonggo darra
teacher CM.SG-DEF introduce-NA.3SG student
[b-u Mareem xam] ñu xam-ante.
CM.SG-COMP Mareem know 3PL know-RECIP
Intended: 'The teacher introduced student that Mareem knows to each other.'

b. Jàngalekat b-i wanale-na ndonggo darra
teacher CM.SG-DEF introduce-NA.3SG student
[y-u Mareem xam] ñu xam-ante.
CM.PL-COMP Mareem know 3PL know-RECIP
'The teacher introduced student that Mareem knows to each other.'

(22) a. * Jàngalekat b-i sang-oloo-na ndonggo darra
teacher CM.SG-DEF wash-CAUS-NA.3SG student
[b-u njool] seen bopp.
CM.SG-COMP tall POSS.3PL head
Intended: 'The teacher made student who is tall wash themselves.'

b. Jàngalekat b-i sang-oloo-na ndonggo darra
teacher CM.SG-DEF wash-CAUS-NA.3SG student
[y-u njool] seen bopp.
CM.PL-COMP tall POSS.3PL head
'The teacher made some tall students wash themselves.'

In sum, in §2, we had concluded that BNs in Wolof behave as if they were singular. In this section, however, we see that this generalization has to be relativized to unmodified BNs only, since BNs modified by a plural relative clause behave is if they were plural. In the next section, we will see that nominal modifiers that do not have the syntax of a relative clause do not have this effect on the number interpretation of BNs.

3.2 Plain modifier

In Wolof, nominal modifiers usually have the syntax of relative clauses (e.g. *tall* in 22b). Expressions for nationality, however, occur as plain modifiers (i.e., without the syntax of a relative clause.)

(23) Mareem dajeele-na a-y woykat brezilien.
Mareem gather-NA.3SG INDEF-CM.PL singer Brazilian
'Mareem gathered some Brazilian singers.'

In this section, we will examine the behavior of BNs when modified by a plain modifier. We will see that they retain the singular construal exhibitted by unmodified BNs (cf. §2), contrasting with BNs modified by a plural relative clause (cf. §3.1). More precisely, a BN combined with a plain modifier cannot saturate a collective predicate, nor can it be the antecedent of plural discourse anaphora, a reciprocal, or plural reflexive.

(24) * Roxaya dajeele-na fécckat brezilien.
Roxaya gather-NA.3SG dancer Brazilian
Intended: 'Roxaya gathered Brazilian student.'

(25) Gis na-a woykat brezilien. Maymuna bëgg na ko / *leen.
see NA-1SG dancer Brazilian Maymuna like NA.3SG OBJ.3SG OBJ.3PL
'I saw a Brazilian dancer. Maymuna admires her/.'

(26) * Jàngalekat b-i desin-ante-loo-na ndonggo darra
teacher CM.SG-DEF draw-RECIP-CAUS-NA.3SG student
brezilien.
Brazilian
Intended: 'The teacher made student draw each other.'

(27) ?? Jàngalekat b-i nataal-oo-na ndonggo darra angale seen bopp.
teacher CM.SG-DEF draw-CAUS-NA.3SG student English POSS.3PL head
Intended: 'The teacher made English student draw themselves.'

In view of the data examined so far, we may ask the following questions:

(28) a. Why does an unmodified BN behave as if it were singular, while a BN modified by a plural relative clause behaves as if it were plural?
b. Why does adding a plain (i.e. number-less) nominal modifier not have the same effect?

4 Towards an analysis

In this section, I will develop an analysis that attempts to address the questions in (28). Before that though, I will consider alternative analyses.

4.1 Other plausible analyses

BNs in Wolof do display some of the telltale properties of PSEUDO NOUN INCORPORATION (PNI; Massam 2001, Dayal 2011, Baker 2014). First, they allow for noun modification, as seen in the two previous sections. Second, there cannot be a low adverb intervening between the verb and its affixes and the BN object.

(29) a. Jàngalekat b-i jàng-na {cikaw} taalif b-i {cikaw}.
teacher CM.SG-DEF read-NA.3SG loudly poem CM.SG-DEF loudly
'The teacher read the poem loudly.'
b. Jàngalekat b-i jàng-na {*cikaw} taalif {cikaw}.
teacher CM.SG-DEF read-NA.3SG loudly poem loudly
'The teacher read a poem loudly.'

A PNI analysis could thus be applicable. However, syntactic PNI analyses often capitalize on the inability of the BN to move (Massam 2001), their consequences to linearization (Baker 2014), or their licensing requirements (Levin 2015). This does not seem sufficient to account for the singular *interpretation* of Wolof BNs.

This brings us to Dayal's (2011) semantic analysis of PNI in Hindi. Dayal remarks that BNs in Hindi are not number-neutral, but rather singular. The author proposes that the plural interpretation arises as a byproduct of a pluractional operator that applies at the sentential level and which is introduced by aspect.

(30) a. anu-ne [tiin ghanTe meN] / [tiin ghanTe tak] kitaab paRhii.
Anu-ERG 3 hours in 3 hours for book read.PFV
i. 'Anu read a book in three hours.' (= exactly one book)
ii. 'Anu read a book for three hours.' (= one or more books)

b. anu-ne [tiin ghanTe meN] / *[tiin ghanTe tak] kitaab paRh Daalii.
Anu-ERG 3 hours in 3 hours for book read COMPL.PFV
'Anu read a book in three hours.' (= exactly one book)

(Dayal 2011: (32); adapted)

(30a) shows that the number interpretation of the BN *kitaab* 'book' depends on the telicity of the predicate. The temporal adverb *tiin ghanTe meN* 'in three hours' picks out the telic reading of the predicate. In that case, the BN has an exclusively singular interpretation. It is only when an atelic reading is singled out (in (30a), by using *tiin ghanTe tak* 'for three hours') that the number-neutral interpretation of the BN arises. To drive the point home, in (30b), the atelic reading is eliminated via the addition of the completive particle *Daalii.* As expected from the pattern observed in (30a), only a singular interpretation is available. Or, more relevantly for Dayal's claim, a number-neutral interpretation becomes impossible.

In brief, the data in (30) demonstrate that the number interpretation of BNs in Hindi is correlated with the aspectual properties of the overall sentence where it is embedded. In order to account for this pattern, Dayal proposes that BNs in Hindi are singular, but aspect may introduce a pluractional operator that applies to the event the BN is a part of. The iterative interpretation of the event has as a byproduct a number neutral interpretation of the otherwise singular object BN.

While I do not have the same type of data as (30), existing Wolof data suggest that aspect does not play the same role as it does in Hindi. Aspectual information remains constant across the data investigated here and yet the number interpretation is different. A sample of the data examined in the previous section is repeated here for convenience.

(31) a. * Jàngalekat b-i dajeele-na xale ci bayaal b-i.
teacher CM.SG-DEF gather-NA.3SG child PREP park CM.SG-DEF
Intended: 'The teacher gathered child in the park.'

b. Jàngalekat b-i dajeele-na xale [y-u Samba xam] ci bayaal b-i.
teacher CM.SG-DEF gather-NA.3SG child CM.PL-COMP Samba know PREP park CM.SG-DEF
'The teacher gathered some children who Samba knows in the park.'

c. * Roxaya dajeele-na féccka brezilien.
Roxaya gather-NA.3SG dancer Brazilian
Intended: 'Roxaya gathered Brazilian dancer.'

What does vary in these data is the presence or absence of modifier and type of modifier, irrespective of aspect (which, to reiterate, remains the same across the examples). The analysis to be put forward will capitalize on this property.[2]

4.2 Proposal

A takeaway from the discussion of plausible analyses is that it appears that, while sentential material does not have an effect on the number interpretation of BNs in Wolof (unlike what happens in Hindi), modifiers do seem to have an effect. However, different modifiers have different effects. Plural relative clauses may render a BN plural, but plain modifiers do not. Thus, it seems feasible that the source of the number interpretation in Wolof BNs is nominal-internal.

The first step in the analysis is the proposal of a structure for full nominals, as it will be the basis for the structure proposed for BNs. The underlying assumption here is that BNs are a truncated version of the full nominals in a given language (Massam 2001). (Linear order was not taken into account.)

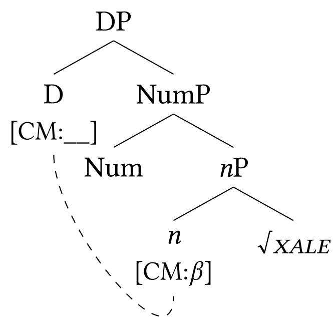

Figure 1: Structure proposed for a full nominal

Following Kihm (2005) and Acquaviva (2009), I assume that idiosyncratic properties the Wolof class marker are represented at the categorizer *n*. Inspired by Torrence's (2013) take on the class marker that appears on relative clauses (§3.1) as an instance of complementizer agreement, I assume that the class marker that appears in the determiner is an instance of D–*n* agreement.

[2]Needless to say, a more complete set of Wolof data would require changes in the aspectual properties of the sentence, as in the Hindi data.

I further stipulate that the feature [plural] (though not [singular]) Num must lower onto *n*. As mentioned, number in nouns is only encoded in the class marker. In the pairs of nouns in Table 1, the shape of the first consonant of the noun changes according to its number. I take this to be a case of root allomorphy.[3] However, it is commonly assumed that allomorphy obeys a strict locality condition. Here, I assume Bobaljik's (2012) formulation, according to which allomorphy cannot affect nodes across a maximal projection.

Table 1: Consonant mutation in SG/PL pairs (Babou & Loporcaro 2016)

	Singular	Plural	Translation
a.	mbaam mi	baam yi	'the donkey/-s'
b.	mbagg mi	wagg yi	'shoulder/-s'
c.	pepp mi	fepp yi	'grain/-s'
d.	këf ki	yëf yi	'thing/-s'
e.	bët bi	gët yi	'eye/-s'
f.	loxo bi	yoxo yi	'hand/-s, arm/-s'
g.	waa ji	gaa ñi	'guy/-s'

Given this condition, Num in Figure 1 could not trigger allomorphy in the class in *n* across the maximal projection *n*P. In order to sidestep this issue, I stipulate Num must lower (Embick & Noyer 2001) onto *n*, as in Figure 2.

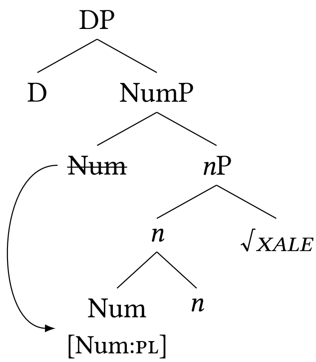

Figure 2: Structure for full nominal and Num to *n* lowering

[3]We could in principle posit a morphological boundary between the first mutating consonant and the rest of the word (e.g. *mb-aam* and *b-aam*) and analyze the first segment as a number morpheme and the rest of the word as the root. However, such roots do not seem to occur elsewhere in the language.

I further assume that "what you see is what you get": all things equal, methodological concerns should prevent one from positing null, purely abstract nodes. I will thus try to propose a structure of BNs in Wolof that is based on the structure proposed for full nominals (Figure 1), but without projections that do not have morphological support. The bare minimum component of the structure is the root, otherwise we cannot capture the basic meaning of the BN. Moving on to *n*P, given the proposal above that Wolof class markers are the exponent of the categorizer *n* and the "what you see is what you get" assumption, because there is no class marker in BNs, I assume they do not project an *n*P. A desideratum is that we model the singular (not number-neutral) interpretation of BNs in Wolof. Following Ritter (1991) and Harbour (2011), I assume that the only interpretable [Number] feature is the one placed in NumP. DP may have unvalued φ-features (Harbour 2011 and references therein), including [Number]. These features are, nonetheless, assumed to be purely syntactic (they participate in agreement with DP-external probes); they play no role at LF. I propose thus that BNs have a NumP projection. Finally, I will remain agnostic as to whether BNs have a silent DP projection or if they lack a DP layer altogether. As far as I can tell, the presence or absence of such a DP plays no role in the present analysis. For convenience, I omit the representation of a DP layer in the diagrams to follow.

Hence, we arrive at structure in Figure 3.

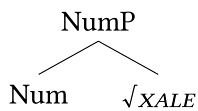

Figure 3: Truncated structure proposed for BNs in Wolof

A comment is in order on previous literature on the syntax of number neutrality. Rullmann & You (2006) and Kramer (2017) investigate BNs in Mandarin and Amharic, respectively. In both languages, BNs are number neutral. Rullmann & You and Kramer capture this semantic property by proposing that BNs lack NumP. A common assumption is that entities of type *e* denote singleton sets (atoms) and their sums; what number does is restrict that denotation to only singleton sets (singular) or pluralities (plural). Under this view, number neutrality in BNs emerges as a consequence of the absence of a restriction that picks out just atoms or pluralities. Because BNs in Wolof are exclusively singular, the same bare syntactic structure will not work. Adopting the rather common assumptions mentioned above about number, a structure like that in Figure 3 may gain further traction: it contains a bare minimum of structure; the functional layer that it does contain is able to restrict the number interpretation of the nominal.

However, Figure 3 alone is consistent with a singular or plural restriction. This overgenerates, as BNs in Wolof are exclusively singular (when unmodified).

4.2.1 Singular interpretation of unmodified BN

To recall, BNs in Wolof are singular, even though BNs in other languages are number neutral. The addition of different types of nominal modifiers has, correspondingly, different effects. If we add a modifier with a plural class marker, the BN behaves as if it were plural. A relative clause is this type of modifier. In contrast, if the nominal modifier lacks number morphology, the BN is still singular. Plain adjectives that name nationalities are this type of modifier.

Wolof clearly has full nominals that have a plural interpretation (*xale y-i* 'the children' in (1)). Assuming that the only interpretable instance of [Number] is in NumP, it must be the case that Wolof has a plural Num. All things equal, this instance of Num should be available for BNs as well. However, under the stipulation that plural Num must lower to *n*, the derivation that builds Figure 4 fails because this requirement cannot be fulfilled. (1) also shows that Wolof should have a singular Num available too, which should also be available in building a BN. By stipulation, a singular Num does not have a lowering requirement to fulfill. As such, the derivation that builds Figure 5 can converge.

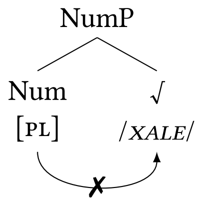

Figure 4: Plural Num cannot lower to *n* in BN

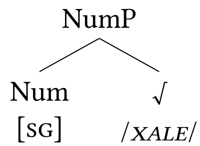

Figure 5: No lowering requirement

We are now in the position to answer the following question: why are unmodified BNs in Wolof interpreted in the singular? The reason is that this is the only possible convergent derivation (Figure 5).

4.2.2 Adding a nominal modifier

To recall, if a plural relative clause is added to the BN, it can have a plural interpretation. Here, I introduce an auxiliary assumption: relative clauses require a bigger, more complex nominal structure.[4] A common assumption is that relative clauses are adjoined to NP, even in different relative clause analyses. Translated into the distributed morphology terms assumed here, this means that relative clauses are adjoined to *n*P (Havenhill 2016).

I proposed that BNs in Wolof lack an *n*P projection due to the lack of a class marker. As such, the presence of a relative clause adjoined to a BN in sentences like (19b) implies the projection of an *n*P – otherwise, the relative could not have been adjoined. The structure for the BN in a sentence like (19b), must thus include an *n*P in order to accommodate the relative clause, as shown in Figure 6. I follow Torrence (2013) in assuming a raising analysis is appropriate for relative clauses in Wolof.

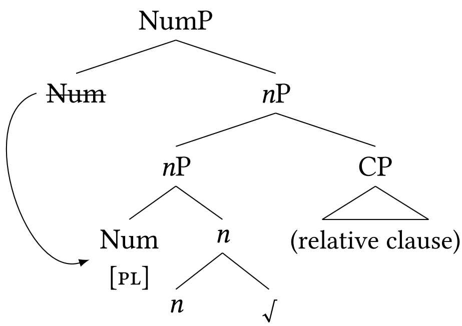

Figure 6: Complex structure for BNs modified by a relative clause

As a byproduct of the projection of *n*P, a plural Num can also be introduced in the derivation, as its lowering requirement can now be fulfilled.

Conversely, why does a plain modifier not have the same effect? A way to account for the difference between full relative clauses and plain modifiers would be to assume that the latter do not need a more complex projection to adjoin to a nominal. Specifically, a *n*P projection would not be required for an adjective like *brezilien* 'Brazilian' to occur. A BN thus modified can be diagrammed as in Figure 7.

The absence of a plural reading is reduced to the same reason why unmodified BNs are exclusively singular: a plural NumP is in principle available in the language, but the derivation crashes because the plural Num cannot have its lowering requirement satisfied. This is schematized in Figure 8.

[4] I am grateful to an anonymous LAGB 2019 reviewer for this suggestion. I assume that the projection or not of an *n*P layer does not affect the bareness of the BN. It is shown in Fong (2021) that BNs in Wolof behave uniformly whether or not they are modified by a relative clause. For instance, they are obligatorily narrow scope indefinites and cannot occur in the subject position of a finite clause, regardless of the presence of a relative clause.

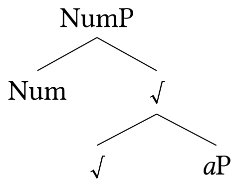

Figure 7: BN modified by plain modifier

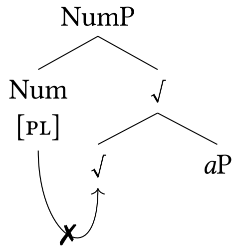

Figure 8: No Num to *n* lowering

The analysis put forward gives rise to a prediction. A crucial ingredient in the analysis is the proposal that relative clauses and plain modifiers attach at different levels of the nominal structure, thus requiring different amounts of structure to be projected. Relative clauses require an *n*P, while plain modifiers require a smaller, simpler structure, being attachable to the root. A common assumption is that the nominal spine has a hierarchical structure, with the *n*P above the root. The prediction thus is that there can be a relative clause outside a plain modifier, since the former adjoins to a layer (*n*P) that includes the layer where the latter is adjoined to (the root). Conversely, the reverse order should not be possible, since the relative clause at *n*P should "close off" the domain where the plain modifier was supposed to be adjoined. The prediction is borne out by facts:

(32) a. Gis-na-a ndonggo darra brezilien [$_{\text{RC}}$ b-u Samba xam].
see-NA-1SG student Brazilian CM.SG-COMP Samba know
'I saw a Brazilian student who Samba knows.'

b. * Gis-na-a ndonggo darra [$_{\text{RC}}$ b-u Samba xam] brezilien.
see-NA-1SG student CM.SG-COMP Samba know Brazilian
Intended: 'I saw a Brazilian student who Samba knows.'

5 Concluding remarks

The goal of the present paper was to answer the following questions:

1. Why does an unmodified BN behave as if it were singular, while a BN modified by a plural relative clause behaves as if it were plural?
2. Why does adding a plain (i.e. number-less) nominal modifier not have the same effect?

While both a singular and plural NumP are available in Wolof, only the former leads to a convergent derivation. This is caused by the stipulation that the plural Num must lower onto *n*, combined with the assumption that BNs lack an *n*P. The licensing of a relative clause implies the addition of an *n*P, which in turn allows a plural Num to satisfy its lowering requirement. Plain modifiers, on the other hand, do not require a more complex nominal structure. In particular, *n*P is not projected, so the plural Num cannot satisfy its requirement, just as in unmodified BNs.

As implied in §4, a number of stipulations are made. Needless to say, further motivation must be provided to support these claims or, alternatively, the analysis should replace them with less stipulative components. Furthermore, aspect data must be elicited, in order to fully rule out an analysis like the one that Dayal (2011) proposes for BNs in Hindi.

Abbreviations

CAUS	causative	PL	plural
CM	class marker	POSS	possessive
COMP	complementizer	PREP	preposition
DEF	definite	RECIP	reciprocal
IMPF	imperfective	REFL	reflexive
NA	*na*, a sentential particle	SG	singular
OBJ	object		

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Chapter 7

Uniqueness and maximality in German and Polish: A production experiment

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According to a prominent hypothesis, word order manipulations in Slavic languages without articles can correspond to the use of definite or indefinite articles in languages that have them. We test this hypothesis using a production design in which participants build sentential picture descriptions from provided constituents. The crucial question is whether articles in German and word order in Polish are sensitive to visually depicted uniqueness or maximality of reference. We fail to find support for the article–word order correspondence; while the use of articles in German is sensitive to uniqueness/maximality, the use of word order in Polish is not.

Keywords: uniqueness, maximality, definiteness, articles, word order

1 Introduction

If a language lacks definite articles, call it an ARTICLELESS LANGUAGE, does it also lack the semantics carried by definite articles? This question is standardly answered in the negative: articleless languages do not lack the pertinent semantics, they just have other formal means of expressing it (see e.g. Krámský 1972). This answer is in line with the common view that all languages are equal in their expressive capacity (e.g. Aronoff 2007). The opposite view, namely that the lack of articles translates to the lack of article-related semantics, is a minor one, but it is not non-existent. Heim (2011), for instance, suggests that the semantics of bare NPs in languages without articles always corresponds to semantics of indefinites (existential and presupposition-free), no matter whether they correspond to (are translated by) definite or indefinite NPs in languages with this distinction.

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The dominant tradition gave rise to a significant body of literature characterizing what we call here DEFINITENESS CORRELATES (following Šimík & Demian 2020) – morphological or syntactic devices whose semantics is claimed to correspond to definite articles. These devices include perfectivity (in its semantic impact on internal arguments; see Krifka 1989; cf. Filip 1993, 1996), topicality (whether manipulated by word order, prosody, subjecthood, or otherwise; see Li & Thompson 1976, Geist 2010, Jenks 2018), certain types of adjectival declension (in Bosnian-Croatian-Serbian or Baltic languages; see Hlebec 1986, Progovac 1998, Leko 1999, Holvoet & Spraunienė 2012, Šerekaitė 2019; cf. Trenkic 2004, Stanković 2015), and others, such as grammatical number, classifiers, case-marking, or the position of NP-internal attributes.

In this paper we concentrate on word order as a definiteness correlate and test whether it has the capacity to convey uniqueness or maximality, concepts that are commonly assumed to be conveyed by definite descriptions. The result of our production experiment does not support this hypothesis. Articles in German and word order in Polish behave very differently: while the former is sensitive to uniqueness and maximality, the latter is not. This result sheds doubt on the idea that the semantics of definiteness is universal. It remains to be seen whether other concepts possibly conveyed by definite descriptions (such as referent identifiability) could be expressed by definiteness correlates in articleless languages.

The paper is organized as follows: §2 introduces the idea of word order being a definiteness correlate; §3 presents the experiment; §4 concludes the paper.

2 Word order as a definiteness correlate

The consensus in the literature is that sentence-initial bare NPs in Slavic languages correspond to definite descriptions and are translated as such. Sentence-final bare NPs have either been considered indefinite or ambiguous/underspecified. A few examples are provided below.

(1) a. Na stole je kniha.
on table is book
'There is a book on the table.'

b. Kniha je na stole.
book is on table
'The book is on the table.' (Czech; Krámský 1972: 42)

(2) a. Na stole stojala lampa.
on table stood lamp
'There was a lamp on the desk.'

b. Lampa stojala na stole.
lamp stood on desk
'The lamp was on a/the desk.' (Russian; Chvany 1973: 266)

(3) W pokoju siedziała dziewczyna.
in room sat girl
'There was a girl sitting in the room.'

a. Wszedł chłopiec.
entered boy
'A boy entered.'

b. Chłopiec wszedł.
boy entered
'The boy entered.' (Polish; Szwedek 1974a: 215)

Although the above observations are half a century old, similar ones have been reiterated and the idea of a more or less strict correspondence between word order and definiteness has gained the status of a truism (see e.g. Szwedek 1974b, 2011, Hlavsa 1975, Birkenmaier 1979, Gladrow 1979, 1989, Weiss 1983, Yokoyama 1986, Hauenschild 1993, Junghanns & Zybatow 1997, Nesset 1999, Leiss 2000, Brun 2001, Biskup 2006, Kučerová 2007, 2012, Topolinjska 2009, Geist 2010, Titov 2012, 2017, Czardybon 2017; for a recent dissenting view see Bunčić 2014).

What is behind this word order–definiteness correspondence? For most researchers it is not word order alone that determines the interpretation. Sentence-initial, prosodically non-prominent bare NPs are considered topical (in the sense of aboutness topicality; Reinhart 1981) and this property imposes a referential interpretation on bare NPs; the idea is that sentences can only be "about" referents and therefore cannot be quantificational (cf. Endriss 2009). And while referential NPs can in principle be indefinite, particularly if they are "specific" (as in Fodor & Sag 1982), a specific indefinite construal has been argued to be unavailable for bare NPs in articleless languages (Dayal 2004, Geist 2010; cf. Borik 2016, Borik et al. 2020, Seres & Borik 2021). Referential bare NPs can thus only correspond to definites.

In formal Neo-Carlsonian approaches like Geist's (2010) (see Chierchia 1998 or Dayal 2004 for influential Neo-Carlsonian accounts), a bare NP like *chłopiec* 'boy' in (3), starts its semantic life as a property – (4a), which, if used as an argument, can be type-shifted either to a DETERMINATE meaning – (4b) – or to an INDETERMINATE meaning – (4c).[1]

(4) a. $[\![\text{chłopiec}]\!] = \lambda x[\textsc{boy}(x)]$ lexical

b. $[\![\text{chłopiec}]\!] = \iota x\ \textsc{boy}(x)$ IOTA-shifted

c. $[\![\text{chłopiec}]\!] = \lambda Q \exists x[\textsc{boy}(x) \wedge Q(x)]$ EX-shifted

Type-shifting is a non-compositional semantic process which can be motivated or constrained by various factors. The primary motivation is a type-mismatch. In sentences (3a)/(3b), *chłopiec* is used as the argument of an intransitive verb, which is of type $\langle e, t\rangle$ and therefore expects an *e*-type expression as its argument. Since *chłopiec* is lexically of type $\langle e, t\rangle$, it must shift. Both IOTA- and EX-shift will do; the former yields an expression of type *e*, the latter yields a quantifier (type $\langle\langle e, t\rangle, t\rangle$) and the argument slot of the verb is filled by the *e*-type trace left behind by quantifier raising. Which type-shift is used is thus decided outside of the realm of semantics. According to Geist (2010), a sentence-final bare NP, as in (3a), can be both determinate and indeterminate. A sentence-initial (prosodically non-prominent) bare NP, on the other hand, can only be determinate because the NP is topical and topical NPs must be referential (rather than quantificational).

In effect – and that is important for our purposes – the utterance in (3b) carries what is known as the UNIQUENESS PRESUPPOSITION, the presupposition that there is exactly one boy (in some relevant evaluation situation). The presupposition is brought about by the IOTA-shift. The resulting semantics of (3a) is provided in (5).

(5) $[\![\text{Chłopiec wszedł}]\!] = [\![\text{The boy entered}]\!] = \textsc{entered}\big(\iota x\ \textsc{boy}(x)\big)$
Presupposition: There is exactly one boy (in the evaluation situation).

The examples so far involved bare *singular* NPs. There is little reason to assume, at least on the type of analysis proposed by Geist (2010), that they would behave differently from bare *plural* NPs.[2] Let us assume, for the sake of the argument,

[1]In the interest of clarity, we follow the terminological convention introduced in Coppock & Beaver (2015): the terms definite and indefinite refer solely to *forms* – NPs with definite and indefinite determiners, respectively, while the terms determinate and indeterminate refer to *meanings* – entities and existential quantifiers, respectively.

[2]See Dayal (2004), who postulates an important difference between singulars and plurals. We set the issue aside here, but see Šimík & Demian (2020) for an experimental evaluation of Dayal's (2004) proposal.

that the determinacy contrast is replicated in (6) – the sentence-initial NP corresponds to a definite NP in languages with articles and the sentence-final one to an indefinite (or more precisely bare) NP.

(6) a. Weszli chłopcy.
entered boys
'Boys entered.'

b. Chłopcy weszli.
boys entered
'The boys entered.' (Polish)

The determinate interpretation, implicated in (6b), involves not the uniqueness presupposition, but rather the MAXIMALITY PRESUPPOSITION – the presupposition that there is a non-atomic entity containing all the atomic entities in the extension of 'boy', what is called the MAXIMAL PLURAL ENTITY (Sharvy 1980, Link 1983). It is this entity that the determinate bare plural NP refers to. The semantics of (6b) is provided in (7).[3]

(7) $[\![$Chłopcy weszli$]\!]$ = $[\![$The boys entered$]\!]$ = $\textsc{entered}\big(\sigma x\ \textsc{boy}(x)\big)$
Presupposition: There is a maximal group of boys (in the evaluation situation).

In summary, sentence-initial, prosodically non-prominent bare NPs in articleless languages are assumed to be topical and hence – via referentiality – correspond to definite NPs in languages with articles. This is what makes word order a definiteness correlate. In formal-semantic analyses like Geist's (2010), the pertinent word order (and prosodic) configuration gives rise to a presupposition on a par with what definite NPs contribute, particularly the uniqueness presupposition (bare singulars) or the maximality presupposition (bare plurals). It is the presence of these presuppositions that we test in our experiment.

3 Experiment

The goal of our experiment is to test the hypothesis that word order in articleless languages (here: Polish) can correspond to articles in languages that have them (here: German). The expectation is that word order production (in Polish) and article production (in German) will be affected by the uniqueness or maximality

[3]In Link's (1983) formalism the formula $\sigma x\ P(x)$ indicates reference to the maximal plural entity in the extension of the plural predicate $^{*}P$.

of reference. We will see that this expectation is borne out for article production but not for word order production, shedding doubt on the idea that word order is a definiteness correlate.

3.1 Design

We tested the impact of visually represented UNIQUENESS and MAXIMALITY (the main independent variables with binary values – ±uniq/max – and used for singulars and plurals, respectively) on the production of WORD ORDER (subject $\prec$ predicate vs. predicate $\prec$ subject) in Polish and DEFINITENESS (±definite) in German.[4] We expect unique/maximal reference (as opposed to non-unique/non-maximal reference) to be matched by an increased proportion of definite description production in German and preverbal subject production in Polish. More particularly, we expect a higher proportion of subj $\prec$ pred order in the +uniq/max condition; for German, we expect a higher proportion of +def NPs in the +uniq/max condition (both as compared to the −uniq/max condition). The expectations are based on two hypothesized pressures governing the production. First, speakers are expected to prefer forms which are more expressive in terms of their presuppositions (in line with the maximize presupposition principle; Heim 1991); this concerns the expected production of +def (in German) and subj $\prec$ pred (in Polish) in the +uniq/max condition. Second, speakers are expected to avoid forms which express presuppositions that are not supported in the situation; this concerns the expected production of −def (in German) and pred $\prec$ subj (in Polish) in the −uniq/max condition.

The UNIQ/MAX manipulation correlated with GRAMMATICAL NUMBER of the clausal subject: UNIQUENESS was manipulated for singular subjects and MAXIMALITY for plural ones. In addition, we included – for exploratory reasons – the binary variable CONVERSATION (±conversation). The variable was manipulated (between subjects) in the instructions to the experiment: the +conv group received a brief instruction that they should imagine that they are looking at the visual stimulus together with a conversation partner and the description they produce is directed to her/him. The −conv group did not receive this instruction; they were simply asked to provide a description of the visual stimulus.

As summarized in Table 1, the experiment involved a $2 \times 2 \times 2$ design, although the prediction only concerned the effect of UNIQUENESS/MAXIMALITY; NUMBER and CONVERSATION have been included for exploratory reasons.

[4] Throughout the paper, we type experimental variables in SMALL CAPS and their levels in sans-serif.

Table 1: Manipulation of independent variables

	UNIQ/MAX	NUMBER	CONVERSATION
	within items within subjects	within items within subjects	within items between subjects
	visual	linguistic	by instruction
1	+unique	singular	+conversation
2	−unique	singular	+conversation
3	+maximal	plural	+conversation
4	−maximal	plural	+conversation
5	+unique	singular	−conversation
6	−unique	singular	−conversation
7	+maximal	plural	−conversation
8	−maximal	plural	−conversation

3.2 Materials, procedure, and participants

We constructed 16 experimental items. The stimuli were selected and modified from Šimík & Demian (2020).[5] An example of a token set is provided in Figure 1 (picture stimuli, manipulating UNIQ/MAX) and in (8) (linguistic building blocks, for Polish and German, respectively). The number of affected entities (here: balloons that flew away) always matched the grammatical number used in the building blocks (marked on nouns, predicates, or both). The picture and the building blocks were presented side-by-side, as illustrated in Figure 2. The building blocks were pseudo-randomly distributed in a field, avoiding a bias in the ordering presented (in both left-right and top-down direction). There were two kinds of building blocks – simple blocks, such as BALONIKI, and "switch blocks", such as MU | JEJ, which presented the participants with a choice between two values.[6] There were two kinds of operations available to the participants: (i) clicking on a switch block in order to switch the value of the block, whereby the selected value appeared on the top, on a white background; (ii) all blocks could be drag-and-dropped anywhere in the field.

[5] All materials, experiment instructions, results, and analyses are available at https://doi.org/10.17605/OSF.IO/KSTBZ.

[6] One of the two values was pre-selected upon item presentation. Which value was pre-selected was pseudo-randomized and balanced across the experiment.

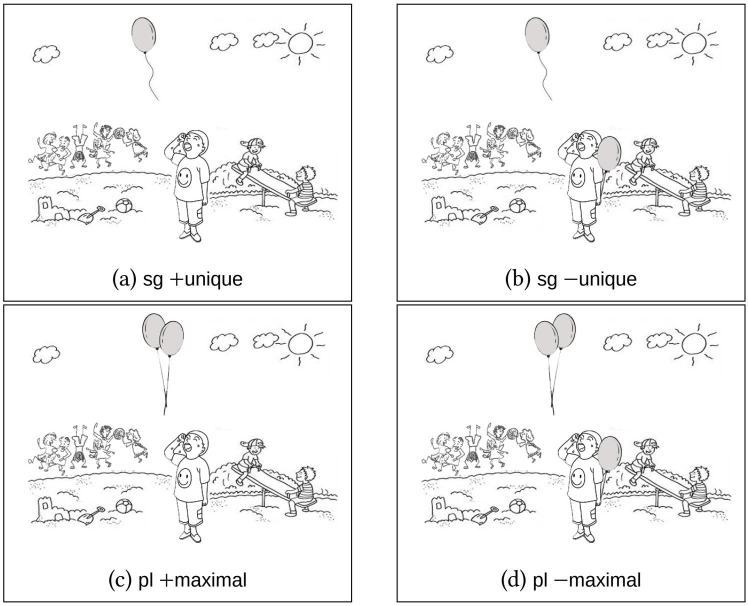


Figure 1: Visual part of token set of item 4 in both UNIQ/MAX conditions divided by NUMBER

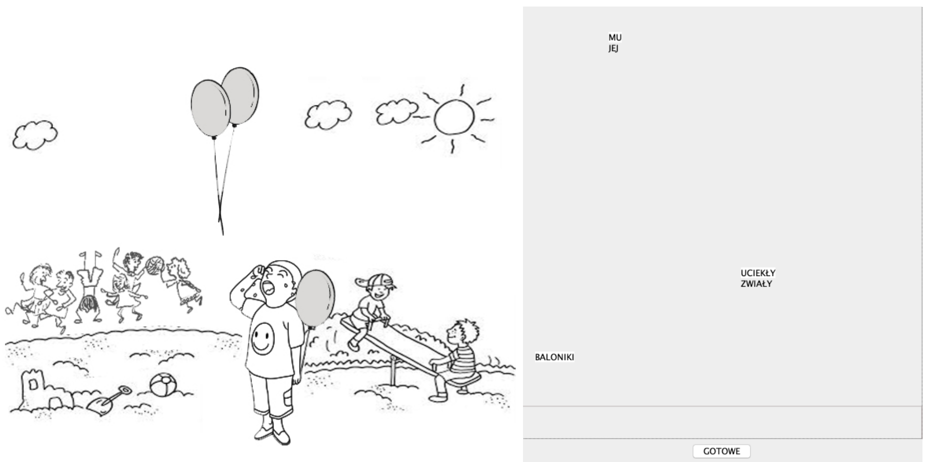


Figure 2: Presentation of item 4 in condition pl −maximal (Polish)

(8) Linguistic part of token set of item 4 divided by NUMBER

a. Polish

i. $\boxed{\text{BALONIK}}$ $\boxed{\text{MU | JEJ}}$ $\boxed{\text{UCIEKŁ | ZWIAŁ}}$ sg
balloon him | her escaped | flew.away.SG

ii. $\boxed{\text{BALONIKI}}$ $\boxed{\text{MU | JEJ}}$ $\boxed{\text{UCIEKŁY | ZWIAŁY}}$ pl
balloons him | her escaped | flew.away.PL

b. German

i. $\boxed{\text{DER LUFTBALLON | EIN LUFTBALLON}}$ $\boxed{\text{IST}}$ $\boxed{\text{IHM | IHR}}$
the balloon | a balloon AUX.SG him | her
$\boxed{\text{DAVONGEFLOGEN}}$ sg
flew.away

ii. $\boxed{\text{DIE LUFTBALLONS | LUFTBALLONS}}$ $\boxed{\text{SIND}}$ $\boxed{\text{IHM | IHR}}$
the balloons | balloons AUX.PL him | her
$\boxed{\text{DAVONGEFLOGEN}}$ pl
flew.away

The task of the participant was to produce a description of the picture, selecting the appropriate values (by clicking on switch blocks), and ordering the blocks one after another in the pane located in the bottom part of the field (by drag-and-dropping). The participants indicated that they are finished by clicking on the $\boxed{\text{GOTOWE}}$ / $\boxed{\text{FERTIG}}$ ('done') button located below the target pane.

Both the German and the Polish version of the experiment made use of both operations – switching block values and drag-and-dropping. In German, the target value of the dependent variable (DEFINITENESS) was achieved by switching block values; in Polish, the target value of the dependent variable (WORD ORDER) was achieved by drag-and-dropping. The operations not essential for the core measure (drag-and-dropping in German, switching non-essential values in both German and Polish) had two functions: bringing the two language versions closer together and distracting the participants from the experimental manipulation. The distractor switches typically involved either synonyms (making the choice non-essential) or a clear match vs. clear mismatch (making the choice easy).

With a single exception, all the experimental items involved intransitive predications, which readily allow for both subject ≺ predicate and predicate ≺ subject orders in all new contexts in Slavic languages (Junghanns 2002). Word order was thus free to be used for other than information-structural purposes.

Apart from the 16 critical items, one of which has just been exemplified, the design involved 32 filler items (partly containing additional miniexperiments). All the items were distributed in multiple versions of the experiment following the Latin square design. Each participant saw exactly one token from each item, more particularly 8 items in the +unique/maximal condition and 8 in the −unique/maximal condition.

The analyzed dataset contained data from 29 Polish participants (students from Wrocław) and from 15 German participants (students from Berlin). The intention was to have 32 Polish and 16 German participants, in order to have the same number of data-points for each individual condition.[7] One German and one Polish participant were missing for technical reasons. Two Polish participants were excluded from the dataset because of low data quality; one formed more than 3 ungrammatical sentences and both never used the switch function, suggesting the lack of attention or non-cooperative behavior. The German participants received a compensation of €5; the Polish participants did the experiment as part of their course requirement.

The experiment was presented in computer pools within scheduled sessions, using Java-based software developed by one of the authors. The experiment itself was preceded by instructions (which included the manipulation of the CONVERSATION variable, as described above) and by an act-out illustration of the procedure, in which the participants were forced to make use of both operations – switching the value of switch blocks and drag-and-dropping. There was no time limit. Most participants completed the experiment in 20–30 minutes.

3.3 Predictions and results

The sentences in (9) illustrate the possible grammatical outcomes of the Polish and German version of item 4 in the singular condition.[8]

(9) a. Polish

i. Balonik mu zwiał. — subj ≺ pred
balloon him flew.away.SG
By hypothesis: 'The balloon flew away (from him).'

ii. Zwiał mu balonik. — pred ≺ subj
flew.away.SG him balloon
By hypothesis: 'A balloon flew away (from him).'

[7] The reason for a larger number of Polish participants is that we expected the effect of UNIQ/MAX to be less robust in Polish than in German. These expectations are based on the effect sizes found in Šimík & Demian (2020).

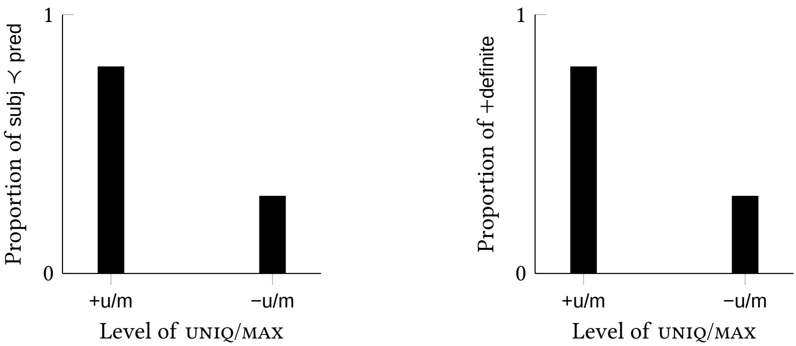
[8] Ungrammatical outcomes such as **się okno zbiło* in Polish or **das Fenster zerbrochen ist* in German were possible but extremely rare (in Polish) and not attested (in German).

b. German

i. Der Luftballon ist ihm davongeflogen. +definite
the balloon is.AUX him flew.away
'The balloon flew away (from him).'

ii. Ein Luftballon ist ihm davongeflogen. −definite
a balloon is.AUX him flew.away
'A balloon flew away (from him).'

Figure 3 illustrates the predicted main effect of the UNIQ/MAX variable on the WORD ORDER in Polish and DEFINITENESS in German.[9] In Polish, we expect a higher proportion of subject ≺ predicate outcomes in the +uniq/max condition than in the −uniq/max condition. Analogously, in German, we expect a higher proportion of +definite outcomes in +uniq/max condition than in the −uniq/max condition.



(a) Polish

(b) German

Figure 3: Prediction: Main effect of UNIQ/MAX on WORD ORDER in Polish and DEFINITENESS in German

[9]The absolute numbers (set to 0.8 and 0.3) are immaterial in these diagrams, what is important is the differing proportion. Although we expect the effect size to be smaller in Polish than in German (cf. footnote 7), this expectation is only based on previous experimental results (Šimík & Demian 2020) and is not theoretically grounded. That is why we do not encode it in the visualization of the prediction.

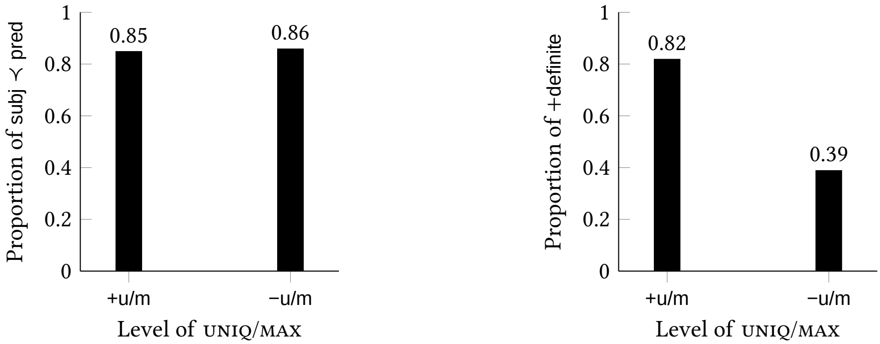
Figures 4–6 show the results.[10] We first discuss them informally, based on the visual inspection of the figures, and then turn to statistical models. As is evident from Figure 4, Polish participants mostly produced the subj ≺ pred order, independently of the UNIQ/MAX manipulation. German participants were sensitive to the UNIQ/MAX manipulation: they produced significantly more +definite NPs if the picture they described satisfied uniqueness or maximality (+u/m) than if it did not (−u/m). Figures 5 and 6 show the results divided by NUMBER and by CONVERSATION, respectively. What is most clearly visible is the effect of NUMBER in German, where definite NPs were used much more in the plural than in the singular. At the same time, there appears to be an interaction between NUMBER and UNIQ/MAX: the expected effect of UNIQ/MAX (more +definite NPs in +u/m) is much more clearly pronounced in the singular than in the plural condition. In Polish, the impact of both NUMBER and CONVERSATION is rather subtle.

We fitted a number of generalized linear mixed-effects models, using the `glmer` function from the `lme4` package (Bates et al. 2015) of R (R Core Team 2017).

For Polish, models in which UNIQ/MAX, NUMBER, and CONVERSATION were all combined did not converge. Therefore, we fitted two less complex models – one with UNIQ/MAX and NUMBER as predictors (see Table 2) and the other with UNIQ/MAX and CONVERSATION as predictors (see Table 3). The predictors were sum coded and random intercepts for subjects and items have been included. Neither of the two models reveal the expected main effect of UNIQ/MAX ($z = 0.207$, $z = -0.064$, respectively, $p > 0.8$ for both). The model with NUMBER reveals a weak interaction between UNIQ/MAX and NUMBER ($z = -2.281, p = 0.023$) and the model with CONVERSATION reveals a weak main effect of this factor ($z = 2.497, p = 0.013$), suggesting that +conv yielded significantly more subj ≺ pred orders than −conv.

For German, we fitted a model with UNIQ/MAX, NUMBER, and CONVERSATION as predictors. The predictors were sum coded and included a random intercept for items (see Table 4); the more complex model with intercepts for items and subjects did not converge. The model reveals the expected main effect of UNIQ/MAX ($z = 6.071, p < 0.001$): more +definite were produced in the +uniq/max condition than in the −uniq/max condition. Additionally, a main effect of NUMBER was found ($z = 5.719, p < 0.001$; more +definite were produced in the plural condition than in the singular condition) and, finally, an interaction between UNIQ/MAX and NUMBER was found ($z = -2.211, p = 0.03$; a much more pronounced effect of UNIQ/MAX in singular than in plural.

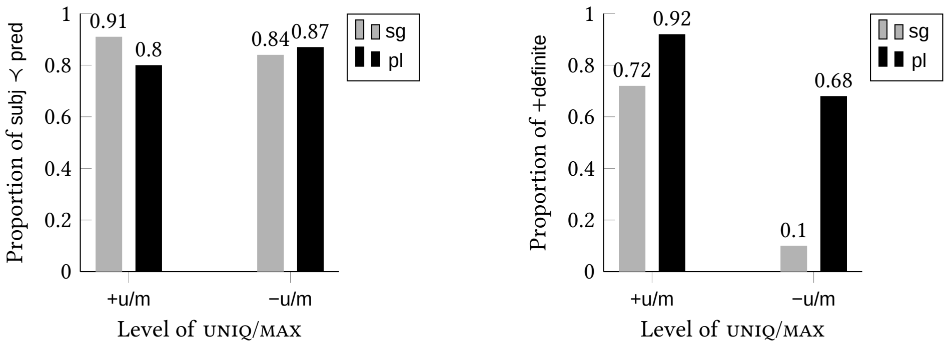
[10]Data from 2 items (3 and 8) have been excluded from the Polish dataset (post-hoc) because of aspects of the language–picture correspondence which (might have) affected the critical manipulation. In addition, 6 datapoints have been excluded from the Polish dataset because they were ungrammatical.



(a) Polish

(b) German

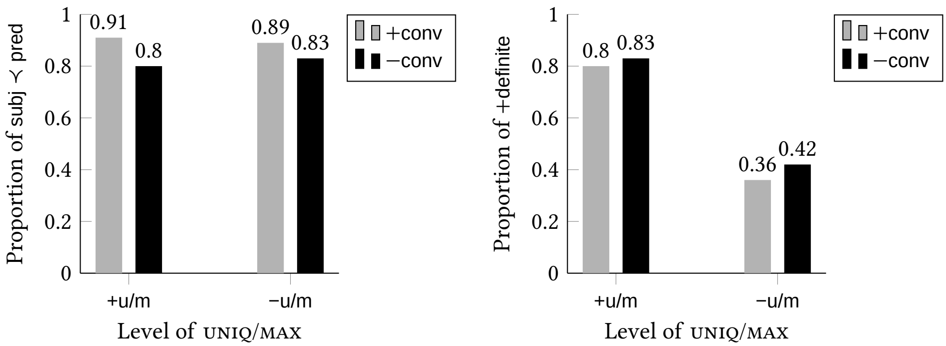
Figure 4: Result



(a) Polish

(b) German

Figure 5: Results divided by NUMBER



(a) Polish

(b) German

Figure 6: Results divided by CONVERSATION

Table 2: Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) for Polish ($N = 400$; predictors: UNIQ/MAX and NUMBER; log-likelihood: −115.5)

	Fixed effects					Random eff.	
	Estimate	SE	z	p		Var	SD
Intercept	−3.8608	0.9963	−3.875	<0.001	Subject	1.184	1.088
UNIQ/MAX	0.0406	0.1959	0.207	0.84	Item	7.082	2.661
NUMBER	0.2898	0.1994	1.454	0.15			
UNIQ/MAX*NUM	−0.4572	0.2005	−2.281	0.023			

Table 3: Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) for Polish ($N = 400$; predictors: UNIQ/MAX and CONVERSATION; log-likelihood: −116.2)

	Fixed effects					Random eff.	
	Estimate	SE	z	p		Var	SD
Intercept	−3.6824	0.9366	−3.932	<0.001	Subject	0.574	0.758
UNIQ/MAX	−0.0124	0.1930	−0.064	0.95	Item	6.548	2.559
CONV	0.6088	0.2438	2.497	0.013			
UNIQ/MAX*CONV	−0.0188	0.7858	−0.024	0.98			

Table 4: Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) for German ($N = 240$; predictors: UNIQ/MAX, NUMBER, and CONVERSATION; log-likelihood: −106.4)

	Fixed effects					Random eff.	
	Estimate	SE	z	p		Var	SD
Intercept	0.4467	0.2724	1.640	0.10	Item	0.4379	0.6618
UNIQ/MAX	1.3564	0.2234	6.071	<0.001			
NUMBER	1.2672	0.2216	5.719	<0.001			
CONV	0.2299	0.2168	1.060	0.29			
UNIQ/MAX*NUM	−0.4780	0.2162	−2.211	0.03			
UNIQ/MAX*CONV	−0.1989	0.2713	−0.733	0.46			
NUM*CONV	−0.2876	0.2154	−1.335	0.18			
UNIQ/MAX* NUM*CONV	0.1213	0.2162	0.561	0.58			

3.4 Discussion

3.4.1 Overall results

The experiment showed that the uniqueness/maximality of reference (as compared to non-uniqe/non-maximal reference) gives rise to increased production of definite NPs in German, but not of preverbal subjects in Polish. The hypothesis that word order in articleless languages can correspond to definiteness in languages with articles has thus not been confirmed. The present results corroborate those reported in Šimík & Demian (2020), who used similar items but a different experimental paradigm (covered box).

3.4.2 German results

The effect of uniqueness/maximality on German definiteness is fairly robust and consistent across singulars (uniqueness) and plurals (maximality). In addition, the statistical model revealed a major effect of grammatical number: participants used definites more in the plural condition than in the singular condition, to the extent that the frequency of plural definites in the −maximal condition (68%) almost matched the frequency of singular definites in the +unique condition (72%). By contrast, singular definites were almost entirely avoided in the non-unique condition (10%) (which resulted in a significant interaction between UNIQUENESS/MAXIMALITY and NUMBER). This result lines up with the observation that plural definites often allow for non-maximal reference (Fodor 1970; for recent discussion see Brisson 1998, Lasersohn 1999, or Križ 2016).[11]

3.4.3 Polish results

What is striking about the Polish results is the extremely high proportion of preverbal subjects – 86% of all the sentences produced involved preverbal subjects, with only very little variation across the different data subsets (divided by NUMBER or CONVERSATION). While SV(O) is the canonical and most frequent order in Polish (Siewierska & Uhlířová 1998), the VS order is quite common in matrix sentences with intransitive verbs; based on a corpus investigation; Siewierska (1993) reports 32% of VS for intransitives (compare to our 14%). We can think of the following two reasons for the high proportion of SV in our results: a topical nature of the subject and a bias against verb-initial sentences. We discuss these in turn.

[11]What is puzzling is that no such effect of/interaction with number was found Šimík & Demian (2020), where definite plurals were sensitive to maximality to the same extent as definite singulars to uniqueness. The contrast must be due to the different designs – sentence production vs. comprehension+picture choice or possibly the absence vs. presence of preceding context – but at present, we have no particular speculations to offer.

The referent of the subject was always (independently of the experimental condition) presented in the picture and was therefore visually salient. It is possible that the participants treated it as the topic of the sentence that they produced. The tendency to place topics preverbally or sentence-initially could then have contributed to the surprisingly high proportion of the subj ≺ pred outcomes. Notice that if this conjecture is on the right track, there would have to be a strict dissociation of topichood and the uniqueness/maximality of reference (counter to Geist's 2010 proposal): subjects were placed sentence-initially, no matter whether they referred uniquely/maximally or not. Notice also that the observed pattern is consistent with the idea that topical referents should be identifiable to the discourse participants (Lambrecht 1994). In our design, the target referent was always (regardless of its uniqueness/maximality) identifiable to the experiment participant and one could hypothesize that the participant assumed the identifiability by a potential conversation partner, too. This view is corroborated by the effect of the conversation factor: the participants who were explicitly instructed to imagine a conversation partner with a shared visual experience produced a slightly higher proportion of sv orders (90%) than those without this instruction (81%).

Let us now turn to the other reason – the problem of verb-initiality. The majority of our items made use of just two major constituents: the subject and the predicate. The participants thus faced the choice between producing an sv or a vs sentence. Only five out of the 16 items contained an additional constituent – typically an adverbial (call it x) – which was a reasonable candidate for the sentence-initial position. This gave the participants the option to produce xvs orders. Upon a closer look at the data, we find that most of the few pred ≺ subj outcomes can be attributed to these cases. While vs in the absence of x was produced in only 6% of the cases, vs in the presence of x was produced in 29% of the cases and virtually all of these were xvs orders.[12] This frequency of vs matches Siewierska's (1993) numbers. Additionally, it matches the finding of Jacennik & Dryer (1992), who noticed that verb-initial vs orders are very infrequent in Polish: in 91% of vs orders there is some constituent preceding the verb; i.e., the majority of vs orders are instances of xvs. This suggests that there is a bias against verb-initial sentences in Polish, which could explain the low frequency of vs in our results.[13]

[12] Despite the higher word order flexibility in the presence of adverbials, participants did not show any sensitivity to the uniqueness/maximality manipulation: the frequency of sv orders was equal (71%) in both the −u/m and the +u/m condition.

[13] The corpus-based support from Jacennik & Dryer (1992) is limited, though, because there is no single sv order without anything *following* the verb. This in turn suggests a bias against verb-final sentences in Polish, something that is by no means matched by our results.

Before we conclude, we would like to discuss an idea proposed to us by an anonymous reviewer. The reviewer suggests that our design might have missed the target and has failed to manipulate topicality. This would be a remedy for the traditional account: if the bare NPs were never treated or perceived as topics by the participants, there would be no reason for them to receive a referential interpretation and therefore no reason to apply the IOTA-shift (or SIGMA-shift). That in turn would explain the insensitivity to uniqueness (or maximality). What leads the reviewer to suggest that topicality was not implicated is that all the sentences might have been treated as thetic statements, i.e., statements without any topic–comment structure (Sasse 1987). Thetic statements are suitable discourse-starters or answers to questions like "What happened?". We admit that there is a good deal of plausibility to this suggestion. Yet it also raises some questions. Thetic statements with intransitive predicates (used in our design) are characterized by sentence stress on the subject. Sentence stress in turn is, by default, sentence-final. For this reason, many researchers (and we alike) have assumed that the most natural way of expressing a thetic statement in Slavic languages is to use the VS order, in which the stress is located sentence-finally (Junghanns 2002, Geist 2010; a.o.). SV orders are not ruled out, but are marked in the sense that they are accompanied by a stress shift, so that the subject is prominent, as it should be in a thetic statement. (If the subject is unstressed in the SV order, its topicality is automatically implied.) If this widely held assumption is correct and if the reviewer is right in claiming that the sentences produced corresponded to thetic statements, it would mean that the participants generally applied a stress shift in their implicit prosody (cf. Fodor 2002). This, of course, cannot be ruled out, but it also cannot be confirmed. A separate study would be needed to resolve the issue.[14]

4 Conclusion

Our experimental investigation failed to find support for the common assumption that word order in articleless languages can correspond to definiteness in languages with articles or, in the present terms, that word order is a definiteness correlate. While German participants were sensitive to the uniqueness/maximality of reference in their production of (in)definite NPs (definites were used more if their referents were unique/maximal), Polish participants were insensitive to

[14] The same reviewer also suggests (and we agree) that a weaker conclusion may safely be drawn from our results, namely that word order alone (topicality aside) does not correlate with the uniqueness/maximality of reference.

uniqueness/maximality in their production of word order (initial subjects were not used more if their referents were unique/maximal). This result corroborates the finding of Šimík & Demian (2020) and further strengthens the position that definiteness and word order are not comparable when it comes to their semantics.

At the same time, the results are consistent with the assumption that preverbal/sentence-initial arguments are topical. The very high proportion of initial subjects could suggest that Polish participants treated the subject as the topic of the sentence they formed, though crucially, this happened independently of whether the referent was unique or maximal. As it appears, in order for a referential argument to be topical/sentence-initial, it was sufficient that the participant (and potentially his/her conversation partner) could identify the referent (Lambrecht 1994). The stronger condition of it being unique or maximal (postulated e.g. by Geist 2010 for Russian) played no role. That said, our experiment manipulated identifiability only very weakly and indirectly (via the CONVERSATION factor), so this claim remains a speculation and calls for a proper experimental justification.

What – if anything – underlies the "definiteness intuition" of the numerous scholars who have dealt with word order in articleless languages is an open question. Referent identifiability (or possibly familiarity) certainly is a plausible option and future empirical work might shed some light on this. What seems increasingly implausible, given the present results and the results of Šimík & Demian (2020), is that topicality, encoded by word order, conveys uniqueness or maximality.

Abbreviations

PL	plural	SG	singular

Acknowledgements

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Part II

Collectivity, distributivity and cumulativity

Chapter 8

Slavic derived collective nouns as spatial and social clusters

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In this chapter, I examine two types of Slavic derived collective nouns, namely spatial collectives such as Polish *kwiecie* 'clump of flowers' and social collectives like *duchowieństwo* 'collective of priests, clergy'. While the former refer to collections of objects perceived as coherent spatial configurations, the latter denote groups of human individuals performing a salient social role. Building on Grimm (2012) and Zobel (2017), I propose an analysis that treats the Slavic derived collective nouns in question as predicates true of spatial and social clusters, respectively. The proposal extends mereotopology to the abstract domain of social roles.

Keywords: collective nouns, social nouns, mereotopology, roles

1 Introduction

A puzzling property of collective nouns is that they simultaneously evoke a sense of plurality and singularity (Jespersen 1924: 195, Gil 1996). For instance, a team is constituted by a number of players but at the same time it seems to be something more than just a collection of players. It is an entity in itself with an internal structure, independent goals and an elaborate way of functioning. As such it seems to be a unit of a higher type. Though it is commonly assumed that collectives are specific to the domain of individuals, see widely discussed examples like (1a), in fact the category is much more general and can be identified also in the domain of eventualities, as in (1b), as well as abstract objects such as numbers, see (1c).

(1) a. committee of women, deck of cards

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b. series of unfortunate events, sequence of murders
c. sequence of integers, set of real numbers

For a long time, it was standardly taken for granted that collective nouns constitute a uniform category (e.g., Landman 1989a, Barker 1992, Schwarzschild 1996). However, recent findings suggest that there are different kinds of such expressions (Joosten 2010, Pearson 2011, de Vries 2015, Henderson 2017, Zwarts 2020; for a recent overview, see de Vries 2021). In this paper, I will argue that Slavic derivational morphology reflects two modes of collectivity. In particular, I will examine two types of derived collectives in Slavic exemplified by the Polish nouns in (2).[1]

(2) a. kwiat ⇒ kwieci-e
flower flower-COLL
'flower' 'clump(s) of flowers'
b. duchowny ⇒ duchowień-stwo
priest priest-COLL
'priest' 'collective of priests, clergy' (Polish)

The main claim of this paper is that both types of Slavic derived collective nouns designate clusters, i.e., structured configurations of objects. I will argue that SPATIAL collectives like that in (2a) denote spatial clusters, i.e., topological arrangements of entities in physical space, whereas SOCIAL collectives as in (2b) refer to social clusters, i.e., abstract configurations of roles individuals can bear in social space.

The paper is outlined as follows. In §2, I discuss different ways in which collective inferences can arise. §3 revises different types of collectives analyzed in the literature, specifically those that construe a group in terms of a topological configuration of their constituents as opposed to those that encode an abstract notion of a group independent of the spatial arrangement of its members. In §4, I explore derived spatial and social collectives across Slavic languages with a special focus on Polish. In §5 and §6, I introduce a theoretical framework including mereotopology and an extension of the ontology with roles. In §7, I propose an extended mereotopological approach on which both spatial and social collectives are analyzed as clusters. Finally, §8 concludes the paper.

[1]The orthographic differences between the singular and collective forms in (2), specifically *a* : *e*, *t* : *ci*, ∅ : *ie* and *n* : *ń* all represent standard morphonological alternations in Polish. Notice also that the two classes in (2) are uncountable aggregate nouns while most of the literature focuses mainly on countable collectives (but see de Vries 2021).

2 Modes of collectivity

According to Landman (1989a, 2000), collective inferences arise due to the special nature of the argument of the predicate, i.e., the fact that it denotes a group rather than an individual. According to this account, there are three ways in which one can construe a collective interpretation (Landman 2000: 165–169). Specifically, a group can be obtained via (i) collective body formation, (ii) collective action and (iii) collective responsibility, as illustrated by the corresponding examples in (3).

(3) a. The boys touch the ceiling.
    b. The boys carried the piano upstairs.
    c. The gangsters killed their rivals. (Landman 2000: 165–167)

The first mechanism creates a group via so-called collective body formation. Figure 1 depicts the distributive reading of (3a). Here, each boy touches the ceiling himself. What is more interesting for our purposes though is the collective reading illustrated by the scenario in Figure 2. Although not every boy touches the ceiling himself, the sentence is true because the boys have put themselves in a particular spatial configuration, i.e., a pyramid, in order to touch the ceiling together. Such a collective body constitutes an independent object in its own right.

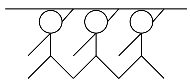

Figure 1: Distributive reading of (3a)

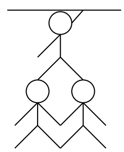

Figure 2: Collective reading of (3a)

On the other hand, the collective interpretation of (3b) results from the fact that the constituent individuals, i.e., the boys, performed a collective action, i.e., carried the piano upstairs together. For an activity to be perceived as such it typically needs to involve a shared goal and simultaneous movement. Individuals involved in collective action often occupy determined positions with respect to each other and move along parallel paths. All those features have the result that a plurality is likely to be perceived as one unit.

Finally, the collective interpretation of (3c) does not arise as a result of a particular spatial configuration of the individuals involved in an event but rather in a more abstract way. The sentence would be true even in a scenario when only one gangster actually pulled the trigger since what is crucial here is shared commitments and collective responsibility stemming from the members' involvement in a particular type of social organization.

Though Landman's distinctions are very useful and instructive, it seems that the cases discussed above generally reduce to the two mechanisms of group formation intuitively characterized in Figure 3 (Zwarts 2020). The left-hand part of Figure 3 represents a process in which the individuals are recognized as making up a higher order unit due to their spatial configuration. As a result of topological contiguity and relative proximity, a perception of a whole that is more than a mere sum of the parts arises. By contrast, the right-hand part of Figure 3 represents a reverse process in which collectivity is regarded as basic. As such it is conceptualized irrespective of the spatial configuration of the members of the group. Instead, it is taken as some abstract connection holding between them, e.g., a web of social relations. For the purpose of this paper, I will refer to the mechanisms in Figure 3 as the two MODES OF COLLECTIVITY. Specifically, I will call them the SPATIAL MODE and the SOCIAL MODE, respectively.

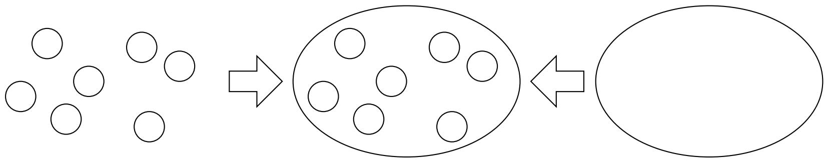

Figure 3: Modes of collectivity

While Landman's collective body formation, recall (3a), is a clear case of the spatial mode, collective responsibility, recall (3c), certainly involves being part of some social entity independent of the position of its members. On the other hand, the cases of collective action exemplified in (3b) can relate to either the spatial or the social mode of collectivity, depending on a particular situation.[2]

3 Types of collectives

Differentiating between two independent modes of collectivity is an important insight not only from the perspective of general conceptual considerations. It turns out that natural language appears to be sensitive to the different ways a group can be construed. In particular, there is a growing body of evidence demonstrating that in fact there are (at least) two types of collective nouns, namely

[2]Though (3b) seems to neatly fit the spatial mode of collectivity, one can easily imagine actions that require the coordination of multiple activities performed at different times and locations:

(i) The personnel launched the space shuttle.

(i) SOCIAL COLLECTIVES designating organizations constituted by their members, e.g., *committee (of women)*, *team (of players)* and *gang (of counterfeits)*, and (ii) SPATIAL COLLECTIVES referring to topological configurations of objects, e.g., *bunch (of flowers)*, *pile (of dishes)* and *crowd (of people)* (Pearson 2011, de Vries 2015, Henderson 2017, Zwarts 2020).[3]

A number of diagnostics to distinguish the two types of collective nouns have been proposed in the literature, e.g, (i) plural agreement in British and Canadian English, (ii) ability to antecede plural pronouns, (iii) embedding in partitive constructions, (iv) quantificational domain of *half*, (v) reference to larger cardinalities, (vi) truth conditions of negated existential statements, (vii) compatibility with spatial modifiers and (viii) compatibility with certain expressions such as the Dutch noun *lid* 'member'. Nevertheless, only (v–viii) turn out to be reliable diagnostics. In order to show that, let us look more closely at each of them.[4]

3.1 Flawed diagnostics

It has been observed that in British and Canadian English nouns such as *committee* allow for plural agreement (Barker 1992), whereas expressions like *bunch of flowers* do not (Pearson 2011), as demonstrated in (4). At first blush, the contrast seems to stem from the spatial/social distinction.

(4) a. The committee are old. (Barker 1992: 89)
b. * The bunch of flowers are tall. (Pearson 2011: 163)

However, this test ignores the role animacy plays in the behavior of collective nouns (see de Vries 2015: Ch. 6) and it turns out that the agreement pattern in (4a) is sensitive to the distinction between animate and inanimate collections rather than that between social and spatial collections. To demonstrate this, let us consider a noun like *crowd*, which designates a spatial configuration and yet can trigger plural agreement on the verb in British English, as in (5). That is because *crowd* refers to a collection of animate individuals.

(5) The crowd are cheerful.

[3] Notice that different terms have been used to describe the distinction, e.g., Pearson differentiates between committee and collection nouns, Henderson distinguishes between group and swarm nouns, whereas Zwarts talks about club and crowd nouns. However, since the expressions designated by these labels encode also (in)animacy (see below), I will use the more general terms social and spatial collectives instead.

[4] I would like to thank Kurt Erbach and Peter Sutton for their judgments concerning American and British English, respectively, as well as for the discussion of the data to be reported below.

According to the second diagnostic (proposed by Henderson 2017), only social collectives can be used as an antecedent of the plural pronoun *they*, see (6a). On the other hand, spatial collectives allow only for singular anaphora, as witnessed by the infelicity of the second sentence in (6b).

(6) a. The committee is in the backyard. They are by the river.
  b. The bouquet is in the backyard. #They are by the river.
  (Henderson 2017: 170)

However, after neutralizing the confounding factor of animacy, we can see in (7) that animate spatial collectives pattern with social collectives such as (6a).[5]

(7) The crowd is in the backyard. They are by the river.

Another alleged diagnostic concerns the behavior of collective nouns in partitives. Pearson (2011) reports that social collectives such as *committee* can be embedded in partitive constructions headed by a count determiner, as in (8a), whereas spatial collective nominals like *bunch of flowers* cannot, see (8b).

(8) a. Three of the committee came to the meeting.
  b. * Three of the bunch of flowers had died. (Pearson 2011: 162–163)

But again, the contrast in (8) does not reflect the spatial/social distinction, but rather it is due to animacy. As evidenced by the grammaticality of (9), the animate spatial collective *crowd* displays the same behavior as the social collective in (8a).

(9) Three of the crowd were killed and several wounded.

Finally, Pearson observes that while (10b) and (10c) can quantify over any part of the wall and the bouquet (and not only individual flowers and bricks), respectively, (10a) quantifies exclusively over individual committee members. Therefore, she postulates that social and spatial collectives differ semantically in that the former have a plural denotation, while the latter have an atomic denotation.

(10) a. Half of the committee had been painted yellow.
  b. Half of the bunch of flowers had been painted yellow.
  c. Half of the wall had been painted yellow. (Pearson 2011: 161–163)

[5] In fact, Henderson himself acknowledges that the nouns *swarm* and *horde* unexpectedly enable plural anaphora.

However, as already pointed out by Zwarts (2020), this test also neglects the effect of animacy. In examples with animate social collectives such as (11), what is quantified over are individual persons making up the crowd rather than arbitrary material parts of the crowd such as people's limbs. Thus, (11) patterns with (10a) despite the fact that *crowd* is not a social collective noun.

(11) Half of the crowd had been painted yellow. (Zwarts 2020: 551)

I conclude that the four tests discussed above fail as reliable diagnostics for distinguishing between social and spatial collective nouns. Instead, what they show is that animate and inanimate collectives behave differently. Let us now examine the remaining four tests, which as I will argue do a better job at discerning the spatial/social distinction.

3.2 More reliable diagnostics

As recognized by Henderson (2017), referents of spatial collectives must be constituted by a sufficiently large number of entities. On the other hand, referents of social collective nouns need not, as witnessed by the contrast in (12).

(12) a. Bill needs to learn to cook for a family of two.
b. # John planted a grove of two redbud trees. (Henderson 2017: 167)

In the previous section, we have discussed the class of animate spatial collectives such as *crowd (of people)*. An interesting question arises whether there is evidence for an inverse category designating inanimate social collections. Though at first blush such entities may seem impossible, notice that the development of information technology and logistics gives rise to higher order configurations of inanimate objects, which are based on function rather than spatial proximity. Hence, I posit that expressions such as *fleet (of trucks)* and *network (of computers)* are good candidates for inanimate social collectives and the comparison between (13) and (12a) shows that in fact they pattern with their animate counterparts.

(13) The company owns a fleet of two trucks for unexpected deliveries.

Another important observation by Henderson is that individuals designated by spatial collectives must occupy the same region of space. Consider, for instance, the spatial entailments in (14) and (15). While social collectives are insensitive to the locations of their constituent members, spatial collections may cease to exist if the topological configuration of the entities that make them up is rearranged.

(14) a. Each member of the committee travels to a different state to visit family.

b. $\not\models$ The committee no longer exists. (Henderson 2017: 168)

(15) a. Someone takes each flower from the bouquet and places it in a different room of the house.

b. $\models$ The bouquet no longer exists. (Henderson 2017: 168)

The behavior of inanimate social collectives like the one in (16), which is on a par with (14) and contrasts with (15), corroborates the validity of the test based on truth conditions of negated existential statements.

(16) a. Each truck from the fleet travels to a different state to deliver goods.

b. $\not\models$ The fleet no longer exists.

The remaining two diagnostics are based on Dutch data examined by Zwarts (2020), who provides a number of linguistic contrasts between social and spatial collectives. First, let us consider certain constraints on spatial modification. For instance, the Dutch preposition *midden in* 'in the middle' specifies precisely a spatial location. The contrast in (17) shows that it is felicitous with spatial collectives since they demarcate a topological region, whereas it is strange with social collectives, which lack this property.

(17) a. ? midden in een comité
middle in a committee
Intended: 'in the middle of a committee'

b. midden in een menigte
middle in a crowd
'in the middle of a crowd' (Dutch; Zwarts 2020: 547)

The last asymmetry to be discussed here concerns compatibility with the Dutch noun *lid* 'member'. As indicated in (18), *lid* can head constructions with social nouns, whereas it is degraded with spatial nouns.

(18) a. Anna is een lid van het comité.
Anna is a member of the committee
'Anna is a member of the committee.'

b. ? Anna is een lid van de menigte.
Anna is a member of the crowd
'Anna is a member of the crowd.' (Dutch; Zwarts 2020: 542, adapted)

I conclude that the four tests discussed above are more reliable diagnostics to detect social and spatial collectives. Moreover, the existence of inanimate social collectives, recall (13) and (16), shows that (in)animacy is orthogonal to the spatial/social distinction. Therefore, in fact there are two dimensions of collectivity illustrated in Table 1 (see also Zwarts 2020 for a similar classification though without specifying social inanimate collections).

Table 1: Dimensions of collectivity

	SPATIAL collections	SOCIAL collections
ANIMATE collections	crowd (of people) swarm (of bees)	committee (of women) club (of gentlemen)
INANIMATE collections	bunch (of flowers) pile (of dishes)	fleet (of trucks) network (of computers)

The fact that different modes of collectivity are encoded in different lexical items invites the question whether they are also reflected in word formation. In the following section, I will discuss how Slavic derivational morphology relates to the distinction between spatial and social collectives.

4 Slavic derived collectives

Additional evidence in favor of the relevance of the distinction between spatial and social collections for natural language meaning and grammar comes from Slavic derivational morphology. Slavic languages have a relatively rich inventory of affixes dedicated to the derivation of collective nouns (cf. Mozdzierz 1994, Ojeda & Grivičić 2005, Mitrović 2011, Tomić 2012, Arsenijević 2017, Grimm & Dočekal in preparation). I will argue that although all Slavic collective affixes form a natural class in terms of meaning, different subtypes of such morphemes correspond semantically to the spatial/social distinction discussed so far.

I will first illustrate the richness of the Slavic system on the basis of Polish data. I will discuss a total of six classes of Polish derived collectives, three of which consist of spatial collectives and the remaining three represent social collectives. For the sake of brevity, I will not discuss the morphonological alternations in the examples below all of which are standard sound changes in Polish.

4.1 Derived spatial collective nouns

Let us begin with derived spatial collectives. Though there are a number of differences between the three classes, what they all share are at least the following properties. First of all, the derived forms in each of the classes occur in addition to regular plurals. Though morphosyntactically they all exhibit singular agreement, they denote pluralities of objects denoted by the root. Furthermore, they all give rise to an inference that the plurality is relatively large. Finally, their referents are not just arbitrary collections of objects but rather they are conceptualized as aggregates, i.e., topological configurations of entities that either touch each other or remain in close proximity.

The first class concerns collectives derived by the suffix *-e* (along with the allomorphs *-owie* and *-iwie*), which attaches to inanimate nouns. Table 2 gives four examples of a tripartite sequence consisting of a singular form, e.g., *kwiat* 'flower', a regular plural, e.g., *kwiaty* 'flowers', and a corresponding collective, e.g., *kwiecie* 'clump(s) of flowers'. All of the forms derived by *-e* show singular neuter agreement, cannot be pluralized and are incompatible with cardinal numerals. They all denote clustered pluralities of relatively small objects. For instance, *pierze* denotes a collection of feathers whereas *listowie* and *igliwie* designate leaf and needle foliage, respectively.

Table 2: Polish spatial collectives derived by the suffix *-e*

GLOSS	SINGULAR	PLURAL	COLLECTIVE
'flower'	kwiat	kwiaty	kwiecie
'feather'	pióro	pióra	pierze
'leaf'	liść	liście	listowie
'needle'	igła	igły	igliwie

The second class consists of spatial collectives derived by the suffix *-ina* (with the allomorph *-yna*). The collective expressions in Table 3 are names of forests and as such refer to collections of trees of a given type that form a dense spatial configuration.[6] For instance, adding the suffix *-ina* to *brzoza* 'birch' results in *brzezina*, a noun denoting a birch wood or grove. Similarly, *buczyna*, *grabina* and *olszyna* refer to a beech, hornbeam and alder forest, respectively. All of them are feminine countable nouns, which can pluralize and combine with cardinals.[7]

[6]Collectives naming types of forests derived with a special affix are also attested outside Slavic, e.g., in Romanian (Henderson 2017).

[7]Note, however, that the collective forms are homonymous with mass nouns designating a type of wood as a material, e.g., *brzezina* can also mean 'birch wood'.

Table 3: Polish spatial collectives derived by the suffix *-ina*

GLOSS	SINGULAR	PLURAL	COLLECTIVE
'birch'	brzoza	brzozy	brzezina
'beech'	buk	buki	buczyna
'hornbeam'	grab	graby	grabina
'alder'	olcha	olchy	olszyna

Finally, the third class of spatial collectives includes names of spatial configurations of artifacts. Such forms include a vocalic prefix as well as post-root morphology, e.g., the suffixes *-ow-* and *-anie*, which strongly suggests that they are derived from verbal expressions which are themselves formed from nominal roots. For instance, *okablowanie* 'wiring' is derived from the verb *okablować* 'to wire', which in turn is derived from the noun *kabel* 'cable, wire'. Such deverbal collectives are singular neuter uncountable nouns. They name pluralities of functional elements arranged as a complex unit, e.g., *olinowanie* designates a set of connected lines forming rigging, *omasztowanie* refers to masting and *ożaglowanie* denotes a configurations of sails making up sailing.

Table 4: Polish deverbal spatial collectives

GLOSS	SINGULAR	PLURAL	COLLECTIVE
'cable'	kabel	kable	okablowanie
'rope'	lina	liny	olinowanie
'mast'	maszt	maszty	omasztowanie
'sail'	żagiel	żagle	ożaglowanie

To conclude, all of the collectives examined above denote collections conceptualized as topologically structured configurations constituted by a relatively large number of objects denoted by the nominal root.

4.2 Derived social collective nouns

Let us now turn to derived social collectives. Here, I will discuss three classes of such expressions in Polish. Similarly to spatial collectives, there are some differences between the classes. However, they all have the following features in common. Firstly, social collectives appear in addition to regular plural forms. Despite being singular in terms of morphosyntax, they usually refer to pluralities of human individuals having the property denoted by the root. Crucially, nouns forming the types of collectives discussed in this section typically denote social roles and capacities associated with profession, social class and status. In addition to a collective inference, they also seem to have a generic component indicating that the group forms a sort of institution.

The first class comprises collective nouns derived by the suffix *-stwo* (*-ctwo* after a velar consonant). Table 5 provides examples of such forms compared to regular singulars and plurals. They show singular neuter agreement, cannot pluralize and do not combine with cardinal numerals. As illustrated in Table 5, the suffix *-stwo* selects for human nouns describing social capacities. For instance, *rycerstwo* denotes chivalry, i.e., a collective of knights. Likewise, *duchowieństwo* refers to clergy, i.e., a collective of priests, *kierownictwo* refers to management as a collective body and *chłopstwo* designates the estate of peasantry.

Table 5: Polish social collectives derived by the suffix *-stwo*

GLOSS	SINGULAR	PLURAL	COLLECTIVE
'knight'	rycerz	rycerze	rycerstwo
'priest'	duchowny	duchowni	duchowieństwo
'manager'	kierownik	kierownicy	kierownictwo
'peasant'	chłop	chłopi	chłopstwo

The second class of social collectives consists of feminine uncountable nouns derived with the suffix *-eria*. Again, the collectives in Table 6 denote pluralities of human individuals that have a flavor of a social institution. Thus, *magnateria* denotes aristocracy, *żandarmeria* refers to the military police and *masoneria* refers to the members of freemasonry. The noun *chuliganeria* 'collective of hooligans' is an example of an interesting subset of pejorative *-eria* collectives denoting pluralities of individuals whose behavior is perceived as violating social order.

Table 6: Polish social collectives derived by the suffix *-eria*

GLOSS	SINGULAR	PLURAL	COLLECTIVE
'magnate'	magnat	magnaci	magnateria
'military policeman'	żandarm	żandarmi	żandarmeria
'freemason'	mason	masoni	masoneria
'hooligan'	chuligan	chuligani	chuliganeria

The final set of social collectives to be discussed here is composed of expressions derived by the suffix *-ja*, see Table 7. Though they are all singular and feminine and they all refer to pluralities of individuals denoted by the root, particular items differ in whether they can be pluralized and co-occur with cardinal numerals or not. For instance, *inteligencja* and *konkurencja* are uncountable nouns referring to intelligentsia, i.e., the institution of intellectuals, and to competition as a body of competitors, respectively. On the other hand, *delegacja* and *reprezentacja* are countable and denote a body of delegates and representatives.

Table 7: Polish social collectives derived by the suffix *-ja*

GLOSS	SINGULAR	PLURAL	COLLECTIVE
'intellectual'	inteligent	inteligenci	inteligencja
'competitor'	konkurent	konkurenci	konkurencja
'delegate'	delegat	delegaci	delegacja
'representative'	reprezentant	reprezentanci	reprezentacja

In each of the cases discussed above, the derived collective denotes a group of individuals who perform a socially salient role and hold closely related capacities.

4.3 Distinguishing spatial and social collectives

The intuitions concerning the nature of the referents of spatial and social collectives are further corroborated by a number of linguistic tests. The first one concerns the compatibility with VPs headed by the verb *należeć* 'belong'. As evidenced by the contrast in (19), PPs including social collectives are perfectly fine as complements of *należeć*, see (19a), whereas PPs with spatial collectives are degraded, as in (19b).

(19) a. Ten mężczyzna należy do duchowieństwa.
this man belongs to priest.COLL.GEN
'This man belongs to the clergy.'

b. # Ta niezapominajka należy do kwiecia.
this forget.me.not belongs to flower.COLL.GEN
Intended: 'This forget-me-not belongs to the clump of flowers.'
(Polish)

Moreover, the existence of social collections (unlike spatial collections) seems to be at least to some degree independent of their constituent members. The sentence in (20a) is fine since the social collective refers to an institutionalized entity, which does not necessarily cease to exist if there are temporarily no priests around. On the other hand, (20b) is strange on a reading where there is a clump with no flowers making it up.

(20) a. Obecnie nikt nie należy do duchowieństwa.
currently no.one NEG belongs to priest.COLL.GEN
'Currently, no one belongs to the clergy.'

b. # Obecnie nic nie jest częścią kwiecia.
currently nothing NEG is part flower.COLL.GEN
Intended: 'Currently, nothing is part of the clump of flowers.'
(Polish)

Furthermore, social collectives are compatible with kind predicates such as *być powszechnym* 'be widespread', see (21a). On the other hand, spatial collectives are not felicitous in such generic environments, see (21b).

(21) a. Duchowieństwo było powszechne w XX wieku.
priest.COLL was widespread in 20th century
'Clergy was widespread in the 20th century.'

b. # Kwiecie było powszechne w trzeciorzędzie.
flower.COLL was widespread in Tertiary
Intended: 'Flowers were widespread in the Tertiary Period.' (Polish)

Finally, social and spatial collectives exhibit different behavior in constructions headed by the preposition *wśród* 'among, amid'. While the most natural interpretation of (22a) is that one of the priests spotted by Ania is intriguing rather than an intriguing non-priest was spotted surrounded by priests, (22b) means that the spotted thing amid the clump is not a flower.

(22) a. Ania zauważyła kogoś intrygującego wśród duchowieństwa.
Ania spotted someone intriguing among priest.COLL.GEN
'Ania spotted someone intriguing among the clergy.'

b. Ania zauważyła coś intrygującego wśród kwiecia.
Ania spotted something intriguing among flower.COLL.GEN
'Ania spotted something intriguing amid the clump of flowers.'
(Polish)

Based on the data discussed above, I conclude that the contrasts indicate that spatial collectives refer to concrete topological configurations of objects in physical space, whereas social collectives denote social organizations. Before we move on to the theoretical part of the paper, let us conclude by discussing some cross-Slavic correspondences.

4.4 Cross-Slavic parallels

As already mentioned, Polish is not exceptional in having a rich inventory of collectivizing affixes. Similar forms are in fact attested in every branch of Slavic. For instance, Table 8 gives an overview of derived spatial collectives equivalent to the Polish expressions formed with the suffix *-e*, recall Table 2, in six other Slavic langunguages.

Table 8: Slavic derived spatial collectives

	GLOSS	SINGULAR	PLURAL	COLLECTIVE
Czech	‘reed’	rákos	rákosy	rákosí
Slovak	‘rock’	kameň	kamene	kamenie
Russian	‘leaf’	list	list’ja	listva
BCMS	‘flower’	cvet	cvetovi	cveće
Macedonian	‘sheaf’	snop	snopovi	snopje
Slovenian	‘bush’	grm	grmi	grmovje

The properties of that class in individual languages may differ in certain regards. For instance, while Czech has a relatively large number of spatial collectives of the discussed type (Grimm & Dočekal in preparation list more than 20 examples), Polish has nowadays only 6 such nouns; though spatial collectives of the discussed type are typically singular and uncountable across Slavic, in Bosnian/Croatian/Montenegrin/Serbian (BCMS) and Slovenian they can pluralize (Ojeda & Grivičić 2005, Mitrović 2011) and so on. However, what all of the collective forms in Table 8 have in common is that they denote collections of objects conceptualized as coherently related in terms of spatial proximity. For instance, Czech *rákosí* does not denote an arbitrary plurality of reeds but rather a reed bed, Slovak *kamenie* refers to a clump of rocks, Macedonian *snopje* means ‘bundle of sheaves’ and Slovenian *grmovje* is probably best translated as ‘clump of bushes’.

Morphemes dedicated to the derivation of social collectives are also widespread across Slavic. Table 9 provides six examples of equivalents of social collectives derived with the suffix *-stwo*, recall Table 5, in other Slavic languages.

Table 9: Slavic derived social collectives

	GLOSS	SINGULAR	PLURAL	COLLECTIVE
Czech	'teacher'	učitel	učitelé	učitelstvo
Slovak	'student'	študent	študenti	študentstvo
Russian	'soldier'	voin	voiny	voinstvo
BCMS	'worker'	radnik	radnici	radništvo
Macedonian	'citizen'	graǵanin	graǵani	graǵanstvo
Slovenian	'leader'	vodja	vodji	vodstvo

All of the collectives in Table 9 denote groups of individuals performing socially salient institutionalized roles. Czech *učitelstvo* and Slovak *študentstvo* refer to a body of teachers and students, respectively. Russian *voinstvo* denotes an army. BCMS *radništvo* means 'collective of workers'. Macedonian *graǵanstvo* is probably best translated as 'society' and Slovenian *vodstvo* as 'leadership'.

Notice also that many of the collectivizing suffixes are polyfunctional. A frequent pattern is that the very same suffix, e.g., Polish *-stwo* and BCMS *-stvo*, is also employed to derive names of abstract properties associated with the root noun. For instance, the BCMS noun *bratstvo* 'brotherhood' is actually ambiguous between the collective 'brotherhood as a group' and the property meaning 'brotherhood as the quality of being brotherly'.[8] This fact further suggests that at their core social collectives relate to certain abstract capacities.

In this section, I have shown that collective noun derivations are widespread across Slavic and that their nature is highly systematic. To conclude, I propose the generalization in (23).

(23) *Generalization:* Slavic collective suffixes form a natural semantic class, which consists of two subclasses corresponding to the distinction between spatial and social collections.

In the next two sections, I will introduce a formal toolbox that will allow us for what I argue is the proper analysis of the two types of derived collectives in Slavic. For this purpose, I will combine two strands of research, specifically mereotopology and theory of roles.

[8] On the other hand, Czech distinguishes the two senses by using different suffixes, e.g., *lidstvo* 'humanity, the human race' as opposed to *lidství* 'humanity, human nature'.

5 Mereotopology

In order to account for the intuition that members forming pluralities denoted by collective nouns are arranged in a structured manner, I follow Grimm (2012) and adopt MEREOTOPOLOGY, a theory of wholes extending standard mereology with topological notions. Though mereotopology only recently has been incorporated into the study of natural-language semantics, it has a long history dating back to the early 20th century (Whitehead 1920) and it has been further developed within formal ontology (e.g., Smith 1996, Casati & Varzi 1999, Varzi 2007).

5.1 Mereotopological structures in natural language

The linguistic evidence for the relevance of mereotopology comes from several domains of nominal semantics. In particular, there are a number of natural language expressions that are sensitive to topological properties of part-whole structures corresponding to their referents, i.e., the manner in which parts of a whole are arranged.

First of all, Grimm (2012) argues that mass nouns that denote aggregates of objects such as *gravel* and *hair* involve reference to clustered individuals, i.e., bundled entities spatially situated with respect to each other in a particular way. When modified by adjectives such as *thin* and *dense*, aggregate nouns give rise to different interpretations than plurals. For instance, (24a) means that the hair is thinly distributed over the head, whereas (24b) indicates that each hair is thin, i.e., their diameter is small. In languages such as Welsh and Daagare, the aggregate meaning is encoded in number morphology.

(24) a. thin hair
b. thin hairs (Grimm 2012: 146)

Furthermore, Scontras (2014) demonstrates that atomizers such as *grain* differ from measure terms and container nouns in that they lack a measure reading referencing a single quantity. Instead, they always individuate entities in terms of compact pieces of matter. Consequently, atomizers are acceptable with the distributive operator *each* even in contexts where measure and container nouns are infelicitous, as witnessed by the contrast between (25a) and (25b).

(25) a. The two grains of rice in this soup cost 2 euros each.
b. # The two {liters / cups} of wine in this soup cost 2 euros each. (Scontras 2014: 61–62)

The final piece of evidence comes from subatomic quantification, i.e., quantification over parts of referents of concrete singular count nouns. Wągiel (2018) argues that certain partitive constructions are sensitive to whether a part of an entity forms a spatially contiguous portion of that entity. For instance, though (26a) can be true of a flag with discontiguous red parts, the sentence in (26b) can only describe a situation in which the red part constitutes a contiguous half.

(26) a. Half the flag is red.
 b. A half of the flag is red. (Wągiel 2018: 110)

Having reviewed linguistic evidence for the relevance of mereotopological notions for nominal semantics, let us now briefly discuss how such notions can be captured formally.

5.2 Extending mereology with topological notions

In order to extend standard mereology with topology, the key move is to introduce the notion of CONNECTEDNESS (C) (Casati & Varzi 1999: 53). Intuitively, two entities are connected if they share a common boundary. Thus, the C relation is reflexive and symmetric, see (27a) and (27b), respectively, but not transitive.

(27) a. $\forall x[\mathrm{C}(x, x)]$ REFLEXIVITY
 b. $\forall x \forall y[\mathrm{C}(x, y) \leftrightarrow \mathrm{C}(y, x)]$ SYMMETRY

In addition, C is introduced in such a way that it interacts with other notions of standard mereology such as PARTHOOD ($\sqsubseteq$) and OVERLAP ($\circ$). These interactions are captured by so-called bridging principles, which intertwine the mereological and the topological component of mereotopology (Varzi 2007). The principle of integrity, see (28a), guarantees that connectedness is implied by parthood. The principle of unity, see (28b), ensures that overlapping entities are connected. Finally, the principle in (28c) secures monotonicity.

(28) a. $\forall x \forall y[x \sqsubseteq y \rightarrow \mathrm{C}(x, y)]$ INTEGRITY
 b. $\forall x \forall y[x \circ y \rightarrow \mathrm{C}(x, y)]$ UNITY
 c. $\forall x \forall y\big[x \sqsubseteq y \rightarrow \forall z[\mathrm{C}(z, x) \rightarrow \mathrm{C}(z, y)]\big]$ MONOTONICITY

5.3 Clusters

Given C, it is possible to define more complex mereotopological notions to capture subtle distinctions between different spatial configurations. One such notion is the property TRANSITIVELY CONNECTED (TC) (see Grimm 2012: 144). As defined in (29), it determines whether two objects are connected through a series of mediating entities. Specifically, entities x and y are transitively connected relative to a property P, a connection relation C, and a sequence of entities Z, when all members of Z satisfy P and x and y are connected through the sequence of z_is in Z.[9]

(29) For a finite sequence $Z = \langle z_1, \ldots, z_n \rangle$, $\textsc{tc}(x, y, P, C, Z)$ holds iff $z_1 = x, z_n = y, \mathrm{C}(z_i, z_{i+1})$ holds for $1 \leq i < n$ and $P(z_i)$ holds for $1 \leq i \leq n$.

To illustrate, consider Figure 4. Though a and c are not directly connected, they are transitively connected since there is a mediating object (b), which is connected to both a and c. For different properties, different types of connections may apply.

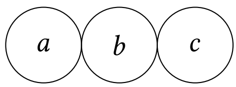

Figure 4: Transitive connection

The property TC allows us for defining the concept of CLUSTER (CLSTR) (Grimm 2012: 144). According to (30), an entity x is a cluster relative to a connection relation C and a property P iff x is a sum of entities falling under the same property, which are all transitively connected relative to a subset of Z under the same property and connection relation.[10] Hence, the sum $a \sqcup b \sqcup c$ in Figure 4 is a cluster.

(30) $\mathrm{CLSTR}_C(P)(x) \overset{\text{def}}{=} \exists Z[x = \bigsqcup Z \wedge \forall z \forall z' \in Z \exists Y \subseteq Z[\textsc{tc}(z, z', P, C, Y)]]$

The notion of CLSTR as defined in (30) allows for modelling certain spatial configurations of entities as complex mereotopological objects. In the next section, I will discuss a further extension of the ontology, which will involve roles.

[9] In Grimm's original proposal, Z does not range over ordered sequences but rather over unordered sets, which results in certain unintended consequences that (29) is designed to avoid. I am grateful to Nina Haslinger for suggesting this modification.

[10] The formula in (30) also differs from Grimm's original definition. The main modification is that I restrict the variable Y to the subsets of Z. Without this restriction if, e.g., $P = \{z_1, z_2, z_3\}$, $Z = \{z_1, z_3\}$, z_1 and z_2 are connected, z_2 and z_3 are connected and nothing else is connected, then z_1 and z_3 are transitively connected via $Y = \{z_1, z_2, z_3\}$, which is a subset of P, so counterintuitively $z_1 \sqcup z_3$ form a cluster relative to P and C even though it is not a connected entity. Again, I would like to thank Nina Haslinger for pointing this out.

6 Roles

In order to explain the behavior of social collectives, I will follow Zobel (2017) and extend the usually assumed ontology of the model with an additional domain, namely the domain of ROLES. Though this is rather uncommon in natural-language semantics (but see de Swart et al. 2007 for a related notion of CAPACITY), the relevance of roles as independent ontological objects has been argued for in the literature on theoretical computer science, conceptual modelling and knowledge representation (e.g., Sowa 1984, Steimann 2000, Loebe 2007).

6.1 Roles vs. individuals

On an intuitive level, roles are certain functions or capacities of individuals. As such they are social constructs that are independent of their bearers and there is solid evidence that natural language is sensitive to the distinction between the two. As argued convincingly by Zobel (2017), a number of linguistic phenomena demonstrate the relevance of distinguishing between class nouns, i.e., nouns denoting properties of individuals, and role nouns, i.e., nouns denoting properties of roles that individuals can bear.

First of all, certain predicates are sensitive to the distinction in question. For instance, consider the contrast in (31) (see also Szabó 2003). Here, *earns 3,000 euros* selects only for as-phrases whose complement is a role noun, thereby (31b) is infelicitous. Notice also that (31a) does not convey any information on the total income Paul makes but only on the amount of money he earns for fulfilling this particular role.

(31) a. Paul earns 3,000 euros as a judge.
b. # Paul earns 3,000 euros as a man. (Zobel 2017: 439)

Moreover, role nouns differ from class nouns with respect to certain entailment patterns, as demonstrated in (32–33) (see Landman 1989b). While the truth of (32c) is guaranteed by the truth of the premises, the conclusion in (33c) is invalid.

(32) a. The man (over there) is on strike.
b. The man (over there) is the hangman.
c. $\models$ The hangman is on strike. (Zobel 2017: 439)

(33) a. The judge is on strike.
b. The judge is the hangman.
c. $\not\models$ The hangman is on strike. (Landman 1989b: 724)

Another piece of evidence comes from the behavior of the two types of nouns in copular sentences. For instance, German role nouns can appear bare in such environments, see (34a), whereas class nouns cannot, see (34b). Similar contrasts are also attested, e.g., in Dutch and French (de Swart et al. 2007).

(34) a. Paul ist (ein) Richter.
Paul is a judge
'Paul is a judge.'

b. Paul ist *(ein) Mann.
Paul is a man
'Paul is a man.' (German; Zobel 2017: 439, adapted)

A single role can be played by multiple individuals (often at once), see (35a), or there can be no individual at all that plays it, see (35b).[11]

(35) a. The three core players and their organizations are executive director of the Tri-County regional planning commission.

b. I long for the day when no one is head of the house. (Zobel 2017: 449)

Finally, roles can have properties that do not apply to the individuals fulfilling them. This is witnessed by the use of DPs such as *this role* in argument position, as in (36). It might also be the case that an individual acquires certain properties stemming from duties, obligations and rights associated with playing their role that expire once they stop playing that role, e.g., consider the role of the prime minister or a spouse.

(36) I submit that this role is outmoded and dangerous. (Zobel 2017: 450)

Now, with the evidence for the relevance of roles for natural language discussed let us review how it can be accounted for formally.

6.2 Capturing class nouns and role nouns

I follow Zobel (2017) in assuming the primitive type r for social roles, which are modeled as independent ontological objects. Hence, alongside the domain of individuals D_e there is also the domain of roles D_r. While class nouns denote properties of individuals (type $\langle e, t\rangle$), see (37a), role nouns denote properties of roles (type $\langle r, t\rangle$), see (37b).

[11] Naturally, it is also the case that one individual can play multiple roles.

(37) a. $[\![\text{man}]\!] = \lambda x_e[\textsc{man}(x)]$
b. $[\![\text{judge}]\!] = \lambda r_r[\textsc{judge}(r)]$

Similarly to individuals, which are referred to by proper names and definite descriptions, particular roles can be designated by dedicated linguistic expressions. Examples include phrases such as the infamous *Grand Wizard* and *President of the United States* as well as demonstrative DPs like *this role* and *that job*.

Importantly, though roles are distinct from individuals, the two ontological categories are closely associated with each other as individuals typically perform roles. This fact is captured by a special shifting operator PLAY, which relates a role with individuals that perform it. As defined in (38), PLAY takes a set of roles P and yields a set of (potentially plural) individuals x for which there are a role r and an eventuality e such that r is a P-role and $\langle r, e\rangle$ is part of the specific role structure $\mathscr{R}_x$ of x, which structures individuals' participation in eventualities relative to the roles they perform, see (39) (Zobel 2017: 451).

(38) $[\![\textsc{play}]\!] = \lambda P_{\langle r,t\rangle}\lambda x_e \exists r_r \exists e_e[P(r) \wedge \langle r, e\rangle \in \mathscr{R}_x]$

(39) For each individual x, the specific role structure $\mathscr{R}_x$ is a set of role-eventuality-pairs. A pair $\langle r, e\rangle$ is a member of $\mathscr{R}_x$ iff x is a participant of e in role r.

With all the theoretical ingredients in place, let us move on to the proposal.

7 Collectives as clusters

In this section, I propose a semantic analysis of Slavic derived collective nouns as properties of clusters. My proposal builds on the mereotopological treatment of aggregate nominals developed by Grimm (2012) and Grimm & Dočekal (in preparation) as well as Zobel's (2017) theory of roles. The main claim is that mereotopological relations hold not only between concrete objects occupying physical space but also between abstract entities such as roles in social space. This extension enables us to capture spatial collectives as predicates true of spatial clusters and social collectives as predicates true of social clusters, i.e., pluralities of abstract capacities conceptualized as being socially connected.

7.1 Pluralities of roles

I propose that not only are roles independent ontological objects, as postulated by Zobel (2017), but also that just like ordinary individuals they enter part-whole relations and form pluralities. The evidence comes from the behavior of conjunction within as-phrases. For instance, consider the analogy in (40).[12]

(40) a. Paul gave 4,000 euros to Tom and Amy.
 b. Paul earns 4,000 euros as a judge and a lecturer.

The conjoined DP in (40a) gives rise to the well-studied ambiguity between the distributive and the non-distributive construal, i.e., Tom and Amy got either 4,000 euros each or 4,000 euros between them. Likewise, (40b) is ambiguous in a very similar way. On the distributive reading, Paul earns 4,000 euros working as a judge and 4,000 euros working as a lecturer, i.e., 8,000 euros in total. In addition, the sentence can be understood in a non-distributive way, i.e., that Paul earns a total of 4,000 euros for both of those two jobs.

Given the evidence described above, it is justified to analyze conjoined role nouns as denoting pluralities of roles built from the denotations of the conjuncts. Such a postulate fits into the general trend in semantic research, which has gradually extended pluralities from the domain of individuals to the domains of events (Bach 1986), information states (Krifka 1996), times (Artstein & Francez 2003) and degrees (Dotlačil & Nouwen 2016) as well as propositions (Lahiri 2002), questions (Beck & Sharvit 2002) and functions (Schmitt 2019).

7.2 Mereotopology in the social space

It is typically assumed that mereological relations hold not only between concrete physical objects but also between abstract entities. As discussed in the previous section, there are good reasons to maintain that this is also true with respect to roles. On the other hand, in §5.1 we have seen evidence that the manner in which parts of a whole are arranged with respect to each other is linguistically relevant. The main claim of this paper is that mereotopological relations apply not only in the domain of concrete physical objects but also in the domain of abstract social roles.

In other words, I assume that both individuals and roles are conceptualized as occupying positions within regions of space. The former are located in physical space whereas the latter inhabit abstract SOCIAL SPACE. At first blush, this idea might seem somewhat controversial but I will argue that the distinction is in fact relevant for natural language. As biological creatures, of course we occupy physical space but as Churchland (1996: 123) puts it “we live also in an intricate space

[12] I would like to thank Kurt Erbach for his judgments and the discussion of the English examples. The same analogy is also attested in other languages, e.g., German and Polish.

of obligations, duties, entitlements, prohibitions, appointments, debts, affections, insults, allies, contracts, enemies, infatuations, compromises, mutual love, legitimate expectations, and collective ideals". For our species the "topology" of this social space is as real and (at least) as important as the topology of the physical space our bodies occupy. Therefore, I believe that it is conceptually plausible that this fact is also reflected in language.

This intuition seems to be supported by the existence of a class of expressions such as *connected*, *close* and *separate* that are systematically polysemous between spatial and social relations. This suggests that the way in which connection is conceptualized in natural language goes beyond spatial connectedness. The notion of social space as part of the semantic model theory would be a way to capture the non-accidental nature of this correspondence.

Hence, I propose to extend mereotopology to abstract domains. The core intuition behind this postulate is that in the case of abstract entities the manner in which their parts are arranged can be as relevant as in the case of concrete individuals. Of course, this move requires abstracting from the connectedness relation C as a relation between physical objects and viewing it as a purely abstract notion that can hold between entities of any type (similarly to the parthood relation $\sqsubseteq$). Here, I will assume two cases of C, specifically SPATIAL CONNECTION (SP) and SOCIAL CONNECTION (SC). The former is defined over the domain of individuals in physical space (let us assume here that it simply amounts to D_e) whereas the latter is defined over D_r, i.e., the domain of roles, which inhabit social space.

What would it then mean that two roles are connected? One intuitive way of making sense of the concept of social connection is by thinking of shared capacities and obligations that center around a certain well-defined aspect of social life or stem from socially significant relationships between roles (see also Joosten 2010). This way an institution, i.e., a complex web of model interactions and dependencies, can arise. As a result, individuals performing connected roles are expected to be involved in similar situations and to exhibit a similar type of behavior in role-related events. For instance, roles of family members involve overlapping duties, affections and expectations, and thus can be viewed as connected. Notice, however, that these obligations and relationships should be viewed as regarding primarily roles and not particular individuals. Thus, the reason why it makes sense to talk about peasantry as a social class is not necessarily because individual peasants co-operate with each other but rather because the role of a peasant is defined in terms of a particular type of relationship with the role of a landlord irrespective of who exactly plays that role.

The extension proposed above allows us to derive more complex mereotopological notions for the domain of roles on a par with what we have already discussed in §5. This in turn enables the modelling of certain pluralities of roles as clusters.

7.3 Spatial and social clusters

I propose that both spatial and social collectives in Slavic denote properties of clusters. Hence, on a general level they are closely related expressions. However, the crucial difference between the two concerns the kind of entities that form a cluster and, consequently, the kind of connection relation holding between them.

Based on the generalization in (23), I argue that all Slavic collective suffixes form a natural class consisting of the spatial and the social subtype. Since spatial collectives demonstrably make reference to clusters and the derivational processes yielding these expressions belong to a larger class that should receive a unified semantics, I postulate that all derivational suffixes for collective nouns involve the notion of a cluster in some way. Together with the independently motivated idea that social collectives denote predicates of pluralities of roles, this entails that they involve clusters in social space. In (41), I propose a schematic lexical entry for Slavic collective suffixes (-COLL) that specifies every aspect of their meaning except the type of the noun they are suffixed to. Specifically, -COLL takes a predicate of type $\langle \alpha, t \rangle$, where α ranges over primitive types (e and r in particular), and yields a set of clusters relative to the relevant property and connection relation. In other words, the result is a semantically plural expression denoting predicates true of cluster individuals of type e or r.

(41) $[\![\text{-COLL}]\!] = \lambda P_{\langle \alpha,t \rangle} \lambda x_\alpha [\text{CLSTR}_\text{C}(P)(x)]$

Following the analysis of Czech derived aggregate nouns by Grimm & Dočekal (in preparation), I posit that Slavic derived spatial collectives refer to clusters of objects in physical space. The denotation of the Polish suffix *-e* is given in (42a), where SP stands for a spatial connection between physical entities.[13] Thus, *-e* takes a property of individuals and yields a set of spatial clusters. For instance, when it attaches to (42b), what we obtain is a set of clumps of flowers, see (42c).

(42) a. $[\![\text{-e}]\!] = \lambda P_{\langle e,t \rangle} \lambda x_e [\text{CLSTR}_\text{SP}(P)(x)]$
b. $[\![\text{kwiat}]\!] = \lambda x_e [\text{FLOWER}(x)]$
c. $[\![\text{kwiecie}]\!] = \lambda x_e [\text{CLSTR}_\text{SP}(\text{FLOWER})(x)]$

[13] (42a) differs from Grimm & Dočekal's proposal with the main difference being that they are also interested in the relationship between objects and kinds, which I ignore here.

Let us now demonstrate linguistic evidence that social collectives do in fact involve reference to roles. First, (43) has a reading on which it can be true even if individual members of the clergy received money from the state, as long as these subsidies were unrelated to their role as clergy.

(43) Duchowieństwo nie otrzymało żadnych pieniędzy od państwa.
priest.COLL NEG received any.GEN money.GEN form state.GEN
'The clergy did not receive any money from the state.' (Polish)

Furthermore, arguments such as (44) have a reading on which they are invalid, similarly to (33). For instance, the conclusion in (44c) does not necessarily follow from the premises in (44a) and (44b) if the delegation is intended to represent interests of the local community rather than the official position of the church.

(44) a. Delegacja na szczyt klimatyczny składa się z lokalnego duchowieństwa.
delegation on summit.ACC climate.ADJ consists REFL from local.GEN priest.COLL.GEN
'The delegation to the climate summit consists of the local clergy.'

b. Lokalne duchowieństwo strajkuje.
local priest.COLL is.on.strike
'The local clergy are on strike.'

c. ⊭ Delegacja na szczyt klimatyczny strajkuje.
delegation on summit.ACC climate.ADJ is.on.strike
'The delegation to the climate summit is on strike.' (Polish)

With this in mind, let me now propose a semantics for derived social collectives. As already mentioned, the core idea is that they are essentially very similar to spatial collective nouns, with the crucial difference that the CLSTR operation is now relativized to SC, and thus applies to roles. As evident in the formula in (45a), the Polish suffix *-stwo* selects a property of roles and returns a set of clusters of roles formed relative to that property. For instance, when *-stwo* combines with (45b), the result in (45c) is a predicate true of clusters of priest roles corresponding to a clerical organization. If needed, this predicate can be associated with particular individuals performing those roles via the shifting operator PLAY. As a result, we can account for the dual life of social collectives, i.e., the fact that they designate an abstract social entity that can have different properties than its constituent members, but at the same time we can talk about the constituent members using a collective noun.

(45) a. $[\![\text{-stwo}]\!] = \lambda P_{\langle r,t\rangle}\lambda r_r[\textsc{clstr}_{\textsc{sc}}(P)(r)]$

b. $[\![\text{duchowny}]\!] = \lambda r_r[\textsc{priest}(r)]$

c. $[\![\text{duchowieństwo}]\!] = \lambda r_r[\textsc{clstr}_{\textsc{sc}}(\textsc{priest})(r)]$

The proposed analysis has two important advantages. First of all, it captures the intuition that the two types of collective nouns are actually closely related since they both make use of the CLSTR operator. At the same time, it also explains the source of the differences between spatial and social collectives, as examined in §3 and §4. Specifically, the CLSTR operator accounts for collective inferences whereas different types of connection, i.e., SP and SC, correspond to the two distinct modes of collectivity discussed in §2.

The proposal captures the core properties of spatial and social collections in the following manner. The reason why spatial collections may cease to exist when the topological configuration of their constituent members is rearranged, as in (14), is simply because the spatial connection relative to which the cluster is defined does not apply anymore, and thus there is no cluster anymore. On the other hand, the location of individuals who perform roles making up a social cluster is irrelevant, recall (15–16), because the cluster is not defined in spatial space, but rather in the abstract social space. In relation to this, the fact that social collections appear to exist independently of their constituent members, recall (20), stems straightforwardly from the different ontological status of social clusters (type *r*) as compared to individuals (type *e*). Consequently, there can be very few or even no individuals performing the relevant roles at a given moment, which also accounts for the contrast in (12–13). Finally, the compatibility of certain predicates, e.g., the Polish verb *należeć* 'belong', only with social collectives, recall (19), can be easily explained by postulating a selectional restriction requiring an expression of type $\langle r, t\rangle$.

8 Conclusion

In this paper, I have discussed data showing that Slavic morphology reflects two different modes of collectivity. In particular, I have examined two types of derived collective nouns, i.e., spatial collectives such as Polish *kwiecie* 'clump of flowers' and social collectives like *duchowieństwo* 'collective of priests, clergy'. Building on a mereotopological approach to nominal semantics (Grimm 2012) and theory of roles (Zobel 2017), I have argued that the former denote properties of spatial clusters, i.e., topologically structured aggregates of entities in physical space, whereas the latter designate properties of social clusters, i.e., abstract configurations of social roles individuals can perform that constitute institutions.

Therefore, both spatial and social collectives make reference to the same type of complex mereotopological structure, the only difference being whether it is defined in the domain of individuals or in the domain of roles. The findings provide novel evidence for a more fine-grained typology of collectives and a richer natural-language ontology.

Abbreviations

ACC	accusative	GEN	genitive
ADJ	adjective	NEG	negation
COLL	collective	REFL	reflexive

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Chapter 9

Conjunction particles and collective predication

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This paper is concerned with Polish *e*-type conjunctions that involve conjunction particles and their semantic properties. The possible interpretations of such conjunctions and the restrictions on the type of predicate they may combine with do not only pose problems for standard assumptions about distributivity and collectivity but also grant insight into the structure of plural predicates in general. The discussion thereof will bear on the observations that have been made with respect to the behavior of the determiner *all* in English (cf. Dowty 1987). Moreover, additional requirements on the context that arise in combination with collective predicates will be taken to suggest an analysis of conjunction particles in terms of focus particles ranging over subpluralities.

Keywords: plural predication, conjunction particles, collectivity, distributivity

1 Introduction

Polish exhibits, in addition to a "simple" conjunction strategy which may be used to conjoin two or more individual-denoting expressions (1), a "marked" conjunction strategy in which the marker *i* occurs before each conjunct (2).

(1)

Ewa	(i)	Karol	i	Iza	palili	w kuchni.
Ewa.NOM	and	Karol.NOM	and	Iza.NOM	smoke.PST.3PL	in kitchen.LOC

'Ewa, Karol and Iza were smoking in the kitchen.'

(2)

I	Ewa	i	Karol	i	Iza	palili	w kuchni.
and	Ewa.NOM	and	Karol.NOM	and	Iza.NOM	smoke.PST.3PL	in kitchen.LOC

'Ewa as well as Karol as well as Iza were smoking in the kitchen.'

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Structurally similar iterative *e*-type conjunction strategies which involve conjunction particles, i.e. particles that occur on each conjunct, have been attested in several other languages, e.g. Turkish (3b), Bosnian/Croatian/Montenegrin/Serbian (BCMS) (3c), Japanese (3d) and Hungarian (3e) and are usually associated with distributivity (see Flor et al. 2017, Mitrović & Sauerland 2014, Szabolcsi 2015).

(3) a. [i A i B i C] Polish
b. [A dA (ve) B dA (ve) C dA] Turkish
c. [i A i B i C] BCMS
d. [A-mo B-mo C-mo] Japanese
e. [A is (és) B is (és) C is] Hungarian

Polish seems to pattern with these languages insofar as conjunction particles enforce distributive interpretations in sentences in which an individual conjunction combines with an ambiguous predicate like *earn 100 euros*. While a sentence that contains a simple conjunction like (4) allows for both a distributive and a non-distributive interpretation, and thus may be judged true in *Situation 1* and in *Situation 2*, sentences containing the marked conjunction only allow for a distributive interpretation, i.e. (5) is only true in *Situation 1*.[1]

(4) Ewa (i) Karol i Iza zarobili 100 euro.
Ewa.NOM and Karol.NOM and Iza.NOM earn.PST.3PL 100 euros
'Ewa, Karol and Iza earned 100 euros.'

(5) I Ewa i Karol i Iza zarobili 100 euro.
and Ewa.NOM and Karol.NOM and Iza.NOM earn.PST.3PL 100 euros
'Ewa, Karol and Iza earned 100 euros each.'

(6) a. *Situation 1:* Ewa earned 100 euros. Karol earned 100 euros. Iza earned 100 euros.
b. *Situation 2:* Ewa earned 30 euros. Karol earned 10 euros. Iza earned 60 euros.

This would suggest that marked structures are always distributive; however, as illustrated in (7), in Polish they may also combine with collective predicates.

(7) I Ewa i Karol i Iza spotkali się wczoraj o 11.
and Ewa.NOM and Karol.NOM and Iza.NOM meet.PST.3PL REFL yesterday at 11
'Ewa, Karol and Iza met yesterday at 11.'

[1] Acceptability judgements in this paper reflect my own intuitions as well as judgements provided by five native speakers of Polish via an informal questionnaire.

This pattern on the one hand challenges some common assumptions about how distributive, cumulative and collective interpretations are derived and related, but may on the other hand, as will be shown below, also provide new insights on the semantics of plural predicates in general (cf. Dowty 1987, Schein 1993, 2017, Winter 2001, Hackl 2002, Champollion 2010 a.o.).

2 Theories of conjunction

The dichotomy observed in Polish is not straightforwardly accounted for by most semantic theories which are concerned with distributive and non-distributive interpretations of *e*-type conjunctions (e.g. Link 1983, Partee & Rooth 1983, Landman 1989, Krifka 1990, Schein 1993, 2017, Schwarzschild 1996).[2] For instance, Link (1983), in order to capture the denotations of plural expressions such as *the girls* or *Mary, Sue and Ann*, assumes that D_e is closed under sum (⊕). This allows us to distinguish and model three types of predicates: collective predicates like *meet* primitively denote properties of pluralities. Distributive predicates like *smoke* – which obligatorily give rise to distributive entailments – must be affixed or lexically supplemented with a distributivity operator and are only true of atomic individuals. The distributive interpretation of ambiguous predicates like *earn 100 euros*, which may receive a distributive and a non-distributive (i.e. collective or cumulative) interpretation, results from affixing the VP with $\mathrm{D_{PRED}}$, which requires the predicate to hold of each atomic individual (cf. Link 1987 a.o.).

(8) $[\![\mathrm{D_{PRED}}]\!] = \lambda P_{\langle e,t\rangle}.\lambda x_e.\forall y \leq_{\mathrm{AT}} x.P(y) = 1$

In principle, one could assume that $\mathrm{D_{PRED}}$ is optional in sentences like (4), which contain the simple strategy and allow for both interpretations, whereas it is obligatory in sentences like (5), forcing a distributive interpretation. This would make the correct predictions for sentences with ambiguous predicates, but collective interpretations of sentences containing the marked strategy would remain unexplained. On the other hand, the morphological properties of the marked strategy suggest that the lack of a non-distributive interpretation should be accounted for in the DP semantics.[3] For instance, one could assume that the distributive interpretation is due to an operator like (9), which applies to the subject DP.

[2]The following discussion focuses only on analyses that are relevant for the phenomenon at hand, since it is beyond the scope of the present paper to provide an exhaustive overview of theories of conjunction. I thank a reviewer for asking to clarify the selective view in this section.

[3]Distributivity of ambiguous sentences like (4) may also be enforced by adding the marker *po* before the measure phrase. However, to take *po* to be the overt realization of $\mathrm{D_{PRED}}$ seems

(9) $[\![\mathrm{D}_{\text{CONJ}}]\!] = \lambda x_e.\lambda P_{\langle e,t\rangle}.\forall y \leq_{\text{AT}} x.P(y) = 1$

However, the fact that the marked strategy is compatible with collective predicates is also inconsistent with this assumption. As introduced above, conjunctions that involve conjunction particles exist in several other, typologically diverse languages (see Mitrović & Sauerland 2014, Szabolcsi 2015, Flor et al. 2017) and recent accounts propose analyzing them in terms of focus (Arsenijević 2011), type-shifts (Mitrović & Sauerland 2014) or postsuppositions (Szabolcsi 2015). Without further assumptions, these analyses predict that such constructions will receive a distributive interpretation in all environments and do not consider the possibility of collective interpretations. Though it is an open empirical question whether conjunction particles can be analyzed cross-linguistically in a uniform way or whether we find distributional and interpretational differences across languages, the behavior of conjunction particles in Polish cannot be captured by existing proposals.

A slightly different distinction, which is proposed in Landman (1989) (see also Link 1983), is to enrich the ontology with intransparent groups which are formed via a group forming operation ↑ that maps sums of individuals onto atomic group individuals.

(10) ↑ is a one-one function from SUM into ATOM such that:
   a. $\forall d \in$ SUM-IND: $\uparrow(d) \in$ GROUP
   b. $\forall d \in$ IND: $\uparrow(d) = d$

(11) ↓ is a function from ATOM onto SUM such that:
   a. $\forall d \in$ SUM: $\downarrow(\uparrow(d)) = d$
   b. $\forall d \in$ IND: $\downarrow(d) = d$

The operation ↑ maps sums of individuals to group individuals that count as atomic and the operation ↓ maps any group to the sum of its members, which is a non-atomic individual unless the group has only one member. For instance, in addition to the sum $m \oplus s \oplus a$, there is an individual $\uparrow(m \oplus s \oplus a)$, which counts as atomic and can itself be part of a sum.

(12) a. $[\![$Mary COORD [Sue COORD Ann]$]\!] = m \oplus s \oplus a$
   b. $[\![\uparrow$ [Mary COORD [Sue COORD Ann]]$]\!] = \uparrow(m \oplus s \oplus a)$

problematic, especially since the marker has been shown to distribute not only over atomic individuals but also over spatial and temporal intervals (Przepiórkowski 2014, Champollion 2016).

While distributive predicates are primitively true of singular individuals, collective predicates are true of groups and ambiguous predicates of both singular individuals and groups. Non-distributive interpretations involve applying a collective predicate or an ambiguous predicate to an atomic group individual (not to a sum). Ambiguous predicates distribute down to the parts of a sum, but not to the parts of a group, since the group counts as an atomic individual. In this way it is also possible to modulate partly distributive readings, e.g. the reading of (13a) on which the predicate *earn 100 euros* distributes down to the atomic singular individual Mary on the one hand, and to the group individual consisting of Sue and Ann on the other hand.

(13) a. Mary and Sue and Ann earned 100 euros.

b. [[Mary COORD [Sue COORD Ann]] [$\mathrm{D_{PRED}}$ [earned 100 euros]]]

c. $\llbracket$Mary COORD $\uparrow$ [Sue COORD Ann]]$\rrbracket$ = $m \oplus \uparrow (s \oplus a)$

d. $\llbracket \mathrm{D_{PRED}}$ [earned 100 euros]]$\rrbracket$ = $\lambda x_e.\forall y \leq_{\mathrm{AT}} x.\llbracket$earned 100 euros$\rrbracket(y) = 1$

e. $\llbracket$(13b)$\rrbracket$ = 1 iff $\forall y \leq_{\mathrm{AT}} m \oplus \uparrow (s \oplus a).\llbracket$earned 100 euros$\rrbracket(y) = 1$

Both strategies in Polish allow for such interpretations, i.e. (14a) and (14b) can be used to describe the mixed scenario in (15).

(14) a.

Ewa	|| i	Karol	| i	Iza	zarobili 100 euro.
Ewa.NOM	and	Karol.NOM	and	Iza.NOM	earn.PST.3PL 100 euros

‘Ewa and Karol and Iza earned 100 euros.’

b.

I	Ewa	|| i	Karol	| i	Iza	zarobili 100 euro.
and	Ewa.NOM	and	Karol.NOM	and	Iza.NOM	earn.PST.3PL 100 euros

‘Ewa and Karol and Iza earned 100 euros.’

(15) *Situation 3*: Ewa earned 100 euros. Karol earned 50 euros. Iza earned 50 euros.

Like in English, this kind of interpretation for (14a) becomes available when the first coordinator is realized overtly.[4] Furthermore, there is a prosodic boundary after the first conjunct in (14a) and in (14b) (cf. Winter 2001, Wagner 2010).[5] So it seems that groups or equivalent higher-order pluralities are needed anyway for the analysis of all possible interpretations of both coordination strategies in

[4] Both strategies also allow for the introduction of further conjuncts, whereby additional group readings potentially become available.

[5] Prosodic boundaries are indicated by the pipe symbol with the number of pipes marking their relative strength (cf. Wagner 2010).

Polish. According to Landman's account, only group-denoting expressions may combine with collective predicates, and, in general, these expressions should allow for non-distributive interpretations when combined with ambiguous predicates. But this is, of course, not what we find in Polish when looking at the marked strategy, as the examples above illustrated. The question then is why, given that the marked conjunction can be combined with collective predicates, a partly distributive interpretation that involves groups is available for (14b), but the group interpretation for the entire conjunction is generally excluded.

3 Compatibility with collective predicates

A closer inspection reveals that only a subclass of collective predicates is compatible with conjunction particles. This class includes predicates like *meet*, *hold hands* and *be similar* (corresponding to *gather*-type predicates in Champollion 2010, set predicates in Winter 2001 and essentially plural predicates in Hackl 2002).

(16) I Ewa i Karol i Iza spotkali się wczoraj.
and Ewa and Karol and Iza met REFL yesterday
'Ewa, Karol and Iza met yesterday.'

(17) I Ewa i Karol i Iza trzymali się za ręce.
and Ewa and Karol and Iza held REFL PREP hands
'Ewa, Karol and Iza were holding hands.'

(18) I Ewa i Karol i Iza są podobni do siebie.
and Ewa and Karol and Iza are similar to REFL
'Ewa, Karol and Iza are similar to each other.'

To a certain degree, *gather*-type predicates allow for distributive subentailments about the members of their plural subject (Dowty 1987, Winter 2001, Hackl 2002, Champollion 2010 a.o.). For instance, if Ewa, Karol and Iza met, then one may conclude that it is the case that Ewa and Karol, Karol and Iza, and Ewa and Iza met. Other collective predicates, like e.g. *be numerous*, *be a couple* and *constitute a majority*, do not allow for such entailments. This class (roughly corresponding to pure cardinality predicates in Dowty 1987, *numerous*-type predicates in Champollion 2010 and genuine collective predicates in Hackl 2002) yields unacceptable sentences when combined with the marked conjunction.

(19) # I Ewa i Karol i Iza byli liczni.
and Ewa and Karol and Iza were numerous

(20) # I Ewa i Karol są parą.
and Ewa and Karol are couple
Intended: 'Ewa and Karol are a couple.'

(21) # I Ewa i Karol i Iza stanowili większość.
and Ewa and Karol and Iza constituted majority
Intended: 'Ewa, Karol and Iza constituted the majority.'

The former class of predicates is compatible with the plural determiner *wszyscy* 'all' (22), whereas the latter usually is not (23) (cf. Dowty 1987).

(22) Wszyscy studenci spotkali się / trzymali się za ręce / są podobni do siebie.
all students met REFL held REFL PREP hands are similar to REFL
'All students met / were holding hands / are similar to each other.'

(23) # Wszyscy studenci byli liczni / są parą / stanowili większość.
all students were numerous are couple constituted majority

But *all* can – in contrast to the marked conjunction – receive a non-distributive interpretation when combined with an ambiguous predicate as in (24).

(24) Wszyscy studenci zarobili 100 euro.
all students earned 100 euros
'All students earned 100 euros.' (distributive or non-distributive)

Thus, the status of the marked conjunction is ambivalent: on the one hand, this strategy and the determiner *all* are alike in that they are compatible only with *gather*-type predicates and stress the fact that every member of the plural subject takes part in the action expressed by the predicate. They also share the property of being distributive with inherently distributive predicates like *smoke*, but being collective with collective predicates like *meet* (cf. Dowty 1987 for a discussion on the status of *all*). On the other hand, their behavior differs with respect to ambiguous predicates – in such environments the marked conjunction only allows for distributive interpretations, whereas *all* is also compatible with non-distributive ones. There, the marked strategy seems to pattern with the determiner *every* in that it forces a distributive reading.

4 Further restrictions

In addition to the collective predicate type that matters for conjunction particles, further limitations may be observed with respect to the possible situations they may appear in. Whereas (26) is felicitous in *Situation 1*, without any further assumptions it does not fit a situation like *Situation 2*.

(25) a. *Situation 1:* Ewa, Karol and Iza are organizing a party together. They have tried to set up meetings once a week, but it has never worked out for all of them. Two weeks ago, only Karol and Iza met. Last week, only Ewa and Iza met.

b. *Situation 2:* Ewa, Karol and Iza are organizing a party together. They have tried to set up a meetings once a week and, surprisingly, it has always worked out for all of them.

(26) Wczoraj i Ewa i Karol i Iza spotkali się.
yesterday and Ewa and Karol and Iza met REFL
'Yesterday Ewa, Karol and Iza met.'

Intuitively, (26) means 'not only Ewa and Karol, but also Iza met' and the situation in (25a) suggests that a meeting in which all of them take part was unexpected in a way. Indeed, such sentences even improve when the quantifier *wszyscy* 'everybody' is introduced as in (27).[6]

(27) Wczoraj wszyscy, i Ewa i Karol i Iza, się spotkali.
yesterday everybody and Ewa and Karol and Iza REFL met
'Yesterday everyone, Ewa, Karol and Iza, met.'

This relates to the requirement on the number of individuals involved: a sentence that contains only two conjuncts seems to be not interpretable at all (28).

(28) ? I Ewa i Karol spotkali się.
and Ewa and Karol met REFL
Intended: 'Ewa and Karol met.'

Informally speaking (28) should mean something like 'not only Ewa, but also Karol met', which is odd for several reasons. Hence, conjunction particles may not only enforce that a predicate holds of each atomic individual as in sentences with ambiguous predicates, with collective predicates they also seem to emphasize that the predicate holds of each member of the subject plurality, but only in cases where the number of individuals is greater than two.

[6] I would like to thank an anonymous reviewer for pointing this out to me.

5 Reciprocal predicates

A theory of conjunction particles thus relies on an analysis of collective predicates which allows us to account for their occurrence in such environments. Following Hackl (2002), I therefore propose to treat *gather*-type predicates in Polish as inherently reciprocal predicates, i.e. containing a silent *each other*, and to derive them from reflexive predicates bearing a non-identity presupposition. This way, the sentence below is true if each individual stands in the relation expressed by the predicate to another individual that is part of the subject plurality.

(29) ⟦Ewa, Karol and Iza met⟧ = 1 iff for each individual that is part of the plural individual Ewa, Karol and Iza there is at least one other individual in Ewa, Karol and Iza who stands in the *meet with each other* relation to him or her

Though it is an open empirical question whether these truth-conditions might be too weak and further (pragmatic) strengthening is needed, interestingly, most (if not all) collective predicates of the *gather*-sort in Polish do include a reflexive (16–18). This could be just the overt realization of the assumed covert reciprocal, which in languages like English is not spelled out.[7] What may be proposed for such predicates is that, in contrast to *numerous*-type predicates, which seem to require groups as their arguments, they only can be satisfied by pluralities, i.e sums, and denote a relation between non-identical individual parts of their subject plurality (following Hackl 2002, also Krifka 1986, Sternefeld 1998, Beck 1999, 2001). The function of the conjunction particles in such a construction is then to introduce focus alternatives (cf. Rooth 1992). The requirement on number of conjuncts suggests that these have to include alternatives which can be arguments of a *gather*-type predicate, i.e. pluralities. In consequence, it is predicted that sentences like (28) will not be felicitous since they do not allow for deriving the "right" sort of alternatives, whereas a sentence that contains three conjuncts like (26) allows for alternatives that include subpluralities such as ⟦Ewa and Karol⟧ and ⟦Karol and Iza⟧.

6 Conclusion

A close examination of the Polish data has shown that Polish conjunction particles force distributive interpretations with respect to ambiguous predicates, but

[7]It is not clear to what extent alternative analyses, for instance in terms of apposition to a silent plural pronoun (cf. den Dikken 2001, Citko 2004), as has been suggested by a reviewer, could account in the same way for the occurrence of reflexives.

allow for collective interpretations with *gather*-type predicates whereby their presence in collective contexts requires the number of conjuncts to be greater than two and the conjunction of them to be "unexpected". I have argued that the ambivalent behavior of conjunction particles can be best understood if a distinction is made between cumulative, genuine collective predicates and plural collective predicates (Dowty 1987, Winter 2001, Hackl 2002, Champollion 2010), plural collectives are treated in terms of reciprocal predicates, and conjunction particles are analyzed in terms of focus particles ranging over subpluralities when combined with plural collectives. This provides further evidence that cumulative and collective interpretations have to be kept apart and the class of collective predicates is indeed heterogenous. Open questions remain whether the behavior of Polish conjunction particles parallels the behavior of such particles in other languages, i.e. whether conjunction particles may be analyzed in a uniform way across languages, and if not, to what extent the patterns diverge from each other.

Abbreviations

LOC	locative	PREP	preposition
NOM	nominative	PST	past tense
PL	plural	REFL	reflexive

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Chapter 10

Cumulation cross-linguistically

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Semantic theories of cumulativity vary in several respects, including (i) whether cumulativity is limited to lexical predicates and (ii) whether there are cumulation operators in the object language. We address the cross-linguistic predictions of different settings of these two parameters and evaluate them in light of a preliminary set of data from 22 languages, largely collected from native-speaker linguists. We submit that cumulative readings of non-lexical predicates are available cross-linguistically. We then address the question whether there are overt morphemes that behave like the cumulation operators **, ***, etc. Our data only give a partial answer, since there are different ways of integrating such operators into the grammar. No language in our sample had overt markers that were required for a cumulative reading, but absent in case of a distributive reading. Assuming that the LFs of distributive readings do not have to contain such cumulation operators, our data set does not provide evidence for their existence.

Keywords: plurals, cumulativity, cumulation operators, semantic typology

1 Introduction

English sentences containing two or more plural-denoting expressions – like *Abe and Bert*, *(the) two cats* etc. – have a particular form of "weak" truth conditions (Kroch 1974, Langendoen 1978, Scha 1981, Krifka 1986 a.o.). For instance, (1a) is true in scenario (1b), where each boy fed only one of the cats.

(1) a. The boys fed the two cats.
    b. *Scenario:* Abe fed cat Ivo. Bert fed cat Joe.

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Such truth conditions are known as CUMULATIVITY:[1] Properties of the individuals making up a plurality "add up" to properties of the entire plurality (Link 1983, Krifka 1986, Sternefeld 1998 a.o.).[2] While (1a) does not state that ⟦fed the two cats⟧ holds of each boy, this property does hold of the plurality ⟦the boys⟧ because the cats fed by the individual boys "add up" to two.

This paper addresses the question what the semantic mechanism behind these cumulative truth conditions is. Most of the existing literature concentrates on complex cases of cumulativity in English and German (e.g., Schein 1993, Beck & Sauerland 2000, Champollion 2010, Schmitt 2019). But the different accounts also make quite simple typological predictions that have received less attention. We will present data relevant to two typological issues on which the existing analyses arguably make different predictions: (i) whether there is morphosyntactic evidence for the presence of CUMULATION OPERATORS and (ii) whether cumulative readings of syntactically complex predicates are cross-linguistically common.

The paper is structured as follows: §2 introduces some theories of cumulativity and two dimensions along which they differ. §3 presents preliminary cross-linguistic data relevant to these parameters and discusses one of the few previous publications known to us that address predictions of theories of cumulativity in an understudied language, namely Beck (2012).[3] §4 explores which theoretical picture the cross-linguistic situation suggests.

2 Different types of theories of cumulativity

We start with a brief sketch of different ways of deriving the weak truth conditions of cumulative sentences (a partially similar overview is given in Champollion 2021). One point of variation concerns the semantic primitives they require. While some accounts (Scha 1981, Krifka 1986, Beck & Sauerland 2000, Champollion 2010) model cumulativity as a property of relations between individuals – like ⟦fed⟧ in (1a) – or of higher-type plural objects based on individuals (Schmitt 2019), others derive it from the properties of thematic-role relations between individuals and events, so that it is inherently tied to event semantics (e.g., Schein

[1] Some of the literature also applies the term cumulativity to a property of one-place predicates: the property of being closed under sum. We will not adopt this usage here: Throughout the paper, we take cumulativity to be a semantic relation between two or more plural expressions.

[2] With non-upward-monotonic plural quantifiers like *exactly two cats*, the cumulative reading is not necessarily weaker than the distributive one. This will become crucial in §3.3.

[3] We thank a reviewer for mentioning Henderson (2012) as another theoretical work discussing cumulativity and distributivity in an underrepresented language (see §3.4).

1993, Landman 2000, Kratzer 2003, Ferreira 2005, Zweig 2008, 2009). Our discussion here, however, will focus on two other parameters structuring the theoretical landscape. Our first parameter is whether cumulativity is always a property of *lexical* predicates of individuals:

(2) *Parameter 1:* Does the theory permit non-lexical cumulative relations?

For illustration, consider first the paraphrase of sentences like (1a) in (3). $\leq_a$ is the atomic-part relation.[4]

(3) The boys fed the two cats.
'Every $x \leq_a$ $[\![$the boys$]\!]$ fed at least one $y \leq_a$ $[\![$the two cats$]\!]$ and every $y \leq_a$ $[\![$the two cats$]\!]$ was fed by at least one $x \leq_a$ $[\![$the boys$]\!]$.'

Such cases can be accounted for via meaning postulates on lexical predicates like *feed* (see Scha 1981, Krifka 1986). But Beck & Sauerland (2000) show that a similar paraphrase exists for cases like (4), where *the boys* and *the two cats* are not co-arguments of a lexical predicate. The cumulation mechanism thus seems to target the relation $[\lambda x.\lambda y.y$ wants to feed $x]$, which is not expressed by a surface constituent in (4).

(4) The boys want [to feed the two cats].
'For every $x \leq_a$ $[\![$the boys$]\!]$, there is at least one $y \leq_a$ $[\![$the two cats$]\!]$ that x wants to feed, and for every $y \leq_a$ $[\![$the two cats$]\!]$, there is at least one $x \leq_a$ $[\![$the boys$]\!]$ that wants to feed y.'

The second parameter is whether cumulativity is contributed by operators in the syntactic representation of cumulative sentences:

(5) *Parameter 2:* Does the theory assume object-language cumulation operators?

This boils down to the question whether there is a silent morpheme (or set of silent morphemes) responsible for cumulation:[5] in (3), cumulativity of *feed* could

[4]Unless indicated otherwise, our discussion employs basic notions from plural semantics. We assume a set $A \subseteq D_e$ of atomic individuals, a binary operation + on D_e (the sum operation mentioned above) and a function $f : (\mathcal{P}(A) \setminus \{\emptyset\}) \rightarrow D_e$ such that: 1) $f(\{x\}) = x$ for any $x \in A$ and 2) f is an isomorphism between the structures $(\mathcal{P}(A) \setminus \{\emptyset\}, \cup)$ and $(D_e, +)$. We thus have a one-to-one correspondence between plural individuals and nonempty sets of atomic individuals. See Link (1983) and Champollion & Krifka (2016) for a more detailed discussion.

[5]A reviewer asks why we use "morpheme" rather than "operator". Our choice relates to our assumption that operators present at LF are visible to morphology, addressed in §2.2.

be due either to its lexical meaning or to a silent cumulation operator attaching to the lexical head *feed* in the syntax. In the non-lexical case (4), this operator would have to attach to a derived LF constituent denoting the relation [$\lambda x.\lambda y.y$ wants to feed x] (Beck & Sauerland 2000). To derive (4) without such operators, cumulativity would have to be built directly into the rules for function-argument composition, as in Schmitt (2019) or in the event-based tradition (see §2.4 for a discussion of both these systems). These parameters yield four logical possibilities (to our knowledge only three of them have been explored), which differ in their typological consequences.

2.1 No non-lexical cumulative relations, no cumulation operators

The assumption underlying most early work on cumulativity (e.g., Scha 1981, Krifka 1986) is that cumulativity is a property of relation-denoting lexical items and thus reflects the lexical meanings of predicates taking more than one argument. The extensions of lexical items denoting binary relations are assumed to be closed under a POINTWISE SUM operation which, for any set of pairs in the relation, sums up all the first components and simultaneously all the second components.[6] This closure condition is illustrated for *feed* in (6) (where "$+(S)$" stands for the sum of all elements in S).

(6) For all $S, S' \subseteq D_e$ such that for every $x' \in S$ there is a $y' \in S'$ s.t. $[\![\text{feed}]\!](x')(y') = 1$ and for every $y' \in S'$ there is an $x' \in S$ such that $[\![\text{feed}]\!](x')(y') = 1$, $[\![\text{feed}]\!](+(S))(+(S')) = 1$.

It follows that if $[\![\text{feed}]\!]$ is true of the pair $\langle a, i\rangle$ and the pair $\langle b, j\rangle$, it is also true of the "pointwise sum" of these pairs, $\langle a+b, i+j\rangle$. In general, the extension of *feed* contains all pairs of individuals that we can form by simultaneously adding up feeders and their feedees. (7) gives a sample extension that meets this condition.

(7) $[\![\text{feed}]\!] =$
$\{\langle a,i\rangle, \langle b,j\rangle, \langle b,k\rangle, \langle a+b,i+j\rangle, \langle a+b,i+k\rangle, \langle b,j+k\rangle, \langle a+b,i+j+k\rangle\}$

In scenario (1b), $[\![\text{feed}]\!](\textsc{ivo})(\textsc{abe}) = 1$ and $[\![\text{feed}]\!](\textsc{joe})(\textsc{bert}) = 1$, so we must also have $[\![\text{feed}]\!](\textsc{ivo} + \textsc{joe})(\textsc{abe} + \textsc{bert}) = 1$, which correctly predicts that (1a) is true, assuming a structure where no additional operators are present.

[6]Sentences with more than two plurals can also have weak truth conditions similar to those of (1a). The theories sketched below differ with respect to whether they predict different formal reflexes of cumulativity for binary predicates, ternary predicates etc. Since this interesting issue is beyond the scope of this work, we focus on cases with two plurals like (1a).

2.2 No non-lexical cumulative relations, cumulation operators

In (6), the closure condition is encoded as a meaning postulate constraining possible extensions of *feed*. But cumulative truth conditions could also be derived from a lexical predicate true of only those pairs where the feeding relation holds "primitively", as in (8a), if it then is affixed with an operator performing closure under pointwise sum. (8b) defines such an operator, **, for binary predicates.

(8) a. $[\![\text{feed}]\!] = \{\langle a, i\rangle, \langle b, j\rangle, \langle b, k\rangle\}$ $\qquad [\![{}^{**}\ \text{feed}]\!] = (7)$

b. For any $P \in D_{\langle e,\langle e,t\rangle\rangle}$, $[\![{}^{**}]\!](P)$ is the smallest relation R such that (i) for all $x, y \in D_e$, if $P(x)(y)$, then $R(x)(y)$ and (ii) for all $S, S' \subseteq D_e$ such that for every $x' \in S$ there is a $y' \in S'$ such that $R(x')(y')$ and for every $y' \in S'$ there is an $x' \in S$ such that $R(x')(y')$, $R(+(S))(+(S'))$.

While this analysis follows the operator-less approach in taking cumulativity to reflect a property of binary predicates, this property is encoded in a separate expression attaching to the predicate, not in the predicate's lexical entry. If ** is constrained to apply to lexical predicates only, we then expect to find cumulative readings in the same configurations in which the purely lexical analysis from §2.1 predicts them. But there is one respect in which predictions diverge: the operator-based approach leads us to expect that the ** operator should have overt counterparts in the morphology of at least some languages.[7] The fact that it can be spelled out as zero in English would be purely accidental. On the other hand, if the operator-less theory (§2.1) had cross-linguistic validity, we would not expect other languages to have overt morphemes marking cumulativity.[8]

[7] A reviewer asks whether, if it were the case that we found morphological reflexes of cumulativity, they could be (semantically vacuous) syntactic agreement markers which indicate that the lexical predicate is cumulative, rather than realizations of **. If such agreement existed, we would indeed expect it to play a role in the morphology of at least some languages. But in order to test whether a morphological marker associated with cumulativity is a realization of ** or an agreement marker on a lexically cumulative predicate, we would arguably need configurations where ** applies to something other than the lexical predicate, i.e. cumulation of complex predicates (see §2.3). So within a theory in which only lexical predicates can be cumulated, we cannot distinguish these two hypotheses.

[8] As the terms "cumulativity" and "cumulation operators" are not used in a uniform way in the literature, we should clarify that we are only concerned with cumulative relations between two or more plurals. The term "cumulativity" is often also applied to a property of unary predicates: being closed under sum. Consequently, the operator (i), which closes a set under sum, is called a cumulation operator by several authors, e.g., Sternefeld (1998).

(i) $[\![{}^{*}]\!](P)$ is the smallest set S such that $P \subset S$ and for any $S' \subseteq S$, $+(S') \in S$.

We will not address the question if there are morphosyntactic counterparts of *, except to note that there are several plausible candidates for them, like nominal plural morphology (Sternefeld 1998) or pluractional morphology in an event-based semantics (see §3.4).

Let us clarify why, given the operator-based approach, we would predict the operator to be visible in some languages. In line with much work on syntactic and semantic typology (see, e.g., Matthewson 2001, Bobaljik 2012), we make two general assumptions that our entire discussion here is based on: first, we assume that operators present at the syntactic level that is visible to semantics are also visible to the morphological component of the language, which means that we expect a correlation between LF complexity and morpho-syntactic complexity. While the other option – that LF operations are not visible to the morphological system – is not ruled out *per se*, it would seem to render the whole body of work that tries to probe LF complexity via morpho-syntactic markedness potentially vacuous (and would raise the question of how else to account for the typological gaps reported by Bobaljik 2012 or also our own work). We discuss this issue at length in Flor et al. (forthcoming).

Our second assumption is that morphemes visible to the syntax should occur overtly in at least some languages – which is to say that we assume that there are no morphemes whose phonological exponent is null obligatorily, in all languages. This assumption is based on what could be considered "reasons of economy": we don't want to postulate material for which we find no grammatical indication.[9]

2.3 Non-lexical cumulative relations, cumulation operators

The main reason why several authors posit cumulation operators for English relates to Parameter 1 – non-lexical cumulation, as described in (2). Under both theories discussed so far, cumulative truth conditions arise only if the plural expressions are co-arguments of a lexical predicate. In English, there are counterexamples to this claim (Beck & Sauerland 2000). Consider (9):

(9) a. The two boys wanted to feed the two cats.
(adapted from Beck & Sauerland 2000)
b. *Scenario:* Abe wanted to feed Ivo. Bert wanted to feed Joe.
c. required relation: $\lambda x_e.\lambda y_e.y$ wanted to feed x
d. LF: [[the two boys] [[the two cats] [** [2 [1 [t_1 wanted to feed t_2]]]]]]

[9] A reviewer mentions indices (as used in Heim & Kratzer 1998) as an element of LF syntax that is obligatorily silent, i.e. does not have any phonological representation. However, first of all, this particular assumption about indices has been subjected to substantial criticism (see, e.g., Jacobson 1999). Second, there is linguistic work that aims to find overt reflections of indices (and other "logical variables") and claims that they are in fact found in sign languages like the American Sign Language (ASL; see Schlenker 2018 for an overview). The objective of such research is analogous to that of this paper: to look for morphosyntactic evidence for material postulated to be present at LF.

(9a) has cumulative truth conditions of the kind paraphrased in (4) – so (9a) is true in scenario (9b) – but the cumulative relation needed to derive this, (9c), is not expressed by a lexical item or even a surface constituent. Beck & Sauerland (2000) propose that in such cases, covert "tucking in" movement derives an LF constituent denoting this relation, which is then affixed with the ** operator from (8b). So Beck & Sauerland (2000) and the approach in §2.2 both use cumulation operators, but differ with respect to their status: for Beck & Sauerland (2000), they are not part of a lexical decomposition of certain predicates, but can apply to any relational expression derivable by syntactic processes.[10]

What are the typological predictions of this theory? First, we would not expect languages where cumulativity is restricted to lexical predicates. Second, as the theory relies on cumulation operators, we might expect to find overt morphemes expressing ** in some languages. The latter prediction is not entirely obvious: if ** is merged after covert movement of the plurals, as (9d) suggests, its insertion should have no effect on the PF side. But given our underlying assumption that morpho-syntactic markedness patterns are informative about LF complexity, laid out in §2.2, it would be undesirable to posit an operator that *cannot* be merged in the overt part of the derivation and thus never has morphological effects.[11] Some languages should then overtly realize ** if the relational expression it modifies is a constituent at both PF and LF. Further, alternative implementations would lead us to expect such marking even if the modified expression is only an LF

[10]In principle, both lexical and syntactic cumulation could be available cross-linguistically. If so, we would expect there to be languages in which non-lexical cumulation requires a certain marker, while lexical cumulation does not. Moreover, languages could then also differ in how they encode cumulativity, i.e. there might be some languages which are restricted to lexical cumulation. While neither of these possibilities can be ruled out by the data sets we present in §3.1 and §3.3 below, these data do not provide support for either of them. In particular, our data on non-lexical cumulation in §3.1 do not provide evidence that some languages lack non-lexical cumulation or associate it with special morphosyntactic marking.

[11]There are also other ways of distinguishing between a theory where the operator is always silent and the operator-less theories discussed in §2.4. Schmitt (2019) argues that operator-based approaches cannot derive the right truth-conditions for cases like (i). In this example, it seems that the predicate conjunction and ⟦the two dogs⟧ can both receive a cumulative reading relative to ⟦the two boys⟧, although *the two dogs* is contained within the predicate conjunction. A cross-linguistic look at cases like (i) would therefore be relevant.

(i) The two boys made Gene [$_P$ feed the two dogs][and [$_Q$ brush the hamster].

Since Beck & Sauerland (2000) derive complex cumulative relations via covert movement, it seems that island constraints on cumulativity could provide a further way of disentangling these two theories. Yet, Schmitt (2019) notes an operator-based approach would not necessarily predict island effects, so the absence of such effects would be compatible with both theories.

constituent, as in (9d): the operator could be merged before covert movement occurs, stranding the indices below it, or else we could appeal to "post-cyclic" merge of overt material (Fox & Nissenbaum 1999).

2.4 Non-lexical cumulative relations, no cumulation operators

The fourth type of analysis is also motivated by non-lexical cases of cumulativity like (9a), but differs more fundamentally from the lexical approaches. Cumulativity is not due to any particular constituent of cumulative sentences, but built into the basic mechanism that combines lexical predicates with their arguments. This allows these systems to account for non-lexical cumulation while interpreting all plurals *in situ*. In this section, we outline two theories of this kind – the PLURAL PROJECTION system from Schmitt (2019) and Haslinger & Schmitt (2018) and a class of theories under which cumulativity is a property of thematic-role relations (Schein 1993, Landman 1996, 2000, Kratzer 2003, 2008, Ferreira 2005, Zweig 2008, 2009).[12]

2.4.1 Plural projection

The plural projection framework relies on the nonstandard ontological assumption that all semantic domains contain pluralities: there are not only pluralities of individuals, but also pluralities of predicates or propositions. We then have semantically plural expressions associated with any type a. Any such plural expression denotes a set of expressions whose elements are pluralities of type a, rather than a single plurality of type a, for reasons clarified below.[13] For example, *the two cats* denotes a set containing the sum of the two cats (10a). Since pluralities are then available throughout the type system, semantic plurality can be treated as a property that, by default, "projects" from a node to its mother: Standard plurals like *Abe and Bert* or *the cats* denote sets of pluralities – but so do larger expressions containing them, like *fed the two cats*, which denotes a set

[12] A reviewer asks whether we take Sternefeld (1998) to be another theory of this type. Sternefeld uses the notion of "semantic glue" – operators that may be inserted more or less freely at LF, and would thus not influence surface syntax. Yet, he suggests that the pluralization operator for *unary* predicates, *, plays "a double role, namely as the semantic interpretation of plural nominal morphology on the one hand, and as freely insertible glue elsewhere in the system, on the other" (Sternefeld 1998: 314, fn. 7). Since his theory does not rule out a similar "double role" for **, we consider it to be a theory with syntactic cumulation operators.

[13] Haslinger & Schmitt (2018) introduce a special type a^* of "plural sets" with elements of type a, which is technically distinct from type $\langle a, t\rangle$, but has a domain with the same structure (up to isomorphism) as type $\langle a, t\rangle$. We suppress this distinction in the main text since it is not crucial to our purposes in this paper.

containing the sum of two properties (in our scenario, feeding Ivo and feeding Joe) (10b). Similarly, the VP in (10c) denotes a set containing the sum of two properties – the property of wanting to feed Ivo and that of wanting to feed Joe.

(10) a. $[\![$the boys$]\!] = \{\textsc{abe} + \textsc{bert}\}$, $[\![$the two cats$]\!] = \{\textsc{ivo} + \textsc{joe}\}$
b. $[\![$fed the two cats$]\!] = \{(\lambda x.\textsc{fed}(\textsc{ivo})(x)) + (\lambda x.\textsc{fed}(\textsc{joe})(x))\}$
c. $[\![$want to feed the two cats$]\!] =$
$\{(\lambda x.\textsc{want}(\textsc{feed}(\textsc{ivo})(x))(x)) + (\lambda x.\textsc{want}(\textsc{feed}(\textsc{joe})(x))(x))\}$

The top row of Figure 1 illustrates the general principle behind this "projection" mechanism: to combine a non-plural functor with a plural argument, we apply it to each atomic part of the argument and sum up the results. The case where the functor, but not the argument is plural is similar. Cumulative sentences always involve configurations where a set of pluralities of a functional type combines with a set of pluralities of a matching argument type. The weak semantics associated with cumulativity results from the behavior of the projection rule for such cases. The mother node will denote the set of value pluralities that can be formed by picking a functor plurality and an argument plurality, applying atomic function parts to atomic argument parts in such a way that each atomic part of the function and each atomic part of the argument is used at least once, and summing up the results. (See Haslinger & Schmitt 2018 for a fully compositional definition of this rule, and Haslinger & Schmitt 2019 for a discussion of its relation to the **-operator.) The plural set derived in the bottom row of Figure 1 contains $f(a) + g(b)$ as this can be derived using each of the function parts f and g, and each of the argument parts a and b, but it cannot contain, e.g., $g(a) + g(b)$.

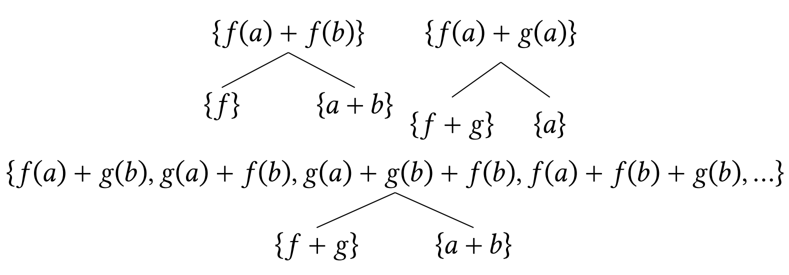

Figure 1: An abstract illustration of the plural projection rule

Applying this principle to the functor set in (10c) and the argument set $[\![$the boys$]\!]$ from (10a), we derive the denotation in (11) for our non-lexical cumulation example (9a). This denotation is a set of pluralities of propositions. A truth definition maps such a set to true iff at least one of its elements consists exclusively of true atoms. This yields the truth conditions paraphrased in (4) for this sentence.

(11) {WANT(FEED(IVO)(ABE))(ABE) + WANT(FEED(JOE)(BERT))(BERT), WANT(FEED(IVO)(BERT))(BERT) + WANT(FEED(JOE)(ABE))(ABE), WANT(FEED(IVO)(ABE))(ABE) + WANT(FEED(IVO)(BERT))(BERT) + WANT(FEED(JOE)(ABE))(ABE), WANT(FEED(IVO)(BERT))(BERT) + WANT(FEED(IVO)(ABE))(ABE) + WANT(FEED(JOE)(BERT))(BERT), …}

For our purposes, the core property of this system is that the weak truth conditions symptomatic of cumulativity are derived without cumulation operators.[14] So if it were cross-linguistically valid, we should not find overt morphemes marking cumulativity. We also would not expect grammars to formally distinguish lexical and non-lexical cases of cumulativity, or to prohibit non-lexical cases. Finally, Beck & Sauerland (2000) argue that the formation of non-lexical cumulative relations is subject to independently motivated syntactic constraints, which would favor the syntactic operator approach (but see Footnote 11 above and Schmitt 2019) – an empirical issue that has not been studied cross-linguistically.[15]

2.4.2 Event-based analyses

There is a second class of theories that accounts for non-lexical cumulation without applying the ** operator to complex predicates (see, e.g., Schein 1993, Landman 1996, 2000, Kratzer 2003, 2008, Ferreira 2005, Zweig 2008, 2009). These theories crucially rely on a neo-Davidsonian semantics in which verbs simply denote sets of events (cf. Carlson 1984) as in (12a), and combine with their arguments via thematic-role relations. If so, *see* denotes a set of "primitive" seeing events, which is then closed under sum as in (12b) to yield a set of possibly plural seeing events. To compose with this verb meaning, each argument must be mapped to a predicate of events. This mapping is achieved by thematic-role predicates, such as AG in (12c), that attach to arguments in the syntax. For instance, ⟦AG⟧ maps the sum ABE+BERT to the set of all events *e* that Abe and Bert cumulatively stand

[14] A reviewer mentions cumulative readings of sentences with modified numerals like *exactly/less than four boys* as a data point in favor of the operator approach. We disagree: Such data are problematic for *any* approach to cumulativity (see, e.g., Krifka 1999, Landman 2000, Brasoveanu 2013), as each theory needs additional assumptions to account for them. Buccola & Spector (2016) provide such an expansion for the operator approach. For an analysis of quantificational plural expressions (and the interaction between plurals and quantifiers) within the projection approach see Haslinger & Schmitt (2018, 2020) (the latter paper discusses modified numerals).

[15] Schmitt (2019) claims that the formation of non-lexical cumulative relations is *not* subject to the constraints usually observed for covert movement: She argues that the examples for which Beck & Sauerland (2000) claim a cumulative reading to be absent – and which would involve island-violating covert movement – permit this reading once more context is added. Schmitt (2019) doesn't consider this a definitive argument against the operator approach, however.

in the agent relation to. For a predicate like *see* that arguably cannot apply collectively, this means e can be decomposed into subevents such that each of Abe and Bert is the agent of some subevent, and each subevent has Abe or Bert as its agent.

(12) a. $[\![\text{see}]\!] = \{e, e'\}$

b. $[\![^{*}\ \text{see}]\!] = \{e, e', e + e'\}$

c. $[\![\text{AG}]\!]$ is the smallest relation R such that (i) for all $x \in D_e$ and all events e, if x is the agent of e, then $R(x)(e)$ and (ii) for all $S \subseteq D_e$ and all sets E of events such that for every $x \in S$ there is an $e \in E$ such that $R(x)(e)$ and for every $e \in E$ there is an $x \in S$ such that $R(x)(e)$, $R(+(S))(+(E))$.

Crucially, if thematic-role relations are defined as in (12c), they are cumulative relations. The theoretical interest of this idea lies in the fact that it provides an account of non-lexical cumulativity that requires neither ** operators attaching to complex constituents, nor a composition rule specific to plurality. To see this, consider the LF a cumulative sentence with infinitival embedding would have under this theory (13). We use *see* here since the intensionality of *want* gives rise to complications (see §4).

(13) [[AG [Ada and Bea]] [$_C$ [* saw] [TH [$_B$ [AG [two women]] [$_A$ * sell [TH [drugs]]]]]]]

The verb meaning in the embedded clause combines intersectively with its object, which also denotes a predicate of events once TH has applied; thus, the node labeled A will denote a predicate true of all (possibly plural) selling events with drugs as the cumulative theme. This combines, again intersectively, with the embedded-clause subject, yielding the set of all selling events with two women as the cumulative agent and some drugs as the cumulative theme. To give an example, if e in (12a) is an event of Claire selling drugs and e' is an event of Dora selling drugs, $e + e'$ will satisfy the predicate expressed by B.

To combine this with the matrix predicate, we need to assume that the theme of a seeing event may be another event. The matrix VP labeled C will then denote the set of all (possibly plural) seeing events with some event satisfying B as their cumulative theme. Crucially, this set would contain, for instance, the sum of an event of Ada seeing Claire sell drugs and an event of Bea seeing Dora sell drugs, since the cumulative theme of this plural event is $e + e'$. Adding the agent argument and applying an existential event quantifier, we get the truth conditions in (14) (relative to a world w), which correspond to a cumulative reading.

(14) $\lambda e'.[\![{}^*]\!]\textsc{see}(w)(e') \wedge [\![\text{AG}]\!](\textsc{ada}+\textsc{bea})(e') \wedge \exists e[[\![{}^*]\!]\textsc{sell}(w)(e) \wedge [\![\text{TH}]\!](e)(e') \wedge \exists x[\textsc{women}(w)(x) \wedge |x| = 2 \wedge [\![\text{AG}]\!](x)(e) \wedge \exists y[\textsc{drugs}(w)(y) \wedge [\![\text{TH}]\!](y)(e)]]]$

In sum, in such theories, cumulation between two individual arguments is always mediated by an event argument. The locus of cumulativity is the thematic-role relations relating individuals to events, or events to other events.

What are the typological predictions of this system? Each of the relevant compositional steps yields a one-place predicate of events. There is therefore no need to account for cumulative truth conditions in terms of lexically cumulated predicates; the only lexically cumulative predicates are the thematic-role relations. But unlike the ** operator, these thematic-role predicates are assumed to be present whenever an argument of an event predicate is introduced, regardless of whether the argument is singular or plural and whether its relation to the other individual arguments is cumulative. While a theory of this type would therefore lead us to expect overt counterparts of the thematic-role predicates, it would not predict the existence of overt morphology specific to cumulativity. Its predictions concerning overt morphology and non-lexical cumulativity therefore coincide with those of the plural projection account. Potential differences between the two operator-less non-lexical accounts are discussed in §4 below.[16]

2.5 Summary

We sketched four approaches to cumulative truth conditions based on the two parameters in Table 1.

The first two are inadequate for English as they limit cumulativity to lexicalized relations. But it remains to be seen if they might be adequate for other languages, i.e. if the availability of non-lexical cumulation varies across languages. The latter two approaches permit non-lexical cumulativity, but differ in how they encode it: a cumulation operator in the syntax or a plural-sensitive composition mechanism. Typological questions relevant to the choice between them include whether ** is realized overtly in some languages.

[16] A reviewer notes that one could have a system where cumulative thematic-role relations like (12c) are derived from "primitive" thematic-role relations via a syntactically represented ** operator. One would then, by our logic, expect to find overt marking of this ** operator. However, this differs from the prediction of the operator-based account in that we would expect this marking on *any* plural argument, regardless of whether there are other plurals in the sentence and whether the sentence as a whole has a cumulative reading. In effect, at least for DP/NP arguments, this marking would have the distribution of plural morphology. Such a system would therefore still not predict that we find morphemes specific to cumulativity.

Table 1: Four types of cumulation approaches

	− non-lexical relations	+ non-lexical relations
+ ** operator		Sternefeld (1998) Beck & Sauerland (2000)
− ** operator	Scha (1981), Krifka (1986) a.o.	Landman (1996, 2000), Schein (1993), Kratzer (2003, 2008) a.o.; Schmitt (2019), Haslinger & Schmitt (2018)

3 Cross-linguistic predictions

We now discuss the cross-linguistic predictions of the different potential settings of Parameter 1, given in (2) (Is there non-lexical cumulation?) and Parameter 2, given in (5) (Are there object-language cumulation operators?). We will draw on data from the literature and preliminary results from two cross-linguistic data samples we are compiling.

3.1 Q1: Does non-lexical cumulation exist cross-linguistically?

We saw above that English exhibits cases of non-lexical cumulation. This is predicted by theories that model cumulativity as a freely available syntactic operation – possibly *modulo* syntactic constraints (§2.3) or via composition rules (§2.4), but not by theories in which cumulativity is due to meaning postulates on lexical predicates (§2.1) or additional operators that exclusively modify lexical predicates (§2.2). We are currently collecting a cross-linguistic data set to test whether English is exceptional in this respect and thus probe the scope of the theories in question. The preliminary data set (here: Sample 1) contains seven languages from three major language families (Indo-European, Uralic, Japanese): Dutch, German, Hungarian, Japanese, Polish, Punjabi, Bosnian/Croatian/Montenegrin/-Serbian (henceforth BCMS). Via a written questionnaire, we asked consultants to construct certain types of sentences in their language and judge their adequacy in certain scenarios.[17] Some of the examples targeted non-lexical cumulativity:

[17] The preliminary character of our results stems from the fact that, so far, these are based on one or two speakers per language (with the exception of German, for which we consulted several speakers) with all of our consultants except one being linguists. The questionnaire (which includes the instructions to those consultants who were linguists) is accessible via https://sites.google.com/view/the-typology-of-cumulativity/questionnaires.

Consultants were asked to identify correlates of (15a–c) in their languages and judge their truth value in cumulative scenarios of the kind shown in (16).

(15) a. Ada and Bea tried to arrest two criminals.
b. Ada and Bea saw two women sell drugs.
c. Ada and Bea believe that two criminals are threatening Gene.

(16) a. *Scenario*: Ada tried to arrest criminal 1, Bea tried to arrest criminal 2.
b. *Scenario*: Ada saw woman 1 sell drugs. Bea saw woman 2 sell drugs.
c. *Scenario*: Ada believes criminal 1 is threatening Gene. Bea believes that criminal 2 is threatening Gene.

The core result is that all seven languages permit non-lexical cumulativity. More precisely, they all permit it for sentences corresponding to (15a) and (15b).[18] For instance, (17) from BCMS and (18) from Hungarian are judged true in scenario (16a), hence both sentences have a cumulative reading.[19]

(17)

Juče	su	Ada	i	Bea	pokušale	da
yesterday	AUX.3PL	Ada.NOM	and	Bea.NOM	try.PF.PTCP.PL.FEM	PRT

uhapse	dva	kriminalca.
arrest.PF.NPST.3PL	two.MASC	criminal.PAUC

‘Yesterday, Ada and Bea tried to arrest two criminals.’ (BCMS)

(18)

Ada	és	Bea	tegnap	megpróbált	letarzóztatni	két	bűnözőt.
Ada	and	Bea	yesterday	PRT.try.PST.3SG	arrest.INF	two	criminal.ACC

’Yesterday, Ada and Bea tried to arrest two criminals.’ (Hungarian)

As the relation that must hold cumulatively, [$\lambda x.\lambda y.y$ tried to arrest x], was not expressed by a single lexical item in either language, we have evidence for non-lexical cumulation. The other languages in the sample behaved analogously. The only major point of variation concerned examples corresponding to (15c): the cumulative reading was available in German for many (but not all) speakers,

[18] One of our consultants for Dutch disliked a cumulative reading for the Dutch correlate of (15b) with an infinitival complement, but accepted it with a finite complement. This is surprising given the lower acceptability of cumulation across *believe* in some languages, but orthogonal to our initial question. Further, one example we gave with seemingly lexical cumulation in English – a sentence with *feed* like (1a) – was translated with complex predicates with causative morphology in Punjabi and Japanese. The sentences were judged true in a “cumulative” scenario, which provides additional evidence for the availability of non-lexical cumulation.

[19] The categorial status of *da* in (17) is controversial (see Todorović & Wurmbrand 2020 a.o.).

Punjabi and BCMS but not in Polish and Hungarian, and the judgements for Dutch and Japanese were unclear.

Irrespective of the judgments for examples involving correlates of *believe*, the data involving correlates of *see* and *try* sufficiently support the conclusion that non-lexical cumulation is possible in all languages in our sample, so we submit Generalization 1. Yet, given the small size of our sample, further research must determine whether any languages systematically block non-lexical cumulation.

(19) *Generalization 1:* Non-lexical cumulation, although potentially subject to further restrictions, exists across languages.

The variation concerning cumulativity with *believe* is an interesting point for further study, especially as we also find variation *within* languages, for instance in German. A potentially relevant observation is that in some of the languages under discussion, belief ascriptions involve a finite complement, whereas the other predicates embed infinitives. (We omit a more detailed data presentation, as the restrictions on non-lexical cumulative readings are not our main concern here and including all the data would exceed the scope of this paper.) While there is certainly no direct correlation between finiteness and lower acceptability of the cumulative reading, one could speculate that cumulative readings are available more easily for complements with a smaller left periphery, assuming a theory where both finite and non-finite complements can come in different "sizes" (Wurmbrand 2015, Todorović & Wurmbrand 2020). This would be in line with "syntactic" theories of cumulation like Beck & Sauerland (2000). Alternatively, attitude predicates might block cumulativity semantically or pragmatically.[20] We briefly return to the theoretical relevance of cumulation across attitude predicates in §4.

3.2 Cumulation and distributivity operators in the grammar

We saw above that English provides no morpho-syntactic evidence for cumulation operators. This is not *per se* a problem for theories assuming such operators: one would not expect them to be overt in *all* languages. Yet, one would expect to

[20] A semantic explanation would have to rely on a lexical semantics of attitudes that differs from the one traditionally assumed and interacts with cumulativity in a non-trivial way. A pragmatic account would have to appeal to the interaction of general pragmatic constraints on the availability of cumulative readings with the semantics of attitude predicates. Accordingly, the different potential explanations would attribute the inter-speaker variation to different sources (syntactic constraints vs. lexical meanings of attitude verbs vs. pragmatic constraints on cumulativity).

find morpho-syntactic correlates of these operators in *some* languages, while the composition-based approaches in §2.4 do not make this prediction. Since cumulation operators could interact with other plural-sensitive semantic phenomena, like distributivity, in different ways, it is not always clear how to identify their overt counterparts in a given language. Let us illustrate the different options in English. English sentences with multiple plurals are often ambiguous between cumulative and distributive readings: under its cumulative reading, (20) is true in scenario (20a), but (at least with *exactly*) false in the distributive scenario (20b). For the distributive reading, the situation is reversed.

(20) Abe and Bert fed (exactly) two cats.

   a. *Cumulative scenario:* Abe fed cat Ivo. Bert fed cat Joe.

   b. *Distributive scenario:* Abe fed cats Ivo and Joe. Bert fed cats Kai and Leo.

The distributive and the cumulative construal are usually assumed to correspond to distinct LFs. The existence of elements that disambiguate the sentence towards one of these construals (e.g., predicate modifiers like English *each* or *between them*, DP-level items like distributive numerals) further confirms that grammar is sensitive to the distinction.[21] This raises the question whether one of the readings is "more primitive": is the cumulative reading built "on top of" the distributive reading or *vice versa*? From the perspective of a theory with cumulation operators, the different possible answers to this question entail different predictions about the distribution of these operators and of their potential overt realizations.

As a starting point, consider the LF in (21a) for the cumulative reading of (20) (see §2.2 for the semantics of the ** operator). Assuming that indices can range over plural as well as atomic individuals, (21a) is true iff there is a plurality of two cats that stands in the relation ⟦** fed⟧ to the sum of Abe and Bert.

[21] While we take *between them* to be an element that is "parasitic" on a cumulative reading that is derived by independent means, a reviewer points out that it could also be analyzed as a realization of **. It is beyond the scope of this paper to settle this issue (or the analogous issue for *together*), but there is some evidence that *between them* does not have the exact distribution assumed for the **-operator. For instance, *between them* seems to be limited to sentences where at least one plural involves a numeral/cardinal/universal expression: all of the sentences in (i) can have a cumulative reading, but only (i.a) permits *between them* (under the relevant reading).

(i) a. Those boys ate ten sausages (between them).

   b. Those boys ate the sausages (# between them).

   c. Those boys saw the dogs (# between them).

We thank Tim Stowell (p.c.) for these judgments.

(21) a. [Abe and Bert [2 [two cats [1 [t_2 [**fed t_1]]]]]]
b. $[\![\text{two cats}]\!] = \lambda P_{\langle e,t\rangle}.\exists x_e[\textsc{cats}(x) \wedge |x| = 2 \wedge P(x)]$

In principle, we could start with a structure with a distributive interpretation and derive the cumulative reading by adding ** to it (and performing the syntactic operations needed to form the right relation). As an illustration of this class of analyses (here: Class I), take the potential lexical meaning for *fed* in (22).

(22) $[\![\text{fed}]\!] = \lambda x_e.\lambda y_e.\forall y' \leq_a y.\forall x' \leq_a x.\textsc{fed}(x')(y')$

So far, we have tacitly assumed that $[\![\text{fed}]\!]$ cannot be true of plural arguments unless affixed with **. But $[\![\text{fed}]\!]$ in (22) takes two potentially plural arguments x, y and requires that each atomic part of y must have fed each atomic part of x – a distributive relation. Given (22), the LF in (23) would yield the distributive reading, but the cumulative reading would require the more complex LF (21a).[22]

(23) [Abe and Bert [2 [two cats [1 [t_2 [fed t_1]]]]]]

We should point out that (as noted by a reviewer) in the case of distributivity, there is a general consensus that a purely lexical account is insufficient and distributivity operators must be represented in the syntax (see, e.g., Champollion 2021). Thus, the lexical item *fed* in (22) should be viewed as a shorthand for a complex structure including a distributivity operator. We suppress these details here to focus on the crucial prediction of Class I analyses: they lead us to expect languages that require special morphology for a cumulative reading of a sentence like (20), while removing this morphology would yield a distributive reading. To derive this prediction, we rely on the assumption that theories with cumulation operators would lead us to expect languages where they have an *obligatory* non-zero spell-out. This is because the operator-based theory would otherwise leave a generalization unexplained, namely that the zero spell-out is universally available. In contrast, an operator-less theory leads us to expect that cumulativity is never obligatorily marked.[23]

The second class of analyses (Class II) assumes that lexical predicates like *fed* cannot hold of plural arguments unless a "pluralizing" operator is added. There

[22] Just as we omit any discussion of collectivity, we also ignore cases (brought up by a reviewer) where some sub-pluralities of the agent and/or theme acted collectively (see e.g, van der Does 1992, Landman 2000, Vaillette 2001, Champollion 2017). A serious investigation the predictions of the different theories for such examples would exceed the scope of the present paper by far.

[23] In particular, since there seem to be languages where distributivity is marked overtly obligatorily (even in the sample discussed in §3.3 below; see Flor et al. 2017, forthcoming), it would be surprising if cumulation operators behaved differently.

could then be two distinct kinds of such operators, yielding cumulative and distributive readings, respectively. Thus, the distributive reading could have an LF like (24b), where D has the denotation in (24a), applying to a unary predicate and a plurality and requiring the predicate to hold of each atomic part of the plurality.

(24) a. $[\![\text{D}]\!] = \lambda P_{\langle e,t\rangle}.\lambda x_e.\forall x'[x' \leq_a x \rightarrow P(x')]$
b. [Abe and Bert [D [2 [two cats [D [1 [t_2 [fed t_1]]]]]]]]

As (24b) lacks ** and the LF for the cumulative reading lacks D, no morphosyntactic containment relation between the two readings is predicted: languages that overtly express both ** and D would have different markers for the distributive and the cumulative reading that are in complementary distribution, and any sentence with plural arguments would contain one of the markers.

The third kind of system (Class III) would be one where predicates always need to be pluralized via ** (or analogous operators for higher arities) before combining with plural arguments, and D can only apply 'on top of' cumulation operators, so that the distributive reading always corresponds to a more complex LF. A suitable LF for the distributive reading of (20) is given in (25). Note that, since the task of making the lexical predicate *fed* compatible with plural arguments is now performed by **, we need only one occurrence of D, unlike in (24b).

(25) [Abe and Bert [D [2 [two cats [1 [t_2 [**fed t_1]]]]]]]

In Class III systems, both readings of a sentence with two plural arguments require a cumulation operator. What does this mean for our question how to identify overt realizations of such operators? Given a system of Class I or II, we could identify such overt realizations by comparing plural sentences with a cumulative reading and those restricted to a distributive reading. But in a Class III system, this is impossible, as cumulation operators would show up in both types of sentences. Instead, we would have to compare sentences with at least one plural argument to those completely lacking plural arguments. This was not the focus of the cross-linguistic study we will now discuss, which concentrated on morphosyntactic contrasts correlating with the distributive/non-distributive distinction. Foreshadowing, while our results don't support operator-based theories of Class I and II, they do not affect operator-based theories of Class III.

3.3 Q2: Is there evidence for object language cumulation operators?

We now turn to the question whether cumulation operators are overtly realized in a way compatible with a Class I or Class II analysis of the distributive reading

– i.e., an analysis where the distributive reading does not involve such operators. We will draw on Sample 1 as well as what we call Sample 2, which stems from an open-ended survey of native-speaker linguists we initiated on the online platform TerraLing (Koopman et al. 2021). Sample 2 currently contains 19 languages, four of which are also in Sample 1, from 7 major language families.[24]

This survey focused on sentences where conjunctions of individual-denoting expressions – specifically proper names – combine with simple predicates containing a numeral as in (20) (=26) or a measure phrase.

(26) Abe and Bert fed (exactly) two cats.

Consultants were again asked to construct relevant examples and judge their truth value in scenarios we provided. The precise questionnaire, including examples and contexts, can be found in our TerraLing group (Schmitt et al. 2020).

In contrast to Sample 1, we did not ask for non-lexical cumulative predicates. The initial goal was to determine whether the cumulative reading – on which (20) is true in scenario (20a) – is cross-linguistically more "primitive" than the distributive reading – on which (20) is true in (20b) – or *vice versa.* Simplifying slightly, we thus asked consultants to check whether correlates of (20) required additional morphology to make the cumulative reading available (i.e. the counterpart of (20) is only true in scenario (20b), and extra morphology is needed to make it true in scenario (20a)). Similarly, they had to check whether correlates of (20) required additional morphology for the distributive reading (i.e. the counterpart of (20) is only true in scenario (20a), and extra morphology is needed to make it true in scenario (20b)). Consultants were asked to use numeral modifiers like *exactly* if possible, to ensure that there is no entailment relation between the two readings (with an 'at least' reading of the numeral, the distributive reading of (20) entails the cumulative one). In our questionnaire about non-lexical cumulation (Sample 1), we also asked if either of the readings required extra morphemes,

[24] As this was a survey on many topics and we only have partial results for many languages, we only count the languages where consultants answered the query whether sentences analogous to (20) show obligatory morphosyntactic marking of the cumulative or the distributive reading, external to the conjunction. These are: Basaá (Niger-Congo/Bantu), Dagara [Burkina] (Niger-Congo/Gur), Dutch (Indo-European/Germanic), Estonian (Uralic), German (IE/Germanic), Greek (IE), Guangzhou Cantonese (Sino-Tibetan/Chinese), Igbo (Niger-Congo), Iranian Persian (IE/Indo-Iranian), Iraqi Arabic (Afro-Asiatic/Semitic), Italian (IE/Romance), Korean (Koreanic), Nones (IE/Romance), Norwegian (IE/Germanic), Polish (IE/Slavic), BCMS (IE/Slavic; referenced as "Serbo-Croatian" in the TerraLing group), Sicilian (IE/Romance), Turkish (Turkic), Wuhu Chinese (Sino-Tibetan/Chinese). The consultants are native-speaker linguists except for the following languages, where we interviewed non-linguist native speakers: Estonian, Iranian Persian and Iraqi Arabic.

but used the linguistic context instead of modifiers to force an exact reading of the numeral.

Our result was that no language in either sample required extra marking for the cumulative reading – but some languages in both samples required overt marking to make the distributive reading available. (Languages for which such judgments were reported both with numeral-modified indefinites and with measure phrases, suggesting a consistent pattern, include Basaá, Greek and Turkish.) So we found no morpho-syntactic evidence that cumulation operators can turn a structure limited to a distributive reading into one with a cumulative reading – if so, we would expect "purely distributive" structures that obtain a cumulative reading if extra morphology is added. We take this to support Generalization 2:

(27) *Generalization 2:* Cross-linguistically, in sentences with a conjunctive subject and a numeral or measure phrase in the predicate, there is no morphological evidence for cumulation operators, assuming that these operators are absent in distributive sentences.

3.4 Pluractional markers as cumulation operators?

To summarize, we did not find overt expressions with the behavior predicted for a cumulation operator by analyses in which *distributive* readings do *not* require such an operator. But our survey data have no bearing on Class III analyses, where distributive readings have strictly more complex LFs with an additional distributivity operator "on top" of the cumulation operator. Beck's (2012) interesting study of the pluractional system in Konso (Afro-Asiatic/Cushitic) addresses potential morphosyntactic evidence for a system of this kind. To conclude our survey, we will summarize this work and explain why we consider the consequences of the Konso data for our questions inconclusive, pending further study.

Konso distinguishes between singulative and pluractional verbs. The semantic correlate of this contrast is a distinction between predicates true of events with multiple individuable subevents (pluractional) and predicates true only of events lacking individuable subevents (singulative). Ongaye & Mous (2017) discuss various secondary inferences triggered by the singulative and the pluractional, which we gloss over here. Lexical verb roots are classified as singulative or pluractional in an unpredictable way, but two derivational processes affect pluractionality: a process that applies to a pluractional root and forms a derived singulative, and a reduplication process that forms derived pluractionals. According to Ongaye & Mous (2017), only the latter is fully productive.

How does this relate to cumulation operators? As (28) shows, the distribution of the pluractional is closely tied to semantic plurality in that, if a verb takes a plural argument, it must bear pluractional marking.[25]

(28) a. harreeta-sik kaharta-siʔ
donkey-def.masc/fem ewe-def.masc/fem
{i=did-diit-t-i / i=diit-t-i}
3=redp-kick[sg]-3sg.fem-pf 3=kick[sg]-3sg.fem-pf
'The donkey (has) kicked the ewe.' (Konso; Beck 2012: (14a), (17a))

b. harreeta-sik kaharraa-siniʔ {i=did-diit-t-i /
donkey-def.masc/fem ewes-def.p 3=redp-kick[sg]-3sg.fem-pf
*i=diit-t-i}
3=kick[sg]-3sg.fem-pf
'The donkey (has) kicked the ewes.' (Konso; Beck 2012: (14b), (17c))

c. harreewwaa-sinik kaharraa-siniʔ i=did-diit-i-n
donkeys-def.p ewes-def.p 3=redp-kick[sg]-pf-pl
'The donkeys (have) kicked the ewes.' (Konso; Beck 2012: (14d))

In (28a), with two singular arguments, both the singulative and the derived pluractional (formed via reduplication) can be used. With pluractional marking, the sentence conveys that the ewe was kicked many times, i.e., it has a so-called "iterative" interpretation, while the singulative conveys there was only one kicking. Crucially, if one of the arguments is plural, the singulative is bad (28b). This arguably follows from the event-based paraphrase given above, since an event in which several sheep are kicked has individuable subevents. Multiple plural arguments, as in (28c), also require the pluractional.

Given this restriction on plural arguments, Beck suggests pluractional verbs denote cumulative predicates, while singulative verbs denote predicates requiring atomic arguments. If so, the reduplication process in (28) provides a fully productive way of deriving a cumulative predicate from a predicate prohibiting plural arguments. If the semantic correlate of this reduplication were ** (or its counterpart for predicates of higher arity), the pattern in (28) would follow.

[25]We cite the data from Beck (2012) as her original source, an unpublished talk handout by Ongaye Oda Orkaydo, was unavailable to us. For clarity, the glosses for the nominal suffixes were adapted following Ongaye (2013). We write ʔ instead of Beck's ? for the glottal stop. According to Ongaye (2013), Konso has what he calls plural gender; this marker, glossed as p, is not fully correlated with semantic plurality. Note also that (28a) can have an iterative interpretation (see below), but we follow Beck's translation.

But there are two reasons why, although the data discussed by Beck (2012) are all compatible with an operator-based account of cumulation, the presence of overt pluractional morphology in her data is not a clear-cut argument for such a theory over a non-lexical, composition-based theory. First, Beck (2012) points out that her source, Ongaye (2010), gives a paraphrase for (28c) suggesting a distributive reading. The question whether a cumulative reading is also available is left open, and is also not resolved in the more recent study of Konso pluractionals in Ongaye & Mous (2017). So a clearer picture of how the language marks distributivity would be needed to evaluate the analytical options discussed above and in Beck (2012). Second, assuming that the cumulative reading is available, the sensitivity of the pluractional to event structure yields new analytical options that do not involve cumulation operators.[26] To illustrate this, we briefly return to the different ways of integrating cumulativity into event semantics.

On one approach, discussed in Beck (2012), transitive verbs have an extra argument position for an event. Thus, *kick* denotes a relation between two individual arguments and an event argument, as in (29a). The cumulation operator ***, which is a generalization of ** to three-place relations (see Sternefeld 1998, Vaillette 2001) then closes this relation under pointwise sum (29b). We could analyze the LF syntax of both (28c) and its English counterpart along the lines of (29c) (ignoring the question whether the plurals undergo LF movement). Structure (29c) denotes a predicate true of all events that are events of the donkeys cumulatively kicking the ewes. Beck suggests that reduplication in (28) could spell out an operator similar to ***, which would derive the data pattern.

(29) a. $[\![\text{kick}]\!] = \{\langle a, b, e\rangle, \langle c, d, e'\rangle\}$
b. $[\![{}^{***}\text{kick}]\!] = \{\langle a, b, e\rangle, \langle c, d, e'\rangle, \langle a + c, b + d, e + e'\rangle\}$
c. [[the donkeys] [[***kicked] [the ewes]]]

Yet, as we saw in §2.4 above, the literature provides another approach to cumulativity in event semantics – the thematic-role approach. On this theory, (28c) and its English counterpart would have an LF along the lines of (30).

(30) [[AG [the donkeys]] [[*kicked] [TH [the ewes]]]]

[26] As the pluractional is compatible with singular arguments (28a) and, in this case, adds the implication that there were multiple kicking events, its semantics cannot appeal exclusively to the semantic number of the verb's type *e* arguments. Ongaye & Mous (2017) provide an independent argument that the pluractional is sensitive to event structure: some verbs can be in the singulative with a plural argument, but only if the latter has a collective reading.

If the pluralized verb in (30) combines with its arguments intersectively, we obtain the set of all kicking events *e* with the following property: the donkeys cumulatively stand in the agent relation to *e*, and the ewes in the theme relation, also cumulatively. Cumulativity arises from the semantics of the thematic-role predicates. But since the * operator is required to get events with more than one atomic part, a cumulative reading would still be unavailable without it.

So even if the cumulative reading is available in Konso, there is an analysis of the pluractional that does not identify it with a cumulation operator (in the sense of "cumulation" we have been using throughout this paper): it could spell out the event-pluralization operator *. The consequences for the question whether overt counterparts of operators like ** or *** exist then depend on the choice between the operator-based analysis in (29) and the thematic-role analysis in (30).[27]

4 Cross-linguistic data and theories of cumulativity

In summary, we can draw two conclusions: (i) Beck & Sauerland's (2000) main finding for English – that we find cumulative readings for relations that don't correspond to lexical elements or even surface constituents – generalizes to several typologically diverse languages. (ii) There is no compelling *positive* evidence for object language cumulation operators (although, depending on our assumptions about their distribution, they might still exist). The question we want to address now is which theories of cumulativity best account for the results.

Result (i) provides evidence for a theory that permits non-lexical cumulation, and our restricted data set did not turn up any evidence that languages vary in this respect, although a larger sample would be needed to settle this question. Result (ii) could be derived from any theory that does not rely on a syntactically represented ** operator. Thus, the theories that account for both generalizations are the two composition-based ones – the plural projection approach and the thematic-role approach. A theory using cumulation operators would of course be compatible with both results at the observational level, in the sense that none of the individual data points in our samples falsify this approach. However, if our

[27] Henderson (2012) provides an analysis of pluractionality in Kaqchikel that relies on cumulation operators: Kaqchikel morphologically marks two different types of pluractionality, which Henderson analyzes as taking scope above and below the cumulation operator, respectively. Since Henderson doesn't identify either of the two pluractional morphemes with the cumulation operator, his data do not directly contradict our conclusion that there is no *morphological* evidence for cumulation operators. That said, it is unclear to us at this point whether the operator-less theories can derive his data set. Since we only became aware of his work at a very late stage of the work reported here, we must leave this issue to future research.

generalization (ii) turns out to reflect a real typological gap, a composition-based approach to cumulativity would correctly predict this gap, while an operator-based approach would have to treat it as coincidental.

This raises the question how one could decide between the two composition-based theories – the thematic-role and the plural projection account. At some level of abstraction, the two theories are similar: both encode cumulation in the mechanism combining predicates with their arguments. However, the thematic-role account encodes a semantic constraint on cumulation that does not hold in the plural projection system. To see this, let us introduce a relation of EVENT-CONNECTEDNESS informally characterized as follows. An individual-denoting definite or indefinite x is EVENT-CONNECTED to an event predicate P in a given LF iff one of the following conditions holds: (i) x is linked to the event argument of P by a thematic-role relation. (ii) x is event-connected to some predicate Q, and there is a thematic-role relation linking particular P-events to particular Q-events.

Let us now consider (31) again – the LF a cumulative sentence with infinitival embedding would have under the thematic-role account. In (31), *Ada and Bea* is event-connected to **saw*, and *two women* and *drugs* are event-connected to **sell*. But since (31) also provides a thematic-role relation linking particular seeing events to particular selling events – it requires there to be a seeing event whose theme is a selling event – *two women* and *drugs* are also event-connected to **saw* and *Ada and Bea* is event-connected to **sell*.

(31) [[AG [Ada and Bea]] [[**saw*] [TH [[AG [two women]] *sell [TH [drugs]]]]]]

The thematic-role approach to cumulation then makes the following prediction: Two distinct individual-type plural definites or indefinites x and y can cumulate only if there is a predicate that both x and y are event-connected to. This does not prevent *Ada and Bea* from cumulating with *the two women* in (31), since both of these arguments are event-connected to **saw*.

The plural projection approach also permits cumulation in examples of this kind, but the predictions of the two theories diverge in other cases. While the plural projection system allows lexical items that block cumulativity (see, e.g., Haslinger & Schmitt 2018 on *every*), it does not take this blocking to be inherently related to particular semantic types. It therefore permits cumulation between individual-denoting expressions that are not event-connected. The most prominent such case are examples where an intensional predicate, like *believe* in (32a), intervenes between the two plurals. If we generalize the traditional possible-worlds semantics for *believe* (Hintikka 1969) to a neo-Davidsonian semantics, the theme arguments of *believe* in a configuration like (32a) are not particular threatening events, but propositions that specify the content of the belief (33).[28] If so, the arguments of *threaten* in (32a) are not event-connected to *believe*. In sum, if a cumulative relation between *two criminals* and *Ada and Bea* is available in (32a) (see Pasternak 2018 and Schmitt 2020 for further discussion of such readings), this relation is not straightforwardly captured by the thematic-role approach.

(32) a. Ada and Bea believe that two criminals are threatening Gene.

b. Ada and Bea tried to arrest two criminals.

(33) $\lambda e.[\![*]\!]\textsc{believe}(w)(e) \wedge [\![\text{AG}]\!](\textsc{ada} + \textsc{bea})(e) \wedge$
$[\![\text{TH}]\!](\lambda w'.\exists e'.[\![*]\!]\textsc{threaten}(w')(e') \wedge \exists x(\textsc{criminals}(w')(x) \wedge$
$[\![\text{AG}]\!](x)(e') \wedge [\![\text{TH}]\!](\textsc{gene})(e')))(e)$

Let us now return to our data set. §3.1 showed that the cumulative reading for the correlate of (32a) was unavailable in some of the languages in our sample – while it was available in the other non-lexical configurations we tested. Further, in English, these cumulative readings are available for some speakers, but there is inter-speaker variation especially with respect to (32a), where the cumulative reading is not universally accepted. So does this finding unambiguously support event-based analyses over the plural projection account? We don't think so – in fact, we believe that none of the data addressed here sufficiently distinguish between the theories. First, recall that while the correlates of (32a) lacked a cumulative reading in some of the languages, they *did* exhibit such a reading in other languages. So while the plural projection account must explain the lack of the cumulative reading in the first set of languages – by appealing to independent syntactic or pragmatic factors blocking cumulativity – event-based analyses must explain its presence in the second set, possibly by assuming language-specific

[28]We think that our argument also extends to most analyses on which the THEME of *believe* is not a proposition (e.g., Kratzer 2006, Moulton 2009, 2015, Hacquard 2006, 2010). These analyses assume primitive entities that carry propositional content, and assume that the THEME of *believe* is such an entity rather than a proposition. However, the cited works use operators in the embedded clause that map a proposition to a set or property of such content-bearing entities. Thus, the embedded clause has a proposition-denoting subconstituent. Consequently, an individual-denoting argument within this subconstituent – e.g., *two criminals* in (32a) – cannot be event-connected to arguments in the matrix clause (like *Ada and Bea* in (32a)), even if the content-bearing entities are events. This is because there is no thematic-role relation that relates particular threatening events to the belief states or other content-bearing entities quantified over in the main clause. Neither are they related by a chain of thematic-role relations. Therefore, a cumulative reading of sentences like (32a) would still remain outside the scope of the thematic-role approach.

additional operations underlying this reading. Further, the predictions of event-based analyses depend on the semantics of the embedding configuration: it is not obvious whether *try* in (32b) can have a particular, actual event as its THEME argument or whether its THEME is irreducibly of a higher type, e.g., a property of events. If the THEMES of *try* are particular events, both theories under discussion correctly permit cumulation. If they are not, *Ada and Bea* in (32b) is not event-connected to *two criminals* and event-based analyses would incorrectly block a cumulative reading.

To distinguish between the two theories, we would therefore need a more detailed data set, controlling not only for the semantic type of the complements in each language, but also for their syntax and for pragmatic factors that might block the cumulative construal. This, however, must be left to future research.

Abbreviations

ACC	accusative
AUX	auxiliary
DEF	definite
FEM	feminine
INF	infinitive
MASC	masculine
NOM	nominative
NPST	non-past tense
P	plural gender agreement
PAUC	paucal
PF	perfective aspect
PL	plural / pluractional
PRT	particle
PST	past tense
PTCP	participle
REDP	reduplication
SG	singular / singulative

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Chapter 11

Distinguishing belief objects

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The problem of intentional identity (Geach 1967) has a counterpart that concerns the notion of DISTINCTNESS for intentional objects. It arises when expressions linked to distinctness, like plurals or numerals, occur in the scope of intensional operators. Focussing on plurals in belief contexts that have a cumulative reading relative to a plural attitude subject, we argue for a notion of distinctness that appeals to the attitude subjects' counterfactual beliefs: two partial individual concepts count as sufficiently distinct if each attitude subject believes that if both were instantiated, they would yield different individuals. After providing a general paraphrase of cumulative belief sentences, we outline potential advantages of this approach over analyses of intentional identity that appeal to real-world "causes" of the intentional objects, or to notions of attitude content that are sensitive to discourse referents.

Keywords: intentional distinctness, plurals, attitudes, counterfactuals

1 Introduction

Some natural language expressions are sensitive to IDENTITY or DISTINCTNESS. Pronouns, for instance, are linked to identity since they can be construed as covarying with their antecedents: on one reading, (1a) says a witch blighted Bob's mare and *that same witch* killed Cob's sow. Numerals and plurals are another class of such expressions: (1b) requires *two distinct* monsters to roam the castle.

(1) a. A witch blighted Bob's mare and she killed Cob's sow.
    b. Two monsters were roaming the castle.

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In extensional contexts as above, the relevant notions of identity and distinctness seem to be based on pre-theoretically given relations between real-world objects.[1] But Geach (1967) noted that the notion of identity becomes non-trivial in certain cases of anaphoric relations in INTENSIONAL CONTEXTS. To see the point, consider (2), where the pronoun and its potential antecedent *a witch* are both embedded under attitude predicates – each of which has a different subject.

(2) Hob thinks a witch blighted Bob's mare, and Nob thinks she killed Cob's sow. (Edelberg 1986: 1, (1), adapted from Geach 1967: 628, (3))

(3) a. *Scenario:* The newspaper reports that a witch called "Sue" has been blighting farm animals. There is no witch: the animals all died of natural causes. Hob and Nob both read the newspaper and believe the stories about the witch. Hob thinks Sue blighted Bob's mare. Nob thinks Sue killed Cob's sow. (adapted from Edelberg 1986: 2) (2) TRUE

b. *Scenario:* Hob and Nob each read newspaper articles about three witches. There are no witches. Hob believes one of the witches blighted Bob's mare, but has no idea which one. Bob believes one of the witches killed Cob's sow, but has no idea which one. (2) NOT TRUE

Geach (1967) observed that (2) can be true in scenarios like (3a), where there are no real-world witches. This raises the problem of how the anaphoric relation can be established at all, as the antecedent and the pronoun are hidden in the "privacy" of different belief contexts. But such sentences give rise to a second, related problem: the relevant reading is only possible if the object of Hob's belief can be "identified" with the object of Nob's belief. This is illustrated by the fact that (2) is false in scenario (3b) – intuitively because, unlike in (3a), we cannot be sure that Hob's and Nob's beliefs are about 'the same witch'. The truth conditions of such examples thus depend on an identity relation, but in the absence of real-world witches, this relation must hold between belief objects or, more generally, intentional objects. The notion of an intentional object is further spelled out in §3; here, we just note that an intentional object (i) picks out different individuals in different worlds and (ii) does not have to correspond to any individual in the actual world. Geach's (1967) observation then raises the question of when two intentional objects are "similar enough to count as one" for semantic purposes.

This paper makes two points: first, we argue that Geach's puzzle is a special case of a more general problem that surfaces whenever the grammar requires a semantic identity or distinctness relation to hold between intentional objects

[1] Yet, in extensional contexts, certain plural and quantificational expressions are arguably sensitive to spatiotemporal configurations of the parts of an object (Wągiel 2018), which suggests that even there the notion INDIVIDUAL should not be a primitive of semantic theory.

associated with different intensional operators. This means (i) that this problem is not specific to anaphora and (ii) that apart from the question of when two intentional objects count as identical, we have to answer the potentially different question of when two intentional objects count as distinct. Second, concentrating on plurals in belief contexts, we develop a preliminary notion of distinctness based on the content of the attitude subjects' COUNTERFACTUAL BELIEFS. This distinctness relation does not appeal to discourse referents or real-world causes of the beliefs (often invoked for Geach's puzzle), which we argue is supported by the data.

2 A more general problem

We now show that the problem goes beyond Geach's original examples. First, it is not just identity between intentional objects that is truth-conditionally relevant, but also distinctness. Second, the puzzle extends to other intensional predicates and to non-pronominal DPs embedded under them. Thus, identity and distinctness between intentional objects play a systematic role in grammar.

2.1 Plurals embedded under attitudes

Why is distinctness of intentional objects truth-conditionally relevant? Schmitt (2020) notes that sentences like (4a), where a plural is embedded under an attitude verb with a plural subject, can be true in scenarios like (4b) (cf. Pasternak 2018 for similar data).[2] Such sentences thus have a cumulative reading: neither Abe nor Bert believe that *two* monsters were roaming the castle, but their beliefs "add up" to a belief about two monsters, in the same way that (5a) is true in scenario (5b) because the books Abe read and those Bert read add up to three. Moreover, as no actual monsters exist in the scenario, we face a problem very similar to that of anaphora across beliefs in Hob-Nob cases: cumulation – the parallel "adding up" of pluralities – must access objects hidden in different belief contexts – the monster Abe 'believes in' and the monster Bert 'believes in'.

(4) a. Abe and Bert believed that two monsters were roaming the castle!

b. *Scenario:* Abe believes in zombies, Bert in griffins. Neither exist. Both spent the night at Roy's castle. Around midnight, Abe thought he heard a zombie in his room. A little later, Bert believed he saw a griffin on his bed. They didn't discuss it with each other. (4a) %TRUE

[2]In both English and German, not all speakers accept this reading. This variation might be due to the fact that (4a) involves a cumulative relation across a finite clause boundary. Our claims here apply to varieties like our own, in which the cumulative reading is possible. For a general discussion of cumulative readings of non-individual-denoting expressions, see Schmitt (2019).

(5) a. Abe and Bert read three books.
    b. *Scenario:* Abe read books 1 and 2. Bert read book 3. (5a) TRUE

Note that the analogy between (4a) and (5a) is not universally accepted: Pasternak (2018) does not treat the relevant reading of (4a) as cumulative, rejecting the analogy with (5a). His basic idea is that Abe and Bert can COLLECTIVELY BELIEVE a proposition *p* if the conjunction of Abe's relevant beliefs and Bert's relevant beliefs entails *p*, so that examples without plurals in the embedded clause should have analogous readings. This is correct for some of Pasternak's examples, but does not generalize (Marty 2019, Schmitt 2020): (6b) is not true in scenario (6a) although Ada's and Bea's relevant beliefs jointly entail its embedded clause. Since collective belief in Pasternak's sense is thus subject to constraints that are not well understood, we will continue to assume a separate, plural-sensitive semantic mechanism in cases like (4a).

(6) a. *Scenario:* Ada is looking forward to Sue's party: She believes every man at the party will fall in love with her. Bea is also looking forward to it: She hates men and is certain that only one man will attend: Roy. Sue tells me: 'Ada and Bea are looking forward to the party…'
    b. They believe that Roy will fall in love with Ada. They are crazy! FALSE in (6a)

As in the Hob-Nob case, the existence of this reading gives rise to second, related problem, namely how the constraints on this reading should be characterized. This is illustrated by the judgment that (4a) is not true in scenario (7): the reading just sketched is possible only if the monsters are intuitively "different enough". Pre-theoretically, we can be sure that we are talking about two different monsters in (4b), but not in (7).

(7) *Scenario:* (Roy's castle, no monsters…) Around midnight, Abe thought it was 1 am and that he heard a monster in his room. A little later, Bert believed it was 2 am and that he heard a monster in his room. (They didn't discuss it…)

Since monsters do not exist in either scenario, this intuitive distinctness relation must again hold between intentional objects. Semantic theory therefore has to answer the question of when two intentional objects count as distinct.

2.2 Plural objects of intensional transitive verbs

The case of intensional transitive verbs (itv) like German *suchen* ‘look for’ shows that the puzzle in (4a) affects intensional contexts more generally and not just attitude complements. Indefinite objects of such verbs, like *ein Gespenst* in (8), do not come with existential entailments, so ITV are usually assumed to take quantifier or property arguments (e.g., Montague 1974, Zimmermann 1993).[3]

(8) Abe hat in der Nacht ein Gespenst gesucht.
Abe has in the night a ghost sought
‘At night, Abe was looking for a ghost.’ (German)

Indefinite *plural* objects of *suchen* can be in a cumulative relation with a plural subject even if they lack an existential entailment: (9a) is true in the cumulative scenario (9b), where no ghosts exist. As with cumulative belief, the numeral is only licensed if the ghost Abe looked for is somehow “distinct” from the one Bert looked for: (9a) seems to be false in scenario (9c) since no further properties of the ghosts are specified and so we cannot conclude that Abe’s and Bert’s search goals are distinct. The contrast becomes even clearer with *unterschiedlich* ‘different’ (10).

(9) a. Abe und Bert haben nachts zwei Gespenster gesucht.
Abe and Bert have at.night two ghosts sought
‘At night, Abe and Bert were looking for two ghosts.’

b. *Scenario:* Last weekend, Abe and Bert stayed at Roy’s castle. They both wrongly believe the castle is haunted by ghosts. At night, Abe went out to look for the ghost of its previous owner, who died in 1980. Bert looked for the ghost of its first owner, who died in 1400. (9a) true

c. *Scenario:* (Roy’s castle, no ghosts…) At night, Abe went outside and tried to find some ghost of a previous owner of the castle (he doesn’t care which one). Bert also went out to look for some ghost of a previous owner. (9a) not true

(10) Abe und Bert haben nachts zwei unterschiedliche Gespenster gesucht.
Abe and Bert have at.night two different ghosts sought
‘At night, Abe and Bert were looking for two different ghosts.’ (German)

[3] See, e.g., Schwarz (2021) and Deal (2008) for arguments that at least a certain subclass of ITV, including *look for*, do not take covert sentential complements.

We can think of 'the ghost Abe is looking for' as an intentional object that picks out a ghost in each world in which Abe's search is successful, but does not pick out anything in the evaluation world. If so, cumulativity in (9a) and (10) is sensitive to a distinctness relation for intentional objects, just like cumulative belief.[4]

2.3 Relative clauses with intensional transitive verbs

We considered two semantic phenomena that are sensitive to a notion of INTENTIONAL DISTINCTNESS. Neither involves anaphora, but semantic mechanisms motivated by anaphora – particularly discourse referents – underlie several accounts of the Hob-Nob puzzle (see §4.2). This mismatch could lead to two contrasting conclusions: (i) that cumulative sentences are unrelated to Geach's puzzle, or (ii) that the connection between Geach's puzzle and discourse referents is less deep than commonly thought. We choose the latter option, based on the following observation: relative-clause constructions with the gap in the object position of an ITV, like (11a), are sensitive to intentional identity (not distinctness!) in a way similar to Geach's puzzle, but do not involve discourse anaphora.

(11) a. Abe hat nachts ein Gespenst gesucht, das Bert auch gesucht hat.
Abe has at-night a ghost sought REL Bert also sought has
'At night, Abe looked for a ghost that Bert also looked for.' (German)

b. *Scenario:* (Roy's castle, no ghosts…) At night, Abe went outside to look for the ghost of the previous owner, who died in 1980. Independently, Bert (who Abe has never met) also went outside to look for the ghost of the previous owner… (11a) TRUE

(11a) must have an intensional reading since it can be true in scenario (11b). Yet this reading does not just require that Abe and Bert are each looking for a ghost, or that there is some property *P* such that they each want to find a *P* ghost: (11a) does not seem true in scenario (9c), where Abe and Bert each want to find the ghost of some previous owner of the castle, but don't care which. Like anaphora in the Hob-Nob case, the construction in (11a) is only licensed if we are justified

[4]Condoravdi et al. (2001) raise an analogous puzzle, arguing that (i) has a reading on which three 'specific' strikes were prevented. This could be true even if three other strikes occurred.

(i) Negotiations prevented three strikes. (Condoravdi et al. 2001: (2))

This raises the question of when potential strikes that did not occur count as distinct. Here, we focus on predicates of search for simplicity, as the downward-monotonicity of the most prominent reading of *prevent* raises additional issues.

in "identifying" the ghost Abe looked for with the one Bert looked for. Abe's and Bert's searches must be directed towards intentional objects "similar enough to count as one".[5] The contrast becomes even clearer with *dasselbe* 'the same':

(12) Abe hat in der Nacht dasselbe Gespenst gesucht, das Bert gesucht hat.
Abe has in the night the.same ghost sought REL Bert sought has
'At night, Abe looked for the same ghost that Bert looked for.' (German)

In sum, the Hob-Nob puzzle belongs to a broader class of configurations where semantic identity or distinctness relations required by certain expressions (plurals, numerals, anaphoric pronouns, relativization, *same, different*, …) cut across two intensional contexts with different subjects. The remainder of this paper concentrates on one special case – cumulative belief sentences – and gives a description quite different from existing analyses of the Hob-Nob puzzle. While it does not generalize straightforwardly to the intentional identity puzzles (2, 11a, 12), we hope it will serve as a first step towards a new unified analysis of the pattern.

3 Distinctness in cumulative belief sentences

We will now develop a paraphrase of sentences like (13) (=4a) under the reading discussed in §2.1. Our starting point is a notion of cumulative belief that appeals to "parts" of the embedded proposition – "parts" determined by distinct monster-concepts f, g. The difficulty is to specify when f and g count as distinct: properties the attitude subjects would consider relevant for individuation must be distinguished from those they would consider irrelevant. But this is hard to implement in a standard attitude semantics based on accessibility relations, as a subject can judge two monster-concepts as distinct without believing that they

[5]The nature of the individuation problem in such relative-clause constructions depends on the DP. Zimmermann (2006) discusses examples like (i) with the "dummy noun" *-thing*, arguing they involve quantification over the ITV's property argument: (i) roughly means there is some property P such that Abe is trying to find an arbitrary P and Bert is trying to find an arbitrary P. Haslinger (2019) argues this is correct for such "higher-order DPs" (*something, two things*), but not for DPs with lexical head nouns (*a ghost, two ghosts*): unlike (11a), the German counterpart of (i) is true in scenarios like (9c), where the conditions for intentional identity are not met. This suggests that, while the relevant reading of (11a) is intensional, the DP quantifies over intentional objects picking out at most one individual per world, not over properties or kinds.

(i) Abe was looking for something Bert was looking for (too).

are both instantiated. We therefore take distinctness to involve counterfactual attitudes: for (4a)/(13), two monster-concepts f, g count as distinct if both Abe and Bert believe that if both f and g existed, they would be distinct individuals.

(13) Abe and Bert believed that two monsters were roaming the castle!

3.1 Global incompatibility of belief states?

We first discuss a "straw man" proposal that will help clarify the truth conditions of cumulative belief sentences. One might think that the "zombie vs. griffin" scenario (4b) makes (4a)/(13) true because it suggests that Abe's relevant beliefs are incompatible, globally, with Bert's relevant beliefs. "Relevant" here is meant to ensure that conflicting beliefs unrelated to monsters (say, about the weather) do not license distinct belief objects (cf. also Pasternak 2018). This generalization faces two problems. First, incompatibility of the subjects' "relevant" beliefs is not necessary for distinctness: in scenario (14a), a variant of (4b), Abe's and Bert's beliefs are compatible with a world where both a zombie and a griffin are at the castle. Yet, this does not make the cumulative reading of (4a)/(13) less acceptable.[6] Further, a generalization based on global (in)compatibility of belief states predicts (14a) to pattern with the '1 am vs. 2 am' scenario (14b), which seems incorrect.

(14) a. *Scenario:* (Roy's castle, no monsters…) Around midnight, Abe thought he heard a zombie in his room. A little later, Bert believed he saw a griffin on his bed. Abe and Bert both consider it possible that both griffins and monsters are at the castle… (13) %TRUE

b. *Scenario:* (Roy's castle, no monsters…) Around midnight, Abe thought it was 1 am and he heard a monster in his room. A little later, Bert believed it was 2 am and he heard a monster in his room. They both consider it possible that the monster they heard was roaming the castle all night… (13) %NOT TRUE

Second, incompatible beliefs are not sufficient for distinctness: Abe's and Bert's beliefs are logically incompatible in scenario (15), yet (4a)/(13) is false. We might claim that beliefs about the total number of monsters are irrelevant, but then our problem would just be shifted to the problem of characterizing relevance.

[6] If one takes the relevant attitudes to be *de se*, this issue might not arise as Abe does not self-ascribe the property of seeing a griffin in (14a) – but our other arguments would still apply.

(15) *Scenario:* (Roy's castle, no monsters...) Around midnight, Abe hears a strange sound. He believes there are exactly four monsters living in the area and concludes he must have heard one of them. A little later, Bert also hears a strange sound. He thinks there are five monsters living in the area and concludes it must be one of them. (13) FALSE

Such examples suggest the standard linguistic conception of belief contents, which relies on an accessibility relation, is not fine-grained enough. A common response – notions of semantic content sensitive to discourse referents – is addressed in §4. Here, we will introduce a different conception of attitude contents that is richer than usually assumed, but still relies on possible worlds semantics. The puzzle posed by (4a)/(13) then has two aspects, which we address in turn: what does it mean to have a cumulative belief "about" certain intentional objects? And how do we paraphrase distinctness without relying on the relation between Abe's and Bert's respective belief worlds in the way just described?

3.2 Individual concepts and cumulative belief

We start by developing a general paraphrase for cumulative belief sentences of the type in (16) (where *P* is a distributive predicate) that simultaneously captures the cumulative relation between the higher DP and the plural indefinite and the non-extensional reading of the plural indefinite. In particular, we need to capture the fact that the relevant reading does not require NP to have a nonempty extension in the evaluation world.

(16) DP believe that [[two NP] *P*]

The paraphrase relies on Schmitt's (2019) semantics for plurals in intensional contexts. As suggested by the analogy between (4a)/(13) and (5a), she generalizes Hintikka's (1969) semantics for *believe* to a cumulative relation between a plurality of individuals ($[\![\text{DP}]\!]$) and a plurality of propositions. The notion of cumulatively believing a plurality of propositions is independently motivated by cumulative readings of conjoined complement clauses, as in (17a):

(17) a. The Paris agency called and the one from Berlin. [...] The agencies believe [$_p$ that Macron is considering resignation] and [$_q$ (that) Merkel is becoming paranoid], but neither had anything to say about Brexit. (adapted from Schmitt 2019: (18))

b. *Scenario:* The Paris agency believes Macron might resign. The Berlin agency believes Merkel is becoming paranoid. (17a) TRUE

Crucially, neither agency in scenario (17b) has to believe both conjuncts. From such data, Schmitt (2019) concludes that sentential conjunctions denote pluralities of propositions, which stand in a one-to-one correspondence to nonempty sets of propositions. The idea is that the set $A_{\langle s,t\rangle}$ of propositions in the usual sense – partial functions from worlds to truth values – is closed under a sum operation $\bigoplus_{\langle s,t\rangle}$ to form the full domain of atomic and plural propositions. $\bigoplus_{\langle s,t\rangle}$ maps any nonempty subset of $D_{\langle s,t\rangle}$ to its unique sum, in analogy to the operation $\bigoplus_e$ that sums up a set of individuals. Instead of giving a set-theoretic construction of $D_{\langle s,t\rangle}$, we simply assume that $D_{\langle s,t\rangle}$ must have the algebraic structure of the set $(\mathcal{P}(A_{\langle s,t\rangle}) \setminus \{\varnothing\}, \bigcup)$ of nonempty sets of propositions, with $\bigoplus_{\langle s,t\rangle}$ isomorphic to set union. Propositional conjunction denotes the binary counterpart $\oplus_{\langle s,t\rangle}$ of $\bigoplus_{\langle s,t\rangle}$. For instance, for the propositions $p = [\![$Macron is considering resignation$]\!]$, $q = [\![$Merkel is becoming paranoid$]\!]$ and $r = [\![$Brexit will be called off$]\!]$ in $A_{\langle s,t\rangle}$, we have $p \oplus_{\langle s,t\rangle} q = \bigoplus_{\langle s,t\rangle}(\{p,q\})$, the counterpart of $\{p,q\}$ in $D_{\langle s,t\rangle}$, and $(p \oplus_{\langle s,t\rangle} q) \oplus_{\langle s,t\rangle} r = \bigoplus_{\langle s,t\rangle}(\{p \oplus_{\langle s,t\rangle} q, r\}) = \bigoplus_{\langle s,t\rangle}(\{p,q,r\})$, the counterpart of $\{p,q,r\}$.[7] The atomic parts of a propositional plurality are the elements of the set of atomic propositions it corresponds to; thus, if $\leq_a$ denotes the atomic-part relation, $p,q,r \leq_a p \oplus_{\langle s,t\rangle} q \oplus_{\langle s,t\rangle} r$, but $p \oplus_{\langle s,t\rangle} q \nleq_a p \oplus_{\langle s,t\rangle} q \oplus_{\langle s,t\rangle} r$. This extended plural ontology now permits us to define cumulative belief:

(18) A (possibly plural) individual $x \in D_e$ CUMULATIVELY BELIEVES a (possibly plural) proposition $p \in D_{\langle s,t\rangle}$ in a world w iff
   a. for every $y \leq_a x$, there is a $q \leq_a p$ such that $[\![\text{believe}]\!](w)(q)(y)$
   b. and for every $q \leq_a p$, there is a $y \leq_a x$ such that $[\![\text{believe}]\!](w)(q)(y)$.

(18) correctly predicts that in scenario (17b), the agencies cumulatively believe $p \oplus_{\langle s,t\rangle} q$. But to apply this definition to our motivating example (4a)/(13), we need a way of deriving plural propositions from an embedded clause like *two monsters are roaming the castle.* Schmitt (2019) outlines such a system; we just give the basic idea for the subcase where the predicate in the embedded clause is distributive. We adopt a simple formalization of intentional objects as partial individual concepts (19); e.g., *two monsters* ranges over $[\![$monster$]\!]$-concepts, partial functions mapping each world w in their domain to a monster in w.[8]

[7] See Schmitt (2020) for the technical details and more independent motivation.

[8] It should be pointed out that letting quantifiers and pronouns range over partial individual concepts is not enough to solve the Hob-Nob puzzle. In particular, Edelberg's (1986, 1992) arguments against a "substitutional" approach to the Hob-Nob puzzle based on definite descriptions carry over to analyses based on individual concepts. See Schwager (2007) for a discussion of the overgeneration problem raised by partial individual concepts in another context.

(19) For a predicate $P \in D_{\langle s,et \rangle}$, a P-CONCEPT is a partial function f from the set W of possible worlds to the set A_e of atomic individuals such that for any $w \in \text{DOM}(f)$, $P(w)(f(w)) = 1$.

(20) gives a preliminary semantics for *two monsters*. We gloss over the internal composition (see Schmitt 2019), but the idea is that we form pluralities of MONSTER-concepts, based on a notion of sum for individual concepts defined in the way just described for propositions, and that the numeral filters out the MONSTER-concept pluralities of the right cardinality. Note that (20) still involves a "place-holder" for the condition that the atoms in each plurality be distinct.

(20) $[\![\text{two monsters}]\!] = \{f + g \mid f, g \in A_{\langle s,e \rangle} \wedge f$ is a MONSTER-concept $\wedge$ g is a MONSTER-concept $\wedge$ f is distinct from $g\}$

The assumption that plural indefinites denote sets of pluralities (see Schmitt 2020 for motivation) is a generalization of Alternative Semantics approaches to indefinites (Kratzer & Shimoyama 2002). As in alternative-based semantics for focus and questions, semantic composition proceeds "pointwise" for each member of the alternative set. However, Schmitt's (2020) semantics follows this principle both at the level of the alternative set and at the level of each plurality: composing (20) with the distributive predicate $[\![\text{roam the castle}]\!]$ yields the set of all propositional pluralities obtained by taking an element of (20), composing each of its atomic parts with the predicate and summing up the results (21).

(21) $[\![\text{two monsters are roaming the castle}]\!] =$
$\{(\lambda w.\text{ROAM}(w)(f(w))) + (\lambda w.\text{ROAM}(w)(g(w))) \mid f, g \in A_{\langle s,e \rangle} \wedge$
f is a MONSTER-concept $\wedge$ g is a MONSTER-concept $\wedge$ f is distinct from $g\}$

We can now combine this semantics for plural sentences with our definition of cumulative belief in (18) to obtain a general paraphrase for cumulative belief sentences, (22). (23) gives the truth conditions this paraphrase predicts for (4a)/(13).

(22) $[\![\text{DP believe that [[two NP] } P]]\!](w) = 1$ iff there is a propositional plurality $p \in \{(\lambda w.P(w)(f(w))) + (\lambda w.P(w)(g(w))) \mid f, g \in A_{\langle s,e \rangle} \wedge f, g$ are $[\![\text{NP}]\!]$-concepts $\wedge$ f is distinct from $g\}$ such that
   a. for every $x \leq_a [\![\text{DP}]\!]$, there is a $q \leq_a p$ such that $[\![\text{believe}]\!](w)(q)(x)$
   b. and for every $q \leq_a p$, there is an $x \leq_a [\![\text{DP}]\!]$ such that $[\![\text{believe}]\!](w)(q)(x)$.

(23) There are two MONSTER-concepts f, g such that f is distinct from g, Abe and Bert each believe at least one of the propositions $\lambda w.[\![\text{roam the castle}]\!](w)(f(w))$ and $\lambda w.[\![\text{roam the castle}]\!](w)(g(w))$, and for each of these propositions, at least one of Abe and Bert believes it.

Importantly, since f and g can be partial, they do not have to be defined in the evaluation world, which accounts for the indefinite's lack of existential commitment. However, if we assume a semantics for *believe* that requires the propositional complement to be defined in each of the subject's belief worlds (24), a propositional plurality based on MONSTER-concepts f and g can only satisfy (23) if f and g are each defined in all of Abe's or in all of Bert's belief worlds (or both).

(24) $[\![\text{believe}]\!] =$
$\lambda w.\lambda p_{\langle s,t\rangle}.\lambda x_e : \textsc{dox}(w)(x) \subseteq \textsc{dom}(p).\forall w'[w' \in \textsc{dox}(w)(x) \rightarrow p(w')]$

In the "zombie vs. griffin" scenario in (14a), the two individual concepts [[the zombie that was in Abe's room]] and [[the griffin that was on Bert's bed]], among others, meet condition (23). But since our preliminary semantics for *two monsters* does not require f and g to be distinct enough to count as two, so do the concepts [[the monster roaming the castle at 1 am]] and [[the monster roaming the castle at 2 am]] in scenario (14b), where (4a)/(13) is intuitively less acceptable. Even worse, we fail to rule out the "four monsters vs. five monsters" scenario (15); the concepts in (25a) and (25b) verify condition (23) in that scenario.

(25) a. λw : there are exactly four monsters in w and Abe heard exactly one monster in w . the monster Abe heard in w

b. λw : there are five monsters in w and Bert heard exactly one monster in w . the monster Bert heard in w

To fix this problem, [[two monsters]] should contain only pluralities of pairwise "distinct" individual concepts. But how do we specify this distinctness relation? Note that the most obvious notion of distinctness for partial individual concepts, on which two concepts f, g count as distinct iff there is no world w such that $f(w) = g(w)$, won't work. It makes good predictions for the "zombie vs. griffin" scenario (if Abe and Bert consider it impossible for a single individual to be both a zombie and a griffin). But on closer inspection, it does not improve on our straw man analysis from §3.1 since it is trivially satisfied if f and g have disjoint domains. Thus, (25a) and (25b) above count as distinct due to their incompatible presuppositions, which wrongly predicts (4a)/(13) to be true in the "four monsters vs. five monsters" scenario. Another wrong prediction is that the acceptability of (4a)/(13) in the "1 am vs. 2 am" scenario should improve if Abe and Bert are assumed to have incompatible beliefs about a different topic like the weather. This would make their sets of belief worlds disjoint, so that (26a) and (26b) count as distinct.

(26) a. λw : w is compatible with Abe's beliefs . the monster roaming the castle at 1am in w

b. λw : w is compatible with Bert's beliefs . the monster roaming the castle at 2am in w

In sum, we can now paraphrase cumulative belief sentences via an independently motivated notion of propositional pluralities. To derive plausible parts for these pluralities, we analyzed plural indefinites in terms of pluralities of partial individual concepts – but this partiality threatens to trivialize the notion of distinctness.

3.3 A counterfactual-based paraphrase

To see how we can avoid this problem, let us take a step back. The data suggest the distinctness relation should rely only on those contrasts that the attitude subjects consider relevant for individuation: what intuitively sets the "zombie vs. griffin" scenario apart from the "1 am vs. 2 am" scenario is that while it is plausible that both Abe and Bert would consider a griffin distinct from a zombie, they wouldn't necessarily consider a monster that shows up at 1 am to be distinct from a monster that shows up at 2 am. If so, our paraphrase should rely on the DISTINCTNESS CRITERIA of the attitude subjects. But these criteria cannot be derived (only) from Abe's and Bert's respective sets of belief worlds: it seems they can have opinions concerning the distinctness of two MONSTER-concepts even if they believe the monsters under consideration do not exist. For instance, our sentence in (4a)/(13) is as good in scenario (27) as in scenario (4b). Crucially, in (27), there are no griffins in Abe's belief words and no zombies in Bert's belief worlds.

(27) (Roy's castle…) Abe believes in zombies, but believes that griffins don't exist. Bert believes in griffins, but thinks that zombies don't exist. Around midnight, Abe thought he heard a zombie in his room. A little later, Bert believed he saw a griffin sitting on his bed. (13) TRUE

A more adequate paraphrase of the subjects' distinctness judgments must thus appeal to worlds outside of their belief states – i.e., to counterfactual beliefs: In (27), both subjects could still believe that *if* a zombie and a griffin existed, they would be distinct individuals. So in order to make individual concepts comparable even in cases like (27), we appeal to the condition in (28).[9]

(28) Two individual concepts f, g count as distinct relative to belief-subjects a, b iff both a and b believe the counterfactual that if both f and g were instantiated, their values would be distinct.

In §3.2, we saw that the natural notion of distinctness for individual concepts – not returning the same value in any world – is trivialized if Abe's set of belief worlds is disjoint from Bert's. We observed in §3.1 that the logical relation between Abe's and Bert's belief worlds is not crucial for our judgements of distinctness. But if we require the restrictor of the counterfactual in (28) to be non-empty, then (28) guarantees that there are worlds where both f and g are defined – and they have different values in at least some of them. Since these worlds are not necessarily among Abe's or Bert's belief worlds, this is a non-trivial condition regardless of whether Abe and Bert believe f and g both exist.

Since the relevant notion of distinctness cannot be defined in terms of the attitude subjects' belief worlds, it is worth asking whether it should be relativized to a subject's belief state at all.[10] For instance, we suggested that (4a)/(13) is not judged true in the "1 am vs. 2 am" scenario (14b) because we can assume that Abe and Bert wouldn't necessarily consider a monster that shows up at 1 am distinct from a monster that shows up at 2 am. But this reasoning seems to rely on the general principle that we can perceive the same individual at different times, rather than anything specific to Abe's and Bert's belief states. So couldn't we derive the same judgment if we simply required that the utterance context, rather than the subjects' belief states, has to support the truth of the relevant counterfactual ((29) in scenario (14b))?

(29) If there were a monster roaming the castle at 1 am and a monster roaming the castle at 2 am, they would be distinct.

However, this alternative would make problematic predictions for examples where the speaker and the attitude subjects disagree on the pertinent individuation criteria. For example, consider (30a), where the subjects believe ghosts can be distinguished on the basis of their appearance, while the speaker doesn't share this belief. It seems to us that the German discourse in (30b) is acceptable

[9] (28) is misleading in one respect: usually, for a subject to believe a counterfactual, they have to believe that its antecedent is false. But a cumulative belief sentence based on concepts f and g can still be true if both subjects consider it possible that both f and g are instantiated.

[10] Thanks to Magdalena Kaufmann, Sarah Zobel and a reviewer for discussion of this issue.

and coherent in this scenario, contrary to the predictions of a theory on which the relevant counterfactual, (31), is always evaluated relative to the speaker's beliefs or the utterance context.[11] That said, further empirical investigation of such examples is needed and may well show that the utterance context or the speaker's individuation criteria have some effect on intentional distinctness.

(30) a. *Context:* Abe and Bert believe in ghosts and think that ghosts cannot change their appearance. At 1 am, Abe thinks he saw a tall, red-haired ghost. At 2 am, Bert thinks he saw a short, black-haired ghost. They tell Roy about their beliefs. Roy isn't sure whether ghosts exist, but he is convinced that *if* ghosts exist, they can shape-shift. Roy says:

b. Abe und Bert glauben, dass zwei Geister im Schloss waren. Aber
Abe and Bert believe that two ghosts in.the castle were but
selbst wenn sie wirklich jeder einem Geist begegnet sind, war
even if they really each a ghost encountered are was
es wahrscheinlich ein und derselbe.
it probably one and the.same
'Abe and Bert believe two ghosts were at the castle. But even if they really each encountered a ghost, it was probably the same one.'

(31) If there existed a ghost that was tall and red-haired at 1 am and a ghost that was short and black-haired at 2 am, they would be distinct.

Let us now return to spelling out the intuition behind (28). We have to specify in *which* worlds f and g must yield distinct values, so we need a semantics for counterfactual beliefs. This is independently needed for overt counterfactuals in belief contexts as in (32a). We follow Lewis (1973) in analyzing counterfactuals in terms of a partial ordering on worlds: when evaluating (32b), we only consider the "most plausible" worlds where a zombie was present; for all those it must hold that there was a noise.

(32) a. Abe thinks that if a zombie had been present, there would have been a noise.

b. If a zombie had been present, there would have been a noise.

[11] A reviewer suggests that intentional distinctness might instead depend on whether the relevant counterfactual is objectively true in the evaluation world. This would presumably still predict cumulative belief sentences to not be fully acceptable if the individuation criteria for the belief objects are subject to debate: assuming that there are no ghosts in the actual world, it is not obvious what the actual truth value of (31) is.

How does embedding under attitude predicates as in (32a) affect this ordering? As (33) is non-contradictory, it seems different subjects can have different opinions regarding the "most plausible" zombie-behavior. We model this by letting attitude predicates shift the ordering so that it is relativized to the attitude subject.[12]

(33) Abe thinks that if a zombie had been present, there would have been a noise, but Bert thinks that it would have been quiet!

More precisely, we associate each attitude subject x and world w with a weak partial ordering $\preceq_{x,w}$ that orders a subset of the possible worlds with respect to their degree of "plausibility" according to x's belief state in w. We assume that the usual accessibility relation for a subject x can be reconstructed from the $\preceq_{x,w'}$ relations for different worlds w' as follows: the elements of $\textsc{dox}(w')(x)$ are the minimal elements of $\preceq_{x,w'}$. The meaning of the non-embedded counterfactual (32b) relative to a discourse context c can then be paraphrased roughly as in (34): we assume that c makes available an ordering relation $\preceq_c$ such that the worlds in the context set of c are exactly the minimal elements of $\preceq_c$ (cf. Yalcin 2007, who argues for a similar assumption wrt. epistemic modals). The counterfactual then entails (and arguably presupposes) that its antecedent is false in those worlds (34a). Importantly though, its consequent is evaluated in the lowest-ranked worlds wrt. $\preceq_c$ that verify the antecedent, and these worlds are *not* in the context set.

(34) a. For all $\preceq_c$-minimal worlds w', no zombie was present in w',
b. & for all worlds w' such that a zombie was present in w' & there is no w'' such that $w'' \prec_c w'$ & a zombie was present in w'', there was a noise in w'.

The truth conditions for the embedded case (32a) when evaluated in a world w are similar. Yet, when in the scope of the attitude predicate *thinks*, the counterfactual is evaluated wrt. the subject-dependent ordering $\preceq_{\text{Abe},w}$, rather than the ordering tied to the discourse context. The presupposition of the counterfactual – there was no zombie – is then required to hold in all of Abe's belief worlds (35a), but the consequent is evaluated in the "most plausible" worlds according to Abe's criteria where a zombie *was* present, which are not among Abe's belief worlds.

(35) a. For all $\preceq_{\text{Abe},w}$-minimal worlds w', no zombie was present in w',
b. & for all w' such that a zombie was present in w' & there is no w'' such that $w'' \prec_{\text{Abe},w} w'$ & a zombie was present in w'', there was a noise in w'.

[12] Arregui (2008) uses different examples that point in the same direction.

These paraphrases suggest that the semantics of attitudes is richer than usually assumed: a counterfactual in the scope of an attitude must have access to the attitude subject's entire $\preceq$-ordering, not just to the belief worlds. This is exactly what we need to give a precise paraphrase for our distinctness condition: two individual concepts f and g count as distinct for a subject if their values are distinct in all worlds that are minimal wrt. the subject's $\preceq$-ordering *among the worlds where f and g are both defined* (36a). Crucially, these worlds don't have to be minimal in the global sense, and thus don't have to be among the subject's belief worlds (but they can – (36a), as opposed to (35), does not require the antecedent of the counterfactual to be false in the relevant belief worlds). This captures the intuition that subjects may have beliefs about whether or not two "potential monsters" are distinct even if they do not believe that both of them exist.[13] Our original cumulative-belief example (4a)/(13) then receives the full paraphrase in (36b).

(36) a. Two partial individual concepts f, g are distinct for a subject x in w – $\textsc{distinct}_{x,w}(f,g)$ – iff $\textsc{dom}(f) \cap \textsc{dom}(g) \neq \emptyset$ and for all worlds w' such that $w' \in \textsc{dom}(f) \cap \textsc{dom}(g)$ and there is no w'' such that $w'' \in \textsc{dom}(f) \cap \textsc{dom}(g)$ and $w'' \prec_{x,w} w'$, $f(w') \neq g(w')$.

b. There are two MONSTER-concepts f and g, such that
   - i. $\textsc{distinct}_{\text{Abe},w}(f,g)$ and $\textsc{distinct}_{\text{Bert},w}(f,g)$
   - ii. Abe and Bert each believe at least one of the propositions $\lambda w.[\![\text{roam the castle}]\!](w)(f(w))$ and $\lambda w.[\![\text{roam the castle}]\!](w)(g(w))$,
   - iii. and for each of these propositions, Abe or Bert believes it.

[13] We assume that such beliefs require each subject's $\preceq_{x,w}$-ordering to contain at least one world in which both MONSTER-concepts are defined. A reviewer suggests scenarios like (i) as a potential problem for this condition. Our predictions for (i) hinge on the interpretation of *impossible*.

(i) Abe believes that zombies exist, but that it is impossible for other monsters to exist. Bert believes that griffins exist, but that it is impossible for other monsters to exist.

The example is unproblematic if epistemic modals in belief contexts quantify over the attitude subject's belief worlds. As only the minimal elements of $\preceq_{x,w}$ are among x's belief worlds, there could then still be non-minimal worlds for each subject in which both types of monsters exist. This point carries over to other analyses of *impossible* as a restricted modal quantifier: worlds excluded from the quantificational domain of *impossible* may still be in the set ordered by $\preceq_{x,w}$, since they are needed to interpret overt embedded counterfactuals. While the reviewer's argument does go through for a 'metaphysical' interpretation of *impossible* as an unrestricted modal quantifier, such modalities poses a more general challenge for the possible-worlds approach.

As suggested in §3.2 above, we build the distinctness condition (36b-i) into the semantics of plural indefinites like *two monsters*. It is worth noting that this gives rise to a compositionality puzzle beyond the scope of this paper: the condition in (36b-i) requires access to each subject's entire $\preceq$-ordering for the evaluation world.[14] But a standard attitude semantics as in (24) evaluates the complement distributively for each belief world. This raises the question of how the indefinite can access the relevant $\preceq$-orderings, which is particularly urgent given Schmitt's (2020) arguments that the lower plural in cumulative belief sentences must be interpreted *in situ*, within the complement clause.

4 Alternative proposals

While the proposal just presented concerns distinctness, not identity, and does not easily generalize to Hob-Nob sentences, it is worth asking how it differs conceptually from recent analyses of the Hob-Nob puzzle. Here, we discuss two ideas shared by many analyses of Hob-Nob sentences that do *not* inform our approach. The first one is that the relevant identity relation relies on real-world individuals or events that are causally related to both belief objects. The second idea is that the identity problem requires an enriched notion of attitude contents that is sensitive to discourse referents. We submit that there is no clear evidence that an analysis of cumulative belief sentences should draw on either of these ideas. (For reasons of space, we focus on these general claims here and therefore cannot do justice to the details of the specific proposals in the literature.)

4.1 Real-world objects

The first idea (van Rooy 1997, Dekker & van Rooy 1998; see also Cumming 2007) is that identity between belief objects in Hob-Nob sentences requires a common real-world "source" of the belief objects: Abe's belief object x can be identified with Bert's belief object y only if there is a real-world individual or event involved in causing Abe to form the belief that x exists, and in causing Bert to form the belief that y exists. Real-world events with this causal role may include linguistic utterances, like the newspaper reports in (3a). Translating this to the problem of distinctness in cumulative belief sentences, two belief objects would count as distinct iff the causal chains leading the subjects to form their respective beliefs are unrelated. Yet, this lack of a common causal source seems neither necessary

[14]But see Haslinger & Schmitt (forthcoming) for a compositional implementation of the paraphrase in (36b) that relies on a generalized version of Yalcin's (2007) domain semantics.

nor sufficient for judgments of distinctness. In scenario (37), the same real-world sound causes Abe and Bert to form their beliefs. If distinct belief objects had to have distinct real-world sources, we would expect our example (4a)/(13) to be false in (37), but it isn't.[15] Intuitively, the belief objects are "individuated" by the properties ascribed to them. Scenario (38), on the other hand, involves different real-world "causes" for the two belief objects. Nevertheless, this is not enough to make (4a)/(13) true. Intuitively, despite the different real-world sources, the properties ascribed to the belief objects are not sufficient to individuate them.

(37) *Scenario:* (Roy's castle…) At 1 am, the pipes make a sound. Abe hears the sound. He thinks it is caused by a zombie in his room. Bert, in the other room, also hears the sound: He thinks it is caused by a griffin on his bed. (13) %TRUE

(38) *Scenario:* (Roy's castle…) At 1 am, the pipes make a sound. Abe wakes up and thinks it is a monster, but isn't sure what kind. At 2 am, the fridge makes a sound. Bert wakes up and thinks it is a monster, but isn't sure what kind. (13) %NOT TRUE

Based on these judgments, there is no reason to extend the externalist identity criteria proposed for the Hob-Nob puzzle to *distinctness* in cumulative belief sentences. We leave open if such criteria still play a role in intentional *identity* (but see Edelberg 1992 for interesting arguments that they do not).

4.2 Discourse referents

Several approaches to the Hob-Nob puzzle (Dekker & van Rooy 1998, Cumming 2007) assign a crucial role to discourse referents in mediating between the identity relation and the semantics of attitudes. The claim we address here (most explicit in Cumming 2007) is that the semantics of attitudes should be sensitive to the number and identity of the discourse referents the complement clause introduces. Any discourse referents free within that clause are taken to correspond to constituents of the belief subject's mental representation of their belief state. The identity relation is then defined on these mental symbols.

For example, to the extent we understand Cumming's (2007) proposal, it involves an externalist identity relation of the kind discussed in §4.1, but this relation holds between "mental discourse referents": there must be a real-world

[15] There don't have to be any obvious external sources: we would still consider the sentence true if Abe and Bert only hallucinate sounds. One could argue that hallucinations have real-world causes (e.g., neural events), but then the question arises why the distinctness condition isn't met in scenario (38) – the relevant neural events in Abe's and Bert's brains would be distinct.

individual/event that was involved in causing Hob to form a mental symbol corresponding to the discourse referent introduced by *a witch*, and also in causing Nob to form a mental symbol corresponding to the one picked up by *she*. If so, Hob-Nob sentences make claims about the structure of Hob's and Nob's mental representations that go beyond their propositional contents: two belief sentences introducing different sets of discourse referents may make distinct claims about the subject's mental state even if the embedded clauses are truth-conditionally equivalent. This is the aspect we are skeptical about: while the analysis of Hob-Nob sentences may involve discourse referents, this is because the anaphoric relation in such examples is constrained by grammar just like other instances of anaphora. Thus, the judgments on Partee's marble example (Heim 1982), which shows that truth-conditionally equivalent sentences may have different dynamic meanings, do not seem to change when it is embedded in a Hob-Nob context:

(39) a. *Context:* Hob and Nob read in the papers that there are 10 witches in Austria. They each believe that nine of the witches live in Vienna. Nob believes that the tenth witch lives in his neighborhood in Graz.
b. Hob thinks all of the ten witches except one live in Vienna. Nob thinks she lives in Graz.
c. Hob thinks nine of the ten witches live in Vienna. #Nob thinks she lives in Graz.

This example shows that the first sentences in (39b) and (39c) have different dynamic meanings, but it does not follow that these sentences make distinguishable claims about Hob's mental state. A semantics for *believe* that is sensitive to the number and identity of free discourse referents in its scope would permit these sentences to differ in truth value. We think this prediction is not borne out and conclude that the distribution of anaphora in (39) is sensitive not to the structure of Hob's belief state, but to the way the belief is reported. So, while Hob-Nob sentences might involve discourse referents ranging over intentional objects, the right way of revising the semantics of *attitude predicates* to model these objects is not to make it sensitive to discourse referents. This is in line with our approach to cumulative belief sentences, which requires an enriched attitude semantics (the $\preceq$-relations), but does not relate this enrichment to discourse referents.

5 Conclusion and outlook

We argued that grammar is sensitive not only to intentional identity, but also to intentional distinctness, and that the grammatical phenomena sensitive to such relations are much more varied than usually assumed. We then considered the relevant notion of distinctness in cumulative belief sentences in more detail, arguing that it relies on counterfactual beliefs of the attitude subjects, so that criteria of individuation are relativized to the subjects. Apart from the question of how this can be implemented compositionally, our claim leaves open two other crucial issues: first, it remains to be seen whether the same kind of treatment is warranted in cases involving intentional identity rather than distinctness, and, if so, how to specify it in this case.

Second, our approach to cumulative belief should be extended to intensional predicates that don't straightforwardly involve a belief component, such as other attitude verbs like *want*, but also ITV like *look for*. The following data, pointed out by a reviewer, suggest that something similar to our distinctness constraint might be at work in the interpretation of plurals under *look for*.

(40) a. *Scenario:* Abe and Bert occasionally go out to pick up litter in order to keep their neighbourhood tidy. Yesterday, Abe went outside and tried to find a piece of litter (he doesn't care what he finds). Bert also went out to look for a piece of litter.

b. Abe and Bert went looking for two pieces of litter. TRUE in (40a)

This fits well with an analysis of *look for* as a quantifier over worlds in which the search is successful (see e.g., Zimmermann 1993, 2006). To evaluate our counterfactual distinctness condition for two individual concepts f and g (e.g., λw.the first piece of litter Abe picks up in w and λw.the first piece of litter Bert picks up in w), we would need to consider the closest worlds wrt. some $\preceq$-ordering where *both* search events succeed. Assuming that it is implausible for Abe and Bert to pick up exactly the same piece, f and g will have distinct values in these worlds. This predicts that such examples should be less acceptable if there are plausible scenarios in which Abe and Bert find the same thing. Indeed, it seems to us that the German counterpart of (41b) is not true in scenario (41a).

(41) a. *Scenario:* Abe and Bert are at a museum that is claimed to have ancient oil paintings. In fact, there is no such thing. Abe and Bert each want to see at least one such painting before they leave, but do not care which one.

b. Abe and Bert went looking for two ancient oil paintings.

However, a closer empirical investigation of plurals under ITV would be needed to whether this analogy with attitude verbs generalizes.

Abbreviations

ITV	intensional transitive verb	REL	relative pronoun

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Part III

Numerals and classifiers

Chapter 12

Splitting atoms in natural language

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The classic Fregean analysis of numerical statements runs into problems with sentences containing non-integers such as *John read 2.5 novels*, since it takes such statements to specify the cardinality of a set which by definition must be a natural number. We propose a semantics for numeral phrases which allows us to count mereological subparts of objects in such a way as to predict several robust linguistic intuitions about these sentences. We also identify a number of open questions which the proposal fails to address and hence must be left to future research.

Keywords: numerals, measurement, density, scales, implicatures

1 A new semantics for numeral phrases

1.1 Problems with the Fregean analysis

Standard analyses of numerical statements have roots in Frege (1884) and take these to be, essentially, predications of second order properties to concepts, that is specifications of cardinalities. Thus, the sentence

(1) John read 3 novels.

is considered to be a claim about the set of novels that John read, namely that it has three members. The truth condition of (1) is taken to be either (2a) or (2b), depending on whether the 'exact' or the 'at least' meaning is assumed to be basic for numerals.[1]

[1]For arguments that numerals have the 'at least' meaning as basic, see Horn (1972), von Fintel & Heim (1997), von Fintel & Fox (2002), Fox (2007), a.o. For arguments that numerals have the 'exact' meaning as basic, see Geurts (2006), Breheny (2008), a.o. Note that the choice between these two views does not affect what we say in this chapter, as will be clear presently.

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(2) a. $|\{x \mid x \text{ is a novel} \wedge \text{John read } x\}| = 3$
b. $|\{x \mid x \text{ is a novel} \wedge \text{John read } x\}| \geq 3$

Let us now consider (3), which we take to be an expression that is accepted as a well-formed sentence of English.

(3) John read 2.5 novels.

Extending the traditional analysis of numerical statements to this sentence yields absurdity: (4a) is a contradiction, and (4b) is logically equivalent to (2b).

(4) a. $|\{x \mid x \text{ is a novel that John read}\}| = 2.5$
b. $|\{x \mid x \text{ is a novel that John read}\}| \geq 2.5$

It is obvious that (3) is neither contradictory nor equivalent to (1). Suppose, for example, that John read *Brothers Karamazov*, *Crime and Punishment*, one-half of *Demons*, and nothing else.[2] In this context, (3) is true and (1) false. The fact that (3) can be true shows that it is not contradictory, and the fact that it can be true while (1) is false shows that the two sentences are not equivalent.

We believe there is no sense in which we can "extend" Frege's theory to include non-integers: the number of objects which fall under a concept must be a whole number. For Frege, the concept of a "concept" entails, as a matter of logic, that it has sharp boundary: "[…] so wird ein unscharf definirter Begriff mit Unrecht Begriff genannt […] Ein beliebiger Gegenstand Δ fällt entweder unter den Begriff Φ, oder er fällt nicht unter ihn: tertium non datur" (Frege 1893: §56).[3] In fact, Frege considers the reals to be of a different metaphysical category from the naturals, and even made the distinction notationally explicit, writing "2" for the real number two and "~~2~~" for the natural number two (Snyder 2016, Snyder & Shapiro 2016).

At this point, an issue concerning the type of expressions we are investigating should be addressed. In Salmon (1997), phrases such as *2½ oranges*, which the author pronounces as 'two and one-half oranges', are discussed. Here we are dealing with expressions like *2.5 novels* which are pronounced, we suppose, as 'two point five novels'. We do not intend to suggest that the two types of expressions should receive the same analysis. An anonymous reviewer raises the question of whether some of our judgements might be an artefact of this pronunciation, i.e. of pronouncing *2.5* as 'two point five' instead of 'two and a half', for example.

[2]John is a Dostoyevsky enthusiast.

[3]In English: "[…] it is therefore wrong to call a vaguely defined concept a concept […] For any object, either it falls under the concept or it doesn't: tertium non datur" (our translation).

This issue, we must admit, goes beyond the scope of our chapter. We would note, however, that independently of how the issue is settled empirically, the fact that it is raised might be symptomatic of a worry which, as we surmised from various discussions, is shared by a number of colleagues. The worry is that we are not investigating "natural language", but instead, are ruminating on some sort of conventional discourse which has been manufactured for the special purpose of making conversation in mathematics more expedient. A question which we have heard more than once is "what about languages spoken by communities which have no mathematics at this level?" We believe the worry is unfounded. It is true that we have to learn how to write and pronounce decimals, but the linguistic judgements involving these expressions which we present and try to account for below do not come about by way of instruction. In fact, these intuitions should be surprising given the definitions we learn in school. As for the question about languages without expressions for decimals, we would say that our study is similar in kind to one of, say, the Vietnamese pronominal system which can express many distinctions that are not lexically encoded in English. Speech communities may differ, due to historical accidents, in how they lexicalize conceptual space, i.e. in what they can say, but this is of course no reason for assuming that research into language particular phenomena does not inform our understanding of what they *could* say, i.e. of universal grammar.

1.2 The proposal

This chapter proposes an analysis of numeral phrases which can account for intuitions about such sentences as (3). First, we will assume the logical form of *John read 2.5 novels* to be the structure shown in Figure 1, where SOME and MANY are covert (cf. Hackl 2000).[4]

Our proposal will consist in formulating a semantics for MANY, leaving other elements in Figure 1 with their standard meaning.[5] This semantics presupposes the fairly standard view of the domain of individuals, $\mathcal{D}_e$, as a set partially ordered by the part-of relation $\sqsubseteq$ to which we add $\varnothing$ as the least element (cf. Link 1983, Landman 1989, Schwarzschild 1996, Bylinina & Nouwen 2018).[6] The join operation $\sqcup$ and the meet operation $\sqcap$ on $\langle \mathcal{D}_e \cup \{\varnothing\}, \sqsubseteq \rangle$ are given the usual definitions below, where ι represents, following standard practice, the function mapping a singleton set to its unique element.

[4] Although we reference Hackl (2000), we should note that existential quantification, i.e. the meaning of SOME, is included in the definition of Hackl's MANY. We thank an anonymous reviewer for reminding us to mention this difference.

[5] In particular, we assume that the covert SOME has the same meaning as its overt counterpart, which is $[\![\text{SOME}]\!] = [\![\texttt{some}]\!] = [\lambda P \in \mathcal{D}_{\langle e,t \rangle} \,.\, [\lambda Q \in \mathcal{D}_{\langle e,t \rangle} \,.\, \exists x \,.\, P(x) = Q(x) = 1]]$.

[6] We do not assume that $\varnothing$ is an element of $\mathcal{D}_e$ itself. Neither do we exclude this possibility.

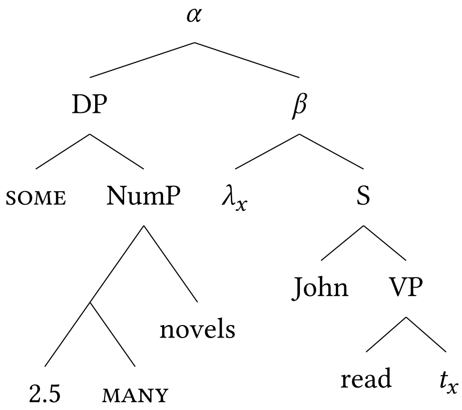

Figure 1: The logical form of (3)

(5) a. $x \sqcup y \ := \iota\{z \mid x \sqsubseteq z \wedge y \sqsubseteq z \wedge \forall z'(x \sqsubseteq z' \wedge y \sqsubseteq z' \rightarrow z \sqsubseteq z')\}$
b. $x \sqcap y \ := \iota\{z \mid z \sqsubseteq x \wedge z \sqsubseteq y \wedge \forall z'(z' \sqsubseteq x \wedge z' \sqsubseteq y \rightarrow z' \sqsubseteq z)\}$

We assume that plural nouns denote cumulative predicates, i.e. subsets of $\mathcal{D}_e$ which are closed under $\sqcup$ (cf. Krifka 1989, Chierchia 1998, Krifka 2003, Sauerland et al. 2005, Spector 2007, Zweig 2009, Chierchia 2010). For each predicate A, the set of A atoms, A_{at}, is defined as

(6) $A_{at} \ := \{x \in A \mid \neg\exists y \,.\, y \sqsubset x \wedge y \in A\}.$

To illustrate, let b and c be the two novels *Brothers Karamazov* and *Crime and Punishment*, respectively. The individual $b \sqcup c$ has proper parts that are novels, hence $b \sqcup c$ will not be in $[\![\texttt{novels}]\!]_{at}$. In contrast, neither b nor c has proper parts that are novels, hence both of these individuals are in $[\![\texttt{novels}]\!]_{at}$. In other words, $[\![\texttt{novels}]\!]_{at}$ contains things that we can point at and say 'that is a novel'. The semantics we propose for MANY is (7), where d ranges over degrees.

(7) $[\![\text{MANY}]\!](d)(A) = [\lambda x \in \mathcal{D}_e \,.\, \mu_A(x) \geq d]$

We then predict that *John read 2.5 novels* is true iff there exists an individual x such that $\mu_{[\![\texttt{novels}]\!]}(x) \geq 2.5$ and John read x. The term $\mu_{[\![\texttt{novels}]\!]}(x)$ represents 'how many novels are in x', so to speak. We want to be able to count novels in such a way that proper subparts of novels, which are not novels, also contribute to the count. To this end, we propose to explicate the measure function μ_A as follows.[7]

(8) $$\mu_A(x) = \begin{cases} \mu_A(y) + 1 & \text{if } a \sqsubset x,\ y \sqcup a = x, \text{ and } y \sqcap a = \emptyset \text{ for some } a \in A_{at} \\ \mu_a(x) & \text{if } x \sqsubseteq a \text{ for some } a \in A_{at} \\ \# & \text{otherwise} \end{cases}$$

Thus, each A atom which is a subpart of x will add 1 to $\mu_A(x)$. If x is an A atom or a subpart of an A atom, $\mu_A(x)$ will be $\mu_a(x)$, which represents 'how much of the A atom a is in x', so to speak. The measure function μ_a is explicated as follows.

(9) For each $a \in A_{at}$,
   a. μ_a is a surjection from $\{x \in \mathcal{D}_e \mid x \sqsubseteq a\}$ to $(0, 1] \cap \mathbb{Q}$
   b. $\mu_a(x \sqcup y) = \mu_a(x) + \mu_a(y)$ for all $x, y \in \text{dom}(\mu_a)$ such that $x \sqcap y = \emptyset$
   c. $\mu_a(a) = 1$

This definition allows us to use any positive rational numbers smaller or equal to 1 to measure parts of an atom, with 1 being the measure of the whole atom. Furthermore, it guarantees that the measurement of parts of an atom is additive: if x and y are non-overlapping parts of an atom, their mereological sum $x \sqcup y$ measures the arithmetic sum of the measurements of x and y. Thus, two chapters, chapters 1 and 2, of a novel cannot be added to two chapters, chapters 2 and 3, of the same novel to give four chapters of that novel because of the overlap.

Two points should be noted about the definition in (8). First, it follows from it that $\mu_A(x)$ is undefined (for all x) if A_{at} is empty. An anonymous reviewer raises the concern that this definition might exclude the denotation of count nouns like *fence* from being measured by μ, the problem being that fences are homogeneous entities. That is, the concern is that $[\![\texttt{fence}]\!]_{at} = \emptyset$ and, consequently, that $\mu_{[\![\texttt{fence}]\!]}(x) = \#$. We hypothesize that measuring this type of noun requires contextual restriction: if C is a syntactic variable and $[\![\texttt{fence}_C]\!]^g = [\![\texttt{fence}]\!]^g \cap g(C)$, then $[\![\texttt{fence}_C]\!]^g_{at} \neq \emptyset$ iff $[\![\texttt{fence}]\!]^g \cap g(C)_{at} \neq \emptyset$; consequently, $\mu_{[\![\texttt{fence}_C]\!]}(x)$ is defined if (and only if) $[\![\texttt{fence}]\!]^g \cap g(C)_{at} \neq \emptyset$ (for certain x). Thus, we surmise that sentences like *Ann passed by 3 fences* or *Ann painted 3.5 fences* presuppose a context in which fences aren't homogeneous entities but maximal stretches of fence, such as the whole stretch of a fence around a property or along a border.

[7]Salmon (1997) tentatively suggests to analyze "2½" by means of the quantifier '2.5' in a logical form like '2.5x(x is an F that is G)'. This quantifier is characterized as a 'mixed-number quantifier', operating on pluralities, where the quantity of a plurality is measured in such a way that whole Fs count as one and "a part of a whole F counts for part of a whole number." Our proposal can be seen as an order-theoretic specification of such a quantifier.

Thus, we agree with Wągiel (2018) that counting can involve a notion of "maximality". However, we put forth the hypothesis that maximality only comes into play through contextual restriction, in the absence of atoms in the unrestricted extension of a noun.

Second, note that overlap is dealt with twice in our definitions, viz. in the first clause of (8), to prevent atoms from being counted more than once, and in (9b), to do the same for subatomic parts. This is in line with the claim that subatomic quantification is subject to the same constraints as quantification over wholes (Wągiel 2018, 2019). However, we are not committed to all aspects of Wągiel's theory. Specifically, we see reason to reject his claim that counting (of atoms and subatomic parts) requires "topological integrity". It seems to us that the sentence *John owns 2 cars* can be much more readily accepted as true if John owns (nothing but) a whole car and a car that is sitting disassembled in various places in his garage than the sentence *John owns two cups* if he owns (nothing but) a whole cup and the shards of a shattered cup. While some notion of "integrity" might play into this contrast, we believe that the way this notion enters is by affecting, dependent on context, what is considered a possible extension of the nouns *car* and *cup* in the actual world. A more thorough comparison of our proposal to Wągiel's theory is beyond the bounds of this chapter but we believe that the two proposals are largely compatible.

Before we discuss some predictions of our proposal, it should be said that the need for non-integral counting in natural language has been recognized. Kennedy (2015), for example, says the following about #, the measure function which maps objects to number: "Note that # is not, strictly speaking, a cardinality function, but rather gives a measure of the size of the (plural) individual argument of the noun in "natural units" based on the sense of the noun [...]. If this object is formed entirely of atoms, then # returns a value that is equivalent to a cardinality. But if this object contains parts of atoms, then # returns an appropriate fractional or decimal measure [...]" (Kennedy 2015: footnote 1). However, this is all Kennedy says about the matter. In particular, he does not explicate what he means by "appropriate", and is not concerned with the data that we present below. The notion of "natural units" refered to by Kennedy in the quote above is due to Krifka (1989), who proposes a function, NU, which maps a predicate P and an object x to the number of natural units of P in x. Like Kennedy, Krifka does not consider the data presented in the next section, and neither does he provide a definition of NU which is explicit enough to relate to them. In fact, Krifka stipulates that NU is an "extensive measure function", on the model of such expressions as *litter of*, which means he actually makes the wrong prediction for the data point presented in §2.2. below. Specifically, Krifka will predict that (11b) must be contradictory as (11a) is. Thus, what we are doing here is essentially improving upon Kennedy and Krifka, with the improvement being explication in the former and explication as well as correction in the latter case.

2 Some predictions of the proposal

This section presents some intuitions about numerical statements which are predicted by our semantics for MANY. The list is not intended to be exhaustive.

2.1 First prediction

We predict the observation made at the beginning of this chapter, namely that (10a) is neither contradictory nor equivalent to (10b).

(10) a. John read 2.5 novels.
b. John read 3 novels.

This is because $\mu_{[\![\texttt{novels}]\!]}(x) \geq 2.5$ is neither contradictory nor equivalent to $\mu_{[\![\texttt{novels}]\!]}(x) \geq 3$. To see that $\mu_{[\![\texttt{novels}]\!]}(x) \geq 2.5$ is not contradictory, let b, c, and d be, again, the three novels *Brothers Karamazov*, *Crime and Punishment*, and *Demons*, respectively, and let d' be a subpart of *Demons* which measures one-half of this novel, so that $\mu_{[\![\texttt{novels}]\!]}(d') = \mu_d(d') = 0.5$. Then, $\mu_{[\![\texttt{novels}]\!]}(b \sqcup c \sqcup d') = \mu_{[\![\texttt{novels}]\!]}(c \sqcup d') + 1 = \mu_{[\![\texttt{novels}]\!]}(d') + 1 + 1 = \mu_d(d') + 1 + 1 = 0.5 + 1 + 1 = 2.5$. The non-equivalence follows from the logical truth that $2.5 < 3$ and the fact that there is an x such that $\mu_{[\![\texttt{novels}]\!]}(x) = 2.5$ (as shown above).

2.2 Second prediction

We predict that (11a) is a contradiction but (11b) is not.

(11) a. # John read 1 Dostoyevsky novel yesterday, and 1 Tolstoy novel today, but he did not read 2 Russian novels in the last two days.
b. John read 0.5 Dostoyevsky novels yesterday, and 0.25 Tolstoy novels today, but he did not read 0.75 Russian novels in the last two days.

The first conjunct of (11a) requires two different novels, say b and c, to have been read by John.[8] As $\mu_{[\![\texttt{novels}]\!]}(b \sqcup c) = 2$, the second conjunct of (11a) contradicts

[8]Here and below, we refer to the conjuncts of *but.*

the first. On the other hand, suppose John read a subpart of b, call it b', yesterday and read a subpart of c, call it c', today, and suppose that b' measures one-half of b and c' measures one-quarter of c, i.e. $\mu_{[\![\texttt{novels}]\!]}(b') = \mu_b(b') = 0.5$ and $\mu_{[\![\texttt{novels}]\!]}(c') = \mu_c(c') = 0.25$. Then the first conjunct of (11b) is true. However, b' and c', put together, do not make up something which has a subpart that is a novel, or something which is a subpart of a novel. In other words, there is no $a \in [\![\texttt{novels}]\!]_{at}$ such that $a \sqsubset b' \sqcup c'$ or $b' \sqcup c' \sqsubseteq a$, which means $\mu_{[\![\texttt{novels}]\!]}(b' \sqcup c') = \#$, which means $\mu_{[\![\texttt{novels}]\!]}(b' \sqcup c') \ngeq 0.75$, which means the second conjunct of (11b) is true.

Note that our prediction in this case differs from that of Liebesman (2016), who would predict that *John read 0.75 novels* is true in the described context, since Liebesman's proposal, according to our understanding, would allow subparts of different novels to be added, as long as the sum is smaller than 1. Furthermore, judgments might be different for an example like (12), which seems to have a contradictory reading.

(12) # John ate 0.5 oranges yesterday, and 0.25 oranges today, but he did not eat 0.75 oranges (or more) in the last two days.

We believe that the difference between (11b) and (12) comes down to the fact that *orange* can be more easily coerced to a mass interpretation than *novel* (cf. *The smoothie contains orange* vs. #*The shredder bin contains novel*). To accommodate the contradictory reading of (12), we tentatively assume that $[\![\texttt{oranges}]\!]$ can be contextually extended by sums of subparts of different oranges.

2.3 Third prediction

We predict that (13) is a tautology.

(13) If John read 0.75 novels, and Mary read the rest of the same novel that John was reading, then Mary read 0.25 novels.

Suppose John read a portion of b, call it b', which measures three-fourths of b, so that $\mu_{[\![\texttt{novels}]\!]}(b') = \mu_b(b') = 0.75$. Suppose, furthermore, that Mary read the rest of b, call it b'', which is all of that part of b which John did not read. Then the antecedent is true. Now by hypothesis, $b' \sqcup b'' = b$, and $b \in [\![\texttt{novels}]\!]_{at}$. This means $\mu_b(b' \sqcup b'') = \mu_b(b) = 1$. Since b' and b'' do not overlap, i.e. $b' \sqcap b'' = \emptyset$, we have $\mu_b(b' \sqcup b'') = \mu_b(b') + \mu_b(b'') = 1$. And because $\mu_b(b') = 0.75$, we have $\mu_b(b'') = 1-0.75 = 0.25$, hence $\mu_{[\![\texttt{novels}]\!]}(b'') = 0.25$, which means the consequent is true.

2.4 Fourth prediction

We predict that (14) is not a contradiction.

(14) John read 0.5 novels, and Mary read 0.25 of the same novel that John was reading, but John and Mary together did not read 0.75 novels.

Suppose John read b' which measures 0.5 of b, and Mary read b'' which measures 0.25 of b. Thus, $\mu_b(b') = 0.5$ and $\mu_b(b'') = 0.25$. The first conjunct is then true. Now let b' and b'' overlap, so that $b' \sqcap b'' \neq \emptyset$. Furthermore, let o be $b' \sqcap b''$ and d' and d'' the non-overlapping parts of b' and b'', respectively. Thus, $b' = d' \sqcup o$, $b'' = d'' \sqcup o$, and $b' \sqcup b'' = d' \sqcup d'' \sqcup o$. This means $\mu_b(b' \sqcup b'') = \mu_b(d' \sqcup d'' \sqcup o) = \mu_b(d') + \mu_b(d'') + \mu_b(o) < \mu_b(d') + \mu_b(o) + \mu_b(d'') + \mu_b(o) = \mu_b(d' \sqcup o) + \mu_b(d'' \sqcup o) = \mu_b(b') + \mu_b(b'') = 0.5 + 0.25 = 0.75$, which means $\mu_b(b' \sqcup b'') < 0.75$, which hence means the second conjunct is true.

2.5 Fifth prediction

We predict that (15a) is coherent, but (15b) is not.[9]

(15) a. John read (exactly) 0.5 novels.

b. # John read (exactly) 0.5 quantities of literature.

That (15a) is coherent is, by now, obvious. It will be true if John read, say, half of *Anna Karenina*. What makes (15b) incoherent, then, must lie in the semantics of *quantities of literature*, henceforth `qol` for short. According to the semantics we proposed for MANY, (15b) entails the existence of an individual x such that $\mu_{[\![\mathtt{qol}]\!]}(x) = 0.5$, which entails the existence of some $a \in [\![\mathtt{qol}]\!]_{at}$ such that $x \sqsubseteq a$. Given that any subpart of a quantity of literature is itself a quantity of literature, we have $[\![\mathtt{qol}]\!]_{at} = \{x \in [\![\mathtt{qol}]\!] \mid \neg\exists y \sqsubset x \wedge y \in [\![\mathtt{qol}]\!]\} = \emptyset$. Thus, there is no $a \in [\![\mathtt{qol}]\!]_{at}$, which means there is no x such that $\mu_{[\![\mathtt{qol}]\!]}(x) = 0.5$, which means (15b) is false. Furthermore, it is analytically false, which is to say false by virtue of the meaning of the word *quantity*. This, we hypothesize, is the reason for its being perceived as deviant. We will come back to this point in the last section.

[9] Note that the word *quantity* in (15b) is not intended to mean '200 pages', or '3000 words', or any contextually specified quantity of literature. The intended meaning of *quantity* here is the lexical and context-independent one.

2.6 Sixth prediction

We predict (16), which we claim to be a fact about natural language.

(16) There is no numerical gap in the scale which underlies measurement in natural language.

What (16) is intended to say, illustrated by a concrete example, is that to the extent *John read 2.5 novels* is meaningful, *John read 2.55 novels* is too, as well as *John read 2.555 novels*, or any member of $\{\texttt{John read n novels} \mid [\![\texttt{n}]\!] \in \mathbb{Q}^+\}$.[10] This follows from the fact that 0.5, as well as 0.55, as well as 0.555, as well as any other rational number in $(0,1] \cap \mathbb{Q}$, are all in the range of μ_a, for any $a \in [\![\texttt{novels}]\!]_{at}$. This fact, in turn, follows from the fact that μ_a is, by stipulation, a function onto $(0,1] \cap \mathbb{Q}$. Note, importantly, that we cannot guarantee (16) by stipulating, merely, that the set of degrees underlying measurement in natural language is dense. To see that density alone does not exclude gaps, consider the set in (17).

(17) $S := \mathbb{Q}^+ \backslash \{x \in \mathbb{Q} \mid 3 < x \leq 4\}$

This is a dense scale, as between any two elements of S there is an element of S. However, S contains a gap: missing from it are numbers greater than 3 but not greater than 4, for example 3.5. Merely stipulating that the scale is dense, therefore, will not guarantee that *John read 3.5 novels* is meaningful, which we claim is a robust intuition that linguistic theory has to account for.

Note that Fox & Hackl (2006), according to our understanding, seems to assume that density of a scale alone guarantees the absense of gaps in it. The authors claim, for example, that density guarantees that exhaustification of *John has more than 3 children* would negate every element of $\{\texttt{John has more than n children} \mid \texttt{n} \in \mathbb{Q} \wedge \texttt{n} > 3\}$. We quote from page 543 of Fox & Hackl (2006): "Without the UDM [i.e. the assumption that the set of degrees is dense], [...] [t]he set of degrees relevant for evaluation would be, as is standardly assumed, possible cardinalities of children (i.e. 1, 2, 3, ...). The sentence would then assert that John doesn't have more than 4 children [...] If density is assumed, however, [...] the assertion would now not just exclude 4 as a degree exceeded by the number of John's children. It would also exclude any degree between 3 and 4." Taken at face value, this claim is wrong, as is evident from the example in (17).

[10] Where $\mathbb{Q}^+$ are the positive rationals. Thus, (16) should really be qualified with the phrase "as far as rational numbers are concerned", as pointed out by an anonymous reviewer, who raises the issue of irrational numbers. We refer the reader to §4.5 for more discussion on this point. Here we would only note that by "meaningful", we mean the sentence has non-trivial truth condition, and licenses inferences, as shown for *John read 2.5 novels* in the last section.

2.7 Seventh prediction

On the assumption that overt *many* and the comparative *more* instantiate MANY, we predict that the argument expressed by the sequence in (18) is is invalid.

(18) John read 2.5 novels and Mary read 2 novels. #Therefore, John read more novels than Mary.

By the definitions in (7) and (8), the scale $[\lambda x \lambda d.\, [\![\textsc{many}]\!](d)([\![\texttt{novels}]\!])(x)]$ is non-monotonic.[11] For instance, if b' is half of *Brothers Karamazov* and c' half of *Crime and Punishment*, then $[\lambda x \lambda d.\, [\![\textsc{many}]\!](d)([\![\texttt{novels}]\!])(x)](b')(0.5) = 1$ but $[\lambda x \lambda d.\, [\![\textsc{many}]\!](d)([\![\texttt{novels}]\!])(x)](b' \sqcup c')(0.5) = 0$. Therefore, (18) is not valid, since it would only be valid if the scale were monotonic, i.e. were a scale of comparison (Wellwood et al. 2012).

This is illustrated in (19). The temperature scale is non-monotonic. Hence, the temperature scale cannot function as the scale of comparison of the comparative in the second sentence of (19a). Therefore, the sequence of the two sentences in (19a) is an invalid argument. The weight scale, in contrast, is monotonic. Hence, the weight scale can function as the scale of comparison of the comparative in the second sentence of (19b), as evidenced by the validity of the argument expressed by (19b).

(19) a. John ate 90 degree hot spaghetti and Mary 70 degree hot spaghetti. #Therefore, John ate more spaghetti than Mary.
b. John ate 500 grams of spaghetti and Mary ate 200 grams of spaghetti. Therefore, John ate more spaghetti than Mary.

To account for the fact that the arguments in (20) are valid, we tentatively assume that MANY can be restricted to atoms and sums of atoms in equatives and comparatives.

(20) a. John read 3.5 novels and Mary read 2 novels. Therefore, John read more novels than Mary.
b. John read 2.5 novels and Mary read 2 novels. Therefore, John read as many novels as Mary.

This means to say that the scale of comparison of `more than`/`as many as` in (20) is the monotonic scale $[\lambda x \in [\![\texttt{novels}]\!]^{\sqcup}_{at}.\lambda d.\, [\![\textsc{many}]\!](d)([\![\texttt{novels}]\!])(x)]$ (where $A^{\sqcup}_{at}$ is the closure of A_{at} under the join operation).

[11] Let S be a scale, conceived of as a function from entities and degrees to truth values, such that for all x the degree function $S(x)$ is monotonic (i.e. such that $S(x)(d) \to S(x)(d')$ for all d, d' such that $d' \leq d$). Then, the scale S is monotonic iff $S(x)(d) = 1 \to S(x')(d) = 1$ for all d and x, x' such that $x \sqsubseteq x'$ (cf. Krifka 1989, Schwarzschild 2002).

3 Excursus: Conditions on predicates

The semantics we propose for MANY, as presented in (7), (8) and (9), requires that for each atom a of a predicate A the measure function μ_a have $(0, 1] \cap \mathbb{Q}$ as its range, and be additive with respect to non-overlapping subparts of atoms.

(21) Conditions on μ_a

a. $\text{RAN}(\mu_a) = (0, 1] \cap \mathbb{Q}$

b. $\mu_a(x \sqcup y) = \mu_a(x) + \mu_a(y)$ if $x, y \sqsubseteq a$ and $x \sqcap y = \emptyset$

This section details the conditions under which such measure functions μ_a exist. While it is possible to derive empirical predictions from these conditions (see footnote 13 below), which could have been added to §2, the main purpose of the current section is to tie in our proposal with a general theory of measurement. Conditions on the existence of measure functions μ_a of the right kind are conditions on subsets A of $\mathcal{D}_e$ with $A_{at} \neq \emptyset$ such that for each $a \in A_{at}$ there is a function μ_a that satisfies (21a) and (21b). Call such subsets of $\mathcal{D}_e$ "measurable predicates".

Let A be an arbitrary subset of $\mathcal{D}_e$ such that $A_{at} \neq \emptyset$. The first assumption we need to make for A to be a measurable predicate is that all of its atoms are divisible into arbitrarily many discrete parts.[12,13] This is stated in (22), where $\mathcal{P}_a := \{x \in \mathcal{D}_e \mid x \sqsubseteq a\}$.

(22) For all $a \in A_{at}$ and $n \in \mathbb{N}$, there is a set $S \subseteq \mathcal{P}_a$ such that $|S| = n$, $\bigsqcup S = a$, and $\bigsqcap S' = \emptyset$ for all $S' \subseteq S$ with $|S'| > 1$

It follows from (22) that no A atom a has a smallest part, and also, that there is no smallest difference between two parts of a. This condition is necessary to guarantee that the range of a measure function μ_a can be the rational interval $(0, 1] \cap \mathbb{Q}$, as demanded in (21a).

[12] It seems that a stricter condition might be desirable, viz. that every entity is arbitrarily divisible into discrete parts. However, such a condition would afford a notion of *possible division* of an entity and it is doubtful whether such a notion can be defined independently of the partial order $\langle \mathcal{D}_e \cup \{\emptyset\}, \sqsubseteq \rangle$.

[13] There are predicates whose members withstand being conceived of as being (arbitrarily) divisible. For example, it is hard to conceive of partial results of an achievement. Correspondingly, combining nominalizations of achievement verbs with non-integer nominals leads to deviance:

(i) a. # Ann fired 3.5 shots.

b. # Bob witnessed 1.5 arrivals.

The second and final assumption we need to make about a measurable predicate A is that its atoms satisfy the condition in (23).

(23) For all $a \in A_{at}$, $\langle \mathcal{P}_a, \sqsubseteq \rangle$ is a σ-algebra on $\langle \mathcal{D}_e \cup \{\emptyset\}, \sqsubseteq \rangle$[14]

σ-algebras are well-known structures of measure theory (see e.g. Cohn 1980) which guarantee, in our case, that the parts of an entity a are measurable in the sense of there being a function μ_a that satisfies (21a) and (21b). In simple words, what we require with (23) is that each $a \in A_{at}$ satisfy the following conditions: (i) the set of parts of a contains a greatest element (trivially satisfied, since a is a part of itself); (ii) for every (proper) part of a, there is another part of a, discrete from the first, such that the two parts together are a; and (iii) countably many parts of a joined together are a part of a. We add another condition to make sure that counting the atoms of a member x of a measurable predicate A is consistent with measuring all of its subatomic parts. For this to be the case, the atoms of A must be pairwise discrete from each other, as stated in (24).

(24) For all $a, b \in A_{at}$, if $a \sqcap b \neq \emptyset$ then $a = b$

4 Open questions

We end with some open questions for future research. Again, the list below is not intended to be exhaustive.

4.1 Concepts

The semantics we propose for MANY predicts the contrast between (15a) and (15b), repeated in (27a) and (27b) below, because it entails that to be half an A is to be half an A atom. This semantics, as it is, makes the wrong prediction that (25) is false.[15]

[14] A partial order $\langle A, \sqsubseteq \rangle$ is a σ-ALGEBRA on a lower bounded partial order $\langle B, \sqsubseteq \rangle$, with $A \subseteq B$, iff (i) it is upper bounded, (ii) closed under complementation, and (iii) closed under countable joins, where $\langle B, \sqsubseteq \rangle$ is LOWER BOUNDED iff $\bigsqcap B \in B$, and $\langle A, \sqsubseteq \rangle$ is UPPER BOUNDED iff $\bigsqcup A \in A$, CLOSED UNDER COMPLEMENTATION iff for all $x \in A$ there is a $y \in A$ such that $x \sqcup y = \bigsqcup A$ and $x \sqcap y = \bigsqcap B$, and CLOSED UNDER COUNTABLE JOINS iff for all countable subsets S of A it holds that $\bigsqcup S \in A$.

[15] According to an anonymous reviewer, this prediction is not wrong. Specifically, the reviewer says that s/he sees the *Unvollendete* (lit. 'unfinished') not as half of a symphony, but as a symphony, hence finds (25) to be false. We are not sure to what extent this opinion of the *Unvollendete* can be accounted for within a semantic theory of numerals. Our point concerns the problems faced by our account given the understanding that the *Unvollendete* is not a whole symphony, i.e. is "unvollendet". That there is a different understanding is orthogonal to the discussion.

(25) The *Unvollendete* is 0.5 symphonies.

Let u be the *Unvollendete*. From (8) and (9), it follows that $\mu_{[\![\texttt{symphonies}]\!]}(u) \neq 0.5$, as there is no $a \in [\![\texttt{symphonies}]\!]_{at}$ such that $u \sqsubseteq a$. Obviously, modality is involved: while there is no singular symphony s such that $\mu_s(u) = 0.5$, there could be one, since the last two movements could have been completed. Thus, counting symphonies seems to be about what could be a symphony, not what is actually a symphony. In other words, it is concepts, not predicates, that seem to be at play. This means we should, perhaps, revise our semantics so as to predict that to be half an A is to be half of something which is an A atom in some possible world. There is a possible world, say one where Schubert died at 41 instead of 31, in which the *Unvollendete* is part of a whole symphony, and this is what makes (25) true. However, we do not want to predict, incorrectly, that (26) is true, for example.

(26) *Crime and Punishment* is 0.5 symphonies.

Thus, while there certainly is a possible world w in which *Crime and Punishment* is a subpart of a symphony, we want w to be inaccessible from the world of evaluation. Plausibly, specifying the relevant accessibility relation in this particular case amounts to fleshing out the concept of 'symphony', and specifying it in the general case, to fleshing out the concept of 'concept'. We leave this task to future work.

4.2 Analyticities

Suppose John read one quarter of *Brothers Karamazov* and one quarter of *Crime and Punishment*, our semantics of MANY predicts, correctly, that neither (27a) nor (27b) is true.

(27) a. John read 0.5 novels.
b. # John read 0.5 quantities of literature.

Both sentences claim of something, which does not exist, that John read one-half of it: in the case of (27a), a novel which contains parts of both *Brothers Karamazov* and *Crime and Punishment*, and in the case of (15b), an quantity of literature which contains no subpart that is also an quantity of literature. Our semantics, however, does not predict the contrast in acceptability between (27a) and (27b): while the former is perceived as false, the latter is perceived as deviant. In §2.5, we said that this contrast has to do with analyticity: it lies in the meaning of the word *quantity* that any subquantity is a quantity, while nothing in the meaning of *novel* rules out a novel which contains parts of both *Brothers Karamazov* and *Crime and Punishment*. Analyticity has been appealed to in explanations of deviance (cf. Barwise & Cooper 1981, von Fintel 1993, Krifka 1995, Abrusán 2007). However, it has been pointed out that all analyticities are not equal: both (28a) and (28b) are analytically false, but only the latter is deviant.[16]

(28) a. Some bachelor is married.
  b. # Some student but John smoked.

Gajewski (2003) proposes that the kind of analyticity which leads to deviance is "L-analyticity". Thus, while (28a) is analytically false, (28b) is L-analytically false, and therefore is deviant. Discussing Gajewski's notion of L-analyticity will take us beyond the scope of this chapter. Hence, we will leave to future research the question whether, and if yes how, sentences such as (27b) can be considered L-analytical.

4.3 Countabilities

Words such as *q*uantity have been analyzed as a sort of "classifier" which turns a [−count] noun into a [+count] one (cf. Chierchia 2010). This analysis is motivated by such contrasts as that in (29).

(29) a. # The vampire drank 2 bloods.
  b. The vampire drank 2 quantities of blood.

Since *blood* is a [−count], it cannot be counted. On the other hand, *quantity of blood* is [+count], therefore it can be. However, such contrasts as that between (29b) and (30), to the best of our knowledge, have not been paid attention to.

(30) # The vampire drank 2.3 quantities of blood.

The semantics we proposed for MANY, unfortunately, makes no distinction between (29b) and (30): both are predicted to be analytically false. The proposal

[16]Assuming that (28a) has the truth condition in (i.a) (cf. Heim & Kratzer 1998) and (28b) the truth condition in (i.b) (cf. von Fintel 1993).

(i) a. $\{x \mid x \in [\![\texttt{bachelor}]\!] \wedge x \in [\![\texttt{married}]\!]\} \neq \emptyset$
  b. $\{x \mid x \in [\![\texttt{student}]\!] \wedge x \notin \{\text{John}\} \wedge x \in [\![\texttt{smoked}]\!]\} \neq \emptyset \wedge$
  $\wedge\ \forall P(\{x \mid x \in [\![\texttt{student}]\!] \wedge x \notin P \wedge x \in [\![\texttt{smoked}]\!]\} \neq \emptyset \rightarrow \{\text{John}\} \subseteq P)$

thus shares with several others the shortcoming of not being able to differentiate between subtypes of [+count] noun phrases. The task remains, therefore, of refining the semantics of MANY so as to predict the contrast in question.

It should be noted, in addition, that words like *quantity* may pose a challenge for the theory of measurement proposed in Fox & Hackl (2006).[17] These authors derive the fact that (31a) does not license the scalar implicature (31b)

(31) a. The vampire drank more than 2 quantities of blood.
b. ¬The vampire drank more than 3 quantities of blood.

from the assumption that the scale mates of *2*, for the deductive system (DS) which computes scalar implicatures, are not the set of natural numbers, but the set of rational numbers. The proposal, therefore, claims that (30) is a scalar alternative of (31a) (see §2.6). To the extent that the deviance of (30) is due to this sentence being deemed ill-formed by the DS itself (see Gajewski 2003, Fox & Hackl 2006, and the discussion in the previous subsection), the question arises as to whether DS uses a sentence which it deems ill-formed in its computation. Again, we leave this topic to future work.

4.4 Morphology

The plural vs. singular distinction in number marking languages has usually been considered to mirror the bare vs. classified distinction in classifier languages (cf. Chierchia 1998, Cheng & Sybesma 1999). Specifically, plural/bare nouns have been analyzed as denoting "number-neutral" predicates, i.e. sets containing both singularities and pluralities, while singular/classified nouns have been analyzed as denoting "atomic" predicates, i.e. sets containing only singularities. However, with respect to numerical statements involving non-integers in English, a number marking language, and Vietnamese, a classifier language, the correlation falls apart: what is obligatory is a plural noun in English and a classified noun in Vietnamese.

(32) a. John ate 0.5 cake-*(s).
b. John ăn 0.5 *(cái) bánh.
John ate 0.5 CL cake
'John ate 0.5 cakes.'

[17]These include *amount* and *fraction*, among possibly others.

(i) a. # The vampire drank 2.3 amounts of blood.
b. # The vampire ate 2.3 fractions of the apple.

We know of no account for this fact, and leave an investigation of it for future research.

4.5 Reals

We have been assuming that the set of numbers underlying measurement in natural language is $\mathbb{Q}$, the set of rationals. But what prevents us from assuming that it is in fact $\mathbb{R}$, the set of reals? Clearly, that assumption will be true to the extent that sentences containing reals which are not rationals are meaningful. Is (33) meaningful?

(33) John ate π (many) cakes.

We have no clear intuition about (33). A confounding factor for such examples as (33) might be that π is too "artificial" to be perceived as part of natural language. One might, then, imagine an experiment along the following lines. Let *ABC* be a cirle on which lie the three points *A*, *B*, and *C*. Let *AB* be the diameter of *ABC*. Now suppose a mathematican, say Euclid, uttering the sentence in (34).

(34) If *AB* is one novel, then *ABC* is how many novels John read.

Obviously, there is no natural language numeral *n* such that Euclid's thought can be expressed as *John read n novels*. The question is whether this thought is, nevertheless, representable by grammar, or more specifically DS, and thus plays a role in inferences such as scalar implicatures (see §4.3). We leave this question to future research.

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Chapter 13

Deconstructing base numerals: English and Polish 10, 100, and 1000

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Base numerals differ from other simplex numerals in that they license mathematical operations like multiplication and addition. This paper investigates the syntactic status of base numerals in two languages, Polish and English, focusing on three numerals: 10, 100, and 1000. It concludes that these numerals instantiate three types of bases, nominal bases, syntactic bases, and lexicalized bases. A nominal base is a noun used as a base, as is the case with Polish 1000. A syntactic base involves the use of a morpheme to create basehood, as is proposed for English 100 and 1000. Finally, lexicalized bases, English 10 and Polish 10 and 100, are the result of grammaticalization, i.e. the reduction of a numeral base into a morpheme. This paper speculates that the three types of bases form a grammaticalization cline, suggesting that more types of bases are possible morphosyntactically, depending on the grammaticalization path.

Keywords: numeral, base, category, syntax, Slavic

1 Introduction

Developed numeral systems are characterized by serialization (von Mengden 2008): the ability to combine numerals together to create reference to unlexicalized quantities. The quantity 304, for example, is expressed via a combination of the numerals 3, 100, and 4 in English. Crucial to serialization, or complex numeral formation, are the base numerals, e.g. English 100 and 1000. Base numerals license mathematical operations like multiplication or addition, which are central to complex numeral formation (e.g. $304 = 3{\times}100{+}4$). This property distinguishes base numerals from other simplex numerals, which do not license mathematical operations, e.g. **two seven* and **seven and one.*

Heidi Klockmann. 2021. Deconstructing base numerals: English and Polish 10, 100, and 1000. In Mojmír Dočekal & Marcin Wągiel (eds.), *Formal approaches to number in Slavic and beyond*, 297–322. Berlin: Language Science Press. DOI: 10.5281/zenodo.5082474

Base numerals have been observed to show morphosyntactic differences from other simplex numerals. Corbett (1978), for example, argues that crosslinguistically, higher numerals differ from lower numerals in being more noun-like, his higher numerals generally corresponding to base numerals. This trend is evidenced with English and Polish base numerals. English 100, for instance, requires an indefinite article when no other material is present (e.g. a determiner, demonstrative, or other numeral), while non-base simplex numerals do not:

(1) a. *(a) hundred books
    b. (*a) two books

Polish 1000 in subject position can trigger gender and number agreement on the verb, while a non-base simplex numeral like 5 does not:

(2) a. Cały tysiąc dziewczyn spał.
    whole.M.SG.NOM 1000.M.SG.NOM girls.F.PL.GEN slept.M.SG
    'A whole thousand girls slept.'
    b. Pięć dziewczyn spało.
    five.NV.NOM/ACC girls.F.PL.GEN slept.N.SG*(default)*
    'Five girls slept.'

That higher numerals in Polish and other Slavic languages differ from other numerals has been recognized in various places in the literature, where such numerals are suggested to be (more) nominal, e.g. Rutkowski (2002) and Miechowicz-Mathiasen (2014) on Polish, Neidle (1988) and Franks (1995) on Russian, Giusti & Leko (2005) on Bosnian/Serbian/Croatian, and Veselovská (2001) on Czech.

Morphosyntactic differences between base and non-base numerals have led some to propose a deeper difference between the two numeral types. Kayne (2005), for instance, proposes a (silent) nominalizing suffix -NSFX which attaches only to base numerals and in effect allows them to act as bases. In his approach, being a base is a matter of whether something combines with silent -NSFX or some overt equivalent, and only bases have this property. From another perspective, Rothstein (2013) proposes that base numerals (or in her terminology, lexical powers, e.g. 100, 1000, but not 10), have a different semantic type than non-base numerals; she relates this to their need for some kind of multiplier, this being built into the semantic type of the base numeral, and the ability of these bases to form approximatives (e.g. *hundreds, thousands*).

Ionin & Matushansky (2018) take an opposing approach, arguing that Rothstein's (2013) base/non-base dichotomy is insufficient empirically and theoretically. Instead, they develop an account in which all numerals are of the same semantic type but have varying morphosyntactic properties, which they argue do not clearly correlate with basehood. They suggest that what is and is not a base is extralinguistic, and make use of a diacritic to identify those numerals that can function as bases. In essence, they reject the idea that bases differ from non-bases semantically, but accept that bases may differ morphosyntactically, though not in any way systematic enough to suggest a special status for bases.

The present paper is concerned with the morphosyntactic status of base numerals. Like Kayne (2005) and Rothstein (2013), it explores the hypothesis that the morphosyntactic differences observed between base and non-base numerals are meaningful, but in line with Ionin & Matushansky (2018), it accepts that a simple dichotomy of base/non-base is insufficient empirically and pursues a more nuanced approach. A conclusion of this paper is that bases can differ syntactically from non-bases, and furthermore, that there are at least three types of base numerals among Polish and English 10, 100, and 1000: nominal bases, syntactic bases, and lexicalized bases; this paper speculates that these may represent steps along a grammaticalization cline, leaving the potential open for even more bases morphosyntactially. Whether morphosyntactic differences between bases and non-bases also relate to semantic differences along the lines of Rothstein's (2013) analysis remains beyond the scope of this paper.

This paper is structured as follows. It begins in §2 by introducing some recent literature on the internal structure of simplex numerals, adopting a root analysis of numerals. It then turns to numerals 10, 100, and 1000 in Polish and English in §3, arguing that they instantiate three types of bases. §4 explores how this might relate to a grammaticalization cline, drawing on historical evidence presented in previous literature, and finally §5 concludes.

2 The internal structure of a numeral

Recent research on complex numeral formation has adopted the view that complex numerals are constructed in the syntax (see especially Ionin & Matushansky 2004, 2006, 2018). According to Ionin & Matushansky (2018), complex numerals are formed using existing syntactic means in a language, e.g. complementation or potentially adjunction for multiplication and coordination or adpositional structures for addition. In most approaches, the numerals involved in complex numeral formation are atoms and have no internal structure themselves. However, there has been a trend in recent research to decompose even apparently atomic words into pieces of structure, starting with approaches in the late 1980s and early 1990s which isolate inflection (tense, agreement, number) from the verb or noun (e.g. Pollock 1989, Ritter 1991), to the relatively recent sub-field of nano-syntax (e.g. Starke 2010), which decomposes individual words into features, even without clearly identifiable morphemes corresponding to those features. This general line of thought has been applied to numerals, with some researchers suggesting that individual simplex numerals can be internally complex. In this section, I will briefly highlight a few analyses, and discuss how they motivate an extended decomposition for base numerals.

Fassi Fehri (2018: Ch. 3) makes the claim that a Distributed Morphology (DM)-style approach is appropriate for simplex numerals. He proposes that numerals correspond to an acategorial root embedded under functional structure, a premise which is also adopted in Klockmann (2017) and Wągiel (2020, forthcoming) for Polish numerals. Fassi Fehri (2018: 61) points out that numerals are *polycategorial*, meaning that they take the form of a variety of categories crosslinguistically (see e.g. Ionin & Matushansky 2018: section 3.4 for examples of nominal, adjectival, verbal, and mixed numerals), and furthermore, that numerals are *polysemous*, meaning that they can express a variety of numerosity-related senses: cardinals, ordinals, fractionals, etc. The proposal that numerals contain a root at their core which is embedded under functional structure provides the needed flexibility for capturing the differing but related senses that are found (presumably via different functional structures above the root), as well as the numerous idiosyncrasies and category types associated with various numerals (e.g. the notorious case and agreement patterns found with Slavic numerals).

There is a further reason to treat numerals as containing roots: numerals can be considered to form a (semi-)open class of elements. The distinction between open and closed class is often taken to correlate with being a lexical or functional category (e.g. Abney 1987), where lexical categories like nouns and verbs are open class, and functional categories like tense or number are closed class. If being lexical corresponds to containing a root (as argued for in Klockmann 2017: Ch. 2), then presumably the correlation relates to it being easier to add new roots to the lexicon than new functional items. As such, the ability to add new numerals to a numeral system would argue in favor of its treatment as open class, and hence as being lexical and containing a root. Fictitious numerals and high numerals provide such evidence. While in a language like English the most useful quantities have already been named (*hundred, thousand, million, billion, trillion*), new lexical items have been created to name very high quantities, e.g. *quadrillion, quintillion, sextillion, vigintillion, centillion, googol, googolplex.* Likewise, numeral-like lexical items also exist to describe fictitious quantities, e.g. *zillion, gazillion, bajillion.* These lexical items are presumably numerals,[1] and as such, suggest that

[1]For example, the definition of *googolplex* on Wikipedia (https://en.wikipedia.org/wiki/Googolplex) clearly makes use of *googol* as a numeral: “Written out in ordinary decimal notation, it is 1 followed by 10^{100} zeroes, that is, a 1 followed by *a googol zeroes*.” (my emphasis)

the set of numerals is not closed class. Further in favor of this view are less developed numeral systems. Comrie (2013) provides examples of languages with very limited sets of numerals, e.g. Mangarayi (Australian) with numerals for 1–3, Ydiny (Australian) with numerals for 1–5, and Hixkaryana (Cariban, Brazil) with numerals for 1–5 and 10; Bowern & Zentz (2012) also provide substantial data on a large number of numeral systems on the Australian continent, where the majority of language varieties (n = 139) have numerals maximally up to 3 or 4. Serialization (complex numeral formation) is dependent on the numerals available in a system, and thus, for these numeral systems to grow beyond the limits of serialization, new numerals must be added to the lexicon. This suggests that the development of a numeral system is in line with its members being open class. I adopt the view that a numeral contains a root.

If numerals contain roots, the next question is what functional structure dominates that root as a cardinal numeral, i.e. in a structure such as Figure 1 what is the identity of F(P)?

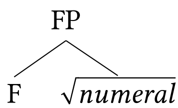

Figure 1: Numeral functional structure

According to Wągiel (2020), who discusses the semantics of Polish numerals but also considers their internal structure, the answer is a classifier operator called Card which gives the numeral its properties as a cardinal. In Wągiel (2020), this classifier is silent and combines on top of a gender marker for numerals like 5 in Polish (which distinguish virile and non-virile gender, e.g. *pięci-u*$_{\mathrm{V}}$ vs. *pięć-*$\varnothing_{\mathrm{NV}}$); in Wągiel (forthcoming), which aligns more closely with the role of gender argued for in Fassi Fehri (2018), he adjusts the analysis and connects the classifier to the overt realization of virile gender, maintaining a silent classifier with non-virile gender. In sum, structurally the numeral 5 looks as in Figure 2 and 3, i.e. as a virile and non-virile numeral (semantic formulas omitted).

The use of a classifier in the structure of the numeral relates to Sudo (2016), who considers Japanese numeral classifier constructions. Sudo (2016) argues against the predominant view that classifiers occur in numeral constructions to make nouns count, and instead proposes that they act to convert the numeral into a modifier. This view is further consistent with the findings of Bale & Coon (2014), who show that in Chol, a Mayan language with mixed sources for numerals, the need for a classifier in a cardinal-noun construction is dependent on the

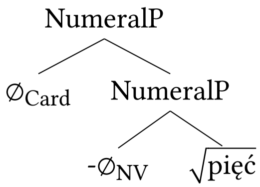

Figure 2: Non-virile numeral 5

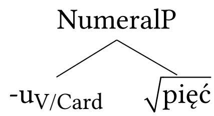

Figure 3: Virile numeral 5

source language of the numeral: native Chol numerals require a classifier while imported Spanish numerals do not. Their conclusion is that the classifier occurs for the numeral. The work of Wągiel (2020, forthcoming), Sudo (2016), and Bale & Coon (2014) suggests a potential identity for the F(P) in Figure 1 – a classifier-like element which gives the numeral root its cardinal properties. For now, I will simply assume a head Card in the functional structure of a cardinal numeral.

The present discussion has focused on the decomposition of simplex numerals, and in particular, non-base simplex numerals. While the presented analyses give us a handle on what the functional structure of non-base numerals might look like, it's not immediately clear that they translate to the base numerals. The base numeral 1000 in Polish, for example, does not distinguish virile and non-virile gender like its non-base counterpart 5, and as we shall see shortly in §3.1, it has a number of other properties that make it incompatible with the structures in Figures 2 and 3. Despite this, the general approach, i.e. decomposing numerals into roots and functional structure, is just as plausible for base numerals as for non-base numerals, and it may turn out that they contain different or additional structure from what we've seen above. In the next section, we turn to morphosyntactic data for numerals 10, 100, and 1000 in Polish and English, which give clues into their syntactic representation.

3 Three types of base numerals

Polish and English numeral systems are centered around 10, with multiples of 10 acting as bases. In both languages, the lexical items for 10, 100, and 1000 are considered to be base numerals, given that they each seem to license addition and multiplication, e.g. in English, *six-ty* (= 6 x 10), *six hundred* (=6 x 100), and *six thousand* (= 6 x 1000) and in Polish, *sześć-dzisiąt* (= 6 x 10), *sześć-set* (= 6 x 100), and *sześć tysięcy* (= 6 x 1000). In this section, I argue that these numerals can be classified into three types of bases: nominal bases, syntactic bases, and lexicalized bases. Polish 1000 is an example of a nominal base, and it involves the use of what is morphosyntactically a noun as a base numeral. English 100 is an example of a syntactic base, and along the lines of what was proposed by Kayne (2005), it involves a silent BASE morpheme which gives the numeral root its basehood. Finally, English 10 and Polish 10 and 100 are lexicalized bases. These are not active bases in the language, but grammaticalized morphemes (and it may not be appropriate to call them bases); the approach pursued is similar to what is proposed in Wągiel (2020).

3.1 Nominal base numerals

The numeral 1000 in Polish behaves morphosyntactically like a noun. This can be seen in its morphosyntactic paradigm and in how it interacts with other elements in the sentence. I will start by illustrating the paradigm of the numeral, and then turn to its case and agreement properties. Examples which are extracted from the National Corpus of Polish are marked as NKJP.

Polish is a language which distinguishes case, number, and gender. The numeral 1000 inflects for case and number using the same morphology as a masculine inanimate noun; this suggests it carries masculine inanimate gender. The paradigm is illustrated in Table 1, which compares the numeral 1000 *tysiąc* to the masculine inanimate noun *miesiąc* 'month'.

Table 1: Paradigm of Polish numeral 1000 and noun *miesiąc* 'month'

	SG		PL	
	'thousand'	'month'	'thousands'	'months'
NOM/ACC	tysiąc	miesiąc	tysiąc-e	miesiąc-e
GEN	tysiąc-a	miesiąc-a	tysięc-y	miesięc-y
DAT	tysiąc-owi	miesiąc-owi	tysiąc-om	miesiąc-om
LOC	tysiąc-u	miesiąc-u	tysiąc-ach	miesiąc-ach
INST	tysiąc-em	miesiąc-em	tysiąc-ami	miesiąc-ami

Simplex numerals and even numerals 10 and 100 in Polish inflect for the gender of the quantified noun, either virile (= grammatically masculine, biologically male, and human, see Rappaport 2011) or non-virile (= everything else) in the plural. The numeral 1000 does not. This is illustrated in (3).

(3) a. pięć dziewczyn, pięciu chłopców
five.NV girls.GEN five.V boys.GEN
'five girls, five boys'

b. dziesięć dziewczyn, dziesięciu chłopców
ten.NV girls.GEN ten.V boys.GEN
'ten girls, ten boys'

c. sto dziewczyn, stu chłopców
hundred.NV girls.GEN hundred.V boys.GEN
'a hundred girls, a hundred boys'

d. tysiąc dziewczyn, tysiąc chłopców
thousand girls.GEN thousand boys.GEN
'a thousand girls, a thousand boys'

The numeral 1000 does not show agreement with the quantified noun for gender. Instead, numeral 1000 seems to have its own gender value, masculine inanimate, as suggested by its paradigm in Table 1 above. That numeral 1000 can carry its own gender feature is further evidenced by adjectival and verbal agreement: pre-modifiers (e.g. demonstratives, adjectives) and verbs can both surface with masculine singular agreement, in agreement with the numeral itself.

(4) Cały tysiąc dziewczyn spał.
whole.M.SG.NOM 1000.M.SG.NOM girls.F.PL.GEN slept.M.SG
'A whole thousand girls slept.'

Furthermore, when plural, as in approximatives (5a) or when quantified by another numeral (5b), the numeral surfaces as plural, and verbal agreement likewise can surface as non-virile plural. The examples below use virile masculine nouns to exclude any possibility that agreement could somehow be with the genitive noun. Verbal agreement is necessarily with the plural numeral.

(5) a. Tysiące Polaków opuszczały obozy i więzienia.
1000s.M(NV).PL.NOM Poles.M(V).PL.GEN left.NV.PL camps and prisons
'Thousands of Poles left camps and prisons.' (NKJP)

b. Cztery tysiące widzów dopingowały Polaków przez całe spotkanie.
four.NV 1000s.M(NV).PL.NOM spectators.M(V).PL.GEN cheered.NV.PL Poles through whole meeting
'Four thousand spectators cheered Poles throughout the meeting.' (NKJP)

What the paradigm of the numeral and its ability to control agreement in its singular and plural form show is that the numeral carries phi-features, number and gender, like any noun in the language. These are nominal properties, and argue for its treatment as a noun.

Note that numeral 1000 can also trigger default agreement in each of the example types in (4–5) above, as illustrated below:[2]

(6) Tysiąc dziewczyn spało.
1000.M.SG.NOM girls.F.PL.GEN slept.N.SG$_{(default)}$
'A thousand girls slept.'

Klockmann (2017) attributes this to an optional absence of gender in the representation of the numeral, a conclusion also found in Ionin & Matushansky (2018). The absence of gender leads to failed agreement on the probe, with default features as the result.

Like a noun, numeral 1000 also triggers genitive case on the quantified noun, as can be observed in previous examples; see also (7). This occurs in all case environments. This property distinguishes 1000 from other numerals like 5, 10, and 100, which only trigger genitive in structural case environments (nominative, accusative), e.g. (3) above, but not oblique case environments, e.g. (8).

(7) a. z tysiącem ptaków
with thousand.INST birds.GEN
'with a thousand birds'

b. z kluczem ptaków
with key(flock).INST birds.GEN
'with a flock of birds'

(8) a. z pięcioma ptakami
with five.INST birds.INST
'with five birds'

b. z dziesięcioma ptakami
with ten.INST birds.INST
'with ten birds'

[2]Pre-modifiers add more to this picture – they can optionally surface with non-virile plural default features (see Klockmann 2017: 121–122 for evidence that these are default features in the nominal domain), which appears to be failed agreement with the numeral, or as genitive plural, in agreement with the quantified noun.

c. ze stoma ptakami
with hundred.INST birds.INST
'with a hundred birds'

The case and agreement properties of numeral 1000 speak towards its positioning in the language as a noun. This suggests that the functional structure dominating the root of the numeral is nominal in nature. Depending on the theory of nominal functional structure adopted, this would imply some position for gender and number, which I will call GenderP and NumberP, respectively.[3] I would also propose that the numeral allows a quantificational layer in its functional structure, QP, as host to other cardinality expressions, such as numerals or quantifiers like *kilka* 'a few' or *wiele* 'many'. A numeral in this position would create a complex numeral, with 1000 as the base and the numeral in QP the multiplier (see also (9) below). Together, this gives a rough structure as below.[4]

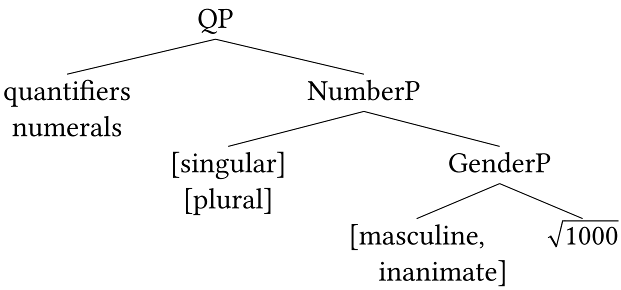

Figure 4: Structure of Polish numeral 1000

As a multiplicand in a complex numeral, the numeral 1000 inflects in the same way as a noun modified by that numeral would, i.e. numeral 2 agrees with the plural noun or numeral in gender and case (9a), while numeral 5 assigns genitive to the plural noun or numeral (9b):

(9) a. dwa ptaki, dwa tysiące
two.M.NOM birds.M.PL.NOM two.M.NOM thousands.M.PL.NOM
'two birds, two thousand'

b. pięć ptaków, pięć tysięcy
five.NV.NOM/ACC birds.M.PL.GEN five.NV.NOM/ACC thousands.M.PL.GEN
'five birds, five thousand'

[3] In the absence of successful agreement, GenderP is absent from the structure, see (6).

[4] I will not address how the numeral combines with the noun as this takes us too far afield. There are various views on this, but most assume a numeral with no internal structure.

This is in line with the nominal status of 1000, since quantificational material combines in the same way with 1000 as with other nouns. Further in favor of this view is the behavior of 1000 with modifiers. A noun allows for an adjective between the quantifier and the noun, e.g. *trzy piękne psy* 'three beautiful dogs'; the same is true for quantified 1000, as illustrated below:

(10) a. … kosztował 8 tys. zł. Trzy kolejne tysiące
cost 8 thousand złoty(currency) three next thousands
wydano na autokary.
spent on coaches
'[It] cost 8000 złoty. The next three thousand (złoty) was spent on coaches.' (NKJP)

b. … i pewnie jeszcze z paroma innymi tysiącami
and probably still with a.few.INST other.INST thousands.INST
ludzi
people.GEN
'and probably with another few thousand people' (NKJP)

Modifiers are permitted internal to a complex numeral as in (10a), which is consistent with the numeral having the functional structure of a noun, even to the QP layer. Together, this argues for numeral 1000's status as a noun in Polish.

Numeral 1000 is both a noun and a base. This implies that it is possible for a base numeral to have the morphosyntax of a noun. Note that the structure in Figure 4 is not immediately compatible with the structures presented above in Figures 2 and 3, as it is not clear where a Card head would belong (Is it in QP? Is there a piece of structure above the nominal functional structure of the numeral? Is it absent?). I leave the status of Card with 1000 aside, and conclude that the nominal properties of 1000, in combination with its ability to act as a base, illustrates that base numerals can be morphosyntactically nouns.

3.2 Syntactic base numerals

The English numerals 100 and 1000 show some nominal properties, but not enough to be classified as a noun as Polish 1000 was. While like nouns they can surface with an indefinite article (*a hundred people, a thousand people*) and also allow a plural form (as an approximative: *hundreds of people, thousands of people*), they differ from nouns in many crucial ways. I will briefly compare them to nouns by considering some of the properties nominal Polish 1000 had, before turning to what makes them a syntactic base. Examples which are extracted from the Corpus of Contemporary American English are marked COCA.

Polish 1000 could control verbal and pre-modifier agreement. English 100 and 1000 cannot; both verbs and demonstratives are plural in agreement with the quantified noun:

(11) a. A {hundred/thousand} books {were/*was} stolen.
b. {these/*this} {hundred/thousand} books

Polish 1000 required case marking on the quantified noun; no comparable *of* surfaces with English 100 and 1000:

(12) * a {hundred/thousand} of books

Likewise, Polish 1000 behaved as a noun would in a complex numeral: it surfaced as plural and it allowed intervening modifiers between it and the quantifier/numeral. Nothing comparable occurs with English 100 and 1000:

(13) a. * two {hundreds/thousands}
b. * two {other/good/extra} {hundred/thousand}

Many of the nominal properties we might expect to find with English 100 and 1000 were they nominal bases are not present. Instead, what we do find that is "nominal" is the indefinite article *a*, which occurs when no other element is present (e.g. a determiner, demonstrative or other numeral). Given this, I would suggest that the presence of *a* is not a nominal property at all, but instead marks the presence of a morpheme BASE, which is absent with non-base numerals. I turn now to evidence in favor of this reinterpretation of the role of the article; note that the proposal below is not intended to apply to the indefinite use of *a* (as in *a cat*). I direct readers to Klockmann (2020) for a fuller discussion of the article in English cardinality expressions, and its relation to the indefinite article.

A crucial difference between English numerals 100 and 1000 and lower numerals, including 10, is the apparent indefinite article:

(14) a. one book
b. two books, ten books
c. a hundred books, a thousand books

However, this difference disappears when a pre-numeral modifier is included. Modification of all numerals, from simplex *one, two, ten* to complex *one hundred, two hundred* and even plural numerals, requires an article if an adjective precedes it. This is a phenomenon which has been observed in a number of works (e.g. Honda 1984, Keenan 2013, Ionin & Matushansky 2018, among others) many of which assume *a* to be an indefinite singular article.

(15) a. One property? One property? A measly one property?
b. Maybe it will be a full two terms, maybe it won't.
c. The animals stopped a respectful ten paces away and bowed their heads.
d. There were more than a thousand of the latter alone, representing a good hundred journals.
e. Sinan's best efforts had raised a bare two hundred warriors to combat the fiends.
f. Yet there are records a mere thousands of years ago of Perseid storms (all from COCA)

The inclusion of the article does not make the construction singular; verbal agreement remains plural, targeting the quantified noun:

(16) A further 18 women were diagnosed with ovarian cancer in the five-year period that followed. (COCA)

I propose that the article we see is a lexicalization of the Card head (see §2), or some other more general head related to quantification. If we adopt some form of phrasal spell-out, then we can assume that the Card head is not necessarily silent, but spelled-out together with the numeral root for those numerals that do not usually show an article (e.g. *one, two, ten*). This is illustrated in Figure 5 below.

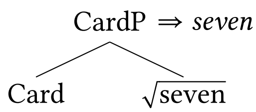

Figure 5: Spell-out of *seven*

When a modifier is included in the structure, it interrupts the adjacency between the numeral root and the Card head, leaving Card stranded and unlexicalized. The article *a* is used as a last-resort spell-out of this head (comparable to *do*-support in the clausal domain; we might call this Card- or Q-support). See Figure 6. Use of a modifier, then, forces this rescue operation of inserting an article, due to a requirement that Card/Q have a phonological realization. In that sense, the article is neither indefinite nor singular, and should be termed a default cardinality marker instead, as suggested by Lyons (1999).[5]

[5] Analyses of this type face questions about how the article disappears in the presence of D-level

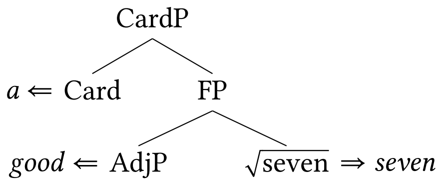

Figure 6: Spell-out of modified *seven*

Returning to English 100 and 1000, even in the absence of a modifier, the article is needed. I propose that the motivation for said article is the same. There is an intervener, and it prevents the numeral from spelling out with Card. Given that what distinguishes these numerals from the others is their basehood, I propose that the intervener is a silent morpheme BASE. BASE blocks phrasal spell-out of the numeral and Card and instead, Card must be realized by the article *a*.

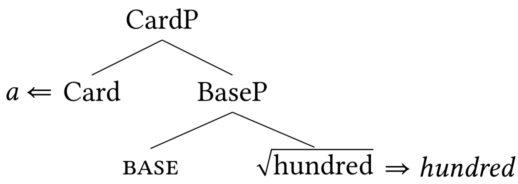

Figure 7: Spell-out of *hundred*

In unmodified multiplicative complex numerals (e.g. *seven hundred*) no article occurs, suggesting the spell-out issue has been resolved. Under the analysis presented in Figure 5 above, non-base simplex numerals spell-out CardP in addition to the numeral root; thus, we can assume that the use of a multiplier provides CardP with a spell-out, alleviating the need for the article. This is depicted in Figure 8. Note that introduction of a modifier (*a good seven hundred*) reintroduces the need for the article, similarly to Figure 6.

Note that the analysis in its current form places different spell-out requirements on BASE and Card; BASE can lack phonological content while Card cannot. This could imply that Card has a special status over BASE; alternatively, it may suggest that *hundred* and *thousand* phrasally spell-out BASE as well, but not Card. I leave this open for now.

material like determiners and demonstratives if it is not a determiner itself (e.g. *the (*a) hundred books*). There are various possibilities – there may be a phonological constraint preventing their co-occurrence (Lyons 1999), *the* might also have quantificational properties which obviates the need for the article (Borer 2005), or they might indeed co-occur if what is in D is only *th-*.

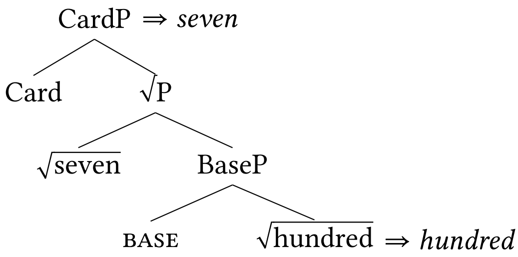

Figure 8: Spell-out of *seven hundred*

The use of a morpheme base to give the numeral roots *hundred* and *thousand* their basehood is what I refer to as a "syntactic base"; these become bases via the syntactic structure. Note that the final proposal, i.e. of a silent morpheme base which combines with the numeral, is not very far from what was proposed by Kayne (2005) and adjusted in Kayne (2019); in both cases a silent morpheme combining with bases is assumed: -nsfx in Kayne (2005) and set in Kayne (2019) (though Kayne's set combines with a wider range of numerals than base).

3.3 Lexicalized base numerals

I reserve the term "lexicalized base" for numerals which appear to license mathematical operations, but do not do so in a transparent or productive way. Instead, I propose that there are lexicalized morphemes, distinct from the numerals they are bases of, which fulfill the base function that the root and its functional structure previously filled. In this sense, these numerals are not true bases. This analysis applies to English 10 and Polish 10 and 100.

English 10 appears to have two allomorphs when functioning as a base, *-ty* and *-teen*. The morpheme *-ty* is a multiplicative base occurring only with multipliers (e.g. *thir-ty, for-ty, fif-ty, six-ty*) and the morpheme *-teen* is an additive base occurring only with additives (e.g. *thir-teen, four-teen, fif-teen, six-teen*). I propose that *-ty* and *-teen* are not allomorphs of *ten*, but instead are distinct morphemes which express multiplication by 10 and addition by 10, respectively (see von Mengden 2010 for a similar approach to *-ty* and *-teen*). This is the approach taken by Wągiel (2020) for Polish, who encodes multiplication and addition in the semantics of the morpheme. These morphemes augment the value denoted by the simplex numeral they combine with (which he takes to be of type *n*). The structures and formulas in Figures 9–10 are borrowed from Wągiel (2020) and adjusted for English and the present paper.[6]

[6]CardP with English lexicalized bases is not realized as the article *a* unless a modifier is present

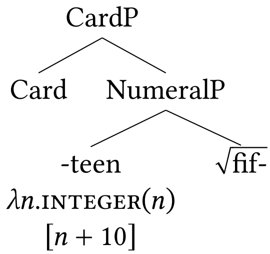

Figure 9: English additive *-teen*

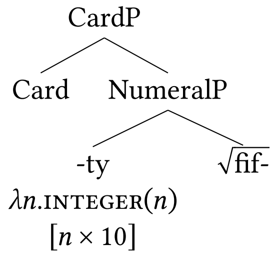

Figure 10: English multiplicative *-ty*

Presumably, contextual allomorphy adjusts the phonological form of the multiplier, e.g. *five* to *fif-* and *three* to *thir-* in the context of a multiplicative or additive base morpheme. Under this analysis, *ten* is a non-base simplex numeral, while *-ty* and *-teen* are functionalized morphemes, grammaticalized from a previous stage in which *ten* was a base. In this sense, *ten* is not a base, but *-ty* and *-teen* are. This captures the fact that *ten* does not need an article (**a ten*) and that it cannot pluralize on its own as an approximative (**tens of people*) (for this, it requires the presence of a base numeral, e.g. *tens of thousands of people*).

Polish 10 and 100 are likewise lexicalized base numerals. As with English 10, the multiplicative and additive base morphemes for Polish 10 and 100 are distinct from the lexical items for 10 and 100. The forms of 10 and 100 are given in Table 2. The NOM/ACC forms are used with non-virile nouns in nominative and accusative case contexts, while the OBL forms are used with virile nouns in all case contexts and with non-virile nouns in oblique case contexts. An additional instrumental form (with *-oma* instead of *-u*), not depicted here, also exists for all numerals except 500–900.[7]

A few words regarding Table 2 are in order here. Firstly, the multiplicative and additive forms of 10 and 100 are not consistent with the forms of the lexical items for 10 and 100 (e.g. the first row vs. all other rows). In the nominative/accusative columns, the forms are fully distinct, while in the oblique columns, they are partially distinct (10 shows regularity with multipliers 5–9, while 100 shows regularity with multipliers 2–4). The distinct forms are frozen, from a stage in which 10 and 100 were transparent, productive bases. For example, *-ście* (in 200) and *-sta* (in 300, 400) are historical nominative dual and plural forms for 100, while *-set*

(e.g. *fifteen minutes* vs. *a good fifteen minutes*); this suggests that lexicalized bases are not interveners for spell-out (unlike BASE) and can spell-out CardP in combination with the numeral root.

[7]The absence of a form with *-oma* correlates with the positioning of the gender/case marker, which for 500–900 occurs on the multiplier and for all other numerals, on the multiplicand.

Table 2: Morphological form of Polish 10 and 100. *Note*: The form of the multiplier/additive differs for 40, 15, and 19.

	10		100	
	NOM/ACC	OBL	NOM/ACC	OBL
	dziesięć	dziesięci-u	sto	st-u
2 ×	-dzieścia	-dziest-u	-ście	-st-u
3–4 ×	-dzieści	-dziest-u	-sta	-st-u
5–9 ×	-dziesiąt	-dziesięci-u	-set	-u-set
1–9 +	-naście	-nast-u		

(in 500–900) is a historical genitive plural form of 100 (Dziubała-Szrejbrowska 2014). These forms are in line with historical (and modern) properties of 2–4 and 5–9, which showed agreement (2–4) or genitive case assignment (5–9) with subjects. This pattern is repeated in the frozen forms of 10 (Miechowicz-Mathiasen 2014); similarly, 10's additive forms are historically derived from a prepositional construction *na dęsete* 'out of ten' (Dziubała-Szrejbrowska 2014: 86). Thus, we see a lack of transparency in the modern multiplicative and additive forms of these numerals.[8] Secondly, in terms of their morphosyntactic behavior, Polish 10, 100 and their multiples and additives behave identically to non-base numerals like 5; this was already shown in (3), which illustrated their gender agreement and genitive case assignment properties, and in (8), which illustrated their case agreement properties in oblique environments. We can add to this their pattern of triggering default agreement, given below:

(17) a. Pięć dziewczyn spało.
five girls.F.PL.GEN slept.N.SG$_{(default)}$
'Five girls slept.'

b. {Dziesięć / dwanaście / dwadzieścia} dziewczyn spało.
ten twelve twenty girls.F.PL.GEN slept.N.SG$_{(default)}$
'Ten / twelve / twenty girls slept.'

[8]Further evidence can be found with numeral 12. In Modern Polish complex numerals, the additive component determines the case properties of the quantified noun, e.g. in subject position, 22–24 have nominative quantified nouns, while 25–29 have genitive quantified nouns (a pattern repeated in the 30s, 40s, etc.). In modern Polish, 12 requires genitive on the noun, but Dziubała-Szrejbrowska (2014: 96–97) reports that in Old Polish it also allowed nominative. This shows a different status of the 2-component in modern numeral 12.

c. {Sto / dwieście} dziewczyn spało.
hundred two.hundred girls.F.PL.GEN slept.N.SG$_{(default)}$
'A hundred / two hundred girls slept.'

There is not the space to attempt a full analysis of the properties of these numerals in this paper, but what we see is that (a) the forms of 10 and 100 as simplex numerals and bases are distinct and (b) both 10 and 100 pattern with non-base numerals morphosyntactically, as do their multiples and additives. Under a lexicalized base analysis, this is because the lexical items for 10 and 100 are not bases in the language, but there are corresponding morphemes which are.[9] There are three lexicalized base morphemes, with allomorphs conditioned by the numeral root and case: × 10 (*-dzieścia, -dziesiąt, -dziestu, -dziesięciu*), + 10 (*-naście, -nastu*), and × 100 (*-ście, -sta, -set, -stu*). These morphemes augment the value of the root they combine with, and furthermore, assign it the morphosyntax of a numeral like 5, 10 and 100. In Wągiel's (2020) analysis of Polish, the root combines with the base morpheme, a gender node, and Card. I will omit gender from the structure for now, pending further analysis on the case and agreement properties of these items; what is crucial here is the status of base morpheme.[10] See Figures 11 and 12.

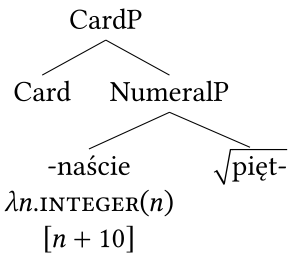

Figure 11: Polish additive *-naście*

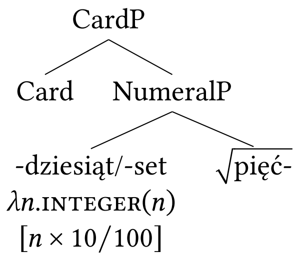

Figure 12: Polish multiplicative *-dziesiąt/-set*

English 10 and Polish 10 and 100 are lexicalized bases. In the context of this paper, this implies that there are grammaticalized morphemes, distinct from the lex-

[9] Something more needs to be said about 100, which does not permit multipliers, e.g. **jedno sto*, but does allow additives, e.g. 101 (*sto jeden*) to 199 (*sto dziewięćdziesiąt dziewięć*). This may suggest it remains an additive base, but not a multiplicative base, in contrast to 10 which is neither.

[10] Differences in the position of the gender/case morpheme in these complex numerals may also suggest that gender/case has a different position with respect to the base morpheme in different numerals: gender/case seems to sit between the root and the base morpheme for 500–900, but above the base morpheme for 11–19, 20–90, and 200–400. Such a low position with 500–900 might explain their lack of a dedicated instrumental form, as mentioned in footnote 7.

ical items for these numerals, which combine with the root of a simplex numeral and create basehood. These base morphemes have a very restricted distribution in that they only augment roots for 1–9 and certain quantifiers.

4 Grammaticalization

I would like to suggest that the three types of bases identified in this paper, nominal bases, syntactic bases, and lexicalized bases, represent stages along a grammaticalization path from noun to morpheme. This section will explore this hypothesis and possible evidence in favor of it.

Nominal bases involve the functional structure of a lexical noun; lexicalized bases are morphemes that give basehood by augmenting the value of the numeral root. These appear to be initial and final stages of a grammaticalization path for base numerals, a hypothesis which is supported by Polish 10 and 100. As mentioned in §3.3, historically numerals 10 and 100 combined transparently with other simplex numerals to form complex numerals (see Miechowicz-Mathiasen 2014 and Dziubała-Szrejbrowska 2014); this is because they were both nominal bases (see also Miechowicz-Mathiasen 2014). This is supported by the examples below, illustrating their ability to control verbal agreement[11] and to trigger genitive case assignment even in an oblique case environment; these are properties which modern-day Polish 1000 carries (see 4, 5, and 7), but modern-day 10 and 100 have lost (see 8 and 17b).

(18) a. Jako minęła dziesięć lat.
as passed.F.SG ten.F.SG years.GEN
'As ten years passed.'
(Siuciak 2008 as cited in Dziubała-Szrejbrowska 2014: 103)

b. ku trzydzieści i ku stu lat
towards thirty$_{?}$ and towards hundred.DAT.SG years.GEN.PL
'to a hundred and thirty years' (Miechowicz-Mathiasen 2013: 99)

This data is suggestive of the nominal base status of Polish 10 and 100 in earlier stages. With regards to English, the picture is less clear, as additive and multiplicative 10 had already fossilized in Old English (and therefore formed a lexicalized base) (von Mengden 2010). However, von Mengden (2010) argues that the grammaticalization relation between *tyn* '10' and *tyne* ' + 10' remained visible in

[11]Though, see Miechowicz-Mathiasen (2014) for a fuller discussion of the intricacies of agreement with Old and Middle Polish numerals.

Old English, *tyne* being an inflected form of *tyn* in a previous stage of English; no such obvious connection is visible with multiplicative *(hund-)-tig* ‘ × 10’, though von Mengden (2010) suggests a similar earlier grammaticalization process.[12]

English 100 and 1000 may have had a more nominal status than they do today. Von Mengden (2010) reports that Old English numerals higher than 20 often participated in a “partitive construction,” namely, the use of genitive on the quantified noun without a subset interpretation. This could also be accompanied by singular agreement on the verb. These patterns are reminiscent of what we see in modern Polish 1000, a nominal base. Example (19) illustrates the use of genitive case with 100 and 1000 but not 10, and (20) illustrates the use of a singular verb with a multiple of 10.

(19) a. tyn colt-um
10 colt-DAT.PL
‘10 colts’ (von Mengden 2010: 219)

b. hund cne-a werþeod-a
100 generation-GEN.PL people-GEN.PL
‘100 generations of men’ (von Mengden 2010: 220)

c. ðusend ge-wæpn-od-ra cemp-ena
1000 CIRC-arm-PTCP-GEN.PL fighter-GEN.PL
‘a thousand armed warriors’ (von Mengden 2010: 220)

(20) wear-ð [...] fiftig mann-a ofsleg-en
become.PRS-3SG [...] 50 man-GEN.PL slay.PTCP-PTCP
‘there were 50 men killed’ (von Mengden 2010: 224)

I suggest the following grammaticalization process. A nominal base begins grammaticalization by shedding some of the projections that make it nominal (see Miechowicz-Mathiasen 2014); this seems plausible for Polish 10 and 100 and English 100 and 1000, and likewise, may be an ongoing process for modern Polish 1000, specifically with regards to a loss of gender (see 6). This results in a reduced functional structure above the numeral root, and I suggest that at some point, this reduced functional structure is reanalyzed as a BASE morpheme, the result being a syntactic base. As a final step, the numeral root and base morpheme coalesce into a single functional morpheme, acting as an additive or multiplicative base. The structures in Figures 13–15 illustrate these three stages (omitting the Card projection).

[12]The morpheme *(hund-) -tig* was a suffix on 2–6 (20–60) and a circumfix on 7–12 (70–120).

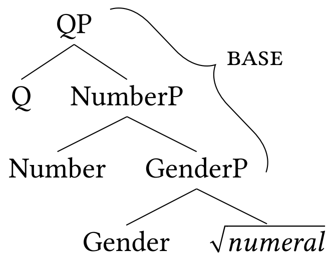

Figure 13: Stage 1 – nominal base

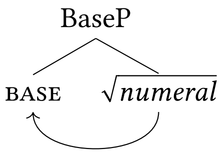

Figure 14: Stage 2 – syntactic base

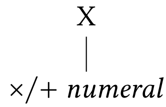

Figure 15: Stage 3 – lexicalized base

There seems to be clear evidence that Polish 10 and 100 have grammaticalized from nominal bases to lexicalized bases (see 18) – however, it remains to be seen whether they underwent a syntactic base stage, as is predicted under the hypothesis above. I leave this for future work, along with the question of whether English 10 and 100 were indeed nominal bases. Altogether, this hypothesis gives us a handle on why we see three types of bases: these are developmental stages from noun to morpheme.

As a final note, this hypothesis predicts substantial variation in the morphosyntax of base numerals cross-linguistically. If a base numeral grammaticalizes from a noun to a morpheme, then its morphosyntax will depend on how noun-hood is realized in the language, how grammaticalization proceeds, and how functional projections are spelled-out. For example, Polish is a rich case and agreement language, with gender on nouns, but no definite/indefinite determiner distinction; English is the reverse, with a rich system of determiners, no gender on nouns, and a morphologically poor system of case and agreement. The consequence is that the properties of nouns in Polish and English differ (e.g. gender or no gender, triggering agreement on something or not, etc.), and thus, nominal bases are likewise expected to differ between the languages. The process of grammaticalization is also important, both regarding the language as a whole and the individual lexical item. Changes in the language, such as the loss of case on Old English nouns or the introduction of a new gender distinction in Old Polish (Miechowicz-Mathiasen & Dziubała-Szrejbrowska 2013), could affect the realization of a numeral and its grammaticalization path. Likewise, the changes that a numeral undergoes, such as gender loss (ongoing for Polish 1000), might differ between numerals, predicting more variation among bases. Finally, how functional projections are spelled-out (for example, if a language has an overt BASE morpheme or not) can create further differences between base numerals. In sum, we expect dramatic differences between base numerals cross-linguistically, but we also expect those differences to be in line with the properties of nouns, defective nouns, and morphemes in that language, diachronically and synchronically. This could mean that we find many "types" of base numerals, but under this hypothesis, they are constrained by the grammaticalization path from noun to morpheme and the spell-out of functional projections.

5 Conclusion

This paper has proposed that there are three types of bases: nominal bases, syntactic bases, and lexicalized bases. This analysis has built on the idea that numerals can be internally complex, and in particular, that they consist of a root which is dominated by functional structure. For nominal bases, that functional structure is nominal in nature; for instance, Polish 1000 consists of a root, number and gender features, and a quantificational layer. For syntactic bases, that functional structure involved a morpheme BASE which gave the numeral root its basehood. Lexicalized bases do not have internal structure, because they are grammaticalized morphemes, distinct from the numerals they are bases of (those numerals being non-bases synchronically). It was also proposed that these bases form steps along a grammaticalization path from noun to morpheme.

The present proposal is limited empirically to Polish and English numerals. However, the general spirit of it may be applicable to other languages, since it predicts a wide array of variation cross-linguistically, constrained by the noun-to-morpheme grammaticalization path and spell-out. How noun-hood is realized and how grammaticalization proceeds can lead to very different looking numerals cross-linguistically; furthermore, how functional projections are spelled-out (e.g. CardP, BaseP) may lead to other differences. Exploring the diachronic and synchronic properties of bases in other languages may provide further evidence for the base types proposed above and the grammaticalization path. Finally, the patterns discussed here are relevant for base numerals which grammaticalize from nouns. It may be possible that base numerals grammaticalize from other categories, in which case more types of base numerals could exist cross-linguistically.

Abbreviations

3	third person	NOM	nominative
ACC	accusative	NV	non-virile
DAT	dative	OBL	oblique
F	feminine	PL	plural
GEN	genitive	PRS	present tense
INST	instrumental	PTCP	participle
LOC	locative	SG	singular
M	masculine	V	virile

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Chapter 14

The architecture of complex cardinals in relation to numeral classifiers

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This paper investigates properties of multiplicative and additive complex cardinals in several languages. The starting point in the discussion will be recent work by Ionin & Matushansky (2018), who show that complex cardinals are not primitive units without complex structure. This paper observes some data that are problematic for their analysis. Based on the data, I argue that in multiplicative complex cardinals, a multiplicand is a syntactic head used for measurement and a multiplier is a phrase appearing in the specifier position of the phrase headed by the multiplicand. Building on the proposed analysis of multiplicative complex cardinals, I further argue that additive complex cardinals can have a non-coordinate structure in some languages, in addition to the coordination structure proposed by Ionin & Matushansky (2018). I propose that in non-coordinate additive complex cardinals, which do not include a coordinator syntactically, a lower-valued cardinal is an adjunct to a higher-valued cardinal.

Keywords: multiplicative complex cardinals, additive complex cardinals, numeral classifiers, left-branch extraction, nominal ellipsis, split topicalization

1 Introduction

This paper investigates two types of complex cardinals: MULTIPLICATIVE COMPLEX CARDINALS like (1a) and ADDITIVE COMPLEX CARDINALS like (1b).[1]

[1]In this paper, I use quotation marks for number concepts and italics for numerical expressions. For instance, *three* denotes "three" in English.

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(1) a. Ivan je pozvao [tri stotine] studenata. Multiplicative
Ivan is invited three hundred student.GEN.PL.M
'Ivan invited three hundred students.' (Serbo-Croatian)

b. Ivan je vidio [dvadeset (i) pet] studenata. Additive
Ivan is seen twenty and five students.GEN.PL.M
'Ivan saw twenty five students.' (Serbo-Croatian)

In (1a), the numeral "three" functions as a MULTIPLIER and "hundred" as a MULTIPLICAND. In (1b), the augend ("twenty") appears with the addend ("five").

Ionin & Matushansky (2018) argue that multiplicative complex cardinals have the cascading structure represented in (2).

(2) [$_{\text{NP}}$ three [$_{\text{NP}}$ hundred [$_{\text{NP}}$ student]]] (Ionin & Matushansky 2018)

Building on their analysis, this paper argues that multiplicative complex cardinals can also have a non-cascading structure in some languages.

Regarding additive complex cardinals, Ionin & Matushansky pursue an analysis in which additive complex cardinals have an NP coordination structure. According to their analysis, additive complex cardinals are derived by deletion of a noun phrase, as in (3b). This analysis is supported by the fact that additive complex cardinals can include an overt coordinator in some languages, as shown in (1b).

(3) a. three hundred three girls

b. [$_{\text{\&P}}$ [$_{\text{NP}}$ three [$_{\text{NP}}$ hundred [$_{\text{NP}}$ ~~girls~~]] & [$_{\text{NP}}$ three [$_{\text{NP}}$ girls]]]
(Ionin & Matushansky 2018)

Although I follow Ionin & Matushansky (2018) regarding the existence of the coordinate structure of additive complex cardinals, I argue in this paper that in addition to the coordinate structure as in (3b), additive complex cardinals can also have a non-coordinate structure. Specifically, I propose that a lower-valued cardinal ("three" in "three hundred three") can directly adjoin to a higher-valued cardinal ("three hundred" in "three hundred three"). The major motivation for the existence of the non-coordinate structure comes from the human classifier *ri* in Japanese and contracted forms of Chinese cardinals.

The paper is organized as follows. In §2, I provide data which pose problems for Ionin & Matushansky's (2018) analysis. §3 presents an analysis which can capture the data discussed in §2. §4 shows that the proposed analysis of multiplicative complex cardinals is compatible with Ionin & Matushansky's analysis of additive complex cardinals. Moreover, I argue that in addition to the coordinate structure proposed by Ionin & Matushansky, additive complex cardinals can also have a non-coordinate structure in some languages. §5 is the conclusion.

2 Multiplicative complex cardinals and constituency tests

In a cascading structure like (2), the multiplicand and the main noun form a constituent to the exclusion of the multiplier. According to this analysis, a multiplicative complex cardinal should not behave as a single constituent since there is no syntactic constituent which directly corresponds to a multiplicative complex cardinal. However, I will show in this section that this prediction is not borne out, by investigating two types of split constructions; left-branch extraction and split topicalization.

2.1 Left-branch extraction

Some languages such as Latin and most Slavic languages allow movement of the leftmost constituent of an NP (Ross 1986). Sentences in (4) are examples of LEFT-BRANCH EXTRACTION (LBE) in Serbo-Croatian, taken from Bošković (2005).

(4) a. Ta$_1$ je vidio [Δ_1 kola].
that is seen car
'That car, he saw.' (Serbo-Croatian)

b. Lijepe$_1$ je vidio [Δ_1 kuće].
beautiful is seen houses
'Beautiful houses, he saw.' (Serbo-Croatian)

What is important is that in Serbo-Croatian, a multiplicative complex cardinal can undergo LBE, as shown in (5b).

(5) a. Ivan je pozvao [tri stotine studenata].
Ivan is invited three hundred.ACC.F students.GEN.M
'Ivan invited three hundred students.' (Serbo-Croatian)

b. [Tri stotine]$_1$ je Ivan pozvao [Δ_1 studenata].
three hundred.ACC.F is Ivan invited students.GEN.M
'Three hundred students, Ivan invited.' (Serbo-Croatian)

Following Corver (1992), I assume that LBE can be applied only to a phrasal constituent. Given this, the acceptability of (5b) shows that a multiplier and a multiplicand can form a phrasal constituent, excluding the main noun. Notice also that *je* in (5b) is a second position clitic; as such it can follow only one constituent (see Bošković 2001 and references therein). The presence of *je* in (5b) then also indicates that (5b) is not derived by multiple LBE, where *tri* and *stotine* would undergo LBE separately.

One may consider that (5b) involves NP fronting and scattered deletion (cf. Fanselow & Ćavar 2002). However, it has been argued that LBE and the scattered deletion construction behave differently in some respects. As discussed in Bošković (2014), one of the main characteristics of the scattered deletion construction is that the remnant must be backgrounded and left in situ as in (6). As shown in (7), this is not the case with LBE.

(6) *NP-fronting + Scattered deletion*

a. ?* [Onu žutu] mu kuću pokazuje.
that yellow him house is-showing

b. [Onu žutu] mu pokazuje kuću.
that yellow him is-showing house

'He is showing him that yellow house.'

(Serbo-Croatian; Bošković 2014: 421)

(7) *Left-branch extraction*

a. [Žutu] mu kuću pokazuje.
yellow him house is-showing

b. [Žutu] mu pokazuje kuću.
yellow him is-showing house

'He is showing him the yellow house.'

(Serbo-Croatian; Bošković 2014: 421)

(5b) patterns with LBE in this respect. As shown in (8), the remnant main noun can appear in the pre-verbal position. (5b) thus should not be analyzed as a scattered deletion construction.

(8) [Tri stotine] je Ivan studenata pozvao.
three hundred.ACC.F is Ivan students.GEN.M invited

'Three hundred students, Ivan invited.'

(Serbo-Croatian; Željko Bošković, p.c.)

One may also argue that (5b) is derived by movement of the main noun out of the complex cardinal expression followed by movement of the remnant phrase. However, if this kind of remnant movement were available in Serbo-Croatian, it is not clear why (9) is unacceptable.

(9) * Visoke lijepe je on vidio [Δ Δ djevojke].
tall beautiful is he watches girls
'He is watching tall beautiful girls.' (Serbo-Croatian; Bošković 2005: 2)

Attributive adjectives can undergo LBE in Serbo-Croatian, as shown in (4b). However, when a noun is modified by two attributive adjectives, LBE of the two adjectives is impossible as in (9) (Bošković 2005). The contrast between (5b) and (9) is not expected under the remnant movement analysis. (For arguments against the remnant movement analysis of LBE more generally, see Bošković 2005, Stjepanović 2010, 2011, Despić 2011, Talić 2017, and references therein.)

Given these considerations, I conclude that the fronted multiplicative complex cardinal in (5b) must be a single phrasal constituent. The acceptability of (5b) then raises a problem for the cascading structure in (2) advanced by Ionin & Matushansky (2018), in which multiplicative complex cardinals cannot be the target of a syntactic operation as a single constituent.

2.2 Nominal ellipsis

Nominal ellipsis also provides an argument against Ionin & Matushansky's (2018) cascading structure. In (10b) and (10c), the second sentence has an elided part.

(10) a. Juan tomó seis cientas fotos, y Maria tomó tres cientas fotos.
Juan took six hundred pictures and Maria took three hundred pictures
'Juan took 600 pictures, and Maria took 300 pictures.'

b. Juan tomó seis cientas fotos, y Maria tomó tres cientas.
Juan took six hundred pictures and Maria took three hundred
'Juan took 600 pictures, and Maria took 300 pictures.'

c. Juan tomó seis cientas fotos, y Maria tomó tres.
Juan took six hundred pictures and Maria took three
Unavailable: 'Juan took 600 pictures, and Maria took 300 pictures.'
Available: 'Juan took 600 pictures, and Maria took 3 pictures.'
(Spanish; Gabriel Martínez Vera, p.c.)

The elided part in (10b) can receive the same interpretation as the one in (10a). On the other hand, the ellipsis in (10c) cannot mean 'three hundred pictures'. Instead, it is interpreted as 'three pictures'. The contrast between (10b) and (10c) is unexpected under Ionin & Matushansky's analysis, because the cascading structure in (11) should be available for the multiplicative complex cardinals in (10).

(11) [$_{NP}$ three [$_{NP}$ hundred [$_{NP}$ pictures]]] (Ionin & Matushansky 2018)

Under their analysis, the ellipsis in (10b) can be derived from the structure in (11) by deleting the main NP (*fotos* 'pictures'). However, we may then also expect that the same deletion operation can be applied to the intermediate NP consisting of the multiplicand and the main NP, resulting in the ellipsis in (10c). This in fact is possible for adjectives in Serbo-Croatian. In (12), the object noun phrase in the second sentence is interpreted as 'a small, square table'.

(12) Ivan je kupio veliki četvrtasti sto, a Petar je kupio mali Δ.
Ivan is bought big square table and Peter is bought small
'Ivan is bought a big square table and Peter is bought a small, square table.' (Serbo-Croatian; Željko Bošković, p.c.)

Given these data, it seems to me that Ionin & Matushansky (2018) need an account for the fact that the ellipsis in (10c) cannot mean 'three hundred pictures'.[2]

2.3 Split topicalization

Another potential problem for the cascading structure in (2) comes from split topicalization in German. As shown in (13c), the main noun alone can undergo split topicalization, while leaving a multiplicative complex cardinal in situ. However, the main noun and a multiplicand cannot move together, leaving a multiplier in situ, as shown in (13d).

(13) a. Hans kaufte [acht tausend Bücher].
Hans bought eight thousand books

b. [Acht tausend Bücher]$_1$ kaufte Hans Δ$_1$
eight thousand books bought Hans

[2] I have examined the data regarding nominal ellipsis in English. Some of my consultants found that although there is a contrast between (i.b) and (i.c), it is not completely impossible for *two* in (i) to be interpreted as 'two hundred books'. Ionin & Matushansky (2006: 338) also reported a similar observation in a footnote.

(i) a. John read three hundred books, but Mary read [two hundred books].
b. John read three hundred books, but Mary read [two hundred].
c. John read three hundred books, but Mary read [two].

This suggests that at least for some speakers, English multiplicative complex cardinals have the cascading structure as in (11). I leave this issue for future research.

c. Bücher$_1$ kaufte Hans [acht tausend Δ_1]
books bought Hans eight thousand

d. * [Tausend Bücher]$_1$ kaufte Hans [acht Δ_1]
thousand books bought Hans eight

(Intended:) 'Hans bought eight thousand books.'

(German; Sabine Laszakovits, p.c.)

Split topicalization in German has received close attention in the literature (van Riemsdijk 1989, Fanselow & Ćavar 2002, van Hoof 2006, Ott 2011, 2015, among others). The problem here is that the unacceptability of (13d) seems to be unexpected under Ionin & Matushansky's analysis, regardless of the details of the analysis of split topicalization. Under Ionin & Matushansky's analysis, the object phrase in (13) has the structure in (14).

(14) [$_{\text{NP}}$ eight [$_{\text{NP}}$ thousand [$_{\text{NP}}$ books]]] (Ionin & Matushansky 2018)

The acceptability of (13b) and (13c) shows that either the topmost NP in (14) or the lowest NP (i.e. the main noun) can be a target of topicalization in German. We may then expect that the intermediate NP in (14) can also undergo topicalization. (It should also be noted that Ionin & Matushansky propose that both multipliers and multiplicands are of type $\langle\langle e,t\rangle,\langle e,t\rangle\rangle$.) It is not clear how to account for the unacceptability of (13d) under Ionin & Matushansky's analysis.

3 Proposal

In §2, I showed that Ionin & Matushansky's cascading structure faces some problems. To solve the problems, I pursue an analysis in which multiplicative complex cardinals can in principle have two structures cross-linguistically.

First, I propose that multiplicands are syntactic heads used for measurement whereas multipliers are phrases appearing in the specifier position of a phrase headed by the multiplicand, cross-linguistically. The noun phrase *three hundred students* in English has the structure given in Figure 1 under the present analysis. What is important is that multipliers and multiplicands are syntactically different from each other.

In Figure 1, the multiplicand is a syntactic head taking the main NP as the complement. Structurally, Figure 1 is similar, at least in spirit, to Ionin & Matushansky's (2018) analysis given in (2) in the sense that a multiplicand takes the main NP as its complement. However, the present analysis departs from Ionin & Matushansky's analysis with regard to the syntactic status of multipliers and

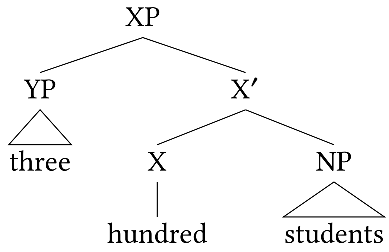

Figure 1: Complementation structure

multiplicands. I propose that multipliers are phrases whereas multiplicands are heads in multiplicative complex cardinals, cross-linguistically.

Regarding semantics, I propose that multipliers are of type n, as in (15a), whereas multiplicands such as *hundred* are of type $\langle\langle e,t\rangle,\langle n,\langle e,t\rangle\rangle\rangle$, as in (15b).[3] A multiplicand used in multiplicative complex cardinals includes a measurement function μ. The denotation of the multiplicand "hundred" is given in (15b).

(15) a. $[\![\text{three}]\!] = 3$

b. $[\![\text{hundred}]\!]$
$$= \lambda P.\lambda n.\lambda x.\exists S.[\Pi(S)(x) \wedge \mu(x) = n \wedge \forall y \in S.[\underbrace{|\{z : z \leq_{\mathrm{AT}} y\}| = 100}_{\text{cardinality restriction}} \wedge \forall z \leq_{\mathrm{AT}} y.[P(z)]]]$$

Following Ionin & Matushansky, I make use of the cover S and the partition function Π defined in (16), to prevent multiple counting of the same members of S. In addition, multiplicands have a restriction on the cardinality of the set of atomic individuals in the cover S.

(16) $\Pi(S)(x)$ is true iff (Ionin & Matushansky 2018: 13)

a. S is a *cover* of x, and

b. $\forall z, y \in S[z = y \vee \neg\exists a[a \leq_i z \wedge a \leq_i y]]$

The topmost XP in Figure 1 has the denotation in (17).

[3] In this respect, the proposed analysis is similar to a series of works by Rothstein (2013, 2017), where multipliers and multiplicands have different semantic types. However, the present analysis is also different from Rothstein's analysis in several crucial aspects. For instance, Rothstein assumes that multiplicands are of type $\langle n,\langle e,t\rangle\rangle$, not $\langle\langle e,t\rangle,\langle n,\langle e,t\rangle\rangle\rangle$. Moreover, my proposal given in (15b) does not include any arithmetic functions such as $\times$, unlike Rothstein's. Ionin & Matushansky argue against Rothstein's assumption regarding the presence of arithmetic functions in semantics. However, this issue does not arise under the current analysis.

(17) $[\![[_{\text{XP}}$ three hundred students $]]\!]$
$= \lambda x.\exists S.[\Pi(S)(x) \wedge \mu(x) = 3$
$\wedge\, \forall y \in S.[|\{z : z \leq_{\text{AT}} y\}| = 100 \wedge \forall z \leq_{\text{AT}} y.[\textsc{student}(z)]]]$

What is important is that the current proposal is different from Ionin & Matushansky's analysis in that the former assumes that multipliers and multiplicands are different syntactically and semantically.

Recall that in §2, I showed that the acceptability of LBE of a multiplicative complex cardinal is not expected under Ionin & Matushansky's analysis. To solve the problems, I propose that multiplicative complex cardinals can occur in the adjunction structure as represented in Figure 2, in addition to Figure 1.

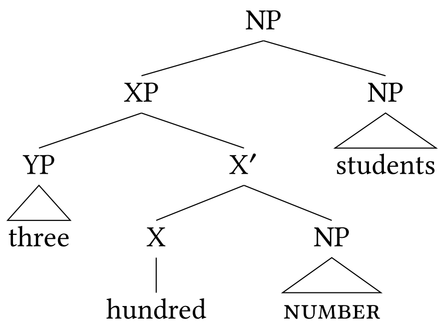

Figure 2: Adjunction structure

In Figure 2, the multiplicand takes the silent NUMBER as the complement, instead of an overt common noun like *students* (see Kayne 2005 and Zweig 2006 for an independent argument for the presence of the silent numerical noun). However, the structural relation between the multiplier and the multiplicand is the same as in Figure 1. The multiplier occurs in the specifier position of the phrase head by the multiplicand.

With regard to the semantics, I assume that the silent NUMBER is interpreted as a property of being a number (i.e. $\lambda x[\textsc{number}(x)]$). The topmost XP in Figure 2 has the following denotation.

(18) $[\![[_{\text{XP}}$ three hundred NUMBER $]]\!]$
$= \lambda x.\exists S.[\Pi(S)(x) \wedge \mu(x) = 3$
$\wedge\, \forall y \in S.[|\{z : z \leq_{\text{AT}} y\}| = 100 \wedge \forall z \leq_{\text{AT}} y.[\textsc{number}(z)]]]$

Following Rothstein (2013, 2017), I assume that the topmost XP in Figure 2 can be converted into a singular term of type *n* by the $^\cap$ function (Chierchia 1985). In

(18), each atomic individual of S has the property of being a number. When the $^{\cap}$ function applies, the topmost XP, which is of type $\langle e, t\rangle$, becomes a numerical expression of type n as in (19).[4]

(19) $[\![^{\cap}\text{XP}]\!] = 300$

In order to modify a noun phrase, cardinals of type n need the covert measurement function ϵ defined as in (20a).[5]

(20) a. $[\![\epsilon]\!]$
$= \lambda P.\lambda x.\exists S.[\Pi(S)(x) \wedge \mu(x) = n$
$\wedge \forall y \in S.[|\{z : z \leq_{\text{AT}} y\}| = 1 \wedge \forall z \leq_{\text{AT}} y.[P(z)]]]$

b. $[\![[[_{\text{XP}}$ three hundred NUMBER$]$ $[\epsilon$ students$]]]\!]$
$= \lambda x.\exists S.[\Pi(S)(x) \wedge \mu(x) = 300$
$\wedge \forall y \in S.[|\{z : z \leq_{\text{AT}} y\}| = 1 \wedge \forall z \leq_{\text{AT}} y.[\textsc{student}(z)]]]$

Although the denotation in (20b) is different from the one in (17), they denote the same set; a set of students whose cardinality is "three hundred" in total. Importantly, the topmost XP in Figure 2 can be the target of syntactic operations such as LBE, while keeping the main noun intact, as discussed below.

[4]When the XP including the silent NUMBER is modified by the $^{\cap}$ function, it functions as a numerical expression of type n. Therefore, the multiplicative complex cardinal *three hundred* can be used as a multiplier, combining with another multiplicand as in (i).

(i) a. $[_{\text{X1P}}\ {}^{\cap}[_{\text{X2P}}$ three $[_{\text{X2}'}$ hundred NUMBER $]]$ $[_{\text{X1}'}$ thousand students $]]$

b. $[\![$three hundred thousand students$]\!]$
$= \lambda x.\exists S.[\Pi(S)(x) \wedge \mu(x) = 300$
$\wedge \forall y \in S.[|\{z : z \leq_{\text{AT}} y\}| = 1000 \wedge \forall z \leq_{\text{AT}} y.[\textsc{student}(z)]]]$

[5]The covert function ϵ is also used when a noun phrase is modified by a numerical expression in the absence of a multiplicand. For instance, the denotation of *three students* is given in (i.b). (See Scontras 2014 (CARD) and Champollion 2017 (MANY) for a similar covert element in the numeral construction.)

(i) a. $[\ [_{\text{YP}}$ three$]$ $[\ \epsilon\ [_{\text{NP}}$ students$]]]$

b. $[\![$three ϵ students$]\!]$
$\lambda x.\exists S.[\Pi(S)(x) \wedge \mu(x) = 3 \wedge \forall y \in S.[|\{z : z \leq_{\text{AT}} y\}| = 1 \wedge \forall z \leq_{\text{AT}} y.[\textsc{student}(z)]]]$

Note also that the covert function ϵ must be unavailable in obligatory classifier languages, where classifiers are generally indispensable in numerical expressions. I speculate in this paper that the existence of numeral classifiers blocks the covert function ϵ in obligatory classifier languages. (See Chierchia 1998 for a similar blocking effect.)

3.1 Left-branch extraction

The acceptability of (5b), repeated here as (21), in which a multiplicative complex cardinal undergoes LBE, can be captured under the proposed analysis.

(21) [Tri stotine]$_1$ je Ivan pozvao [Δ_1 studenata].
3 100.ACC.F is Ivan invited students.GEN.M
'Three hundred students, Ivan invited.' (Serbo-Croatian)

Under the current analysis, the multiplicative complex cardinal in (21) can be an adjunct to the main NP, as represented in (22) (cf. Figure 2).

(22) [$_{NP}$ $^{\cap}$[$_{XP}$ three hundred] [$_{NP}$ students]]

The XP in (22) can undergo LBE, while leaving the main noun in situ.

3.2 Nominal ellipsis

The current analysis can also account for the (im)possible interpretations of elliptical examples. The crucial example is repeated here as (23).

(23) Juan tomó seis cientas fotos, y Maria tomó tres.
Juan took six hundred pictures and Maria took three
Unavailable: 'Juan took 600 pictures, and Maria took 300 pictures.'
Available: 'Juan took 600 pictures, and Maria took 3 pictures.' (Spanish)

What is important is that the elided part in (23) cannot be interpreted as 'three hundred pictures'. The current proposal can capture the interpretation of the elliptical example in (23). The structure of the object phrases in (23) is represented in (24) (cf. Figure 1).

(24) [$_{XP}$ three [$_{X'}$ hundred [$_{NP}$ pictures]]]

The elliptical example in (23) cannot be derived from the structure in (24) because there is no phrasal constituent that can undergo ellipsis in (24), to the exclusion of the multiplier "three".[6] The present analysis can thus capture the fact that the elliptical part in (23) cannot mean 'three hundred pictures'.

[6] I assume that X′-level cannot be a target of ellipsis.

3.3 Split topicalization

The data about split topicalization in German can also be captured under the current analysis. What is problematic for Ionin & Matushansky's analysis is the unacceptability of (13d), repeated here as (25).

(25) * [Tausend Bücher]$_1$ kaufte Hans [acht Δ_1]
thousand books bought Hans eight
Intended: 'Hans bought eight thousand books.' (German)

The contrast in question is expected by assuming that the multiplicative complex cardinal in (25) has the structure given in (26) underlyingly.

(26) [$_{XP}$ eight [$_{X'}$ thousand [$_{NP}$ books]]]

The NP *Bücher* can be a target of split topicalization because it is a phrasal constituent. On the other hand, the constituent composed of the multiplicand and the main noun cannot be a target of topicalization because it is not a phrasal projection.

It is worth noting here that numeral classifiers in Mandarin and Vietnamese behave like multiplicands in German regarding leftward movement, as shown in (27) and (28).

(27) a. Qiang mai le [wu tiao xianglian].
Qiang buy ASP five CLS necklace

b. xianglian$_1$ Qiang mai le [wu tiao Δ_1].
necklace Qiang buy ASP five CLS

c. * [tiao xianglian]$_1$ Qiang mai le [wu Δ_1].
CLS necklace Qiang buy ASP five

(Intended:) 'Qiang bought five necklaces.' (Mandarin; Shengyun Gu, p.c.)

(28) a. Khanh mua [năm cuón sách].
Khanh bought five CLS book

b. sách$_1$ Khanh mua [năm cuón Δ_1].
book Khanh bought five CLS

c. * [cuốn sách]$_1$ Khanh mua [năm Δ_1].
CLS book Khanh bought five

(Intended:) 'Khanh bought five books.' (Vietnamese; Thuy Bui, p.c.)

As shown in the b-examples of (27) and (28), the main noun moves to the sentence initial position, while leaving the cardinal and the numeral classifier in situ. However, it is impossible to move the numeral classifier and the main noun together, as in the c-examples in these classifier langugages.

The current analysis can capture the similarity between numeral classifiers and multiplicands in German. Huang & Ochi (2014) propose that Chinese numeral classifiers project their own phrases, taking a noun phrase as its complement. I assume that the classifier phrases in Chinese and Vietnamese have the complementation structure given in (29).[7]

(29) $[_{XP}$ five $[_{X'}$ $[_{X}$ CLS $]$ $[_{NP}$ … $]$ $]$ $]$

The c-examples in (27) and (28) are unacceptable because the non-maximal projection (i.e. X′) cannot be a target of the relevant movement, similarly to split topicalization in German.

One piece of supporting evidence for the structure in (29) comes from the fact that it is impossible to move a cardinal and a numeral classifier while leaving the main noun in situ, as shown in (30) and (31).

(30) * [wu tiao]$_1$ Qiang mai le [Δ_1 xianglian].
five CLS Qiang buy ASP necklace
Intended: 'Qiang bought three necklaces.' (Mandarin; Shengyun Gu, p.c)

(31) * [năm cuón]$_1$ Khanh mua [Δ_1 sách].
five CLS Khanh bought book
Intended: 'Khanh bought five books.' (Vietnamese; Thuy Bui, p.c.)

The unacceptability of (30) and (31) follows from the current analysis. They are unacceptable because there is no constituent composed of the cardinal and the classifier to the exclusion of the NP in (29). Notice that multiplicative complex cardinal in German cannot undergo split topicalization while leaving the main noun in situ, as in (32).

(32) * [Acht tausend]$_1$ kaufte Hans [Δ_1 Bücher].
eight thousand bought Hans books
Intended: 'Hans bought eight thousand books.'
(German; Sabine Laszakovits, p.c.)

[7] See however Nguyen (2004) for a different analysis of classifier phrases in Vietnamese. See also Zhang (2013) and references therein for a detailed syntactic analysis of Chinese numeral classifier phrases.

The unacceptability of (32) indicates that multiplicative complex cardinals in German do not appear in the adjunction structure as in Figure 2.

It should be noted here that it is possible to front a cardinal and a numeral classifier together in some classifier languages such as Ch'ol and Japanese, as shown in (33b) and (34b).

(33) a. Ta' jul-i-y-ob [ux-tyikil x'ixik]$_1$.
PFV arrive-ITV-EP-PL three-CLS woman
'Three women arrived.'

b. [Ux-tyikil]$_1$ ta' jul-i-y-ob [Δ_1 x'ixik].
three-CLS PFV arrive-ITV-EP-PL woman
'[Three]$_{\text{foc}}$ women arrived.' (Ch'ol; Bale et al. 2019: 19)

(34) a. kyoositsu-ni [zyosei san-nin]-ga toochaku-sita .
classroom-LOC woman three-CLS-NOM arrive-DID
'Three women arrived at the classroom.'

b. [san-nin]$_1$ kyoositu-ni [zyosei Δ_1]-ga toochaku-sita .
three-CLS classroom-LOC woman -NOM arrive-DID
'[Three]$_{\text{foc}}$ women arrived at the classroom.' (Japanese)

Following Huang & Ochi (2014), I assume that there are in principle two structures for numeral classifier phrases; the complementation structure as in (29) and the adjunction structure as in (35).[8]

(35) $[_{\text{NP}}$ $[_{\text{XP}}$ THREE $[_{\text{X}}$ CLS]] $[_{\text{NP}}$ …]]

I take the acceptability of (33b) and (34b) as evidence that numeral classifier phrases in these languages make use of the adjunction structure in (35). The XP in (35) can be a target of the relevant movement operation, similarly to LBE in Serbo-Croatian.

3.4 Section summary

In the present paper, I assume that the two structures are in principle available for multiplicative complex cardinals; the complementation structure Figure 1 and the adjunction structure Figure 2. The current analysis differs from Ionin & Matushansky's (2018) analysis regarding the treatment of multipliers and multiplicands. I have proposed in this section that multiplicands are syntactic heads used

[8] See §4 for further references and discussion regarding Japanese numeral classifiers in relation to additive complex cardinals.

for measurement, whereas multipliers are phrases appearing in the specifier position of the phrase headed by a multiplicand. In addition, I have shown some similarities and differences between multiplicands and numeral classifiers, on the basis of the data about topicalization and fronting. The cross-linguistic data are summarized in Table 1.

Table 1: Multiplicative complex cardinals & numeral classifier phrases

	multiplicands	numeral classifiers
complementation	German	Mandarin Chinese, Vietnamese
adjunction	Serbo-Croatian	Ch'ol, Japanese

Building on the proposed analysis of multiplicative complex cardinals, I will investigate additive complex cardinals in the next section.

4 Additive complex cardinals

In this section, I discuss Ionin & Matushansky's treatment of additive complex cardinals, showing that the proposed analysis of multiplicative complex cardinals is compatible with their analysis of additive complex cardinals. Ionin & Matushansky pursue an analysis in which additive complex cardinals have an NP coordination structure. According to their analysis, additive complex cardinals are derived by deletion of a noun phrase, as in (36).

(36) a. three hundred three girls (Ionin & Matushansky 2018)

b. [$_{\&P}$ [$_{NP}$ three [$_{NP}$ hundred [$_{NP}$ ~~girls~~]] & [$_{NP}$ three [$_{NP}$ girls]]]

The current analysis of multiplicative complex cardinals is compatible with the coordination analysis of additive complex cardinals. For instance, *three hundred three students* has the coordinate structure given in Figure 3.

The first conjunct in Figure 3 is headed by the multiplicand *hundred*, and the X1P has the complementation structure of multiplicative complex cardinals. In the second conjunct (X2P), the simplex cardinal *three* appears in the specifier of X2P. Recall that the covert function ϵ is used for simplex cardinals in non-classifier languages, as in Figure 3.

Although I follow Ionin & Matushansky (2018) regarding the existence of the coordinate structure of additive complex cardinals, I argue in this section that in addition to the coordinate structure as in (36), additive complex cardinals can

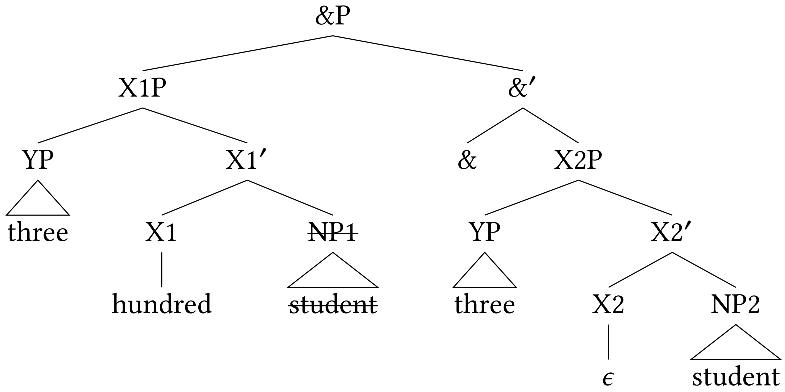

Figure 3: Coordinate structure under the present analysis

also have a non-coordinate structure. Specifically, I propose that a lower-valued cardinal ("three" in "three hundred three") can directly adjoin to a higher-valued cardinal ("three hundred" in "three hundred three"). The major motivation for the existence of the non-coordinate structure comes from the human classifier *ri* in Japanese and contracted forms of Chinese cardinals.

4.1 The human classifier *ri* in Japanese

Firstly, I consider human classifiers in Japanese. Japanese is an obligatory classifier language, and cardinals must co-occur with an appropriate classifier to modify a noun phrase. Japanese has two classifiers for common nouns referring to human beings; *nin* and *ri*. Crucially, the classifier *ri* has a contextual restriction regarding the type of a cardinal it combines with. It co-occurs with the native Japanese cardinals *hito* 'one' and *huta* 'two' as in (37a), but not with the Sino-Japanese cardinals *ichi* 'one' and *ni* 'two', as shown in (37a).

(37) a. {hito / huta}-ri-no gakusei
   one two-CLS-GEN student
   '{one/two} student(s)'

b. {*ichi / *ni}-ri-no gakusei
   one two-CLS-GEN student
   '{one/two} student(s)' (Japanese)

I assume that the noun phrase in (37a) has the adjunction structure as in (38) (cf. 35 in §3.3).[9]

[9] See Saito & Murasugi (1990) and Huang & Ochi (2014) for the adjunct status of pre-nominal classifier phrases in Japanese.

(38) [$_{NP}$ [$_{XP}$ {one / two} [$_{X}$ CLS]] [$_{NP}$ student]]

In Japanese, when a nominal modifier precedes a noun phrase, the genitive linker *no* intervenes between the pre-nominal modifier and the noun phrase (e.g. *gengo-gaku-no gakusei* 'students of linguistics', lit. linguistics-GEN student). Following Kitagawa & Ross (1982), and Watanabe (2006), I assume that the genitive linker *no* is inserted, post-syntactically.

I propose that the classifier *ri* is selected as an exponent of the classifier head when the human classifier head is a sister of *hito* or *huta*. In (38), the cardinal is a sister of Cls and the relevant contextual restriction is satisfied.

Crucially, the contextual restriction is violated when a cardinal occurs in an additive complex cardinal, as in (39a). In this environment, the classifier *nin*, which is the elsewhere exponent of the classifier head dedicated to human beings (Watanabe 2010), must be used together with the Sino-Japanese cardinals, as shown in (39b).

(39) a. [yon zyuu {*hito / *huta}]-ri-no gakusei
four ten one two-CLS-GEN student
'forty {one / two} students'

b. [yon zyuu {ichi / ni}]-nin-no gakusei
four ten one two-CLS-GEN student
'forty {one / two} students' (Japanese)

The coordination analysis predicts that the additive complex cardinal in (39a) includes the structure in (38) as the second conjunct of the coordinate structure. Therefore, the coordination analysis does not expect the contrast between (37a) and (39a).

However, if a non-coordinate structure is available for Japanese additive complex cardinals, the contrast can be accounted for. Specifically, I propose that (39a) has the non-coordinate structure as in (40).

(40) Non-coordinate additive complex cardinal
[$_{NP}$ [$_{X2P}$ $\boxed{\text{[[}_{XP}\text{ four [}_{X'}\text{ ten NUMBER]] \{one / two\}]}}$ [$_{X2}$ CLS]] [$_{NP}$ ...]]

In (40), the lower-valued cardinal (i.e. {one / two}) combines directly with the higher-valued cardinal (i.e. XP), which includes the silent NUMBER. The lower-valued cardinal is not a sister of the classifier, and the relevant contextual restriction cannot be satisfied in (40). This problem does not arise when *hito* and *huta* do not occur in complex cardinals. In the non-complex cardinal construction, a cardinal is a sister of the classifier head and nothing intervenes between them, as shown in (38). The contrast between (37a) and (39a) can thus be accounted for by assuming the non-coordinate structure of additive complex cardinals.

It should be noted here that it seems that Japanese additive complex cardinals can have the coordinate structure in some cases. As shown in (41), Japanese additive complex cardinals can contain the overt coordinator *to* 'and' (Hiraiwa (2016)). What is important is that the contextual restriction of the classifier *ri* is respected in the presence of *to*.

(41) [yon zyuu to {hito / huta}]-ri-no gakusei
four ten and one two-CLS-GEN student
'forty and {one / two} students' (Japanese)

I assume that when an additive complex cardinal contains the overt coordinator, it has the coordinate structure as in (42) (see Figure 3).

(42) [$_{\&P}$ [$_{X1P}$ four [$_{X1'}$ [$_{X1}$ ten] ~~NP~~]] & [$_{NP}$ [$_{X2P}$ {one / two} [$_{X2}$ CLS]] student]]

In (42), the lower-valued cardinal is a sister of the classifier head in the second conjunct. The contextual restriction is therefore satisfied in (42). (The Japanese conjunctive particle *to* appears between two nominal conjuncts, e.g. *Yuta to Hiro* 'Yuta and Hiro'.)

Ionin & Matushansky (2018) propose that additive complex cardinals generally involve coordinate structures, and a coordinator can be overtly realized in some languages. In fact, the presence/absence of an overt coordinator seems to be superficial in some languages such as Serbo-Croatian (see 1b). However, I showed in this section that Japanese additive complex cardinals have different structures, according to the presence/absence of an overt coordinator, which makes a significant difference regarding morphosyntactic behaviors.

4.2 Contracted forms in Mandarin Chinese

Contracted forms of Chinese cardinals also offer supporting evidence for the existence of non-coordinate additive complex cardinals. Chinese is an obligatory classifier language, and a cardinal must appear with an appropriate classifier when it modifies a noun. Mandarin Chinese has a contracted form consisting of *san* 'three' and the general classifier *ge*; *sa*, as shown in (43b).[10]

[10] *liang* 'two' also has a contracted form; *lia*. Since *lia* behaves like *sa*, I use examples with *sa* in this paper.

(43) a. san-ge xuesheng
three-CLS student
'three students'

b. sa xuesheng
three.CLS student
'three students' (Mandarin)

However, as observed by He (2015), the contracted form cannot appear in additive complex cardinals, as in (44).

(44) a. [si-shi san]-ge xuesheng
four-ten three-CLS student
'forty three students'

b. * [si-shi sa] xuesheng
four-ten three.CLS student
'forty three students' (Mandarin)

I propose that additive complex cardinals in Mandarin Chinese have the non-coordinate structure. First, let us consider the simplex cardinal in (43). I assume that the nouns in (43) have the structure represented in (45).[11] Here, the numeral "three" appears in SpecXP headed by the numeral classifier *ge* (cf. 29).

(45) $[_{XP}$ three $[_{X'}$ $[_{X}$ ge] $[_{NP}$ student]]]

Suppose that *san* 'three' and the classifier *ge* can be fused only when they are in a Spec-Head relation. In (45), they can then undergo morphological fusion without any problems.

On the other hand, when *san* 'three' appears inside an additive complex cardinal, *sishi* 'forty' and *san* 'three' form a constituent, resulting in the non-coordinate structure in (46).[12]

(46) Non-coordinate additive complex cardinal
$[_{X2P}$ $\boxed{[[_{XP} \text{ four } [_{X'} \text{ ten NUMBER }]] \text{ three}]}$ $[_{X2'}$ $[_{X2}$ CLS] $[_{NP}$ student]]]

[11] For a detailed syntactic analysis of Chinese classifier phrases, see Zhang (2013), Huang & Ochi (2014) and references therein.

[12] This line of approach is also taken taken by He (2015). However, the details are different from the current analysis. For instance, I assume that a higher-valued cardinal includes the silent NUMBER based on my analysis of multiplicative complex cardinals.

In (46), *san* 'three' adjoins directly to XP, which contains the silent NUMBER. In this case, morphological fusion cannot take place because *san* and *ge* are not in a Spec-Head relation. The non-coordinate structure can thus account for the unavailability of a contracted form in Mandarin Chinese, similarly to the Japanese data discussed in §4.1.

It should be noted here that the coordinate structure of additive complex cardinals should be unavailable in Mandarin Chinese. If the coordinate structure as in (47) were available in Mandarin Chinese additive complex cardinals, the numeral "three" and the general classifier *ge* would be able to undergo morphological fusion, contrary to the fact.

(47) [$_{\&P}$ [$_{X1P}$ four [$_{X1'}$ [$_{X1}$ ten] ~~NP~~]] & [$_{X2P}$ three [$_{X2'}$ [$_{X2}$ CLS] student]]]

In fact, additive complex cardinals in Mandarin Chinese do not allow the presence of an overt coordinator, as in (48), in contrast to Japanese additive complex cardinals (cf. 41).

(48) *si-shi he san-ge xuesheng
four-ten and three-CLS student
'forty three students' (Mandarin)

The unacceptability of (48) indicates that the coordinate structure of additive complex cardinals is unavailable in Chinese.[13]

5 Summary

This paper examined properties of complex cardinals in several languages, in order to determine what kind of cascading structure is available for numerical expressions cross-linguistically. I focused on multiplicative complex cardinals and additive complex cardinals.

[13] There are certain cardinals that cannot occur in complex cardinals, cross-linguistically. Ionin & Matushansky discuss Polish examples in Chapter 6 and 7. Hurford (2003) observes that in German, the non-agreeing counting form *eins* 'one' must be used in compounding cardinals like "one hundred one", instead of *ein* 'one', which agrees with the main noun. He also reports that the presence of an overt coordinator changes the agreement pattern (e.g. **hundert eine Frau(en)* vs. *hundert und eine Frauen*, p. 616). A similar pattern is observed in Mandarin Chinese. Mandarin has two forms of the cardinal "two"; *liang* and *er*. However, *liang* cannot be used in additive complex cardinals (e.g. **si-shi liang-ge xuesheng* 'forty two students', lit. 'four-ten two-CLS student', vs. *liang-ge xuesheng* 'two students', lit. 'two-CLS student'). I thank an anonymous reviewer for bringing this point to my attention.

I argued that in multiplicative complex cardinals, a multiplicand is a syntactic head used for measurement and a multiplier is a phrase appearing in the specifier position of the phrase headed by the multiplicand. Moreover, I proposed that multiplicands and numeral classifiers can in principle appear in the two different structures: the complementation structure and the adjunction structure.

Based on the proposed analysis of multiplicative complex cardinals, I argued that additive complex cardinals can have the non-coordinate structure in some languages such as Japanese and Chinese, in addition to the coordination structure proposed by Ionin & Matushansky (2018). In non-coordinate additive complex cardinals, which do not include a coordinator syntactically, a lower-valued cardinal is an adjunct to a higher-valued cardinal.

Abbreviations

ACC	accusative
ASP	aspect
CLS	classifier
F	feminine
GEN	genitive
M	masculine
NOM	nominative
PL	plural

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Chapter 15

Even superlative modifiers

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We observe that numerals with superlative modifiers – *at least* and *at most* – are systematically unacceptable with certain focus particles, most notably *even*. We analyze the infelicity of such sentences as arising from a clash between the presupposition of the focus particle and the obligatory implicature of the superlative modifier. We claim that to obtain these results it is crucial to make the following two assumptions: (i) the set of alternatives that focus particles operate on is generated by the same mechanism as the set of alternatives for implicatures, and (ii) additive presuppositions are *de re*.

Keywords: superlative modifiers, even, additive presupposition, ignorance implicature, alternatives

1 Introduction

The main puzzle that we would like to grapple with in this paper consists in the observation that numerals with superlative modifiers – *at least* and *at most* – are unacceptable with focus particles like *even*, as demonstrated by (1). We employ nominal ellipsis in this example to force the intended, narrow focus structure. We mark the focused element by *F* throughout this paper.

(1) I speak two languages. #James even speaks [at least five]$_F$.

To show that the infelicity of sentences like this is indeed a puzzle, let us go through some similar cases. Firstly, observe that when associating with a bare numeral, *even* means that the number is big in a given situation.

(2) I speak two languages. James even speaks five$_F$.
$\rightsquigarrow$ James speaks many languages

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A similar inference is observed with a comparative modifier.

(3) ? I speak two languages. James even speaks [more than four]$_F$.
$\rightsquigarrow$ James speaks many languages

Although some of the speakers of English we consulted do not like (3) as much as (2), all of them judge (1) to be worse. Crucially, the contrast between (1) and (3) suggests that the intended meaning of (1) itself is not the source of its infelicity.

It is also important to point out that focussing a numeral with a superlative modifier does not necessarily result in infelicity. Concretely, when the focus is interpreted broadly, *even* + *at least n* becomes felicitous, as the following example demonstrates.

(4) James did everything to impress the interviewers.
He sang songs in three different languages, and even [answered questions in at least five]$_F$ during the interview.

Furthermore, we observe that *only*, another focus particle, can felicitously associate with *at most n*, as well as *fewer than n*, as shown in (5).[1]

(5) I speak five languages. James only speaks $\begin{cases}\text{a. [at most three]}_F.\\ \text{b. [fewer than four]}_F.\end{cases}$

These observations suggest that the infelicity of examples like (1) is not due to failure of focus association. Then, why can (1) not mean something similar to (3)?

We claim that the culprit is a conflict between the *obligatory ignorance implicature* of *at least five* and the *additive presupposition* of *even*. Simply put, the ignorance implicature of (1) implies that the speaker is not sure whether James speaks exactly five languages or more than five languages, but its additive presupposition requires that the speaker be sure that James speaks *n* languages, for some particular number $n \geq 5$. Evidently these two inferences cannot hold at the same time.

We furthermore claim that in order to obtain this result, it is necessary to assume that the set of alternatives that focus particles operate on is generated by the same mechanism as the set of alternatives used for computing implicatures, as previously proposed by Rooth (1992) and Fox & Katzir (2011) on independent grounds, and that the additive presupposition of *even* is *de re*, in the sense to be made clear later (Kripke 2009).

[1]It turns out that *even* cannot felicitously associate with *at most n*, and *only* cannot felicitously associate with *at least n*. But we think that these cases need a separate explanation, as their comparative counterparts are also infelicitous. We will discuss relevant examples and sketch an analysis in the appendix.

The paper is organized as follows. We will first discuss the semantics and pragmatics of superlative modifiers in detail in §2, and the presuppositions that *even* triggers in §3. In §4, we will then put these two ingredients together to show how the infelicity of examples like (1) can be accounted for. We will also discuss some predictions of our analysis there. §5 contains conclusions and remarks on some additional open questions.

2 The implicatures of numerals with superlative modifiers

2.1 The ignorance inference as an obligatory implicature

One of the notable characteristics of numerals with superlative modifiers is that they often give rise to *ignorance inferences* very robustly (Cohen & Krifka 2014, Büring 2007, Geurts & Nouwen 2007, among others). Concretely, consider the following examples.

(6) a. ?? I have at least three children.
    b. ?? I have at most four children.

These examples very strongly suggest that the speaker does not know the exact number of his or her children, which, in normal circumstances, is perceived to be odd. A similar remark applies to the following examples.

(7) a. ?? A triangle has at least two sides.
    b. ?? A triangle has at most four sides.

What exactly is the content of the ignorance inference of a numeral with a superlative modifier? It is clear that it is not ignorance about every number in the range of the modified numeral. That is, (8) below does not imply that for each number n greater than two, the speaker does not know whether or not Jacopo has exactly n many children, schematically: $\forall n > 2[\neg B(n) \wedge \neg B(\neg n)]$, where each n represents the proposition that Jacopo has exactly n children, and $>$ orders these propositions according to the natural order of natural numbers. This is evidently too strong, because the sentence is perfectly felicitous even when the speaker is sure that Jacopo does not have 10 or more children, for example.

(8) Jacopo has at least three children.

Similarly, the ignorance inference is not that for each number n greater than two, the speaker either believes the negation of the proposition that Jacopo has exactly

n many children or is not certain about the truth of this proposition, schematically: $\forall n > 2[B(\neg n) \vee \neg B(n)]$. This is weaker than the previous hypothesis, but it is now too weak, because this is compatible with the speaker believing that Jacopo does not have exactly three children, and has at least four, as long as he or she is not certain about any number above three. This is a bad prediction, as the sentence is perceived as infelicitous if that is the case.

The ignorance inference of (8) can more aptly characterized as follows (see Büring 2007, Mayr 2013, Schwarz 2016): the speaker is uncertain about whether or not Jacopo has exactly three children, and about whether or not he has more than three children, schematically: $\neg B(3) \wedge \neg B(\neg 3) \wedge \neg B(>3) \wedge \neg B(\neg >3)$. Similarly, the ignorance inference of (9) is that the speaker is uncertain about whether or not Jacopo has exactly three children, and whether or not he has fewer than three children, schematically: $\neg B(3) \wedge \neg B(\neg 3) \wedge \neg B(<3) \wedge \neg B(\neg <3)$.

(9) Jacopo has at most three children.

We will assume these characterizations of the ignorance inferences of superlative modifiers in the rest of the paper.

Previous studies on this topic, furthermore, regard the ignorance inference of a superlative modifier to be a kind of implicature, and we adopt this idea (Büring 2007, Mayr 2013, Schwarz 2016, Buccola & Haida 2018, Mendia 2018; see also Geurts & Nouwen 2007, Coppock & Brochhagen 2013, Cohen & Krifka 2014 for other related ideas). Empirical support for this analysis comes from the observation that it exhibits characteristic properties of implicatures with respect to certain linguistic operators. For instance, under a necessity operator, the ignorance inference can disappear.

(10) Andy doesn't need to write papers, but Patrick needs to write at least three.

This example has a reading without ignorance inferences (in addition to one with ignorance inferences). Instead, it has a scalar implicature implying that it is ok if Patrick writes exactly three papers, and it is also ok if Patrick writes more than three papers.

This behavior is reminiscent of more familiar cases of (generalized) implicatures that arise from items like *or*. Specifically, *or* gives rise to ignorance implicatures and a scalar implicature in sentences like the following.

(11) Katie speaks French or German.

The ignorance implicatures of this example are that the speaker does not know whether or not Katie speaks French or whether or not she speaks German, and the scalar implicature is that Katie does not speak both French and German. When embedded under a universal quantifier, these ignorance implicatures turn into scalar implicatures, as demonstrated by (12).

(12) Katie is required to speak French or German.

That is, (12) has a reading with scalar implicatures that Katie is not required to speak French and that she is not required to speak German. As we will discuss below, this observation is standardly accounted for by theories of scalar implicatures. Given the parallel behavior exhibited by numerals with superlative modifiers, it would be desirable to extend the scalar implicature approach to them as well.

Before moving on, it should be remarked that implicatures of this kind are very robust, especially in comparison to particularized conversational implicatures, and sometimes even considered to be obligatory. To capture this, it could be hypothesized that *or* and superlative modifiers obligatorily activate alternatives and demand some inference to be derived from them, for example. This is a well-discussed issue in the current theoretical literature, and why that is so is far from settled and different views have been proposed in different theoretical frameworks (see, for example, Levinson 2000, Magri 2009, Schwarz 2016, Buccola & Haida 2019). For the purposes of this paper, fortunately, we need not make theoretical commitments regarding this issue, although as we will discuss now, we will have to make specific assumptions about the alternatives that superlative modifiers activate.

2.2 Alternatives of superlative modifiers

We assume the assertive meanings of *at least n* and *at most n* to be simply lower-bounded at *n* and upper-bounded at *n*, respectively. The compositional details of how that is derived do not matter much here (but see §5). To derive the ignorance inference of a superlative modifier as an implicature, previous studies postulate particular sets of implicature alternatives for them (Cohen & Krifka 2014, Büring 2007, Mayr 2013, Schwarz 2016, Mendia 2018; see also Coppock & Brochhagen 2013). We adopt the following idea from Büring (2007) and Schwarz (2016).

(13) a. $\textsc{alt}(\ulcorner\text{at least } n\urcorner) = \{\ulcorner\text{at least } n\urcorner, \ulcorner\text{at least } n+1\urcorner, \ulcorner\text{exactly } n\urcorner\}$

b. $\textsc{alt}(\ulcorner\text{at most } n\urcorner) = \{\ulcorner\text{at most } n\urcorner, \ulcorner\text{at most } n-1\urcorner, \ulcorner\text{exactly } n\urcorner\}$

Note that the assertive meanings of the alternatives *at least* $n + 1$ and *exactly* n are independent from each other, but both of them are stronger than that of *at least* n (in terms of generalized entailment). Similarly, the assertive meanings of *at most* $n - 1$ and *exactly* n are independent from each other, but are both stronger than that of *at most* n.

Notice importantly that if these stronger alternatives are both negated, the overall meaning will be contradictory. In order to see this, consider (14).

(14) James speaks at least five languages.

   a. Alternatives: James speaks at least six languages.

   b. Alternatives: James speaks exactly five languages.

The assertive meaning of (14) is that James speaks five or more languages. If the first alternative is negated, it will imply that James speaks exactly five languages. If the second alternative is also negated, then, the entire meaning will be contradictory.

Generally, when there are non-weaker alternatives that cannot be negated simultaneously while maintaining consistency with the assertion, each of them gives rise to an ignorance implicature (Sauerland 2004, Fox 2007, Mayr 2013, Meyer 2013, Schwarz 2016). This is exactly how the ignorance implicatures of *or* are accounted for. For instance, consider the following example with the three alternatives given here.

(15) Katie speaks French or German.

   a. Alternative: Katie speaks French.

   b. Alternative: Katie speaks German.

   c. Alternative: Katie speaks French and German.

Among these alternatives, (15a) and (15b) cannot be negated simultaneously to maintain consistency with what is asserted, and they indeed give rise to ignorance implicatures that the speaker does not know whether or not Katie speaks French, and does not know whether or not she speaks German.

The classical way to derive ignorance implicatures is by resorting to the maxim of quantity.[2] Notice that in the above example, all three alternatives are stronger than what is asserted. It is reasonable to assume that utterances of these alternatives would have respected the maxim of manner and the maxim of relevance,

[2] Alternatively, we could use a "grammatical theory" of ignorance implicatures (Meyer 2013, Buccola & Haida 2019) without any crucial changes in our analysis.

so given the speaker must be obeying the maxim of quantity, it must be the case that the speaker would have flouted the maxim of quality. What this implies is that the speaker's beliefs do not support the truths of these alternatives. Together with the assumption that the speaker respects the maxim of quality and so believes the truth of what she asserted, this amounts to the ignorance implicatures of the sentence.

Now, using the same mechanism, we can derive the ignorance implicatures of numerals with superlative modifiers. They simply amount to the fact that the speaker's beliefs do not entail the truths of the stronger alternatives to the prejacent. Together with the assertive meaning of the prejacent, the overall meaning entails the ignorance inferences we wanted to derive.

In the case of *or* there is also a scalar implicature to be accounted for. For (15) above, for example, the scalar implicature is that (15c) is false. This needs an additional explanation. Sauerland (2004), for example, assumes that scalar implicatures are also derived from ignorance implicatures by additional reasoning called the epistemic step, which strengthens the above quantity implicatures to the speaker's beliefs about the falsity of the alternatives, as long as consistency with the rest of the meaning can be maintained. Alternatively, one could assume that scalar implicatures are derived by a separate mechanism, as proposed by Fox (2007), for example (see also Buccola & Haida (2019) for more discussion). According to Fox (2007), the scalar implicatures are first generated by negating all the alternatives that can be negated while maintaining consistency, and then those that were not negated in this process give rise to scalar implicatures.

For the purposes of this paper, we do not have to choose between these theoretical options, but one nice consequence of the implicature approach we are considering here is that it also explains with the same set of alternatives cases where scalar implicatures are observed instead of ignorance implicatures, such as (10) and (12). Let us consider the former example (the analysis of the latter is parallel). The relevant alternatives are:

(16) a. Patrick needs to write exactly three (papers).
     b. Patrick needs to write at least four (papers).

Since the negations of these alternatives are consistent with what is asserted, they give rise to scalar implicatures, rather than ignorance implicatures.[3]

[3]As we remarked in passing, (10) also allows for a reading with an ignorance implicature. One way to derive this is by assigning wider scope to *at least three*, above the necessity modal, but the compositional details are a little complicated, as the (implicit) existential quantifier should stay under the scope of the modal. See, for example, Cohen & Krifka (2014), Hackl (2000), Beck (2012) for relevant discussion.

3 The presuppositions of *even*

Let us now discuss the second ingredient, the presuppositions of *even*. It is standardly considered that the focus particle *even* triggers two presuppositions, an *additive presupposition* and a *scalar presupposition*, based on a contextually relevant set of focus alternatives to the sentence it modifies, the *prejacent* (see Karttunen & Peters 1979, Rooth 1985, Kay 1990, Wilkinson 1996, Crnič 2011, among others).[4]

(17) ⌜Even ϕ⌝ presupposes:

a. ϕ is relatively unlikely among $\textsc{alt}(\phi)$ — Scalar

b. ψ is true, for some $\psi \in \textsc{alt}(\phi)$ that is not entailed by ϕ — Additive

A couple of remarks are in order. Firstly, we state the scalar presupposition in terms of likelihood, but whether or not this is an accurate characterization in the general case is highly controversial and alternative ideas have been put forward that make use of other kinds of ordering among alternatives (Rooth 1985, Kay 1990, Herburger 2000, Greenberg 2018). Furthermore, these previous studies do not agree on how exactly the alternatives are quantified over. Specifically some argue that *all* the alternatives distinct from the prejacent must be ranked higher with respect to the relevant ordering, while others assume something weaker like we do above, or even weaker with existential quantification. There is no consensus on these issues in the literature, and we certainly cannot settle them in this paper, so we remain somewhat loose on these points. Therefore, our account to be developed below should ideally not rely on a particular way of stating the scalar presupposition.

Secondly, there is a separate debate as to whether the additive presupposition is actually part of the core semantics of *even* or it comes from something else (Rullmann 1997, Crnič 2011, Francis 2018). One of the main reasons to think that it is not inherently part of the semantics of *even* is that the additive presupposition does not seem to be present in certain examples, although the judgments might not be stable across speakers, as noted by Francis (2018). For now, we treat the additive presupposition as part of the semantics of *even*, as in (17), and discuss relevant cases and issues they pose for our account at the end of the paper.

[4]For our purposes we can assume that *even* always takes propositional scope. Depending on one's syntactic assumptions, some examples might require covert movement of *even*, but we could also dispense with such a scope-taking mechanism by type-generalizing the meaning given here, as done by Rooth (1985) (see also Panizza & Sudo 2020).

It should also be noted that we state the additive presupposition in a particular way, namely as a *de re* presupposition, rather than as an existential presupposition about the existence of a true non-entailed alternative. We will come back to this point, after presenting our analysis in the next section.

Now, let us illustrate how the above semantics of *even* works with a simple example in (18).

(18) Even James_F danced.

We follow Fox & Katzir (2011) in assuming that focus alternatives are contextually relevant expressions that are obtained by replacing the F-marked constituent with alternative expressions. Without loss of generality, let us assume the following set of alternatives here.

$$\left\{ \begin{array}{ll} \text{James danced,} & \text{Katie danced,} \\ \text{Lucas danced,} & \text{Ruoying danced} \end{array} \right\}$$

The scalar presupposition is that James was relatively unlikely to dance, compared to the other people mentioned here, and the additive presupposition requires there to be someone else than James that danced. This seems to capture the intuitive meaning of the sentence in (18).

4 Analysis

4.1 Putting the ingredients together

With what we discussed in the previous two sections, we are now ready to come back to our main puzzle. We will use the following sentence as a representative example.

(19) # James even speaks $[\text{at least three}]_F$ languages.

What are the focus alternatives that *even* operates on here? Following Fox & Katzir (2011), we crucially assume that the alternatives that focus particles operate on and the alternatives used for computing implicatures are generated by the same mechanism. Concretely, *even* in (19) will operate on the following set of alternatives.

$$\left\{ \begin{array}{l} \text{James speaks at least three languages,} \\ \text{James speaks at least four languages,} \\ \text{James speaks exactly three languages} \end{array} \right\}$$

With this set of alternatives, let us compute the scalar and additive presuppositions predicted by the semantics of *even* reviewed in the previous section. If either of them is not satisfiable, we have an account of the infelicity of the sentence.

The scalar presupposition will be that the prejacent of *even*, i.e. the top sentence in the above set, is relatively unlikely to be true. Note that this is unsatisfiable, because it is the weakest element in this set in the sense that the other two alternatives asymmetrically entail it. Since probability is monotonic with respect to entailment, the prejacent can at most be as likely as the other two, and cannot be less likely.

However, we are reluctant to see this as a satisfactory account of the infelicity of (19). As we mentioned in the previous section, there is a debate about how the scalar presupposition of *even* should be stated, in particular, with respect to which ordering to use. The above explanation depends crucially on the monotonicity of probability with respect to entailment, but if the scalar presupposition turns out to be able to use ordering that is not monotonic with respect to entailment, the scalar implicature may actually come out as satisfiable. In fact, such notions as remarkableness or noteworthiness are non-monotonic with respect to entailment and seem to be good candidates for the semantics of *even*.

Moreover, a more empirical reason to eschew this explanation comes from the fact that *only* can felicitously modify *at most n*, as we saw in (5). When associating with a numeral, *only* generally triggers a scalar inference that the amount in question is small. The acceptability of the inference in (5) suggests that a scalar inference and the ignorance inference of a superlative modifier are compatible with each other.

For these reasons, we think that the scalar presupposition is actually not problematic after all. Rather, we propose that the real culprit is the additive presupposition. We will present additional evidence that this is the case later that comes from an additive particle like *too*, but let's first see how it can render the example in (19) infelicitous.

The additive presupposition says of at least one alternative that is not weaker than the prejacent that it is true. In the above set, therefore, either it is presupposed that James speaks at least four languages or that James speaks exactly three languages.

Turning now to the ignorance implicatures of (19) there are two candidates for the set of alternatives: (i) the set of alternatives is identical to the set we considered above for computing the presupposition of *even*, or (ii) it is the following set, where each member contains *even*.[5]

[5]An anonymous reviewer asks if (i) is possible at all. If one assumes the Roothian Alternative Semantics (Rooth 1992), as we do here, there is a natural way of making sense of it. Under

$$\left\{\begin{array}{l}\text{James even speaks at least three languages,}\\ \text{James even speaks at least four languages,}\\ \text{James even speaks exactly three languages}\end{array}\right\}$$

The only difference between the two sets is the presence/absence of the particle *even*, whose assertive meaning is vacuous. It is currently a hotly debated issue how presuppositions behave in the computation of implicatures (e.g. Gajewski & Sharvit 2012, Spector & Sudo 2017, Marty 2017, Anvari 2019), and the current literature contains no explicit discussion of the behavior of *even* in implicatures, or how presuppositions of alternatives behave in the computation of ignorance implicatures, as opposed to scalar implicatures. For this reason, this issue will remain as another open question, but for our purposes in this paper, it is enough to approach this issue bottom-up. That is, the examples in (4) and (5) contain numerals with superlative modifiers and focus particles, and crucially, they have the same ignorance implicatures as the versions of these sentences without the focus particles. Extending this to example (19), we expect it to have the same ignorance implicatures as the version of the sentence without *even*. Theoretically, we could obtain this result by forcing the option (i) above, or by adopting (ii) but somehow making sure that the computation of ignorance implicatures ignores *even*, which we will leave open here.

Now notice crucially that the ignorance implicatures of (19) contradict the additive presupposition of *even*. Specifically, the additive presupposition is either that James speaks at least four languages or that James speaks exactly three languages, but then it must be the case that the speaker believes it to be true, and so cannot be ignorant about its truth (cf. Stalnaker 1978). We claim that this conflict is what is behind the infelicity of (19).

To reiterate the crucial assumption of our analysis, the focus alternatives that *even* operates on are generated in the same way as the alternatives that give rise to ignorance implicatures, based on the alternatives of numerals with superlative modifiers in (13) (cf. Rooth 1992, Fox & Katzir 2011). If not, the additive presupposition could well be compatible with the ignorance implicatures. That is, if the additive presupposition could be about an alternative that was not in the set of alternatives for the ignorance implicatures, the truth of that alternative would not conflict with the ignorance implicatures.

this framework, the set of alternatives for *even* is structurally represented as the complement of the ~-operator, and there is no reason why the mechanism used for generating ignorance implicatures cannot make use of the same set. It should also be noted that for (ii), it needs to be assumed that *even* does not always make the set of alternatives trivial, contrary to what Rooth (1992) stipulates. As Krifka (1991) and Panizza & Sudo (2020) discuss, there is independent evidence for abandoning Rooth's stipulation.

4.2 *De re* additive presuppositions

Notice at this point that it is crucial for us that the additive presupposition is about a particular alternative, and in this sense *de re*. More specifically, the additive presupposition of *even* ϕ is satisfied in a given context if the truth of some alternative not weaker than ϕ is common ground. This contrasts with an existential presupposition, which says that it is common ground that some alternative not weaker than ϕ is true. Such an existential presupposition is too weak for our purposes, as it is compatible with the ignorance implicature that the speaker does not know which non-weaker alternative is true.

There is independent empirical reason to adopt the *de re* additive presupposition. Kripke (2009) argues that the additive presuppositions that additive particles like *too* trigger are similarly stronger than existential, based on examples like the following (see also Geurts & van der Sandt 2004; but see Ruys 2015).

(20) Sam_F is having dinner in New York tonight, too.

If it is merely existential, the presupposition that there is someone else having dinner in New York tonight will be very easy to satisfy. Rather, the intuition tells us that this sentence requires a prior mention of some particular individual, who is at least known to be in New York tonight, and perhaps also known to be going to have dinner there.

We observe that *even* behaves similarly in this regard. To see this, consider the following example.

(21) Even Daniele_F has a bike.

Intuitively, this example similarly requires it to be clear in the context which alternative or alternatives are relevant, at least.

Kripke (2009) analyzes the additive presupposition of *too* to be anaphoric. That is, it is not merely propositional but contains an anaphoric component that needs to be resolved to an antecedent accessible in the discourse that satisfies the relevant property. For example, the additive presupposition of (20) above has an anaphoric component that needs to be resolved, and then it furthermore presupposes that that individual is going to have dinner in New York (see also Geurts & van der Sandt 2004). We essentially adopt this analysis for *even*, but the way we state it is slightly weaker, as it does not have an anaphoric component, but an existential quantifier over alternatives that is *de re* with respect to the presuppositional attitude. At this point, we cannot tease apart these two analytical possibilities on empirical grounds, and we could as well adopt Kripke's idea, but crucially, both types of analyses, when applied to (19), will result in a conflict with the ignorance inference.

4.3 Predictions

One prediction that our analysis makes is that the additive particle should also give rise to infelicity, when used in a sentence like (19) in place of *even*, because the conflict should arise as long as an additive presupposition is triggered. This prediction is borne out. Note, however, the infelicity of an example like the following is not telling, because the truth-conditional meanings of the two sentences are simply incompatible with each other anyway.

(22) Daniele speaks exactly two languages. #He speaks [at least three]$_F$, too.

Rather, we need to look at examples like (23).

(23) Daniele is allowed to smoke exactly two cigarettes today. #He is allowed to smoke [at least three]$_F$, too.

Here, the truth-conditional meanings of the two sentences should be compatible with each other. In fact, the comparative version of this example is perfectly felicitous.

(24) Daniele is allowed to smoke exactly two cigarettes today. He is allowed to smoke [more than two]$_F$, too.

According to our account, (23) is rendered infelicitous because of the clash between the additive presupposition and the ignorance implicature.[6]

Another prediction we make is that a similar conflict should arise with a scalar implicature of a superlative modifier as well. In order to see this, consider the following example, which is infelicitous.

(25) Andy is giving two lectures at the summer school. #Patrick is even required to give [at least four]$_F$.

Recall that a superlative modifier gives rise to a scalar implicature under a universal quantifier like a necessity modal. The second sentence of this example, therefore, has a scalar implicature that Patrick is not required to give exactly four lectures and he is not required to give more than four lectures. On the other hand, the additive presupposition requires that it be presupposed that Patrick is required to give exactly four lectures, or that he is required to give more than four. This clash explains the infelicity.

[6] It is actually an open issue why the second sentence of (23) has to have an ignorance implicature, rather than a scalar implicature. See Buccola & Haida (2018) for discussion.

5 Conclusion and open issues

To summarize, we have developed an account of the observation that numerals with superlative modifiers are not compatible with focus particles like *even*, which as far as we know has not been previously discussed. We proposed that what causes the infelicity is the additive presupposition triggered by *even*, which conflicts with the ignorance implicature of the numeral with the superlative modifier. We remarked that in order to obtain these results, two theoretical assumptions are necessary: (i) the set of alternatives for implicatures and the set of alternatives for focus operators are generated in the same way based on the alternatives for numerals with superlative modifiers (Fox & Katzir 2011, Rooth 1992, Mendia 2018), and (ii) the additive presupposition is stronger than a merely existential presupposition, and is *de re* (Kripke 2009, Geurts & van der Sandt 2004). Both of these points have been proposed in the literature on independent grounds, and we hope to have provided further support for them in this paper. Before closing, we will discuss some open issues that arise from our analysis.

5.1 Alternatives of superlative modifiers

In Section 2, we simply followed previous analyses and postulated particular sets of alternatives for numerals with superlative modifiers, but we did not provide a principled account as to why these alternatives must be used. In fact, this is one of the open issues discussed in Schwarz (2016) and Mayr (2013), and unfortunately we do not have anything additional to offer. Having said that, however, we would like to discuss how to extend our analysis to other uses of superlative modifiers, which might shed some light on this question.

So far, we have only looked at cases where superlative modifiers combine directly with a numeral, but superlative modifiers can modify other types of expressions as well. In fact, it is reasonable to assume that superlative modifiers are focus sensitive operators themselves. Concretely, in examples like the following, one observes the usual focus association effects.

(26) a. Andy at least introduced Patrick_F to Tom.
b. Andy at least introduced Patrick to Tom_F.

In order to capture this, we can analyze *at least* and *at most* as focus sensitive operators. As in the case of *even*, let us assume that the superlative modifiers take sentential scope, although this assumption is strictly speaking not necessary (cf. fn. 4).

(27) a. $\ulcorner$at least $\phi\urcorner$ requires contextually determined partial ordering $\leq$ among $\textsc{alt}(\phi)$, and asserts the grand disjunction of $\{\phi' | \phi \leq \phi'\}$.

Furthermore, $\textsc{alt}(\text{at least } \phi) = \{\ulcorner\text{at least } \phi\urcorner, \ulcorner\text{Exh}_{\{\phi' \in \textsc{alt}(\phi) | \phi < \phi'\}}\, \phi\urcorner,$ $\ulcorner\text{at least } \psi\urcorner\}$ where ψ is the grand disjunction of $\{\phi' | \phi < \phi'\}$.

b. $\ulcorner$at most $\phi\urcorner$ requires contextually determined partial ordering $\leq$ among $\textsc{alt}(\phi)$, and asserts the grand disjunction of $\{\phi' | \phi' \leq \phi\}$ and the negation of the grand disjunction of $\{\phi'' | \phi < \phi''\}$.

Furthermore, $\textsc{alt}(\text{at most } \phi) = \{\ulcorner\text{at most } \phi\urcorner, \ulcorner\text{Exh}_{\{\phi' \in \textsc{alt}(\phi) | \phi' < \phi\}}\, \phi\urcorner,$ $\ulcorner\text{at most } \psi\urcorner\}$ where ψ is the grand disjunction of $\{\phi' | \phi' < \phi\}$.

Exh here is the exhaustivity operator à la Fox (2007). The notion of innocent exclusion used in its definition is crucial to state the above semantics in a general way.

(28) $\ulcorner\text{Exh}_A\, \phi\urcorner$ is true iff ϕ is true and all innocently excludable alternatives to ϕ with respect to A are false.

(29) a. ψ is an innocently excludable alternative to ϕ with respect to A iff ψ is a member of every maximal set of excludable alternatives with respect to ϕ and A.

b. A set S is a set of excludable alternatives with respect to ϕ and A iff $S \subseteq A$ and ϕ and the negation of the grand disjunction of S are consistent.

To see how this works, let us apply it to the following example.

(30) Pietro invited at least Daniele$_F$.

The alternatives to *Daniele* need to be ordered here in some way. One of the most natural options here is the following kind of set of alternatives, partially ordered by generalized entailment.

$$\left\{\begin{array}{l} \vdots \\ \text{Pietro invited Danile and Taka and Ruoying, ...} \\ \text{Pietro invited Daniele and Taka, ...} \\ \text{Pietro invited Daniele, ...} \end{array}\right\}$$

The assertive meaning only concerns those alternatives that are commensurable with the prejacent, and so will be that Pietro invited Daniele (and possibly someone else), and the ignorance implicature will amount to the speaker's lack of certainty whether Pietro only invited Daniele or if he invited someone else.

The analysis also works for cases like the following where the scale is dense.

(31) a. Daniele is at least [180 cm]$_F$ tall.
b. It at most takes [15 min]$_F$.

It also works when the scale is not ordered by (generalized) entailment, as in (32).

(32) a. Daniele is at least a [postdoc]$_F$.
b. Andy won at most the silver$_F$ medal.

Crucially, this analysis predicts the following examples to be infelicitous for the same reason as numerals with superlative modifiers are incompatible with focus operators with additive presuppositions, which is a good prediction.

(33) a. # Pietro even invited [at least Daniele$_F$]$_F$.
b. # Pietro also invited [at least Daniele$_F$]$_F$.

5.2 Comparative modifiers

As we saw in several places in this paper, numerals with comparative modifiers behave differently from numerals with superlative modifiers. Part of this comes from the fact that numerals with comparative modifiers do not give rise to robust ignorance implicatures. For example, the following sentences sound more felicitous than their superlative counterparts.

(34) a. I have more than two kids.
b. I have fewer than three kids.

(35) a. A triangle has more than two sides.
b. A triangle has fewer than four sides.

If numerals with comparative modifiers do not necessarily give rise to ignorance implicatures, then it is predicted that they should be compatible with focus particles with additive presuppositions.

However, this matter is not as clearcut as one might hope. That is, the sentences like those above actually do often have have inferences that amount to something similar to an ignorance implicature or an indifference/irrelevance implicature (Meyer 2013, Lauer 2014). How this arises and what alternatives are used are interesting questions, but we cannot offer a concrete account here, and as far as we know, they are currently debated in the literature (see Fox & Hackl 2006, Mayr 2013, Schwarz 2016).

In addition to this question about alternatives, the morphosyntactic difference between comparative and superlative modifiers is also puzzling. As we discussed in the previous subsection, superlative modifiers are focus sensitive operators and can appear in all sorts of adverbial positions. By contrast, there is no indication that comparative modifiers are focus sensitive, and in fact their distribution seems to be more constrained. We are presently not aware of a satisfactory account of why this is so.

5.3 When *even* is not additive

The last open issue we would like to mention has to do with the additive presupposition of *even*. As mentioned in passing, the additive presupposition of *even* sometimes seems to be absent (Rullmann 1997, Crnič 2011). The following is a well-discussed example of this.

(36) Andy even won the silver$_F$ medal.

This sentence has a reading that does not imply that Andy also won another medal, although according to Francis (2018), these judgments are not stable across speakers of English.

As Crnič (2011) discusses in great detail, there is currently no satisfactory account of exactly when the additive presupposition of *even* arises, and we have nothing insightful to add here. Yet, it is our prediction that in the absence of an additive presupposition, *even* should be compatible with superlative modifiers. One might then think that the fact that an example like (37) is infelicitous might be problematic for our account.

(37) Patrick won the bronze medal. ??Andy even won [at least the silver$_F$]$_F$ medal.

However, in the absence of a good understanding of the distribution of the additive presupposition, we cannot be sure if this example actually lacks an additive presupposition. In particular, entailment among the focus alternatives might be one relevant factor that correlates with the presence of additivity, as Crnič (2011) claims, and if so, the presence of *at least* in (37) should matter crucially, as with it, the focus alternatives presumably stand in an entailment relation (cf. the semantics of *at least* above).[7]

[7] An anonymous reviewer asks about examples like *I even doubt that one$_F$ person came* (cf. Crnič 2011). If the numeral and its alternatives receive lower-bounded readings, then indeed the additive presupposition would be problematic because the alternatives would be entailed. However, it is well known that numerals generally can easily receive bilateral readings even in negative contexts (Geurts 2006, Breheny 2008, among others). With this as an option, such examples do not pose an issue. For the above example, the additive presupposition would be satisfied if the speaker doubts that exactly *n* people came for at least one $n > 1$, which seems to be a reasonable analysis.

Due to these complications, we cannot offer a conclusive example involving *even*, but it should be remarked that nothing rules out the existence of a scalar particle like *even* that is never associated with an additive presupposition in a natural language. For instance, Italian *addirittura* is a good candidate (Daniele Panizza, p.c.). If this is the case, we predict it to be compatible with superlative modifiers. We, however, have left investigation of this for future research.

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Appendix

We saw in the main part of this paper that a numeral with *at least* is incompatible with *even*, as in (1) while a numeral with *at most* is compatible with *only*, as in (5). Our explanation for the former is that the additive presupposition clashes with the obligatory implicature of *at least*. For the latter, we could resort to the fact that *only* does not trigger an additive presupposition and hence does not cause a conflict.

We also mentioned in fn. 1, a numeral modified by *at least* is incompatible with *only* and a numeral with *at most* is incompatible with *even*, as shown below.

(38) a. I speak five languages. #James only speaks [at least two]$_F$.
  b. I speak two languages. #James even speaks [at most five]$_F$.

For (38b), we could extend our analysis and maintain that the additive presupposition clashes with the ignorance implicature, but (38a) is not amenable to this explanation. Generally, when associating with a quantity expression, *only* gives rise to an inference that the relevant quantity is small, so one would expect the second sentence of (38a) to mean James speaks more than one language, and he speaks many languages.

We think that examples like these require an entirely different explanation anyway, because their comparative counterparts are equally unacceptable.

(39) a. I speak five languages. #James only speaks [more than one]$_F$.
  b. I speak two languages. #James even speaks [fewer then six]$_F$.

Here is a sketch of a possible analysis. As mentioned above, *only* associating with a quantity expression triggers an inference that the named amount is small. *Even*, on the other hand, triggers an inference that the named amount is large.

(40) a. James only speaks five$_F$ languages. $\rightsquigarrow$ five is a small amount
b. James even speaks five$_F$ languages. $\rightsquigarrow$ five is a large amount

There are several accounts of when and how *only* can trigger such a scalar inference (Grosz 2012, Coppock & Beaver 2014, Alxatib 2020), which we will not get into here. For *even*, the semantics we discussed in §3 can derive a scalar inference with reasonable assumptions about the flavor of the scalar presupposition and about the alternatives of numerals.

What seems to us to be going on in the above cases with modified numerals is that these scalar inferences arise from all numerals in their range. That is, the scalar inference of (38a)/(39a) is that each $n > 1$ is a small amount, and that of (38b)/(39b) is that each $n < 6$ is a large amount. We leave open the compositional details of how these inferences arise from the semantics of the focus operators and modified numerals here, but they account for the infelicity of these examples. Further support for this analysis comes from the following contrast.

(41) Katie speaks four languages, which is a lot.
a. James only speaks [at most two]$_F$ languages.
b. # James only speaks [at most ten]$_F$ languages.

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Chapter 16

Classifiers make a difference: Kind interpretation and plurality in Hungarian

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This paper provides an analysis of Hungarian sortal classifiers, shedding light on the complex interplay between classifiers, plurality and kind interpretation in the language. We build on Schvarcz & Rothstein's (2017) approach to the mass/count distinction, providing further evidence for noun flexibility. We show that Num+N and Num+CL+N constructions have different interpretations; in particular, kind interpretation tells the two apart. We provide evidence against plural-as-a-classifier (Dékány 2011) and number-neutrality (Erbach et al. 2019) views and argue that classifier optionality can be accounted for by the predictions the Nominal Mapping Parameter (Chierchia 1998b) makes with respect to bare singular nouns. We claim that Hungarian nominals are born as kind-denoting expressions which then can undergo a kind-to-predicate shift explicitly triggered by a sortal individuating classifier. We analyze classifiers in Hungarian as functional operators on kinds of type $\langle k, \langle e, t \rangle \rangle$, which apply to kind denoting terms generating instantiations of that kind.

Keywords: classifier optionality, plurality, noun flexibility, bare nominal denotation, kind interpretation, Hungarian

1 Introduction

Why does a numeral expression allow sortal classifiers in a mass/count language? It has been widely assumed that classifiers serve as mediating elements between numerals and nouns and perform an individuating or portioning out function,

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allowing mass-denoting nouns to be modified by numerals. Classifiers are obligatorily used in classifier languages since all nouns in these languages have mass denotations. In mass/count languages, on the other hand, count nouns can be directly modified by numericals. If a language exhibits wide mass/count phenomena, we do not expect it to have a functional category of classifiers. Hungarian, however, seems to contradict this paradigm.

Even though Hungarian has been categorized as a mass/count language (Schvarcz 2014, Schvarcz & Rothstein 2017), counting in this language allows an apparently optional classifier: numerical constructions involving a notionally count noun can be realised with a construction of direct modification by a numerical (henceforth NUM+N) (1a), as well as with a construction involving a sortal classifier (henceforth NUM+CL+N) (1b).

(1) a. három újság
three newspaper
'three newspapers'

b. három darab újság
three $\text{CL}_{\text{GENERAL}}$ newspaper
'three newspapers'

As examples (1a) and (1b) illustrate, numerals in Hungarian combine with singular nouns, despite the existence of a genuine plural marker (Schvarcz & Rothstein 2017). In addition, the language exhibits unique bare nominal phenomena. This combination of properties poses interesting questions about the category of number. There is a complex interplay between the various grammatical devices linked to the cognitive notion of number, including numerals, classifiers, plural-marking and bare noun denotations. Investigating the category of classifiers can help us gain a better understanding of the function performed by the above-mentioned devices as well as of the category of number in Hungarian and beyond.

The aim of this paper is to provide an explanation for the optional use of sortal classifiers in Hungarian, with special focus on the general classifier *darab*. Relying on novel linguistic data, we provide evidence that the presence of a classifier inside a numerical construction restricts the interpretation of the phrase: while NUM+N can have a plurality of kinds, of sub-kinds and of individuals reading, NUM+CL+N can only refer to a set of plural individuals. This interpretational difference raises questions about the denotation of the nominal and the semantic significance of the classifier.

The structure of this paper is as follows. In the remainder of this section, we will discuss various approaches to the Hungarian mass/count and classifier phenomena proposed in the literature. In §2, we present a range of tests where sortal classifiers make a difference in the interpretation of numerical constructions. In §3, we discuss evidence against treating plurality as a classifier as well as data that questions number-neutrality. In §4, we explore the problem of kind interpretation in Hungarian and try to place the language in Chierchia's (1998b) typology of nominal denotation. In §5, we provide a semantic analysis of sortal classifiers. In §6, we draw some conclusions and discuss implications.

We begin by providing some general background on classifiers in Hungarian, followed by a review of the existing analyses of Hungarian classifier phenomena in the literature. The phenomenon of classifiers has been often noted in the literature on Hungarian classifiers (Beckwith 1992, 2007, Csirmaz & Dékány 2014, Schvarcz & Rothstein 2017, Szabó & Tóth 2018, Schvarcz & Wohlmuth forthcoming). Some of the canonical examples include:

(2) a. két (fej) hagyma
two CL$_{\text{HEAD}}$ onion
'two heads of onion'

b. három (szál) rózsa
three CL$_{\text{THREAD}}$ rose
'three (threads of) roses'

c. három darab könyv
three CL$_{\text{GENERAL}}$ book
'three books'

Crucially, the classifiers in (2) are optional and look like sortal classifiers. While some select nouns according to shape and size (e.g. *fej* 'head' takes nouns denoting large round objects and *szál* 'thread' combines with nouns denoting long thin objects), the general classifier *darab* combines with any notionally countable noun. The construction without the classifier has the same meaning as its classifier counterpart. (3a) and (3b) have the same meaning, while (3c) contrasts with (3b). This is due to the fact that *köteg* 'bunch' is a so called 'group or collective classifier' which groups roses into a higher order entity.

(3) a. három rózsa
three rose
'three roses'

b. három szál rózsa
three $\text{CL}_{\text{THREAD}}$ rose
'three threads of roses'

c. három köteg rózsa
three CL_{BUNCH} rose
'three bunches of roses'

These facts about Hungarian pose a problem for the traditional categorizations, which define two major systems of making nouns countable (Greenberg 1974, Chierchia 1998a). On the one hand, we find languages such as Mandarin Chinese and Japanese, which lack a genuine plural marker; have no distinction between count and mass nouns on the nominal level; and where bare nouns can occur as arguments of kind-taking predicates. On the other hand, there are languages, such as English, French or Dutch, where nouns are categorised as count or mass; count nouns are directly modified by numerals. These languages have a genuine morphological marker of plurality; and do not allow bare singular arguments. Hungarian exhibits both typical classifier language traits and mass/count language traits. While it has a rich classifier system and uses bare singular arguments (4), it also manifests a genuine mass/count distinction (Schvarcz 2014) and morphologically marks plurality (5).[1]

(4) Sas nem kapkod legyek után.
eagle not fluster.PRES.3SG fly.PL after
'Eagles do not fluster after flies.'

(5) újság / újság-ok
newspaper newspaper-PL

To account for the occurrence of sortal classifiers, three approaches have been proposed in the literature.

First, Csirmaz & Dékány (2014) suggest treating Hungarian as a classifier language, in which "bare nominals [...] are non-atomic, they denote an undifferentiated mass" (p. 142), and hence counting requires either an explicit lexical classifier (e.g. *darab*) or a null sortal classifier:

(6) a. három darab újság
three $\text{CL}_{\text{GENERAL}}$ newspaper

b. három $\varnothing_{\text{CL}}$ újság
three $\text{CL}_{\varnothing}$ newspaper

[1]While examples such as (4) are limited and not highly productive in the language, they highlight the availability of bare singular arguments in Hungarian. The few context and constructions in which the use of the bare singular is possible are discussed in detail under §4.

Treating Hungarian as a classifier language is supported by the absence of plural marking on the nominal upon combining with numerals greater than 'one'. To address this issue, Dékány (2011) suggests treating the Hungarian morphological plural marker *-k* as a type of plural classifier which spans in two positions: Number and Classifier.

While Csirmaz & Dékány's analysis accounts for the use of sortal classifiers, it cannot account for the facts about plurality and mass/count phenomena manifested in the language. Other analyses suggest that the issue of plural is orthogonal and that the absence of plural marking is not related to countability (Borer 2005, Schvarcz & Rothstein 2017).

Second, regarding mass/count phenomena, Schvarcz & Rothstein (2017) argue that Hungarian has purely mass nouns, a few purely count nouns and a wide range of flexible nouns. Nouns like *újság* 'newspaper' can be used in counting contexts either as a count noun or in a sortal classifier construction. They observe that the patterns of classifier use is due to the ambiguity between a count and mass interpretation of a flexible noun. This is illustrated below, where in (7a) the mass counterpart of the flexible noun *újság* 'newspaper' obligatorily takes the general classifier *darab*, while the count counterpart of the same flexible noun (7b) can be counted without any classifier and even bars the use of one.

(7) a. három *(darab) újság
three CL$_{\text{GENERAL}}$ newspaper.MASS
'three copies of newspapers'

b. három (*darab) újság
three CL$_{\text{GENERAL}}$ newspaper.COUNT
'three copies of newspapers / three titles of newspapers'

Third, Erbach et al. (2019) argue that notionally count nouns are semantically number neutral, in the sense of Farkas & de Swart (2010), denoting both atomic entities and sums thereof. Under their analysis, classifiers are required by the numeral semantics and not by the nominals (Krifka 1995, Sudo forthcoming). However, their analysis does not address classifier optionality per se.

In this paper, we will defend the noun-flexibility analysis. We base our analysis on observations emerging from the interpretations of the two structures, and show that neither plural-as-a-classifier nor number-neutrality fully explains the data on kind interpretation and classifier optionality. Our data show that the availability of a kind interpretation tells apart the two structures in (1): while the NUM+N construction (1a) can either refer to a set of individuals or subkinds, the classifier construction (1a) can only refer to a set of individuals. In addition to identifying the function and interpretation of the classifier, we observe that plural marked nouns can freely get a subkind interpretation while classifier phrases can not. Based on this semantic difference, we maintain and provide further evidence for the claims of Schvarcz & Rothstein (2017) that plural marking cannot be treated as a classifier (contra Dékány 2011), showing that the two elements fulfill different functions. We will also discuss several cases which contradict the assumptions made by Erbach et al. (2019) and rule out a number-neutrality analysis for Hungarian.

2 The semantic effect of *darab* on kind and subkind reading

While Schvarcz & Rothstein (2017) suggest that there is no significant interpretational difference between numerical constructions involving an overt classifier and a covert one, we observe that there is, in fact, an important semantic contrast between the two structures. For example, NUM+N in (8a) may refer to a plurality of newspaper copies; to a plurality of sub-kinds of newspapers (daily, monthly, weekly); or to a plurality of newspaper titles (*The Herald Tribune*, *The New York Times*, *The Economist*).[2] In contrast, NUM+CL+N in (8b) can only have a plurality of individuals interpretation under which it can only refer to a plurality of newspaper objects, namely three copies.

(8) a. Subkind/plurality of individuals interpretation
Három újság-ot árul ez az újságárus.
three newspaper-ACC sell.PRES.3SG this the news.vendor
'This newspaper vendor sells three newspapers.'

b. Plurality of individuals interpretation
Három darab újság-ot árul ez az újságárus.
three $\text{CL}_{\text{GENERAL}}$ newspaper-ACC sell.PRES.3SG this the news.vendor
'This newspaper vendor sells three newspapers.'

[2] An anonymous reviewer points out that while the plurality of sub-kinds reading exists, it is rather unnatural in the case of the noun *újság*. More natural examples include:

(i) ? Három állat rak tojás-ok-at: a hal, a hüllő és a madár.
three animal lay.PRES.3SG egg-PL-ACC the fish, the reptile and the bird
'Three animals lay eggs: the fish, the reptile and the bird.'

(ii) Két madár nem tud repülni: a strucc és a pingvin.
two bird not can fly.INF the ostrich and the penguin
'Two birds cannot fly: the ostrich and the penguin.'

The ambiguity between an existential and a subkind interpretation of NUM+N constructions can also be observed in English (9). English, however, does not have a mechanism parallel to the Hungarian general classifier to disambiguate the two readings in favor of an individuating one.

(9) a. This newsvendor sells three newspapers: *The New York Times, The Herald Tribune* and *The Economist.* He has 50 copies delivered of each.
b. This newsvendor sells three newspapers: he only has one copy left of *The New York Times, The Herald Tribune* and *The Economist.*

Based on the contrast in (8), we suggest that the role of sortal numeral classifiers in Hungarian is that of restricting subkind reading, thereby eliminating the ambiguity found in numerical expressions. A number of tests and contexts confirm our prediction for Hungarian. In order to test our hypothesis, we carefully selected structures and contexts that disallow the existential interpretation to occur. In these cases, we expected the use of a sortal individual classifier to be infelicitous.

First, kind-reference generic sentences express properties true of kinds, species or classes of objects, but not of individual objects (Krifka et al. 1995), hence they should be incompatible with the general classifier *darab*. The use of the kind classifier, *fajta* 'kind of/type of', is felicitous in such contexts.[3]

(10) Három {(*darab) / (fajta)} újság a megszűnés szél-én
three $\text{CL}_{\text{GENERAL}}$ CL_{KIND} newspaper the ceasing.to.exist verge-SUP
áll.
stand.PRES.3SG
'Three newspapers are on the verge of ceasing to exist.' / 'Three kinds of newspapers are on the verge of ceasing to exist.'

[3] An anonymous reviewer brings our attention to an alternative interpretation: *újság* may have a title reading. In that case *darab* can refer to newspaper titles, suggesting that the titles reading may be individual-denoting. This ambiguity in the interpretation can be attributed to a polysemy between physical object and informational object senses (Pustejovsky 1995, Asher 2011). It has been discussed by Schvarcz & Wohlmuth (forthcoming) if such polysemous nouns occur in classifier expressions, the numeral can only count physical objects. Nevertheless, with nouns that do not exhibit such polysemy, the classifier expression is ruled out:

(i) * Két darab madár a kihalás szélén áll: a strucc és a
two $\text{CL}_{\text{GENERAL}}$ bird the extinction verge.SUP stand.PRES.3SG the ostrich and the
pingvin.
penguin
'Two birds stand on the verge of extinction: the ostrich and the penguin.'

(11) Ez az újságárus árulja a három {(*darab) / (fajta)}
this the newsvendor sell.pres.3sg the three cl$_{\text{general}}$ cl$_{\text{kind}}$
betiltott újságo-t, bár tudja, hogy azok
banned newspaper-acc although know.pres.3sg that those
feketelistá-ra kerültek.
blacklist-sbl get.past.3sg

‘This newsvendor sells the three banned newspapers, although he knows that those have been backlisted.’ / ‘This newsvendor sells the three kinds of banned newspapers, although he knows that those have been backlisted.’

(12) János három {(*darab) / (fajta)} marhá-t tenyészt: Holstein
John three cl$_{\text{general}}$ cl$_{\text{kind}}$ cattle-acc breed.pres.3sg Holstein
marhá-t, Angus-t, és barna svájci marhá-t
cattle-acc Angus-acc and brown Swiss cattle-acc

‘John breeds three cows: Holstein, Angus and brown Swiss cow.’ / ‘John breeds three kinds of cows. Holstein, Angus and brown Swiss cow.’

Second, distributive operators and reciprocals require plural atomic antecedents (Link 1983, Rothstein 2009, Schwarzschild 2011, Schvarcz 2014). The verb *kiadni* ‘to publish’ in (13), and the adverb *gyakran* ‘often’ in (15) rule out a plurality of individuals interpretation. In contexts where only a plurality of subkinds interpretation is possible, the interplay between these verbs and distributive or reciprocal phrases results in the impossibility of the use of the classifier. In (13), for example, the context refers to a multiplicity of copies of different newspapers, as we expect news agencies to publish a large number of various newspaper editions. Therefore, a plurality of individuals reading induced by the classifier is ruled out.

(13) A Magyar Távirati Iroda három (*darab) újság-ot
the Hungarian news agency three cl$_{\text{general}}$ newspaper-acc
egymás után adott ki.
each.other after publish.past.3sg vm

‘MTI [Hungarian news agency] published three newspapers one after another.’

(14) Susan Rothstein öt (*darab) könyv-ét egymás után
Susan Rothstein five cl$_{\text{general}}$ book-acc each.other after
adták ki.
publish.past.3sg vm

‘Susan Rothstein’s five books were published one after the other.’

(15) János három (*darab) újság-ot vesz keddenként,
John three CL$_{\text{GENERAL}}$ newspaper-ACC buy.PRES.3SG on.Tuesdays
ez-ek-ből folyamatosan tud tájékozódni arról, hogy mi
DEM-PL-ELA successively can.PRES.3SG about that what happen
történik a nagyvilág-ban.
PRES.3SG the big.world-INESS
'John buys three newspapers on Tuesdays. He learns from these what goes on in the world all the time.'

The third test involves expressions which refer to multiple instantiations of a noun. Contexts which indicate multiple instantiations of kinds are not compatible with the structure involving a sortal individual classifier. The classifier can be used in the second sentence to mark the contrast between the two interpretations of the noun: (17b) is a constellation in which *újság* in the first sentence must have a sub-kind reading, while in the second sentence, it can only be interpreted as a plurality of newspapers.

(16) Mari három (*tő) rózsá-t ültetett: angol-, futó- és
Mari three CL$_{\text{ROOT}}$ rose-ACC plant.PAST.3SG English rambler and
teahibrid rózsá-t. Összesen ötvenhárm-at.
hybrid rose-ACC in.total fifty.three-ACC
'Mary planted three roses: English roses, rambler roses and hybrid roses. In total 53. '

(17) *Context*: John buys newspapers for all ten workers in his office, one from each kind.

a. János három (*darab) újság-ot vett. Összesen
John three CL$_{\text{GENERAL}}$ newspaper-ACC buy.PAST.3SG in.total
harminc-at.
thirty-ACC
'John bought three newspapers. In total 30.'

b. János három újság-ot vett. Összesen harminc
John three newspaper-ACC buy.PAST.3SG in.total thirty
darab újság-ot.
CL$_{\text{GENERAL}}$ newspaper-ACC
'John bought three newspapers. In total thirty newspapers.'

Fourth, kind-referring anaphoric expressions, such as *ezek a fajta* 'these kinds', are not compatible with the NUM+CL+N construction. Expressions of this kind include the kind classifier *fajta* 'kind of/type of', and thus can only refer back to a kind-denoting expression.

(18) János három (*darab) újság-ot gyűjt. Ez-ek a
John three $\text{CL}_{\text{GENERAL}}$ newspaper-ACC collect.PRES.3SG DEM-PL the
fajta kiadás-ok ritká-k.
CL_{KIND} edition-PL rare-PL
'John collects three newspapers. These kinds of editions are rare.'

(19) Mari három (*tő) virág-gal ültette be a kert-et:
Mari three CL_{ROOT} flower-INST plant.PAST.3SG VM the garden-ACC
nárcisz-szal, tulipán-nal és rózsá-val. Ez-ek a fajta virág-ok csak
daffodil-INST tulip-INST and rose-INST DEM-PL the CL_{KIND} flower-PL only
tavasz-szal ültet-hető-ek.
spring-INST plant-POS-PL
'Mary filled the garden with three flowers: daffodils, tulips and roses. These kinds of flowers can only be planted in the spring.'

The above tests indicate that the insertion of a sortal individuating classifier in NUM+N constructions has an impact on the interpretation, namely: NUM+N can have subkind and existential readings, while NUM+CL+N can only have an existential reading.

This interpretational difference is not expected under a null classifier analysis, such as the one put forward by Csirmaz & Dékány (2014), which assigns the same semantics for the null sortal classifier as the one assumed for *darab*. If we assume a one-to-one mapping between the syntactic structure and semantic interpretation, the differences between subkind and plurality of individuals readings observed above remain unexplained. However, theoretically we could assume the existence of a semantically underspecified null classifier which could potentially derive the readings observed in this paper: under the subkind reading, the null classifier could have a semantics similar to the kind-classifier, *fajta*, while under the plurality of individuals reading, the semantics of the null classifier would be equivalent to *darab*. To the best of our knowledge, such null classifiers have not been observed in other languages.

As we will discuss in the next section, number neutrality does not fully explain the data on kind interpretation nor does it provide a solution for classifier optionality. Erbach et al. (2019) does not address the interpretational ambiguity discussed above. In addition, the kind interpretation of nominals in Hungarian is more complex than assumed in Erbach et al. (2019). Moreover, the role of the optionally used classifier in a framework in which the classifier is required by the numeral remains unsolved. In the next section, we argue that the noun flexibility approach is able to better capture the facts discussed above.

3 In defense of noun flexibility

First, we provide further support to Schvarcz & Rothstein's (2017) claims. Based on syntactic and semantic evidence, we argue against Csirmaz & Dékány's (2014) 'plurality-as-a-classifier' claim, showing that classifiers and the plural neither compete for the same syntactic position nor do they have the same interpretation. In addition, by taking a closer look at kind-readings of number-neutral nominals, we give counterarguments to the number-neutrality analysis.

3.1 Plural is not a classifier

As mentioned above, Csirmaz & Dékány (2014) argue in favour of treating Hungarian as a classifier language. In line with this view, Dékány (2011) suggests treating the plural in Hungarian as a classifier, whilst maintaining a strict complementarity hypothesis. However, due to the fact that Hungarian has a productive plural marker, unlike typical classifier languages, which lack such a marker (Chierchia 1998a, 2010, Cheng & Sybesma 1999), Hungarian cannot be considered a classifier language. Moreover, as Schvarcz (2014) and Schvarcz & Rothstein (2017) show, not only does Hungarian have a plural marker, but plurality is also sensitive to the mass/count distinction. We present novel data that support the claim that plurality should not be analysed as a plural sortal classifier. In this section we raise five issues: frequency of co-occurrence; the impossibility of classifier doubling; differences in the distributions of plurals and classifiers and in agreement phenomena; and interpretational contrasts.

We look first at the frequency of classifiers and plurals co-occurring in the same phrase. A corpus study reveals that plural marking and classifiers co-occur much more frequently than previously thought in contexts that were not discussed before. These include: bare adjectival phrases (20a), (21a) and (22a), definite constructions (20b), (21b) and (22b) and demonstratives (20c), (21c) and (22c). The only constructions in which the two cannot co-occur are the ones that contain either a numeral or a quantifier, which cannot combine with plural-marked nouns at any rate.[4]

[4] Addressing the observations made by an anonymous reviewer regarding the unexpected co-occurrence of plural marking and classifiers, we assume that the classifier first combines with the mass counterpart of a flexible noun deriving a count expression. This expression then can be marked plural. Since numerals combine with singular expressions, it follows that the that CL+N.PL expressions do not take a numeral and these expressions appear only with adjectives, demonstratives and definite constructions. Deriving the syntax behind constructions involving plurals and classifiers lies beyond the scope of this paper.

(20) a. szép szál virág-ok
pretty CL$_{\text{THREAD}}$ flower-PL
'pretty flowers'

b. a (szép) szál virág-ok
the pretty CL$_{\text{THREAD}}$ flower-PL
'the pretty flowers'

c. (ez-ek) a szál virág-ok
DEM-PL the CL$_{\text{THREAD}}$ flower-PL
'these threads of flowers'

(21) a. szép darab hús-ok
nice CL$_{\text{PIECE}}$ meat-PL
'nice pieces of meat'

b. a (szép) darab hús-ok
the nice CL$_{\text{PIECE}}$ meat-PL
'the nice pieces of meat'

c. (az-ok) a szép darab hús-ok
DEM-PL the nice CL$_{\text{PIECE}}$ meat-PL
'those nice pieces of meat'

(22) a. nagy fej káposztá-k
big CL$_{\text{PIECE}}$ cabbage-PL
'big (head of) cabbages'

b. a (nagy) fej káposzt-ák
the big CL$_{\text{PIECE}}$ cabbage-PL
'the big (heads of) cabbages'

c. (az-ok) a fej káposztá-k
DEM-PL the CL$_{\text{PIECE}}$ cabbage-PL
'those big (heads of) cabbages'

A second issue concerning the co-occurrence of plural marking and a classifier is reduplication. If plural were a classifier, then in the above examples, we would assume a double classifier. Yet classifier doubling – either the reduplication of the same classifier (23a) or the combination of two different classifiers (23b) – is ruled out in Hungarian. In contrast, in Mandarin Chinese, a true classifier language, reduplicated classifiers serve as unit-plurality markers (24) (Zhang 2013). A similar phenomena can be found in Cantonese (25) (Wong 1998).

(23) a. * egy darab szál virág
one CL_{PIECE} $\text{CL}_{\text{THREAD}}$ flower

b. * egy szál szál virág
one $\text{CL}_{\text{THREAD}}$ $\text{CL}_{\text{THREAD}}$ flower

(24) a. ge-ge xuesgeng dou you ziji de wangye
CL-RED student all have own DE website
'All of the students have their own webpages.'
(Mandarin Chinese; Zhang 2013: p. 118, ex. (234a))

b. he-li piao-zhe (yi) duo-duo lianhua
river-in float-DUR one CL-RED lotus
'There are many lotuses floating on the river.'
(Mandarin Chinese; Zhang 2013: p. 118, ex. (230a))

(25) go go hoksaang
CL CL student
'every student' (Cantonese; Wong 1998: p. 16)

Third, the distribution of bare classifier and bare plural expressions differ: while bare plurals are allowed in argument positions, bare classifier phrases are not. While speakers of some dialects may find (26b) acceptable, all of our informants rule out (27b).[5] This difference is due to the position of the bare classifier phrase: as arguments they are unequivocally ungrammatical.

(26) a. Rózsá-k-at ültettem a kert-be.
rose-PL-ACC plant.PRES.3SG the garden-ILL
'I planted roses in the garden.'

b. * Tő rózsá-t ültettem a kert-be.
CL_{ROOT} rose-ACC plant.PRES.3SG the garden-ILL

(27) a. Újság-ok érkeztek az Amazon csomag-ban.
newspaper-PL arrive.PAST.3PL the Amazon package-INESS
'Newspapers arrived in the Amazon package.'

b. * Darab újság érkezett az Amazon csomag-ban.
$\text{CL}_{\text{GENERAL}}$ newspaper arrive.PAST.3SG the Amazon package-INESS

[5] While informants point out that (26b) may be acceptable in a context where more information is provided prior to the utterance, all of them agree that without any context it is ungrammatical.

Fourth, we look at agreement phenomena. Following the Hungarian patterns of agreement, verbs agree with their subjects in person and number, and external demonstratives agree in number and case (Kenesei et al. 1998). The plural marker induces agreement on the verb and on the demonstrative. Classifiers do not.

(28) a. Ez-ek a virág-ok szép-ek.
DEM-PL the flower-PL beautiful-PL
'These flowers are beautiful.'

b. Ez a szál virág szép.
DEM the $\text{CL}_{\text{THREAD}}$ flower beautiful
'This thread of flower is beautiful.'

(29) Ez-ek a káposzták már megértek, de az a fej
DEM-PL the cabbage-PL already VM.ripe.PAST.3PL but that the CL_{HEAD}
(káposzta) még nem ért meg.
cabbage yet not ripe.PAST.3SG VM
'These cabbages are ripe already, but that head of cabbage has not yet ripened.'

Lastly, interpretational differences can be observed between the two expressions discussed: constructions containing a classifier cannot receive a subkind interpretation, while plural-marked nouns can have either a kind, subkind or a plurality of individuals reading. (31a) is modeled on an example from Landman & Rothstein (2010) and can refer to the guest-kind, and to a plural set of guests. We may also imagine dividing a set of guests into sub-kinds: invited guests and uninvited guests. (31a) may also be true in this scenario: *Vendégek érkeztek két órán át, meghívottak és hívatlanok* ('Guests arrived for two hours, invited and uninvited ones'). In (31b) we can only get the plurality of guests reading.

(30) a. Subkind/plurality of individuals interpretation
Újság-ok-at árul ez az újságárus.
newspaper-PL-ACC sell.PRES.3SG DEM the newsvendor
'This newsvendor sells newspapers.'

b. Plurality of individuals interpretation
Három darab újság-ot árul ez az újságárus.
three $\text{CL}_{\text{GENERAL}}$ newspaper-ACC sell.PRES.3SG DEM the newsvendor
'This newsvendor sells three newspapers.'

(31) a. Subkind/plurality of individuals interpretation
Vendég-ek érkeztek két órá-n át.
guest-PL arrive.PAST.3PL two hour-SUP for
'Guests arrived for two hours.' (Schvarcz & Rothstein 2017: p.188, (14))

b. Plurality of individuals interpretation
Három darab vendég érkezett két órá-n át.
three $\text{CL}_{\text{GENERAL}}$ guest arrive.PAST.3SG two hours-SUP for
'Three guests arrived for two hours.'

These data suggest that Hungarian sortal classifiers cannot be syntactically and semantically equated to plural markers. Their distribution and interpretation differ; they exhibit different agreement patterns; and they can in fact co-occur more frequently than previously assumed. We now turn to the number-neutrality analysis proposed by Erbach et al. (2019).

3.2 Ruling out number neutrality

Based on a cumulativity approach to measurement, i.e. that measure DPs call upon cumulative predicates (Krifka 1989, Filip 1992, 2005, Nakanishi 2003; Schwarzschild 2006), and on an analysis under which it is the semantics of numerals requires the use of the classifier rather than that of a noun, (Krifka 1995, Erbach et al. 2019, Sudo forthcoming) argue that Hungarian notionally count singular nouns are number-neutral.

At a closer investigation, however, we find that number neutrality cannot accurately account for the data. Some of the phenomena we point out include: the inaccessibility of atoms in pseudo-partitive measure DPs and the availability of mass readings of singular nouns. For further evidence see Schvarcz & Nemes (2019).

First, contra Erbach et al. (2019), our data indicate that in Hungarian measure DPs, atoms are not accessible in the denotation of nouns – may they be notionally count, dual-life or mass. One of the major arguments of Erbach et al. (2019) relies on atomicity: while in the case of plural count nouns used in measure DPs atoms are accessible to semantic operations making them felicitous in reciprocal contexts, this does not hold of mass nouns. Their examples include *books* – a plural count noun –, *chocolate(s)* – a dual-life noun –, and *livestock* – a naturally atomic mass noun:[6]

[6]Judgements of English native speakers are divided on the acceptability of (32a). For discussion, see Erbach et al. (2019).

(32) a. Twenty kilos of books are lying on top of each other.
b. I bought 200gs of chocolates, each of which was filled with a different kind of ganache.
c. * I made 1.5 kgs of hummus, each of which was eaten at the party.
d. ? Quite a few livestock/cattle have disappeared today.
(Erbach et al. 2019: p. 93 (13–18))

The equivalents of all of the above sentences are ruled out or have a low degree of acceptability in Hungarian. We can see that (33a) is not unanimously accepted by informants: while it may be interpreted as a plurality of books piled on top of each other having a cumulative weight of 20 kilos, some informants can only interpret it as 20 books each of which weighs one kilo. Moreover, both native speaker authors of this paper consider this sentence slightly infelicitous, yet for different reasons. The first author points out a preference for expressing the situation described in (33a) with a different structure, roughly equivalent to 'There are books on top of each other which in total weigh 20 kilos.' The second author finds the combination of the measure phrase *kilo* and the reciprocal phrase *egymás tetején* 'on top of each other' unacceptable. As for dual life nouns, chocolate in Hungarian patterns with the mass *hummus* (33b–33c); and nouns such as *állatállomány* 'livestock' are ruled out with count quantifiers such as 'a few' (33d).

(33) a. ??? Húsz kiló könyv egymás tetején van a föld-ön.
20 kilo book each.other on.top.of be.PRES.3SG the ground-SUP
'Twenty kilos of books are on top of each other on the ground.'
b. * 200g csokoládé-t vettem, mindegyik más töltelék-kel volt megtöltve.
200g chocolate-ACC bought each different filling-INST be.PAST.3SG filled
'I bought 200 grams of chocolate, each of which was filled with a different filling.'
c. * Másfél kiló humuszt készítettem, mindegyik-et megették a parti-n.
one.and.a.half kilo hummus-ACC prepare.PAST.1SG each-ACC VM-eat.PAST.3PL the party-SUP
'I prepared one and a half kilo of hummus, each of which was eaten at the party.'

d. * Elég kevés állatállomány tűnt el ma.
quite few livestock disappear.be.PAST.3SG VM today
'Quite a few livestock have disappeared today.'

Second, Erbach et al.'s (2019) assumption that bare singular nouns lack a mass reading in argument position does not hold. Our data indicate that mass readings of singular Ns are available in fact in full argumental positions. In (34) *könyv* is preceded by the definite determiner , while in (35) it appears bare. We assume that bare singular nominals that have a kind interpretation are mass nouns (Chierchia 1998b). The bare singular nouns *könyv* 'book' and *ima* 'prayer' in (35) pattern with the bare mass nouns *homok* 'sand' and *vér* 'blood' (36), evincing a mass interpretation to such nouns.[7] The interpretation of nominals in Hungarian will be further discussed in the next section.

(34) A könyv ritka jószág manapság amikor mindenki már Kindle-t használ.
the book rare stuff nowadays when everyone already Kindle-ACC use.PRES.3SG
'Books are rare nowadays when everybody uses Kindle already.'

(35) Könyv és ima a mindennapi intellektuális táplálék-om.
book and prayer the daily intellectual nutrition-POSS.1SG
'Books and prayers are my daily intellectual nutrition.'

(36) Te jól láthatod, amit én érzek, azt kifejezi a képeslap, amelye-n homok és víz egyesül.
you well see.POS.PRES.2SG what I feel.PRES.1SG that express.PRES.3SG the postcard which-SUP sand and water merge.PRES.3SG
'You may see well what I feel, it is expressed by the postcard on which sand and water merge.'
(Source: Hungarian National Corpus, MNSZ 2, Oravecz et al. 2014)

In sum, the number-neutral analysis may not accurately reflect the empirical facts of Hungarian, as the discussion of the accessibility of atoms in measure DPs is English-based. In addition, as we have shown, the linguistic facts are different

[7]The kind interpretation in (35) is not due to the conjunction, the same holds for a bare singular:

(i) Eminens tanuló-nak könyv fölött a hely-e.
eminent student-DAT book above the place-POSS.3SG
'The place of eminent students is above books.'

in Hungarian. Moreover, the number-neutral analysis does not account for mass readings of bare singular nouns. Further evidence ruling out the number-neutral approach to the Hungarian nominal system can be found in Schvarcz & Nemes (2019). We now turn to the interpretation of nominals in Hungarian.

4 Are Hungarian nouns kind-denoting?

Although the data indicate that Hungarian cannot be considered to be a classifier language, the question remains: Is the function of the sortal classifier in Hungarian the same as in typical classifier languages? In order to provide an answer to this question we will look at the interpretation of bare nominals in Hungarian, as the use of classifiers is closely related to nominal denotation.

4.1 Exploring kinds in Hungarian

Regarding the basic denotation of nominals, Chierchia (1998b) distinguishes two types of languages. On the one hand, in languages like Mandarin Chinese all nouns have a default kind interpretation and can be used as arguments without determiners. On the other hand, in languages like English, count nouns denote properties and since these nouns are of the predicative-type, in order to be used as arguments the use of determiners is required. In contrast, mass nouns in this second type of language are assumed to denote kinds and can be used determinerless in argument positions.

Focusing on classifier optionality, we contrast Hungarian with the Chinese-type of languages. In these languages, classifiers are obligatorily used in order to retrieve instantiations of a kind, thereby allowing numerical modification. Unlike in typical classifier languages, however, classifiers in Hungarian are optionally used. These facts raise the question about the interpretation of Hungarian nominals: are they kind-denoting as are their the Chinese counterparts, or property denoting as in English?

In Mandarin Chinese, bare nouns can be used as subjects of kind-level predicates (37) (Li 2013), while the kind interpretation seems to be much more limited in Hungarian. Kind-level predicates in Hungarian require the definite construction (38):

(37) jing kuai juezhong le.
whale soon be.extinct PRF
'Whales will soon be extinct.' (Mandarin Chinese; Li 2013: p. 90, ex. (4))

(38) *(A) bálna a kihalás szélé-n áll.
the whale the extinction verge-SUP stand.PRES.3SG
'Whales are on the verge of extinction.'

In certain constructions bare nominals can have a kind interpretation. Farkas & de Swart (2003) suggest that generic interpretations of bare plurals are not usually available in Hungarian, unless they are incorporated. Schvarcz & Rothstein (2017) show that with kind-level predicates, incorporated bare plurals can be interpreted as kinds. Constructions such as (39) are limited, and their interpretation varies among informants between kind and subkind readings. The incorporated bare plural *bálnák* 'whales' in (40) can have both a plurality of individuals as well as a kind interpretation.

(39) Kind/subkind interpretation
Bálná-k állnak a kihalás szélé-n.
Whale-PL stand.PRES.3PL the extinction verge-SUP
'Whales (in general) are / the whale is on the verge of extinction.' / 'Some kinds of whales are on the verge of extinction.'
(Schvarcz & Rothstein 2017: p. 188, (13))

(40) Plurality of individuals/kind interpretation
János és Béla bálná-k-at vadásznak az óceán-ban.
John and Bill whale-PL-ACC hunt.PRES.3PL the ocean-INESS
'John and Bill are hunting whales in the ocean.' / 'John and Bill are whale hunters (and not dolphin hunters).'

Carlson (1977) takes narrow-scope reading of bare plurals as an indication of a kind interpretation. This phenomenon can also be observed in Hungarian:

(41) János és Béla rózsá-k-at keresnek a piac-on.
John and Bill rose-PL-ACC look.for.PRES.3PL the market-SUP
'John and Bill are looking for roses on the market.'
(Schvarcz & Rothstein 2017: p. 203, (13))

Bare plural subjects of achievement verbs have a kind interpretation, as argued by Landman & Rothstein (2010). This has been shown to hold for Hungarian as well (Schvarcz & Rothstein 2017 – see example (31) above). (42), modelled on their example, shows that this is generally available in Hungarian:

(42) Nagy-ot csalódtunk a delfinfigyelő túrá-n
big-ACC be.disappointed.PAST.3PL the dolphin.watching tour-SUP
mert két órá-n át báln-ák érkeztek (és nem delfin-ek).
because two hour-SUP for whale-PL arrive.PAST.3PL and not dolphin-PL
'We were very disappointed by the dolphin-watching tour since whales arrived for two hours and (not dolphins).'

Schvarcz (2018) shows that in contrastive contexts, a kind interpretation of bare plurals is widely available:

(43) Hód-ok építenek gát-ak-at, nem menyét-ek.
beaver-PL build.PRES.3PL dam-PL-ACC not weasel-PL
'Beavers build dams, not weasels.' (Schvarcz 2018: p. 116, (50a))

(44) Ember-ek vagyunk, nem állat-ok.
people-PL be.PRES.1PL not animal-PL
'We are people, not animals.' (Schvarcz 2018: p. 116, (50c))

The fact that bare plurals can be interpreted as kinds is not surprising, given the fact that this is also the case in mass/count languages, such as English (Carlson 1977). Yet the case of bare singulars in Hungarian remains unexplored. The availability of a kind interpretation with these nouns is of capital importance for determining whether nouns can indeed be seen as kind-denoting. Hungarian bare singulars can get a kind interpretation in negative sentences: when the verb is under negation (45–46) as well as in contrastive contexts (47–49):

(45) Ember ilyet nem csinál.
man this not do.PRES.3SG
'Men don't do this/such a thing.' (Schvarcz 2018: p. 115, (49a))

(46) Sas nem kapkod legy-ek után.
eagle not fluster.PRES.3SG fly-PL after
'Eagles do not fluster after flies.' (Schvarcz 2018: p. 115, (49b))

(47) Nem sas lopkodja a tyúk-ok-at hanem róka.
not eagle steal.PRES.3SG the hen-PL-ACC but fox
'It is not the eagles who are stealing hens but foxes.' / 'It is not an eagle who is stealing hens but a fox.'

(48) Nem búzá-t termesztenek Ázsiá-ban hanem rizs-et.
not wheat-ACC grow.PRES.3PL Asia-INESS but rice-ACC
'It is not wheat that they grow in Asia, but rice.'

(49) János könyv-et szeret olvasni, nem újság-ot.
John book-ACC like.PRES.3SG read.INF not newspaper-ACC
'John likes reading books, not newspapers.'

As the examples above show, in a limited number of contexts both bare singular and bare plural nouns can get a kind interpretation. Nevertheless, the kind interpretation seems to be significantly more limited in Hungarian than it is in the case of typical classifier languages, like Mandarin Chinese or Japanese. The default choice for expressing a generic is the use of the definite construction (38). Unlike typical classifier languages which generally lack a definite article, Hungarian has one.

4.2 A hypothesis for the denotation of Hungarian bare nominals

Our hypothesis is that in terms of kind reference, Hungarian count nouns are property-denoting, while mass nouns are kind-denoting. The mass counterpart of a flexible pair has a default kind interpretation, and hence can appear bare in characterizing sentences (45) and generic statements (48). This is also the reason why it requires a classifier upon combination with numerals – see (7b) above. We assume that the classifier takes the mass counterpart of a flexible noun, a kind-denoting term, and turns it into a property-denoting one.

Assuming that in Hungarian the majority of nouns, if not all, are flexible between count and mass versions, which correspond to a property-denoting and to a kind-denoting term respectively, both a definite and a bare construction is available for achieving genericity. Nevertheless, the definite construction is favored, while the bare construction is more marked and is available in contextually and syntactically restricted cases only. While the default argument of kind-taking predicates in generic sentences is a definite phrase, incorporation, negative and contrasting structures seem to override this requirement. Syntactically, we assume that these constructions have a more complex structure which allows bare nominals to receive a kind reading. A more comprehensive account and a formal analysis of this issue is a subject for further study.

5 The semantics of Hungarian classifiers

We define the meaning of classifiers in a framework in which kinds are perceived to be individual concepts, functions from worlds to pluralities. The newspaper-kind can be thought of as the set of newspapers, the totality of newspapers, the sum of all instances of the newspaper kind (Chierchia 1998b).

Treating mass-counterparts of Hungarian flexible nouns as kind-denoting terms lends itself to an analysis of sortal individuating classifiers under which they are functional operators on kinds, expressions of type $\langle k, \langle e, t \rangle \rangle$. Classifiers serve as functions to access the instantiations of a kind modeled by the INST operation. In other words, classifiers apply to kind denoting terms generating the set of individuals such that they are instantiation of that kind. From this perspective, the semantics of the general classifier *darab* could be formalised as follows:[8]

(50) a. három darab újság
three $\text{CL}_{\text{GENERAL}}$ newspaper
b. $[\![\text{darab}]\!] = \lambda k.\lambda x.\text{INST}(x, k)$
c. $[\![\text{darab újság}]\!] = \lambda x.\text{INST}(x, \text{NEWSPAPER}_{\text{KIND}})$
d. $[\![\text{három}]\!] = \lambda x.|x| = 3$
e. $[\![\text{három darab újság}]\!] = \lambda x.\text{INST}(x, \text{NEWSPAPER}_{\text{KIND}}) \wedge |x| = 3$

Our semantics of the general classifier can be further extended to those sortal individuating classifiers in Hungarian that select nouns based on size, shape and form:

(51) a. két fej hagyma
two CL_{HEAD} onion
b. $[\![\text{head}]\!] = \lambda k.\lambda x.\text{INST}(x, k) \wedge \text{LARGE}(x) \wedge \text{ROUND}(x)$
c. $[\![\text{fej hagyma}]\!] = \lambda x.\text{INST}(x, \text{ONION}_{\text{KIND}}) \wedge \text{LARGE}(x) \wedge \text{ROUND}(x)$
d. $[\![\text{két}]\!] = \lambda x.|x| = 2$
e. $[\![\text{két fej hagyma}]\!]$
$= \lambda x.\text{INST}(x, \text{ONION}_{\text{KIND}}) \wedge \text{LARGE}(x) \wedge \text{ROUND}(x) \wedge |x| = 2$

(52) a. három szál rózsa
three $\text{CL}_{\text{THREAD}}$ rose
b. $[\![\text{szál}]\!] = \lambda k.\lambda x.\text{INST}(x, k) \wedge \text{LONG}(x) \wedge \text{THIN}(x)$
c. $[\![\text{szál rózsa}]\!] = \lambda x.\text{INST}(x, \text{ROSE}_{\text{KIND}}) \wedge \text{LONG}(x) \wedge \text{THIN}(x)$
d. $[\![\text{három}]\!] = \lambda x.|x| = 3$
e. $[\![\text{három szál rózsa}]\!]$
$= \lambda x.\text{INST}(x, \text{ROSE}_{\text{KIND}}) \wedge \text{LONG}(x) \wedge \text{THIN}(x) \wedge |x| = 3$

[8] In line with Rothstein (2017) we assume that numerals in prenominal positions are functions that map entities onto the value true if they have *n* atomic parts.

If we assume that classifiers take kind-denoting expressions, then examples where the plural and the classifier can co-occur (20–22) require further explanation. One option to explain such examples is to treat the bare plural noun as denoting a kind. This is further supported by (39–44) illustrating the kind interpretation of bare plurals in various contexts. Another option is to compose the structure of classifier-plural nominal co-occurrences in the following way: the classifier combines with the kind-denoting singular noun deriving instantiations of the noun, which is then pluralized. This would assume a syntax in which the plural marker *-k* is higher than the CL+N. Both of these options allow us to maintain the semantics of classifiers proposed in this paper.

6 Summary and implications

This paper explored classifier optionality in Hungarian and argued that the phenomena can best be captured in a noun-flexibility approach, while the role of sortal individuating classifiers is to trigger a kind-to-predicate shift in nouns which are born as kind-denoting expressions.

The foundation of our analysis is a flexibility-based approach to Hungarian mass/count phenomena, according to which most nouns in the language are ambiguous between a mass and count denotation (Schvarcz & Rothstein 2017). The count and mass versions are derived from the same neutral lexical root of a noun, via the COUNT and MASS operations, resulting in two identical lexical forms. Under this analysis, flexibility is a purely grammatical phenomenon and does not postulate any semantic ambiguity. This approach has numerous advantages over alternative theories of Hungarian nominal semantics. It helps explain novel data that neither a non-ambiguity (Dékány 2011, Csirmaz & Dékány 2014) nor an underspecification (Erbach et al. 2019) approach has discussed. In addition, it accounts for the optionality of sortal individuating classifiers and captures the interpretational differences of Hungarian numerical expressions.

We first explored the differences in interpretation between NUM+N and NUM+CL+N constructions and showed that there is a significant interpretational difference between them: while the former can refer to a plurality of individuals or to a plurality of subkinds, the insertion of the classifier in the latter construction restricts the reading to a plurality of individuals.

We then provided evidence in defense of the noun-flexibility approach showing that neither a plural-as-a-classifier nor a number-neutrality approach captures the semantic effect induced by the optional classifier. The distribution, interpretation, and co-occurrence of plurals and classifiers as well as the different agreement patterns induced by the two strongly suggest that the plural cannot be treated as a classifier. Moreover, number-neutral analysis does not account for mass readings of bare singular nouns nor for the semantic input of the classifier observed in our study.

We claimed that Hungarian nominals are kind-denoting by default and can undergo a kind-to-predicate shift (Chierchia 1998a) explicitly triggered by a sortal individuating classifier. Hungarian has a unique set of properties, allowing both for bare and for definite constructions to express kind. We have shown that bare singulars with a kind-reading are available both for mass Ns and for the mass counterparts of flexible Ns, indicating that nouns are kind-denoting expressions.

Hungarian appears to be a "mixed system" in terms of the use of a mass/count system and classifiers and has unique properties with regards to the distribution and interpretation of bare nominals, which points to more typological variation between languages than has been suggested before.

Abbreviations

1	first person	INST	instrumental
2	second person	K.	kind reading
3	third person	PAST	past tense
∅	null element	PL	plural
ACC	accusative	POS	possibility
CL	classifier	POSS	possessive
DAT	dative	PRES	present tense
DE	associative particle	PRF	perfectivity marker
DEM	demonstrative	RED	reduplication
DUR	durative	SBL	sublative
ELA	elative	SG	singular
ILL	illative	SUP	superessive
INESS	inessive	VM	verbal modifier
INF	infinitive		

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Part IV

Other quantifiers

Chapter 17

Some, *most*, *all* in a visual world study

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In a visual world eye-tracking study I find that Polish quantifiers *niektóre* 'some', *większość* 'most of', *najwięcej* 'the most' and *wszystkie* 'all' elicit distinctive patterns of looks, consistent with their semantics. *Niektóre* 'some' has a strong scalar implicature: the meaning 'some-not-all' is processed immediately as the quantifier is heard. The superlative *najwięcej* 'the most' quickly triggers comparisons between the target and the other sets. The proportional *większość* 'most of' elicits a pattern suggesting that its verification involves the estimation of the total set. With *wszystkie* 'all' the identification of the target set is the fastest.

Keywords: quantifiers, semantics–cognition interface, eye-tracking, Polish

1 Introduction: Interpreting quantifiers

We talk about quantities all the time while describing the world. Quantifiers are natural language expressions used to describe quantities with or without using number terms. Semantically they express relations between sets (Barwise & Cooper 1988), e.g., *most of* in the sentence *Most of the balls are blue* tells us that the set of balls that are blue is larger than the set of non-blue balls. We can easily assess the conditions that make this sentence true/false, but how do we verify such sentences in real-life situations? The generalized quantifier theory (Mostowski 1957, Lindström 1966, Montague 1973) is silent about this issue, mainly because for philosophers (Montague 1973, a.o.) semantics was a branch of mathematics and not of psychology (Partee 2011). Psychologists, however, have long been studying the number sense in humans, a dedicated brain system for abstract representation of number and the source of our mathematical intuitions, which is employed in the judgments involving quantifiers (Feigenson et al. 2004,

Barbara Tomaszewicz-Özakın. 2021. *Some*, *most*, *all* in a visual world study. In Mojmír Dočekal & Marcin Wągiel (eds.), *Formal approaches to number in Slavic and beyond*, 399–426. Berlin: Language Science Press. DOI: 10.5281/zenodo.5082482

McMillan et al. 2005, 2006, Clark & Grossman 2007, Dehaene 2009, 2011, Troiani et al. 2009). Speakers have different ways of referring to quantities: number terms when the specific size of the set is at issue, and vague quantifiers like *some* and *most* or context-dependent quantifiers like *few* and *many*, when they refer to approximate quantities. The present study addresses two critical questions about quantifiers: (i) what is included in the lexical representation of quantifier meanings and (ii) what the psychological mechanisms involved in the interpretation of those meanings are.

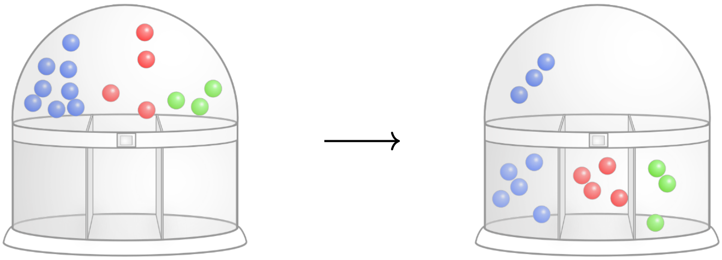
Investigating those two questions, Pietroski et al. (2009) and Lidz et al. (2011) put forth a novel hypothesis that what participants are doing to verify sentences containing quantifiers, i.e., (ii), can be directly determined by quantifier semantics, (i). To illustrate, in order to verify that most balls are blue we need to compare the numbers of blue and and non-blue balls, but how do we obtain the number of non-blue balls? If there are balls in one other color, we can simply count them. If there are more colors, we can count the numbers of balls in each other color and add them up; or we can obtain the number of all balls and subtract the number of the blue balls from it; or we can instead verify if blue balls are more than the half of all balls. But do we even need to count? Children who are not yet able to count are perfectly able to understand sentences containing *most* (Halberda et al. 2008, Odic et al. 2018), and in real-life situations we do not need to know precise quantities to use *most*.

Pietroski et al. (2009), Bates, Kliegl, et al. (2015), Tomaszewicz (2011, 2012, 2013, 2018), Hunter et al. (2017), Knowlton et al. (2021) obtained experimental evidence that *most of* induces a subconscious choice of a procedure based on subtraction for verification against visual displays, even in situations where comparing the numerosity of the target set and one other set directly would be more efficient. Why would the mind not subconsciously choose the most efficient procedure in a given situation? According to the hypothesis it is because the mind follows the “instructions” encoded in the logical function representing the meaning of a quantifier. Tomaszewicz (2011, 2012, 2013, 2018) showed that, in contrast to the proportional quantifier *most of* (Polish *większość*), the superlative *najwięcej* ‘the most’, as in *Najwięcej kulek jest niebieskich* ‘Blue balls are more numerous than balls in any other color’, directs participants’ subconscious attention to obtaining the numerosities of each other color set. The participants were prompted to switch between verification procedures by a change in the linguistic input, but not by a change in the visual input. Thus, the motivation for the subconscious switch in procedures is not to maximize efficiency. Participants used the procedure associated with each quantifier, and in effect, the same display was verified differently depending on which information the visual system was instructed to use by the lexical representation of quantifier meanings.

The present experiment was designed to uncover the details of the lexical semantic specification of the Polish quantifiers *niektóre* 'some' and *większość* 'most of' in comparison to *wszystkie* 'all' and *najwięcej* 'the most'. It utilizes eye-movement as a representational measure in the visual world paradigm. Visual world eye-tracking has been used to demonstrate how comprehenders rapidly integrate different sources of information in order to identify the referents in the visual display as the sentence unfolds over time (Tanenhaus et al. 1995, Allopenna et al. 1998). The visual world paradigm allows for the closest approximation of real-life visual contexts in an experimental setting. Our conscious experience is that our eyes glide from one thing to another thing, but, in fact, unless we are tracking a moving object, our eyes perceive images in a series of rapid jerky movements (saccades). We can track the series of fixations at a particular point and the saccades away from that point in order to analyze which parts of the image attract attention and how. In a visual world task, participants hear the sentence as they inspect the visual scene and their eye movements are recorded; in particular, the proportion of looks to the target in the picture is measured. This makes it an excellent tool for the investigation of incremental processing. At the point in the sentence when the quantifier is heard, participants' subconscious attention should be directed to different aspects of the scene, towards or away from the target, depending on the semantics of the quantifier.

In the current experiment, the four Polish quantifiers, *wszystkie* 'all', *niektóre* 'some', *większość* 'most of' (proportional *most*), and *najwięcej* 'the most' (superlative *most*, henceforth *most*-SUP), appeared in the same carrier sentence, describing the same identical display for *some*, *most of* and *most*-SUP (screens for *all* needed to differ as will be explained shortly). I employed the gumball paradigm of Degen & Tanenhaus (2011, 2016). Participants evaluated sentences of the form 'You got all/some/most of/most-SUP blue balls' against displays of a ball machine dispensing balls of three colors from upper to lower chambers; see Figure 1. The correlate of the processing of the information about the quantifier semantics was the proportion of looks to the target (the set of blue balls) vs. the so-called distractors (the two other color sets).

I thus build on the results of Huang & Snedeker (2009, 2011), Grodner et al. (2010), Degen & Tanenhaus (2011, 2016), who showed that contextual effects on the interpretation of quantifiers are reflected in eye-movement patterns. Those studies investigated the time course of scalar implicatures, i.e., the pragmatic aspects of the meaning of the quantifier *some*, while I concentrate on the precise semantic distinctions between the four Polish quantifiers to test both the scalar implicature of Polish *niektóre* 'some' (Spychalska 2009) and the verification procedure associated with Polish *większość* 'most of' (Szymanik & Zajenkowski



The ball machine at the beginning of the trial

After a button press, the machine dispenses balls to the lower chambers and after 500 ms the stimulus sentence is played

Figure 1: The blue set is the target.

2010). The results of the visual verification experiments (visual search paradigm) in Pietroski et al. (2009), Lidz et al. (2011), Tomaszewicz (2011, 2012, 2013), Hunter et al. (2017), and Knowlton et al. (2021) indicate that quantifier semantics guides the subconscious adoption of a verification strategy. The visual search paradigm involves comparisons of the accuracy of judgments with reference to rapidly presented displays (200–300 ms), i.e., accuracy is taken as a proxy for the processing cost. In these prior experiments the number of different color sets affected accuracy in different ways depending on the quantifier in the stimulus sentence. So while in the visual search paradigm it is assumed that the sentence stimulus somehow provides an instruction for verification, the visual world paradigm in the current study enables us to tap into the real-time construction of this instruction as the auditory stimulus unfolds.[1]

2 The current study

2.1 Methods

In each trial (72 trials in 3 blocks of 24), participants (n = 35), saw a fixation cross and the display of a ball dispensing machine with its upper chambers filled with 3 colors of balls (bottom chambers empty), as in the left panel of Figure 1.

[1] See Huettig et al. (2011) for an argument how the two paradigms, visual world and visual search, provide converging evidence for the role of working memory in the interactions between linguistic input and visual attention.

After 2 seconds, the button in the center of the machine turned yellow, and the participants clicked on the button. Upon clicking, a grey mask was displayed for 200 ms. (Clicking the central button ensured that the participants were looking at the central fixation point at the time of the auditory stimulus onset.) Now the second display was shown: the ball machine was redisplayed with a certain number of balls of each color having dropped to the lower chamber, e.g., right panel in Figure 1.

After 500 ms, the participants heard one of the stimulus sentences in (1). Their task was to click on that lower chamber which contained the balls mentioned in the statement if they thought the statement was true, and click on the central button otherwise.

(1) Dostałeś…
got.PAST.2SG
'You got…'

a. większość {niebieskich / czerwonych / zielonych} kulek. — MOST-OF
most.of blue red green balls
'most of the blue/red/green balls.'

b. najwięcej {niebieskich / czerwonych / zielonych} kulek. — MOST_{SUP}
most-SUP blue red green balls
'the most blue/red/green balls.'

c. niektóre {niebieskie czerwone zielone} kulki. — SOME
some blue red green balls
'some blue/red/green balls.'

d. wszystkie {niebieskie / czerwone / zielone} kulki. — ALL
some blue red green balls
'all of the blue/red/green balls.'

All the sound files were cross-spliced and normalized using Praat Vocal Toolkit (Corretge 2020) so that all the quantifiers and color expressions had the same duration. Once the participants clicked indicating their response, a grey screen was displayed for 1s and the experiment advanced to the next trial. Participants' eye movements were recorded with an Eyelink 1000 eye-tracker at a sampling rate of 1000 Hz.

There were 8 conditions: 4 quantifiers (SOME/MOST-OF/MOST_{SUP}/ALL) * 2 display types (EARLY/LATE). In EARLY trials there was only one partitioned set, e.g. the blue set in Figure 1. In LATE trials all sets were partitioned. The difference between the EARLY and LATE displays is discussed and illustrated with pictures in the next section (Figure 4). The displays for the test sentences for the analysis of eye-movements required a Yes response. Filler trials, half of all trials, required a No response. For Yes responses participants clicked the chamber that matched the sentence, for No responses they clicked the button. Following Degen & Tanenhaus (2011, 2016) I included what they call GARDEN-PATH trials among the fillers in order to force the participants to pay attention and notice that the sentences throughout the experiment might not always be true. On these trials, one set was partitioned allowing an anticipation of a quantifier, but as the sentence unfolded it turned out this set did not match the sentence (leading to a garden-path-like effect where you had to revise your search for the target); see Figure 2.

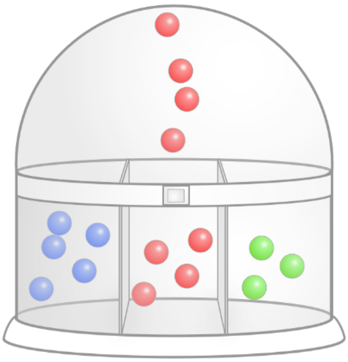
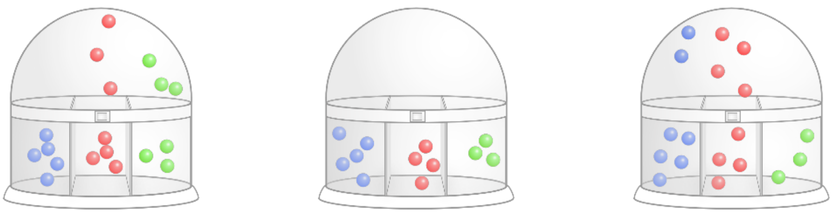


Figure 2: GARDEN-PATH condition

The displays were identical for 3 quantifiers: *some*, *most of*, *most*-SUP. The quantifier *all* had different displays, because the top chamber for that color had to be empty, Figure 3.



all-EARLY *all*-LATE *all*-GARDEN-PATH

Figure 3: The displays for the ALL condition

2.2 Predictions

The visual world studies in Huang & Snedeker (2009, 2011), Grodner et al. (2010), and Degen & Tanenhaus (2011, 2016) compared the quantifiers *some* and *all* in order to establish whether the processing of the scalar implicature of *some* is delayed. The literal interpretation of *some*, as in *You got some of the blue balls*, is that you got at least one blue ball, so if you got all of them, the sentence is true.[2] But in most contexts, we understand this sentence as saying that we got some blue balls but not all of them. This interpretation is a pragmatic inference: the speaker would have said 'You got all of the blue balls' if we got all of them because that would be a more informative statement. Quantifiers *all* and *some* form a scale, so when *some* is used instead of the stronger *all*, the meaning 'some-not-all' is inferred – this inference is called a scalar implicature (Horn 1972, Levinson 1983, a.o.). Huang & Snedeker (2009) found that the 'some-not-all' reading was delayed in comparison with *all*, but Grodner et al. (2010) found no delay and Degen & Tanenhaus (2011, 2016) hypothesized that the reason for the delay in Huang & Snedeker (2009) was the availability of other descriptions of the scene: sentences with number terms in addition to *some* and *all*. Degen & Tanenhaus (2016) indeed found that when no such alternatives were present, the processing of the *some-not-all*-implicature was not delayed relative to the processing of the meaning of *all*, but it was somewhat delayed when those alternatives were available. Thus, the processing of pragmatic meaning may be no more costly than the processing of the literal meaning of a quantifier, depending on the context. In the present experiment, I used the gumball paradigm of Degen & Tanenhaus (2011, 2016) to investigate the time course of processing of both pragmatic and semantic information.

Given the findings of Degen & Tanenhaus (2011, 2016), the implicature of the Polish 'some', *niektóre*, could be delayed due to the presence of alternative utterances that could describe the same situation. However, Spychalska (2009) argues that the implicature of *niektóre* is stronger than that of English *some*, so if we find no delay, the current methodology is a useful tool for the investigation of cross-linguistic semantic differences. To get more specific information about the time course of the processing of *niektóre*, it is compared with the two majority quantifiers whose literal meaning allows us to make precise predictions for processing, given the findings in Tomaszewicz (2011, 2012, 2013, 2018) that each of them drives a distinct verification procedure consistent with its semantics.

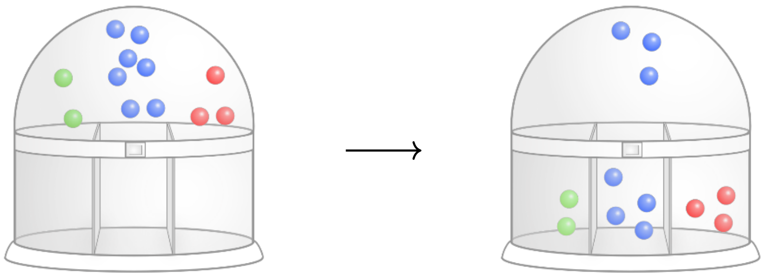
[2] As observed in Spychalska (2009) in Polish *niektóre* must mean 'at least two', because the quantifier occurs only in the plural form.

The superlative *most* (*most*-SUP) in the sentence *You got the most blue balls* (true in the right top panel of Figure 4) requires a comparison between the balls in the lower chambers of the machine. In Figure 4, the machine has dropped down 4 blue, 3 red, 2 green balls. Figure 4 illustrates how the stimulus sentence unfolds: when hearing the quantifier *najwięcej* (*most*-SUP, i.e., 'the most'), you already know you need to compare the numbers of the balls and if you had already determined that the blue set is the biggest, you can anticipate the adjective 'blue'. The proportional quantifier, *most of*, on the other hand, requires you to compare the numbers of the blue balls in the lower and the upper chambers. So these two majority quantifiers require very distinct patterns of eye-movements. The proportion of the looks to the target blue set at the moment of hearing the quantifier should be lower with *most*-SUP because two comparisons are needed (with the red and the green set) whereas with *most of* just one comparison is necessary (between the lower and upper blue sets). This predicted contrast between *most of* and *most*-SUP allows us to test whether the looks to the target with *some* will be delayed like with the *most*-SUP. In addition, obtaining this contrast would set up a baseline for further visual world studies on majority quantifiers cross-linguistically.

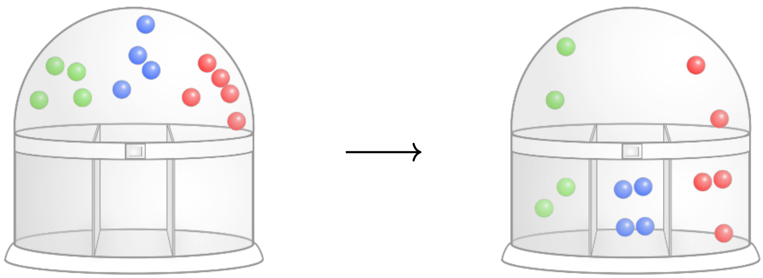
The experiment also includes a comparison with the universal quantifier *all*, but it was not possible to present it together with the same displays as for the three other quantifiers; see the bottom panels of Figure 3. The displays for *all* contained the same numbers of balls in the lower chambers and the colors were in the same order as in the corresponding displays for the other quantifiers (the exact location of the balls within a chamber was a little different because the displays were generated with a random scatter). The displays for *all* make it very easy to anticipate the color adjective at the point of hearing the quantifier so this condition provides us with a time course for the highest proportion of looks to the target (I already note here that this is not the baseline for statistical comparisons because I want to compare the quantifiers with the same identical displays).

The contrasts described above are predicted for the displays where the quantifier provides a point of disambiguation as to which color is the target set. This is the EARLY condition, i.e., in these displays target identification can happen earlier than the color adjective is heard. The looks to the target set in the EARLY condition should begin to increase in the quantifier window (as in Degen & Tanenhaus 2016). In contrast, in the LATE condition, see Figure 5 below, the point of disambiguation is the color adjective.

The theoretical predictions outlined above may be affected by possible confounds, because in experiments on visual identification participants may exhibit



Dostałeś najwięcej/większość/niektóre...
'You got most-SUP/most-of/some ...'



Dostałeś wszystkie ...
'You got all ...'

Figure 4: Sample displays in EARLY condition – target: blue.

different kinds of biases that come, for instance, from the way the visual system works. One of them is the bias to look more at larger set sizes (also found in the study of Degen & Tanenhaus (2016). This means that already during the preview of the picture, before the sentence is heard, participants will tend to look at the blue set in the top right panel of Figure 4. We also know that when precise counting is impossible or simply not needed as in the current experiment, people use the Approximate Number System (ANS) that generates a representation of magnitude rather than an exact cardinality, (Feigenson et al. 2004, Dehaene 2009, 2011). It is also known that with a 500 ms display ANS automatically enumerates the total set (the superset) and up to two color subsets in parallel, (Halberda et al. 2006). Thus, the time course of eye-movements over the three regions of interest is expected to reflect the following effects in the EARLY condition (the summary is in Table 1).

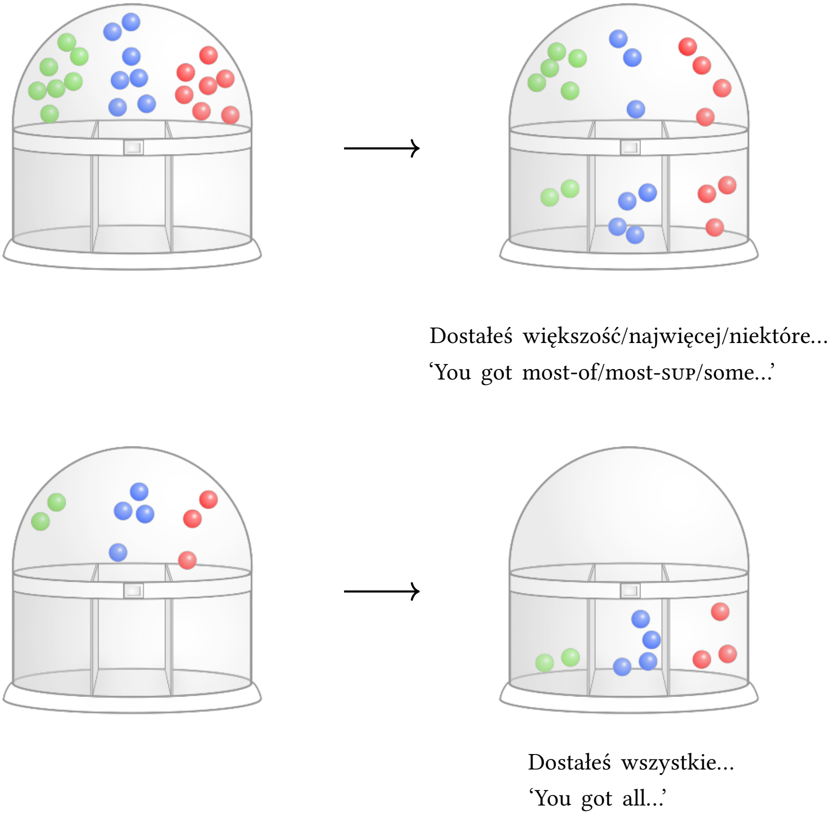


Figure 5: Sample displays in LATE condition – target: blue.

2.2.1 Preview and 'You got' (EARLY)

During the 500 ms preview of the display (the right panel of Figures 1–3) and during the beginning of the sentence (*Dostałeś...* 'You got...') I expect no differences in the looks to the target for the four quantifiers, except for the bias to look at the biggest set (the blue target pops out as different than the other two sets, hence it may attract looks early on).

2.2.2 Quantifier (EARLY)

In the EARLY condition, where the quantifier disambiguates which set is the target, in the quantifier window, I expect fewer looks to the target with *most*-SUP than with *most of* and with *all*. The theoretical prediction explained above is that *most*-SUP requires two comparisons (between the blue and the red set, and between the blue and the green set in the lower chambers), while *most-of* requires one (between the blue set in the lower chamber and that in the upper chamber). During the preview and the 'You got' window the looks may be attracted to the biggest and partitioned set which is the blue target, therefore in the quantifier window the looks may already move to the distractors. The quantifier *all* requires no comparisons. This prediction is summarized as 'MOST_{SUP} < MOST-OF, ALL' in Table 1 ('fewer looks to the target set in the MOST_{SUP} condition than in the MOST-OF and ALL conditions').

The predictions for *some* in the EARLY condition in the quantifier window depend on which interpretation could be in the minds of the participants at this point. If the scalar implicature, 'some-but-not-all', has already been processed, the identification of the target should be (almost) just as easy as with *all*: it cannot be the red nor the green set, and the blue partitioned set has already stood out during preview. Hence, 'SOME-NOT-ALL = ALL' in Table 1. This interpretation would also attract more looks to the blue target than with *most*-SUP, 'SOME-NOT-ALL > MOST_{SUP}'. If, instead, participants are first considering the literal meaning of *some*, 'some-and-possibly-all', then their looks will be directed to the green and red color sets as with *most*-SUP, 'SOME-POSSIBLY-ALL = MOST_{SUP}'.

Finally, there should be more looks to the target in the EARLY condition in the quantifier window with *some* on the 'some-but-not-all' interpretation than with *most of*, 'SOME-NOT-ALL > MOST-OF'. With both quantifiers the looks will be attracted to the partitioned set, the blue target, but with *most of* you need to estimate the numerosities of the two blue subsets and compare them to verify that the sentence is true.

2.2.3 Color + 'balls' (EARLY)

In the EARLY condition, all but one of the effects observed in the quantifier window are predicted to be carried over to the color window. The exception is the quantifier *most of*, which now may attract a similar proportion of looks to the target as *some-not-all*, 'SOME-NOT-ALL = MOST-OF'. The alternative is that with *most of* there will still be more looks away from the target, 'SOME-NOT-ALL ‘ MOST-OF', because '*most of the blue balls*' requires more operations for visual verification than the comparison of the top and bottom blue set as I stated above. Pietroski et al. (2009) and Lidz et al. (2011) propose that sentences with *most of* are verified against visual displays of multicolored dots not by directly comparing two sets but by a subtraction procedure: you estimate the superset, you estimate the target set, subtract and compare the result with the target. This procedure involves more steps than direct comparison of two sets but the reason it is followed is because it is directly specified in the lexical semantics of the proportional quantifier *most*. Lidz et al. (2011) argue that sentential meanings are "individuated more finely than truth conditions" (p. 2) precisely because they interface with perception systems such as visual cognition. It has been established that numbers can be represented as "noisy magnitudes" even for the purposes of basic arithmetic operations like addition and subtraction (Feigenson et al. 2004, Degen & Tanenhaus 2011), so the subtraction procedure is possible even with a 200 ms display, but crucially it is less efficient than direct comparison. This effect was shown in the visual search studies of Pietroski et al. (2009), Lidz et al. (2011), Tomaszewicz (2011, 2012, 2013), Hunter et al. (2017), Knowlton et al. (2021), which measured accuracy of Yes-No responses. In the current study I should find evidence that participants follow the subtraction procedure, as specified in (2), in contrast to direct selection of the two sets as in (3), if we find fewer looks to the target in the color window than with SOME-NOT-ALL because of continuing looks to the top blue set in order to establish the total set. Perhaps, the proportion of looks to the target will even be as low as with *most*-SUP ('SOME-NOT-ALL = MOST-OF?/SOME-NOT-ALL > MOST-OF/MOST-OF = MOST$_{\text{SUP}}$?' in Table 1). Such a result in the color window in the EARLY condition would provide support for a higher number of processing steps involved in (2) as opposed to (3).

(2) SUBTRACTION procedure for the verification of the sentence 'You got *most of* the blue balls':
#[BLUE(x) & BELOW(x)] > #[BLUE(x) & ABOVE(x) & BELOW(x)] – [BLUE(x) & ABOVE(x)]

(3) SELECTION procedure for the verification of the sentence 'You got *most of* the blue balls':
#[BLUE(x) & BELOW(x)] > #[BLUE(x) & ABOVE(x)]

The differences expected to occur in the LATE condition are presented in the following subsections.

2.2.4 Preview and 'You got' (LATE)

I expect no differences. As can be seen in Figure 5, bottom-right panel, the target set cannot be identified during the preview by the big set bias (the blue bottom set is not the only large set).

Table 1: Predictions. (†) marks the *point of disambiguation.*

(a) EARLY

Preview	'You got'	Quantifier (†)	Color + 'balls'
No differences/ Big set bias?		MOST$_{SUP}$ < MOST-OF & ALL SOME-NOT-ALL = ALL SOME-NOT-ALL > MOST$_{SUP}$ SOME-POSSIBLY-ALL = MOST$_{SUP}$ SOME-NOT-ALL > MOST-OF	MOST$_{SUP}$ < MOST-OF & ALL SOME-NOT-ALL = ALL SOME-NOT-ALL > MOST$_{SUP}$ SOME-POSSIBLY-ALL = MOST$_{SUP}$ SOME-NOT-ALL = MOST-OF? / SOME-NOT-ALL > MOST-OF / MOST-OF = MOST$_{SUP}$?

(b) LATE

Preview	'You got'	Quantifier	Color + 'balls' (†)
No differences		MOST$_{SUP}$ > ALL/MOST-OF/SOME SOME-NOT-ALL > MOST-OF SOME-NOT-ALL < ALL	MOST$_{SUP}$ < ALL/MOST-OF/SOME SOME-NOT-ALL > MOST-OF SOME-NOT-ALL < ALL

2.2.5 Quantifier (LATE)

In the LATE condition, the target set can only be reliably disambiguated upon hearing the color adjective, that is, in the last time window of interest. However, I do expect differences in the quantifier window already.

Because the target set cannot be biased during the preview, upon hearing the quantifier *most*-SUP, the looks could be immediately directed to the largest of the bottom sets, the blue target, while with *most of* and *some* the looks will also be directed to the upper sets and with *all* to the other bottom sets. Thus, the prediction is 'MOST$_{SUP}$ > ALL, MOST-OF, SOME' in Table 1. Alternatively, the identification of the largest set with *most*-SUP is delayed until the color window, but given the big set bias, I find this option unlikely.

I also expect more looks to the target with *some-not-all* than *most of* because *most of* requires the estimation of the numerosity of the bottom blue set relative to the top set (in one of the two ways in (2–3) discussed above). Additionally, there should be fewer looks to the target with *some-not-all* than with *all* because the set for the latter is unpartitioned. These two effects should persist in the color window.

In the LATE condition, the *some-possibly-all* interpretation is not tested because all sets are partitioned.

2.2.6 Color + 'balls' (LATE)

At the point of hearing the color adjective in the LATE condition, the proportion of looks to the target with *most*-SUP should be lower than with other quantifiers because now the looks are attracted to the other two color sets in order to make the comparisons to confirm that indeed the blue set is the largest, 'MOST$_{\text{SUP}}$ < ALL, MOST-OF, SOME'. Could it be that once the largest set is identified already in the quantifier window, participants stop making the comparisons upon hearing 'blue' because it matches the already identified target? I do not think so, simply because the 'identification of the target' as early as the quantifier happens unconsciously, and only when the color is heard are the participants aware of the semantics of the full sentence, thus I expect the processing to keep going and to follow the semantics of the superlative sentence: 'There are more blue balls than the balls in any other color'. Accordingly, I expect that in the color window, comparisons with other colors will take place.

Of all of the above, the predictions of main theoretical interest are the following:

(i) In the EARLY condition, at the quantifier (which disambiguates the target set) there will be fewer looks to the target with MOST$_{\text{SUP}}$ than MOST-OF and ALL because the superlative semantics requires comparisons with other color sets, MOST$_{\text{SUP}}$ < MOST-OF & ALL. The looks to the target with MOST$_{\text{SUP}}$ can serve as the baseline for establishing if the implicature of *niektóre* 'some' is processed early: SOME-NOT-ALL > MOST$_{\text{SUP}}$ VS. SOME-POSSIBLY-ALL = MOST$_{\text{SUP}}$.

(ii) In the EARLY condition, in the last region (Color + 'balls'), with MOST-OF the looks will either stay on the target as with SOME (if participants follow the direct Selection procedure in (3)), SOME-NOT-ALL = MOST-OF, or there will be fewer looks to the target (if participants need to establish the total set of blue balls for the Subtraction procedure in (2)), SOME-NOT-ALL > MOST-OF, MOST-OF = MOST$_{\text{SUP}}$.

(iii) In the LATE condition, at the quantifier, there should be more looks to the target with MOST$_{\text{SUP}}$ than with the other quantifiers, reflecting the immediate processing of the superlative semantics, MOST$_{\text{SUP}}$ > ALL, MOST-OF, SOME.

(iv) In the LATE condition, at the disambiguation point (Color + 'balls'), the looks to the target with MOST$_{\text{SUP}}$ should decline, MOST$_{\text{SUP}}$ < all, MOST-OF, SOME, because the semantics requires comparisons with other color sets.

2.3 Results: Behavioral

The mean accuracy on the test conditions (i.e, EARLY and LATE that required a Yes response) was 95%. Of the 35 participants, 30 got 97–100% correct and 3 got less than 70% correct (54%, 58%, 65%). I kept all of the responses because I did not aggregate the data for statistical analyses and I used the eye-movement data only from the correct trials. I removed the extremely long outlier reaction times (three standard deviations above the mean); those constituted 1.3% of the Yes and No data and were equally found in all conditions and regions of interest. The accuracy of the responses and reaction times (RTs) are plotted in Figure 6.

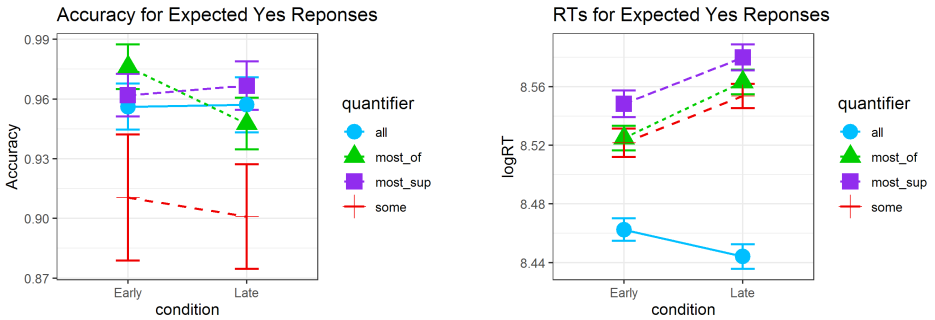


Figure 6: Accuracy and log-transformed reaction times (error bars represent standard errors)

I fitted a mixed-effects regression model of the log-transformed RTs and a mixed effects logistic regression model of the (binary) yes/no variable in R version 3.6.2 (R Core Team 2017) using the lme4 package version 1.1-21 Bates, Mächler, et al. (2015). The p-values were obtained using model comparison and the Satterthwaite approximation implemented in the lmerTest package (Kuznetsova et al. 2017).

For the accuracy data, there is a significant main effect of quantifier ($\chi^2 = 13.72$, df $= 3$, $p = 0.003$). With ANOVA-style contrast coding, there are no differences in pairwise comparisons between the conditions. There are also no differences in pairwise comparisons when ALL is the baseline; with SOME as the baseline only MOST-OF is significantly different, $\beta = 2.066$, SE $= 0.758$, $t = 2.742$, $p = 0.026$ (including the Bonferroni correction for multiple comparisons). Summing up, the accuracy across the conditions ranged from 87% to 99%, and participants were significantly less accurate in the SOME condition in comparison to the MOST-OF condition. We do not see such a difference in reaction times (right panel in Figure 6): SOME is not slower than the other conditions, which means that this condition was not harder, but either that people were fast and made mistakes (which is unlikely given that MOST-OF and MOST_{SUP} had similar RTs) or rather that they believed 'No, I did not get *some* of the balls in color X, I got *most* of them.'

The plot of the RTs in Figure 6 shows significant effects of the EARLY/LATE condition ($\chi^2 = 9.39, \text{df} = 1, p = 0.002$) and Quantifier ($\chi^2 = 72.91, \text{df} = 3, p < 0.0001$) and their interaction ($\chi^2 = 11.62, \text{df} = 3, p = 0.009$). Pairwise-comparisons with MOST_{SUP} as the baseline confirm what we see in the plot: that only the ALL condition is significantly faster ($\beta = -0.085, \text{SE} = 0.014, t = -6.085$, $p < 0.0001$). This is expected given that as discussed in §2.1, ALL had the easiest screens (since the accuracy with ALL, MOST_{SUP} and MOST-OF was very high, we do not see differences due to the difficulty of the screens).

Note that while the semantics of MOST_{SUP} requires comparisons with the two other color sets in the bottom chamber, we see that these comparison procedures have no effect on the accuracy nor on the reaction times. This is compatible with the predictions (as summarized in Table 1) where on the EARLY condition, looks to the target with MOST_{SUP} could benefit from the big set bias in the first two time windows with the rest of the time spent on looking at the other colors; on the LATE condition in the quantifier window there should be more looks to the target and then fewer in the color window than with the other quantifiers. In the next section we will see that the predicted differences are in fact reflected in the eye movements.

2.4 Results: Eye-movements

The pre-processing of the eye-movement data and plotting was carried out using the VWPre package (version 1.2.2, Porretta et al. 2018). The first line in Figures 7–8 shows the plots of the proportion of looks to the target for the EARLY and LATE conditions. The black lines mark the time windows in the audio stimulus adjusted by 200 ms (i.e., 200 ms post the actual onset).[3]

I fitted generalized additive mixed models (GAMMs) using the packages mgcv (version 1.8-31; Wood & Scheipl 2017, Wood 2017) and itsadug (version 2.3; van Rij et al. 2020) to the eye data because a regression line is unable to capture the

[3]200 ms was chosen following Degen & Tanenhaus (2016) because the earliest language mediated fixations are at 200–250 ms after the relevant acoustic landmark that could establish a point of disambiguation (Salverda et al. 2014) The proportion of looks for each interest area has been converted to empirical logits because proportions are inherently bound between 0 and 1 but logits provide a transformation resulting in an unbounded measure suitable for use in the statistical tests (Barr 2008).

nonlinear nature of the time course data as in Figures 7–8. GAMM is a nonlinear regression analysis which in addition to linear effects includes smooth terms as well as random smooths to capture the random effects. Model comparisons involve the full model, with all terms and interactions, and a nested model that excludes the main term and the smooth term corresponding to the predictor and the interactions with these terms (Winter & Wieling 2016, Sóskuthy 2017, Wood 2017). Because in this experiment the predictions are only about the parametric terms (the proportion of looks to the target within a given time window) and not about the differences between the shapes of the curves, significance testing is based on the t-values and I only report those.

The third line in Figures 7–8 shows the model predictions for each of the time windows without random smooths, Preview (−500–0 ms), *Dostałeś* 'You got' (0–1030 ms), the quantifier (1030–2122 ms), *niebieskich/zielonych/czerwonych kulek* 'blue/green/red balls' (2122–3682 ms). The fourth line shows the model predictions including the random smooths that capture the random effects of Subject, Item and Trial. The fifth line summarizes the statistical findings showing which of the contrasts were significant – the unpredicted significant effects are highlighted in grey. The non-highlighted findings match the predictions summarized in Table 1.

In the EARLY condition, Figures 7, there is a main effect of Quantifier in each time window (Preview: $\chi^2 = 10.96, \mathrm{df} = 9, p = 0.009$; 'You got': $\chi^2 = 105.5, \mathrm{df} = 9, p < 0.0001$; the quantifier: $\chi^2 = 55.8, \mathrm{df} = 9, p < 0.0001$; the color window: $\chi^2 = 140.35, \mathrm{df} = 9, p < 0.0001$). Pairwise comparisons reveal the following differences (p-values include the Bonferroni correction for multiple comparisons):

In the Preview window, there are more looks to the target with MOST$_{\text{SUP}}$ than with MOST-OF ($\beta = -0.388, \mathrm{SE} = 0.119, t = -3.268, p = 0.004$) and with SOME than MOST-OF ($\beta = -0.389, \mathrm{SE} = 0.107, t = -3.617, p = 0.001$).

In the 'You got' window, the proportion of looks to the target is higher with MOST$_{\text{SUP}}$ than with SOME ($\beta = -0.653, \mathrm{SE} = 0.102, t = -6.382, p < 0.0001$) and than with MOST-OF ($\beta = -1.259, SE 0.111, t = -11.377, p < 0.0001$), as well as with SOME in comparison with MOST-OF ($\beta = -0.604, \mathrm{SE} = 0.101, t = -6.011$, $p < 0.0001$).

In the quantifier window, the trend is reversed and there are fewer looks to the target with MOST$_{\text{SUP}}$ than with SOME ($\beta = 0.637, \mathrm{SE} = 0.115, t = 5.528, p < 0.0001$) and with MOST-OF ($\beta = 0.866, \mathrm{SE} = 0.123, t = 7.02, p < 0.0001$).

In the color adjective plus noun 'balls' window, there are still fewer looks to the target with MOST$_{\text{SUP}}$ than with SOME ($\beta = 0.574, \mathrm{SE} = 0.106, t = 5.436, p <$ 0.0001). But now there is no difference between MOST$_{\text{SUP}}$ and MOST-OF. There are now fewer looks to the target with MOST$_{\text{SUP}}$ than with ALL ($\beta = 1.761, \mathrm{SE} =$

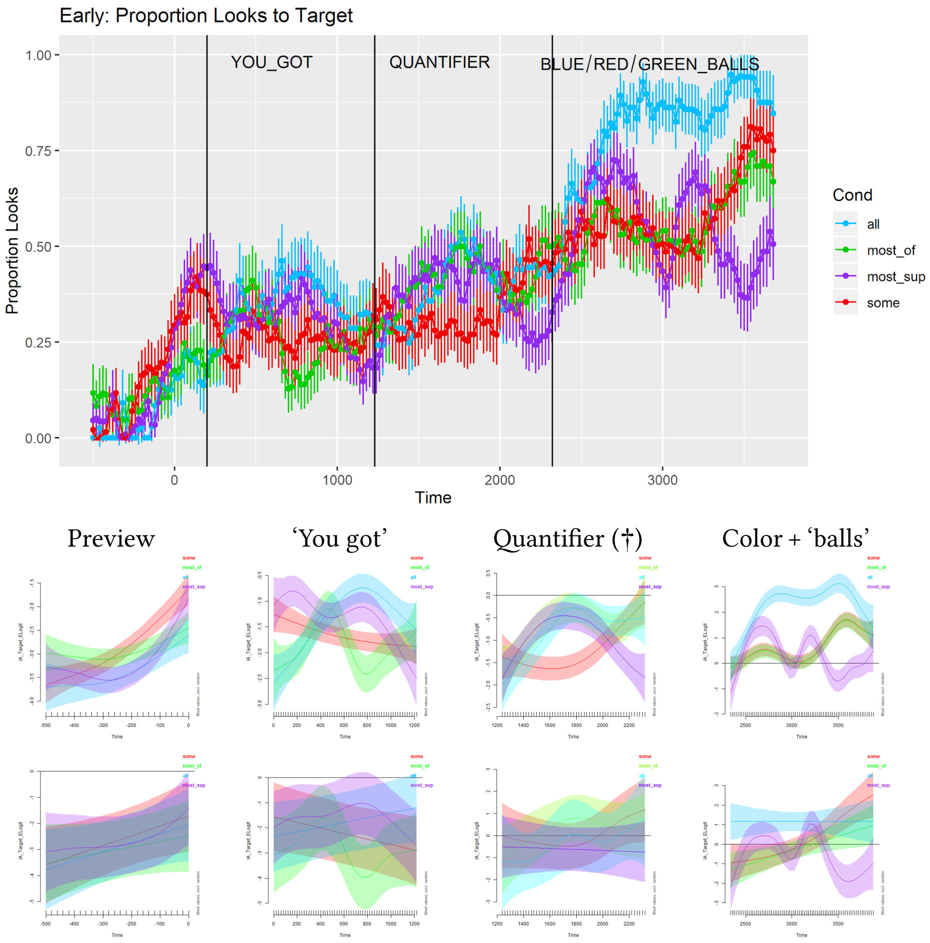
$0.166, t = 10.6, p < 0.0001$). Also SOME has fewer looks to the target than ALL ($\beta = 0.95, \mathrm{SE} = 0.172, t = 5.533, p < 0.0001$), but it has more looks to the target than MOST-OF ($\beta = -0.41, \mathrm{SE} = 0.102, t = -4.003, p = 0.0002$).

Strikingly, there are differences between the quantifiers already during Preview and in the 'You got' window. An exploratory analysis is needed to find out what drove the differences. Perhaps it was some property of the previous trial such as the quantifier, the location of the target (left, center, right) or the numerosities of the sets. Or perhaps this reflects the anticipation of which sentence would best describe the display given that in the LATE condition, there are no differences at Preview, but the differences start at 'You got' such that MOST-OF and SOME get more looks than MOST_{SUP}.[4]

Crucially for the goals of the experiment, in the quantifier window the unexpected trends from the previous windows do not persist. Instead, I find that the predictions have been met: with MOST_{SUP} there were fewer looks to the target than with SOME and MOST-OF. This is the prediction 'MOST_{SUP} < MOST-OF, ALL' in Table 1. (There is no significant difference between MOST_{SUP} and ALL, which was unpredicted, however, SOME is also not significantly different from ALL and it can be seen in the plot with random effects that there is a lot of variation with ALL).

I predicted that the lower proportion of looks to the target with MOST_{SUP} than with MOST-OF should be due the fact that its semantics requires two comparisons (between the target and the two color sets in the lower chamber) while with MOST-OF one comparison is required (between the lower and upper subsets of the partitioned set). The question was whether with SOME the looks to the target would be the same as with MOST_{SUP} suggesting that the processing of the scalar implicature does not happen in the quantifier window. I find that this is not the case: there are more looks to the target with SOME than with MOST_{SUP} and SOME is no different from MOST-OF (and ALL). This result is compatible with the prediction 'SOME-NOT-ALL > MOST_{SUP}' in Table 1, meaning that the scalar implicature, 'some-but-not-all', has already been processed in the quantifier window. I find no support for the alternative, that first the literal meaning of *some*, 'some-and-possibly-all', is processed, 'SOME-POSSIBLY-ALL = MOST_{SUP}' in Table 1.

[4] A reviewer objects to this saying that it is unlikely that the participants would try to guess the upcoming quantifier or were clairvoyant. But my suggestion is that the big-set bias has consequences for the mental representation of the description of the visual scene. See Huettig et al. (2011) for the explanation of the interaction between the visual stimuli and higher order cognitive biases as induced by task goals and language. In the LATE condition, a salient visual cue is absent and the looks do not diverge during Preview. In the EARLY condition, the target set pops out and may bias some mental description of the scene, which is additionally affected by the memory of any salient features of the previous trial.



Preview	'You got'	Quantifier (†)	Color + 'balls'
MOST$_{\text{SUP}}$ > MOST-OF	MOST$_{\text{SUP}}$ = ALL	MOST$_{\text{SUP}}$ = ALL	MOST$_{\text{SUP}}$ < ALL
SOME > MOST-OF	MOST$_{\text{SUP}}$ > MOST-OF	MOST$_{\text{SUP}}$ < MOST-OF	MOST$_{\text{SUP}}$ = MOST-OF
MOST$_{\text{SUP}}$ = ALL = SOME	MOST$_{\text{SUP}}$ > SOME	MOST$_{\text{SUP}}$ < SOME	MOST$_{\text{SUP}}$ < SOME
	SOME > MOST-OF	SOME=ALL=MOST-OF	SOME < ALL
	SOME = ALL		SOME > MOST-OF

Figure 7: Results: EARLY condition. (†) marks *disambiguation*.

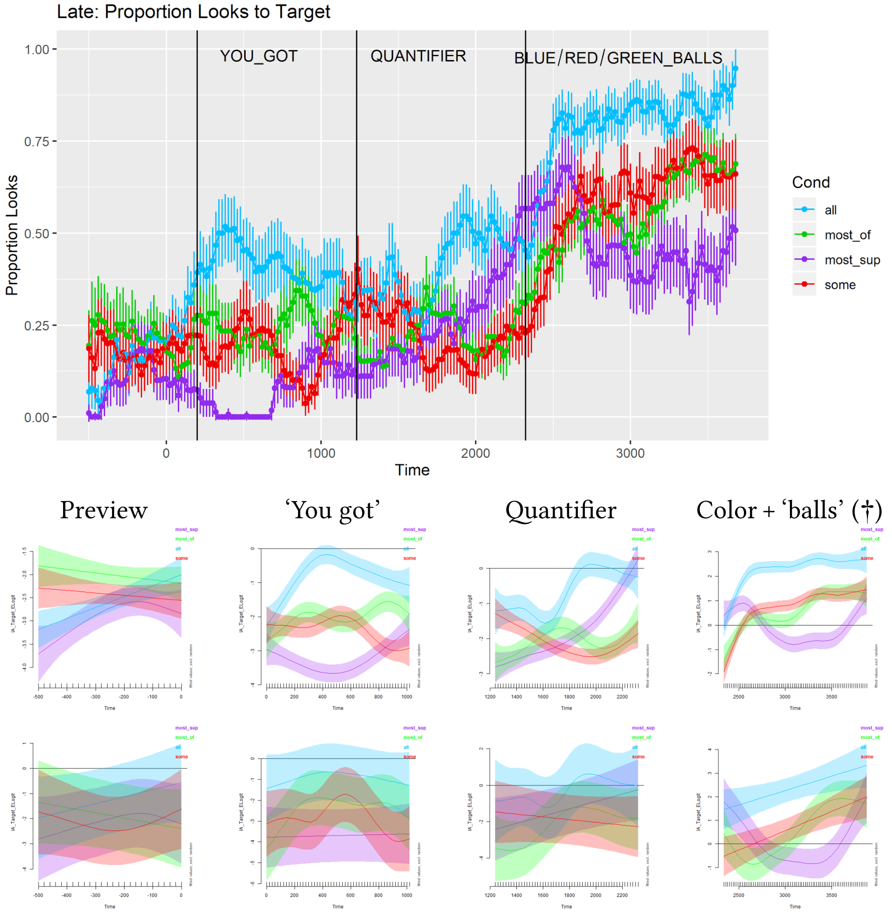
It was also predicted that in the EARLY condition in the quantifier window SOME-NOT-ALL would get more looks to the target than MOST-OF (‘SOME-NOT-ALL > MOST-OF’ in Table 1), but instead we find that SOME is no different from MOST-OF (‘SOME = MOST-OF’ in Figure 7) – we do find evidence for this effect but in the next region.

The prediction for the color adjective window was ‘SOME-NOT-ALL > MOST-OF’ if MOST-OF requires more looks between the two partitioned sets than SOME in order to establish the total set of the balls in the target color for the Subtraction procedure, (2). I hypothesized that the proportion of looks to the target with MOST-OF could be as low as with MOST_{SUP}, which is what we find (‘MOST_{SUP} = MOST-OF’ in Figure 7). However, looking at the plots we see that the difference between MOST-OF and SOME is rather small; there are more looks to the target with SOME at the very beginning and mostly at the end of the region. The trajectory for MOST-OF is quite different than for MOST_{SUP}, where the looks diverge between the target and the distractors. Still, the proportion of looks to the target within the whole region is as low with MOST-OF as with MOST_{SUP}, which is consistent with a higher number of processing steps involved in the Subtraction procedure in contrast with the direct Selection procedure.

The results for the LATE condition are presented in Figure 8. In the LATE condition, there are also effects of Quantifier in each time window (Preview: $\chi^2 = 18.4, \text{df} = 9, p = 0.009$; ‘You got’: $\chi^2 = 113.12, \text{df} = 9, p < 0.0001$; the quantifier: $\chi^2 = 112.61, \text{df} = 9, p < 0.0001$; the color window: $\chi^2 = 163.25, \text{df} = 9, p < 0.0001$). In contrast to the EARLY condition, in the Preview window multiple comparisons show no significant differences. In other windows pairwise comparisons reveal the following differences (p-values include the Bonferroni correction for multiple comparisons):

In the ‘You got’ window, in the LATE condition, MOST_{SUP} got fewer looks to the target than all the other conditions (SOME, $\beta = 0.847, \text{SE} = 0.102, t = 8.321, p < 0.001$, ALL, $\beta = 2.754, \text{SE} = 0.855, t = 3.223, p = 0.005$, MOST-OF, $\beta = 1.274, \text{SE} = 0.108, t = 11.749, p < 0.0001$). SOME received fewer looks to the target than MOST-OF ($\beta = 0.434, \text{SE} = 0.102, t = 4.258, p < 0.0001$). As in the EARLY condition, this result is unexpected and requires an exploratory analysis.

In the quantifier window, in the LATE condition, there were more looks to the target with MOST_{SUP} than with SOME ($\beta = -0.562, \text{SE} = 0.099, t = -5.688, p < 0.0001$) and than with MOST-OF ($\beta = -0.838, \text{SE} = 0.11, t = -7.606, p < 0.0001$). This is in line with the prediction ‘MOST_{SUP} > ALL, MOST-OF, SOME’ in Table 1 (except that MOST_{SUP} is not significantly different from ALL). We also find that there are more looks to the target with SOME than with MOST-OF ($\beta = -0.276, \text{SE} = 0.103, t = -2.685, p = 0.029$), which fits the prediction ‘SOME-NOT-ALL > MOST-OF’



Preview	‘You got’	Quantifier	Color + ‘balls’ (†)
no differences	MOST$_{\text{SUP}}$ < ALL	MOST$_{\text{SUP}}$ = ALL	MOST$_{\text{SUP}}$ < ALL
	MOST$_{\text{SUP}}$ < MOST-OF	MOST$_{\text{SUP}}$ > MOST-OF	MOST$_{\text{SUP}}$ < MOST-OF
	MOST$_{\text{SUP}}$ < SOME	MOST$_{\text{SUP}}$ > SOME	MOST$_{\text{SUP}}$ < SOME
	SOME = ALL	SOME = ALL	SOME < ALL
	SOME < MOST-OF	SOME > MOST-OF	SOME = MOST-OF

Figure 8: Results: LATE condition. (†) marks *disambiguation*.

in Table 1 and further indicates that with SOME there is no delay in the processing of the scalar implicature.

I predicted that the latter effect would persist in the color window, but instead I find that SOME was no different from MOST-OF. This could be related to the low accuracy with *some*, namely, participants who accepted 'some-not-all' as the description of the display (recall that I analyzed the looks with correct responses only) nevertheless compared the numerosities of the different color sets. However, SOME had significantly fewer looks to the target than ALL ($\beta = 1.676, \mathrm{SE} = 0.276, t = 6.071, p < 0.0001$). This effect, 'SOME-NOT-ALL < ALL' was predicted to occur already in the quantifier window, but we find it later.

In the color window, with $\mathrm{MOST_{SUP}}$ there were fewer looks to the target than with the other quantifiers: SOME ($\beta = 0.642, \mathrm{SE} = 0.097, t = 6.641, p < 0.0001$), ALL ($\beta = 2.075, \mathrm{SE} = 0.277, t = 7.505, p < 0.0001$), and MOST-OF ($\beta = 0.46, \mathrm{SE} = 0.101, t = 4.536, p < 0.0001$). This results is exactly as predicted: with $\mathrm{MOST_{SUP}}$, as the color adjective is heard the looks must be directed to the other two color sets in order to make the comparisons to confirm that the target set is indeed the largest.

3 Discussion and conclusions

The results of the current study contribute to the debate about the processing of the scalar implicature of the quantifier *some* during visual verification (Huang & Snedeker 2009, Grodner et al. 2010, Degen & Tanenhaus 2011, Huang & Snedeker 2011, Degen & Tanenhaus 2016) and provide novel predictions for experiments on the processing of *some* in comparison with other quantifiers in languages other than English. I find support for the claim in Spychalska (2009) that the Polish counterpart of *some*, *niektóre*, has a strong implicature – I find that the meaning 'some-not-all' is processed immediately as the disambiguating quantifier is heard. I compared *niektóre* 'some' to *większość* 'most of' and *najwięcej* (the superlative *most*) and *wszystkie* 'all'. In the prior visual world eye-tracking studies, *some* and *all* were compared on the basis of the theory that these two quantifiers form a scale, so when *some* is used instead of the stronger *all*, the inferred meaning is 'some-not-all' (Horn 1972, Levinson 1983, a.o.). However, the results of Degen & Tanenhaus (2011, 2016) showed that whether there is a delay in the processing of the 'some-not-all' meaning depends on whether the experiment contains alternative descriptions using number terms and not just *some* and *all* ('You got some/all/two/three/four/five of the blue gumballs'). When those alternatives are available the processing of the 'some-not-all', implicature is delayed relative to the processing of the meaning of *all*. Without such alternatives, *some* is not delayed relative to *all*.

In the current experiment, adopting the gumball paradigm of Degen & Tanenhaus (2011, 2016) alternative descriptions of the visual scene contained the quantifiers *most of* and the superlative *most* (*most*-SUP) because (i) they allowed for more specific predictions about the time course of the looks to the target than just a comparison with *all*, and (ii) two alternative strategies for *most of* could be tested. Specifically, the semantics of the superlative *most* requires comparisons between the target color set and the two other colors in the lower chambers of the ball machine, which I expected to elicit a distinctive pattern of looks that would serve as the baseline for statistical comparisons (the displays were identical for *some*, *most of* and *most*-SUP, but they had to be different for *all*). As in the study of Degen & Tanenhaus (2016) the quantifiers were compared with two types of displays, EARLY and LATE (Figures 4–5 in §2.2). In the EARLY condition, the quantifier in the stimulus sentence ('You got some/all/most of/the most blue/red/green balls') disambiguated which set of the three sets of balls in the bottom chambers was the target. In the LATE condition, the target was identifiable only when the color adjective was heard.

In the EARLY condition, the results showed no delay for the Polish counterpart of *some* as compared to *all* and *most of*, as well as a higher proportion of looks to the target than with *most*-SUP. I considered two alternatives in the predictions. On the one hand, if the 'some-not-all' meaning was processed early (at the point of hearing the quantifier), the identification of the target set should be just as easy as with *all*, given that the target set was partitioned and as such stood out already during the preview. If, on the other hand, the 'some-possibly-all' meaning was processed first, the looks should be first directed to the unpartitioned sets as with *most*-SUP. The results show support for the first option: the 'some-not-all' meaning is processed early. In the LATE condition, I also find evidence for the 'some-not-all' interpretation in comparison with *all* and *most of*.

The second novel finding concerns the semantics of the majority quantifier *most of*. Pietroski et al. (2009) and Lidz et al. (2011) propose that the verification of sentences like 'You got most of the blue balls' involves a procedure of subtraction (schematized in (2) vs. (3) in §2.2). This procedure requires multiple steps: estimate the superset (the blue balls remaining in the top chamber and the blue balls in the bottom chamber), estimate the target set (the blue balls in the bottom chamber), subtract and compare the result with the target. Subtraction involves more steps than direct comparison of two sets (3 in §2.2), so my hypothesis was that I should find fewer looks to the target in the quantifier and color windows because of the continuing looks to the top blue set in order to establish the total set. Indeed, in the color window there were significantly fewer looks to the target than with both *some* and *all*; the proportion of looks was as low as in the *most*-SUP condition. The low proportion of looks with *most*-SUP can be directly linked to the superlative semantics requiring comparisons with the other color sets. *most of* could be verified by merely comparing the top and bottom numerosities of the partitioned set, but this simple comparison would have elicited a similar proportion of looks to the target as with *some*. The profiles of eye-movements with *some* and *most of* looked similar but the proportion of looks to the target was lower with *most of* than with *some*. In the LATE condition I also predicted fewer looks to the target with *most of* than with *some* in both the quantifier and color windows, and this effect was observed in the quantifier window.

The fact that the pattern of looks with *most of* is compatible with the subtraction procedure and not with the more efficient direct comparison procedure supports the hypothesis in Pietroski et al. (2009) and Lidz et al. (2011) that the mind follows the "instructions" encoded in the lexical representation of quantifier meanings. They argue that lexical semantics interfaces with the cognitive system, which means that lexical meanings require more fine grained distinctions than just truth-conditions. The present experiment showing that with the same display there are distinctive patterns of looks for the three Polish quantifiers *some*, *most of* and *the most* supports the idea that lexical semantics provides direct instructions to visual cognition processes.

Abbreviations

1	first person	PAST	past tense
2	second person	SG	singular
COP	copula	SUP	superlative

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Chapter 18

Group-denoting vs. counting: Against the scalar explanation of children's interpretation of 'some'

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The computation of scalar implicatures based on the scale ⟨*some, all*⟩ represents a problem for children. This paper argues that the source of children's difficulties with interpreting 'some' is that it is ambiguous; it has a non-partitive interpretation, corresponding to 'a few', which forms a scale with non-partitive 'many', and a partitive reading, corresponding to 'a subset of', which forms a scale with 'all'. The two readings have different distributions; they are selected by different predicates, and in Hungarian, they occur in different structural positions. We tested and confirmed the hypothesis that young children are not sensitive to the partitivity feature of 'some'-phrases; they first acquire the non-partitive reading, which they overgeneralize for a while. Experiment 1, a forced choice task, showed that the default reading of 'some' NPs for six-year olds is the 'a few' interpretation. Experiment 2, a truth value judgement task, demonstrated that children also accept the 'not all' interpretation of 'some', and the acceptance rates of the 'a few' and the 'not all' readings are similar irrespective of the partitivity feature of the given NP.

Keywords: scalar implicature, 'some', counting quantifier, partitive, Hungarian, language acquisition

1 Introduction

Whereas adults interpret *some* e.g. in *Some horses jumped over the fence* as 'some but not all', children understand it as 'some and possibly all' (e.g. Noveck 2001,

Katalin É. Kiss, Lilla Pintér & Tamás Zétényi. 2021. Group-denoting vs. counting: Against the scalar explanation of children's interpretation of 'some'. In Mojmír Dočekal & Marcin Wągiel (eds.), *Formal approaches to number in Slavic and beyond*, 427–457. Berlin: Language Science Press. DOI: 10.5281/zenodo.5082484

Papafragou & Tantalou 2004). It has been claimed that the basic meaning of plural *some* is 'some and possibly all', and the 'some but not all' reading is a pragmatic inference, a scalar implicature, which children cannot access (see Noveck 2001, Chierchia et al. 2001, Papafragou & Musolino 2003, Guasti et al. 2005, Foppolo et al. 2012, Huang & Snedeker 2009, Katsos & Bishop 2011, Barner et al. 2011). The assumption that children generally have problems with computing scalar implicatures cannot explain though why pragmatic inferencing has proved to be much easier for them in the case of scales involving cardinal numbers than in the case of the scale involving *some* and *all* (Papafragou & Musolino 2003).

Recently it has been proposed that a scalar implicature is often a problem for children because they lack knowledge of the relevant scalar alternatives. That is, young children accept *some* in situations which could be more appropriately described by *all* because they are still not aware of the fact that *all* is a stronger alternative of the same scale that includes *some* (Barner et al. 2011, Foppolo et al. 2012, Pagliarini et al. 2018).

We argue that the source of children's difficulties with interpreting *some* and its Hungarian equivalent *néhány* is that *some/néhány* is ambiguous. It has a non-partitive interpretation, corresponding to 'a few', which forms a scale with non-partitive *many*, and a partitive reading, corresponding to 'a subset of', which forms a scale with *all*.[1] The two variants of *some/néhány* have different distributions; they are selected by different predicates, and in Hungarian, they occur in different structural positions. We have hypothesized that for young children, the primary reading of 'some' NPs is the non-partitive reading; this is what explains their behaviour in the experiments cited above. We tested this assumption with the two experiments to be presented in this paper.

The paper is organized as follows: §2 presents linguistic evidence of the ambiguity of *néhány* 'some'. §3 surveys previous experiments testing children's interpretation of 'some'. §4 presents our own experiments with *néhány*. §5 is the conclusion.

2 Group-denoting versus counting *néhány/some*: Linguistic evidence

For adults, a *some* NP in English or a *néhány* NP in Hungarian is often ambiguous, e.g.:

[1] *Many* also has a non-partitive reading, paraphraseable as 'a large number of', and a partitive or proportional reading, paraphraseable as 'a large subsection of'. This well-known ambiguity is discussed in connection with examples (13a–13b), (16a–16b), and (17–18).

(1) Találkoztam néhány diákkal.
meet.PAST.1SG some student.with
'I met some students.'

The Hungarian sentence and its English equivalent in (1) can mean both that I met a small indefinite number of students, and that I met a (small) subset of a contextually given set of students. (To what extent the 'small' component is part of the latter, partitive meaning, as well, appears to be individual dependent – as was revealed by the reactions of the adult control group of our experiments. In the experiments of Degen & Tanenhaus (2015), the default set size associated with *some* by English adults is 6–8.)

In two structural positions in the functional left periphery of the Hungarian sentence, the *néhány* phrase ceases to be ambiguous. These are the two preverbal slots of the basic Hungarian sentence: a topic slot (the specifier of an iterable TopP), accessible to referential constituents, and an immediately preverbal slot (the specifier of PredP) harboring a non-referential, predicative complement – as shown in Figure 1 (for details, see É. Kiss 2002, 2008, 2010, Szabolcsi 1994, 1997, among others).

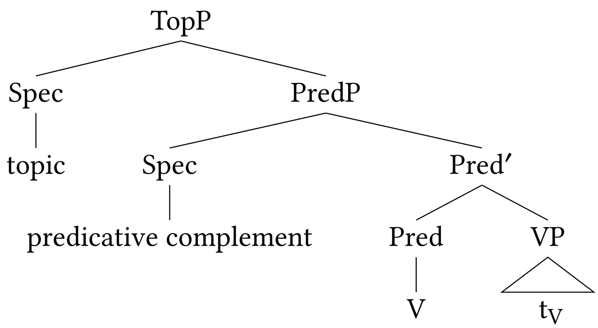

Figure 1: Hungarian sentence structure

The topic and the filler of SpecPredP can be separated by sentence adverbials, by distributive quantifiers, and by an exhaustive focus. The topic precedes the (first) pitch accent, whereas the constituent in SpecPredP either itself bears a pitch accent, or follows another pitch-accent-bearing element.

In the topic position, the *néhány* phrase is understood to denote a (small) subset of a contextually given set – see examples (2a) and (2b), where the topic status of the *néhány* phrase is ensured by its position preceding the universal quantifier, the locus of pitch accent (denoted by ˊ). (2a) and (2b) represent the same structure, with the grammatical functions distributed in different ways; they illustrate that word order in the preverbal section of the Hungarian sentence is determined by logical role rather than grammatical functions.

(2) a. [$_{\text{TopP}}$ Néhány diák [$_{\text{DistP}}$ ˈminden professzorral
some student every professor.with
[$_{\text{PredP}}$ konzultált.]]]
consult.PAST.3SG
'Some students consulted with every professor.'

b. [$_{\text{TopP}}$ Néhány diákkal [$_{\text{DistP}}$ ˈminden professzor
some student.with every professor
[$_{\text{PredP}}$ konzultált.]]]
consult.PAST.3SG
'With some students, every professor consulted.'

The topic of the sentence represents the logical subject of predication, therefore, it must have restricted reference, i.e., must be specific. Partitivity corresponds to a type of specificity (Enç 1991, Farkas 2002, Kamp & Bende-Farkas 2019), thus the partitive interpretation associated with *néhány* in topic position is a manifestation of its specificity feature.

In the specifier of the PredP projection, by contrast, the non-partitive interpretation of *néhány*, corresponding to 'a few', is evoked (see 3a). SpecPredP is filled by the non-referential complement of the verb, and its filler has the smallest possible scope (Szabolcsi 1983), which is also true of the *néhány*-phrase in SpecPredP (see 3b). As opposed to the topicalized, partitive *néhány* NP in (2a) and (2b), the non-partitive *néhány* NP in SpecPredP bears a pitch accent. The relative stress of *néhány* within the NP is also different in the two cases: whereas the partitive *néhány*, a strong determiner, itself bears the secondary stress of the *néhány* NP, in the non-partitive *néhány* NP, the pitch accent falls on the nominal determined by *néhány*.

(3) a. [$_{\text{PredP}}$ Néhány ˈdiák érkezett.]
some student arrive.PAST.3SG
'Some students arrived.'

b. [[$_{\text{DistP}}$ ˈMind-három professzor [$_{\text{PredP}}$ néhány ˈdiákkal
all-three professor some student.with
konzultál.]]
consults
'Each of the three professors is consulting with some students.'

The left periphery of the Hungarian sentence can also include a focus slot between PredP and TopP, in the specifier of a focus phrase (FocP). The focus elicits verb movement from Pred to Foc, hence a preverbal *néhány* NP can sit either in SpecPredP or in SpecFocP. (SpecFocP position is traditionally marked by small capitals.) Whereas the *néhány* NP in SpecPredP is [−partitive], the exhaustive/contrastive *néhány* phrase in SpecFocP is [±partitive], i.e., it can either mean 'a few, not many', or it can mean 'a (small) subset of a contextually given set, not the whole set' – see *néhány diák* 'some students' in (4). The excluded alternative shares the partitivity feature of the *néhány* phrase. When *néhány diák* 'some students' is understood as [−partitive], the excluded alternative is the [−partitive] 'many students' – see (5a). When it is understood as [+partitive], what it excludes is 'all students' – see (5b).

(4)

$[_{\text{FocP}}$	(Csak)	´NÉHÁNY	DIÁKKAL	konzultáltam$_{\text{i}}$	$[_{\text{PredP}}$ t_{i} ...]]
	only	some	student.with	consult.PAST.1SG	

'It was (only) some students that I consulted with.'

(5) a.

$[_{\text{NegP}}$	Nem $[_{\text{FocP}}$	(csak)	´NÉHÁNY	DIÁKKAL	konzultáltam$_{\text{i}}$
	not	only	some	student.with	consult.PAST.1SG
$[_{\text{PredP}}$ t_{i} ...]]]	hanem	sokkal.			
	but	many.with			

'I consulted not (only) with some students but with many.'

b.

$[_{\text{NegP}}$	Nem $[_{\text{FocP}}$	(csak)	´NÉHÁNY	DIÁKKAL	konzultáltam$_{\text{i}}$
	not	only	some	student.with	consult.PAST.1SG
$[_{\text{PredP}}$ t_{i} ...]]]	hanem	minddel.			
	but	all.with			

'I consulted not (only) with some students but with all.'

In our experiments, we intended to test the interpretations of *néhány* NPs in SpecTopP and in SpecPredP, where they are not ambiguous; i.e., we excluded focussed *néhány* phrases. Since the verb moves to Pred in neutral clauses, and moves on to Foc in focus constructions, an immediately preverbal *néhány* can, in principle, occupy either SpecPredP or SpecFocP; however, the filler of SpecFocP and the filler of SpecPredP behave differently under negation, which makes their identity easily testable. Namely, FocP negation elicits no further verb movement, resulting in a Neg–SpecFocP–V order – as shown in (5a) and (5b). PredP negation, on the contrary, elicits V-to-Neg movement, yielding a Neg–V–SpecPredP order (6a); (7a). A non-partitive *néhány* phrase inside a negated PredP is marginal; it tends to be replaced by the negative polarity indefinite *egy...sem* 'not even one; no' (6b); (7b):

(6) a. ? [$_{\text{NegP}}$ ´Nem érkezett$_i$ [$_{\text{PredP}}$ néhány diák t_i …]]
not arrive.PAST.3SG some student
'It is not the case that some students have arrived.'

b. [$_{\text{NegP}}$ ´Nem érkezett$_i$ [$_{\text{PredP}}$ egy diák sem t_i …]]
not arrive.PAST.3SG one student even
'No student arrived.'

(7) a. ? [$_{\text{TopP}}$ A professzor [$_{\text{NegP}}$ ´nem konzultált$_i$ [$_{\text{PredP}}$ néhány
the professor not consult.PAST.3SG some
diákkal t_i …]]
student.with
'It is not the case that the professor consulted with some students.'

b. [$_{\text{TopP}}$ A professzor [$_{\text{NegP}}$ ´nem konzultált$_i$ [$_{\text{PredP}}$ egy
the professor not consult.PAST.3SG one
diákkal sem t_i …]]
student.with even
'The professor did not consult with any student.'

The claim that the different preverbal positions of the Hungarian sentence let in different types of quantifiers was first made by Szabolcsi (1994, 1995). She claimed that the topic position is open to group-denoting quantifiers such as *a fiú* 'the boy', *hat fiú* 'six boys'; the distributive quantifier position is open to universals, among others, whereas the specifier of PredP can take so-called counting quantifiers such as *pontosan hat fiú* 'exactly six boys', *kevés fiú* 'few boys', *hatnál kevesebb fiú* 'less than six boys', *sok fiú* 'many boys' etc. The difference between counting and non-counting quantifiers is procedural. The mode of operation of group-denoting (and distributive) quantifiers is "predicate and +/−distribute", and that of counting quantifiers is "count". Group-denoting and distributive DPs are monotonically increasing quantifiers whose witness sets serve as logical subjects of predication. Their combination with a predicate asserts that the predicate holds, or does not hold, of that witness set or its elements. In contrast, counting quantifiers specify the size of a participant of the atomic or plural event described by the verbal predicate in conjunction with the counting quantifier's restriction. Szabolcsi (2010) associates the two interpretations with Brentano's categorical and thetic judgments, citing Ladusaw (1994).

Szabolcsi (1994, 1995, 2010) also called attention to the fact that a noun phrase can belong to more than one quantifier type, and its behavior and interpretation in Hungarian depends on which position it occupies in the sentence structure. For example, *sok fiú* 'many boys' can stand both in SpecDistP (8a) and in

SpecPredP (8b), and it is obligatorily distributive only in the distributive quantifier position (8a):

(8) a. [$_{\text{DistP}}$ ˈSok fiú [$_{\text{PredP}}$ ˈfel emelte az asztalt.]]
many boy up lift.PAST.3SG the table.ACC
'Many boys each lifted the table.'

b. [$_{\text{PredP}}$ ˈSok fiú emelte$_i$ [$_{\text{vP}}$ fel t_i az asztalt.]]
many boy lift.PAST.3SG up the table.ACC
'Many boys lifted the table.'

When functioning as a non-counting quantifier, *sok* assumes a partitive interpretation; it marks a value of the scale involving 'all'. When used as a counting quantifier, it lacks partitivity; it forms a scale with 'few', among others. Compare the interpretations of *sok* in SpecDistP and in SpecPredP. While (9a) is a meaningful statement confronting two large subsets of a contextually given set, (9b) involves a contradiction, making two opposing statements about an event.

(9) a. [$_{\text{DistP}}$ ˈSok diák [$_{\text{PredP}}$ ˈel jött a tüntetésre]],
many student off come.PAST.3SG the demontration.to
sok diák ˈnem jött el.
many student not come.PAST.3SG off
'Many students have come to the demonstration; many students haven't come.'

b. * [$_{\text{PredP}}$ ˈSok diák jött a tüntetésre], ˈnem
many student come.PAST.3SG the demontration.to not
jött sok diák.
come.PAST.3SG many student
Intended: 'There arrived many students at the demonstration; there didn't arrive many students.'

Notice that the *sok* phrase in SpecDistP of the second clause of (9a) precedes the negative particle and is outside the scope of negation, whereas the *sok* phrase in SpecPredP of the second clause of (9b) follows the negated verb, and is inside the scope of negation.

The different partitivity features of non-counting and counting quantifiers are manifested in further facts of Hungarian. Hungarian syntactically distinguishes verbs of creation and coming-into-being from their change-of-state counterparts (Szabolcsi 1986, Piñón 2008). Verbs stating the existence, or appearance, or creation of an individual have an obligatorily non-specific, hence non-partitive, internal argument – one whose existence or coming into being is asserted or negated (10a). Notice that if these verbs take a telicizing verbal particle, they express the change-of-state of an individual that has already existed partially or in the form of a plan, and the noun phrase denoting this individual is obligatorily partitive-specific (10b). (In English, the existence/coming-into-being/creation interpretation and the change-of-state interpretation are not distinguished formally. The *there is* construction enforces the existence/coming-into-being reading, but a 'preverbal subject, verb' complex is ambiguous. For a detailed semantic analysis of the two readings, see Piñón 2008.)

(10) a. {Vendég / *a vendég / *Mari vendége / *minden vendég}
guest the guest Mary guest.3SG every guest
érkezett.
arrive.PAST.3SG
'There arrived a guest/*the guest/*Mary's guest/*every guest.'

b. {A vendég / Mari vendége / minden vendég / *vendég} meg
the guest Mary guest.3SG every guest guest PRT
érkezett.
arrive.PAST.3SG
'The guest/Mary's guest/every guest/*guest arrived.'

The *sok* determiner of a noun phrase complementing a particleless verb of existence, coming-into-being or creation is understood as 'a large number of' (11a), whereas the *sok* determiner of a phrase complementing a particle verb expressing the change-of-state of a presupposed referent is understood as 'a large subset of' (11b):

(11) a. Sok vendég érkezett.
many guest arrive.PAST.3SG
'There arrived a large number of guests.'

b. Sok vendég meg érkezett.
many guest PRT arrive.PAST.3SG
'A large subset of the guests arrived.'

In Hungarian, *néhány* 'some' NPs behave similarly to *sok* phrases in that they can occur in different preverbal positions, where they represent different quantifier types. A *néhány* phrase can stand in SpecTopP, where it behaves as a group-denoting quantifier, or it can stand in SpecPredP, where it acts as a counting quantifier. The test demonstrating the interpretive difference of the partitive-specific non-counting use in SpecTopP/DistP and the non-partitive counting use in SpecPredP yields the same result in the case of *néhány* as in the case of *sok*. Compare with (12a) and (12b):

(12) a. [$_{\text{TopP}}$ Néhány diák [$_{\text{PredP}}$ ˊel jött a tüntetésre]],
some student off come.PAST.3SG the demontration.to
néhány diák ˊnem jött el.
some student not come.PAST.3SG off
'Some students have come to the demonstration; some students haven't come.'

b. * [$_{\text{PredP}}$ Néhány ˊdiák jött a tüntetésre], ˊnem
many student come.PAST.3SG the demontration.to not
jött néhány diák.
come.PAST.3SG some student
Intended: 'There arrived some students at the demonstration; there didn't arrive some students.'

We attest the same correlation between the interpretation of the quantifier and the partitivity requirement imposed on it by the selecting predicate in the case of *néhány* phrases as we observed in the case of *sok* phrases. Thus a *néhány* phrase representing the non-partitive internal argument of a verb of existence or coming-into being means 'a small number of…'. A *néhány* phrase representing the partitive-specific internal argument of a change-of-state particle verb, on the contrary, means 'a (small) subset of a contextually given set of…':

(13) a. [$_{\text{PredP}}$ Néhány ˊvendég érkezett.]
some guest arrive.PAST.3SG
'There arrived a small number of guests.'

b. [$_{\text{TopP}}$ Néhány vendég [$_{\text{PredP}}$ ˊmeg érkezett.]]
some guest PRT arrive.PAST.3SG
'A (small) subset of the guests arrived.'

In sum, the countable determiner *néhány* 'some' is ambiguous between a partitive (more precisely, partitive-specific) reading, corresponding to 'a (small) subset of', and a non-partitive, non-specific reading, the equivalent of 'a small number of'. The partitive *néhány* 'some' forms a scale with *mind* 'all', whereas the non-partitive *néhány* 'some' forms a scale with the non-partitive (or non-proportional) reading of *sok* 'many'. Certain sets of verbs select one or the other variant of *néhány*. Hungarian formally distinguishes the coming-into-being/creation variants and the change-of-state variants of many accomplishment verbs. The former select a non-specific internal argument; the latter only accept a specific internal argument. 'Some' phrases representing the internal argument of coming-into-being/creation verbs only have the 'a few' reading, whereas those representing the internal argument of the change-of-state variants only have the 'not all' interpretation. The two types of 'some' phrases also have different distributions across sentence positions. In the Hungarian sentence, the topic position is only open to partitive-specific 'some' phrases, whereas the immediately preverbal SpecPredP slot only accepts non-partitive 'some' NPs. (In the focus position, and postverbally, both variants are possible.)

The question is to what extent the above observations hold of the English *some*. Szabolcsi (2010: 173) identifies counting quantifiers in English on the basis of two properties: they can host a binominal *each*, and they are poor inverse scope takers, and she lists *some* NPs among the non-counters. We have found in an inquiry involving adult native English speakers that the acceptance rate of the test sentence in (14), containing a *some* NP hosting a binominal *each*, is 30%.[2]

(14) The boys have seen some films each.

The following comment of a participant suggests that the marginal acceptability of (14) is due to the difficulty of constructing an appropriate context for it. Namely: "The kind of context in which it seems okay [is] where these boys didn't make much of an effort, say, in the context of a course. So *The boys saw some films each, but otherwise they didn't make a whole lot of effort to engage with the course content or the prescribed work*." The other criterion of counting quantifiers is satisfied more straightforwardly: where the predicate enforces a non-partitive, counting reading on a *some* NP, it cannot take wide scope:

(15) In front of every house, there are some trees.
every > some; *every < some

A topicalized *some*-phrase, on the contrary, clearly behaves like a group denoter; it is partitive-specific, it has wide scope (16a), and does not support a binominal *each* (16b):

(16) a. In front of some houses, every tree is in blossom.
b. * Some films, the boys have seen each.

[2]The inquiry was not a controlled experiment; it was a grammaticality judgement request sent to a number of English native speakers; hence this data (the result of 15 answers) is to be considered as indicative only.

Although these facts may not be conclusive as regards the counting quantifier status of the non-partitive *some*, *some* NPs in [−specific] contexts, e.g. in the subject position of thetic, presentative sentences such as (17), and those in [+specific] contexts, e.g. in the subject position of categorical sentences such as (18) show the same interpretive difference as we attested in Hungarian – as was already observed by Diesing (1992) and was confirmed by von Fintel (1998):

(17) a. There are some major mistakes in this manuscript.
b. ⇔ A small number of major mistakes can be found in this manuscript.

(18) a. Some mistakes in this manuscript are major.
b. ⇔ A (small) subset of the mistakes in this manuscript are major.

The Hungarian and English facts surveyed above raise the possibility that the non-adult-like interpretation that children assign to 'some'-phrases in acquisition experiments may not be due to their inability to carry out scalar implicatures. It may be the case that of the two readings of 'some'-phrases, the non-partitive reading, corresponding to 'a small number of…' emerges first and remains the default reading for some time, because that is the cognitively simpler interpretation, not requiring the identification of two referents: the set denoted by the quantifier phrase, and a superset, as well.

3 The acquisition of 'some'

The first experiment testing children's interpretation of *some* that has become widely known is that reported in Smith (1980). Smith tested how 4–7-year-old children understand the quantifiers *some* and *all*, and found that most of them give a Yes answer not only to questions like (19a) but also to questions like (19b), which would also be true if the quantifier were *all*.

(19) a. Do some birds live in cages?
b. Do some birds have wings?

Noveck (2001) conducted a similar experiment with older French children, testing how they interpret affirmative sentences involving the existential quantifier *certains* in sentences of the type *Some giraffes have long necks*. He found that the acceptance rate of such sentences is still 89% among 7–8-year olds, and 85% among 10–11-year olds, as opposed to the 41% acceptance rate of adults. Noveck concluded that children treat scalar terms logically; they acquire the pragmatic skill to draw scalar implicatures only at an older age.

Subsequent experiments tested children of different mother tongues, among them Greek (Papafragou & Musolino 2003, Papafragou & Tantalou 2004), German (Doitchinov 2005), Italian (Guasti et al. 2005, Foppolo et al. 2012), French (Noveck 2001, Pouscoulous et al. 2007), English (Chierchia et al. 2001, 2004, Papafragou & Skordos 2016), Hungarian (É. Kiss & Zétényi 2018), etc. They involved tasks of various kinds, for example, a sentence judgement task based on world knowledge (e.g. Smith 1980, Noveck 2001), a truth value/acceptability judgement task based on visual evidence (Papafragou & Musolino 2003, Pouscoulous et al. 2007); a felicity judgement task, i.e., selecting between alternative linguistic descriptions of a visual stimulus (Chierchia et al. 2001, Foppolo et al. 2012), a picture selection task (Doitchinov 2005), and an action-based judgement task (Papafragou & Tantalou 2004).[3]

These experiments have all confirmed that young children have difficulties with computing scalar implicatures, but, at the same time, they have also shown that children's achievement depends on several factors, among them the experimental conditions, the scalar elements involved, the syntactic structure of the linguistic stimulus, and the age of the children.

Various aspects of the experimental conditions have been shown to influence children's performance. If the sentence containing the scalar element is embedded in a rich naturalistic context, especially, if the context highlights the difference between its alternative interpretations, children are more likely to react in an adult-like fashion (Papafragou & Musolino 2003, Papafragou & Tantalou 2004, Foppolo et al. 2012). A training session also improves children's achievement – as demonstrated by Papafragou & Musolino (2003), although Guasti et al. (2005) showed that this is not a long-term effect.

The evaluation metric used by the experimenter also influences the results obtained. Katsos & Bishop (2011) tested the false, underinformative, and informative uses of *some* by introducing a ternary evaluation scale (represented by a small, a big and a huge strawberry, respectively). Whereas only 26% of Katsos & Bishop's 5–6-year-old subjects rejected underinformative *some* in a binary truth value task, 89% of them assigned the middle value to underinformative descriptions, which is unexpected if children's use of *some* is determined by logic. Katsos & Bishop's conclusion is that children are sensitive to underinformativeness, and

[3]The visual world paradigm, too, has appeared in experiments testing adults' interpretation of scalar implicatures (see, e.g., Huang & Snedeker 2009, Grodner et al. 2010, Degen & Tanenhaus 2016).

their acceptance of underinformative *some* in binary judgement tasks is not evidence of their incompetence with implicatures but is due to their tolerance of pragmatic violations.

The question may arise why children didn't accept the underinformative *some* expressions as optimal answers under the 'a few' interpretation of *some*. The stimuli in Katsos & Bishop's experiments were sentences describing animated actions where a protagonist manipulated members of a set one by one, with each action acknowledged by the experimenter separately. In the case of the sentence *The mouse picked up some of the the carrots*, for example, the animation showed a mouse which moved across the screen to a set of five carrots five times, and each time carried one carrot back to its starting position. Each time the mouse came back with a carrot, the experimenter commented "Look, he picked up a carrot". The emphasis was clearly on repeating the action until each carrot was affected. Our hypothesis is that the animation, reinforced by the experimenter's comments, evoked the distributive determiner *each* so strongly that *some* under any interpretation seemed suboptimal.

As demonstrated by several former experiments, children's success with scalar implicatures varies with the type of scale involved. Numerical scales, scales formed by such verb pairs as *start* and *finish*, and scales formed by disjunction and conjunction are difficult to a different degree for children (see Noveck 2001, Papafragou & Musolino 2003, and Barner et al. 2011, among others). Papafragou & Musolino (2003), testing Greek preschoolers' ability to draw scalar implicatures, found a significant difference also between the interpretations of the scale ⟨*some, all*⟩ and the scale ⟨*two, three*⟩. Their subjects had to judge the truth value of sentences involving 'some (of)' in contexts which satisfied the semantic content of 'all (of)', and sentences involving 'two (of)' in contexts which satisfied the semantic content of 'three (of)', e.g., they had to judge the truth value of (20a) and (20b) in a situation where all three members of a group of three horses jumped over a log.

(20) a. Two of the horses jumped over the log.
 b. Some of the horses jumped over the log.

Whereas the children rejected 65% of the sentences involving *two*, they only rejected 12.5% of the sentences involving *some*. In a follow-up experiment, preliminary training, and the introduction of contexts that made the stronger alternative salient, led to higher rejection rates, but they did not eliminate the difference between the ⟨*some, all*⟩ scale and the numerical scale (the rejection rate rose to 90% in the case of the ⟨*two, three*⟩ scale, but only to 52.5% in the case of the ⟨*some, all*⟩ scale).

Barner et al. (2011) compared children's ability to access a stronger scalar alternative in the case of context-dependent scales versus context-independent scales involving *some*. Four-year-old children were shown pictures in which three out of three objects fit a description (e.g., three animals were sleeping), and were asked to answer questions that relied on context-independent alternatives (e.g., *Are (only) some of the animals sleeping?*) or contextual alternatives (e.g., *Are (only) the cat and the dog sleeping?*). The children answered *yes* to questions involving a context-independent scale in two thirds of the cases even when the word *only* was used, but correctly answered *no* to questions involving a context-dependent scale. The authors concluded that children fail to compute scalar implicatures because they lack knowledge of the relevant scalar alternative to the word *some*. Children know that *some* and *all* denote different set relations; what they need is additional learning in order to rapidly and automatically access lexical items as scalar alternatives. They become aware of scale members by a gradual association of syntactically replaceable alternatives. The scale that the authors associate with *some* is ⟨*a, some, many, most, all*⟩. However, as we argued in §3, this scale is a conflation of two scales: the counting scale ⟨*a, some, many*⟩, and the partitive scale ⟨*some, most, all*⟩, the members of which cannot replace each other in various syntactic contexts. We assume that the source of children's difficulties is the fact that *some* belongs to two different scales (in fact, more than two if we also regard the singular *some*), and children's default choice may be the scale that does not include *all*.

Miller et al. (2005) noticed that *some* is interpreted differently in the presuppositional context of (21a), and in the non-presuppositional context of (21c), where the *some*-phrase represents the object of a verb of creation. Their main research question was the role of stress in the interpretation of presuppositional *some* (21b), though. In various act-out tasks, they tested the following three constructions (C1–C3):

(21) a. C1: Make some faces ˊhappy. (unstressed 'some'/presuppositional)
b. C2: Make ˊsome faces happy. (stressed 'some'/presuppositional)
c. C3: Make some ˊhappy faces. (unstressed 'some'/non-presuppositional)

They found that children correctly associate no scalar implicature with non-presuppositional, i.e., non-partitive, *some* (the percentage of partitive responses in C3 was 10%). However, unlike adults, they also fail to enforce a scalar implicature with unstressed presuppositional (i.e., partitive) *some* (the percentage of partitive responses in C1 was 50%). At the same time, children are able to access the quantity implicature associated with presuppositional *some* when it is focused (the percentage of partitive responses in C2 was 90%). In the view of Miller et al., scalar implicatures are made more salient by contrastive focus on the quantifier because the implicature is part of the alternative set generated by the focus. Miller et al., however, did not test the interpretation of stressed non-presuppositional *some*, i.e., they did not test (22), and did not mention, let alone resolve, the apparent contradiction between the non-presuppositionality of the object of a creation verb and the implicature arising with the alternative set generated by its focusing.

(22) Make ˊsome happy faces.

In fact, focused presuppositional/partitive and non-presuppositional/non-partitive 'some'-phrases generate partitive and non-partitive alternative sets, respectively – as was discussed in connection with the Hungarian examples in (7a), (7b), (8a–8b). The excluded alternative of the partitive-specific *some faces* in *Make ˊsome faces happy* is *all faces*, whereas the excluded alternative of the non-partitive *some happy faces* in *Make ˊsome happy faces* is the non-partitive *many happy faces* – in accordance with our claim that 'some' is semantically ambiguous.

The first experiments apparently did not attribute any significance to the presence or absence of a partitive 'of the' in the scalar expression. Foppolo et al. (2012), testing how five-year-old Italian children interpret sentences of the type *Some Smurfs went by boat*, carried out an experiment in two versions: first using the simple determiner *qualche* 'some', and then replacing it by the partitive *alcuni dei* 'some of'. They found that the use of the partitive form did not help children "to focus on a certain 'quantity' in relation to a given set"; on the contrary, children's rejection rate dropped from 42% to 38.5% (Foppolo et al. 2012: 371).

The experiments surveyed tested children of various age groups, including children as young as 2;6–3;5 (Huang et al. 2013) and children as old as 10–11 (Noveck 2001). It has been found that children's achievement improves with age, but the improvement is not gradual. Foppolo et al. (2012) tested the interpretation of sentences like *Some smurfs went by boat* embedded in a story satisfying the condition of plausible dissent, discussing the possibility of some of the Smurfs taking a boat, others taking a car, or all of them taking a boat. They found that 4–5-year-old children are bimodally distributed; the turning point in the interpretation of 'some' is at the age of 6, after which children soon attain adult-like performance. The turning point obviously depends on the conditions discussed above; e.g. in Noveck's experiment testing the interpretation of the French *certains* in out-of-the-blue sentences, the achievements of 7–8-year-old and 10–11-year-old children are equally far from the achievement of adults (89% and 85% acceptance rates of underinformative 'some' as opposed to the 41% acceptance rate of adults).

In sum: the experiments have found that children's interpretation of 'some' ('some and possibly all') is different from the adult interpretation ('some but not all'). The prevailing explanations derive children's difficulties with 'some' from their pragmatic immaturity, i.e., from their unawareness that a scalar term is inferred to represent the strongest scalar value which can be truthfully used in the given situation. The children, however, had considerably more problems with the scale involving 'some' and 'all' than with scales of other types, among them scales of cardinal numbers, which suggests that a factor other than their inability to compute scalar implicatures is involved. An experiment by Miller et al. (2005) has shown that the structural position of the *some*-phrase affects children's interpretation, but no conclusion has been drawn from this observation. The ambiguity of *some* NPs, with the 'a few' and 'not all' readings licensed in different contexts, has not been considered. The *some*-phrases of the test sentences all occurred in contexts associated with a partitive-specific interpretation; the 'a few' reading of *some* did not emerge. This lead us to the assumption that children's non-adult-like responses may arise from the the fact that they learn the cognitively simpler 'a few' reading first, which they overgeneralize for a while, not being aware of the structural, prosodic, and/or lexical factors eliciting the specific interpretation.

4 Experiments

The theoretical considerations discussed in §2 and the questions raised by the experiments surveyed in §3 prompted us to formulate the hypothesis that young children react to stimuli involving a *some*-phrase in a non-adult-like manner because *some* means for them 'a few'. For adults, *some*, and its Hungarian equivalent *néhány* are ambiguous between the non-partitive 'a few' reading and the partitive-specific 'not all' reading, but the interaction of the structural position, the prosody, the internal structure of the 'some'-phrase, and the selectional properties of the predicate usually support one of the readings and block the other one. For young children, however, the cognitively simpler non-partitive reading may be more easily accessible in all conditions than the partitive reading requiring the identification of two discourse referents (the set denoted by the quantified phrase, and a superset). Below we give an account of two experiments testing this hypothesis. Experiment 1, a forced choice task, tested whether children associate the meaning ‘not all of the NPs’ or the meaning ‘a few NPs’ with a topicalized, hence partitive-specific *néhány* NP. If children most often select the picture where the *néhány* phrase denotes all the members of a small set, this would be evidence that for the majority of them, the default meaning of *néhány* is the non-partitive meaning ‘a few’, i.e., the children are not sensitive to the specificity feature associated with topics in adult language.

4.1 Experiment 1: A forced choice task

4.1.1 Participants

Children of three age groups participated in the experiments: 24 children from the ‘big kids group’ of a Budapest kindergarten (mean age 6;1, age range 66–84 months), as well as 20 first graders (mean age 7;6, age range: 82–96 months), and 20 third graders (mean age 9;6, age range: 112–121 months) of a Budapest primary school. (The tests were carried out shortly before the end of the school year, which is why children may seem older for their grade than expected.) We also tested 16 adults.

4.1.2 Materials and methods

The children were shown 11 pairs of pictures, each pair accompanied by a sentence. They had to decide which of the two pictures the sentence described. Six picture-sentence combinations were test stimuli; the rest of them were fillers. The test cases involved Hungarian sentences with a *néhány* ‘some’ NP in topic position, where it is expected to give rise to a partitive reading (e.g., 23 and 24). The visual stimuli accompanying these sentences were pairs of pictures shown next to each other on a computer screen. One of the pictures represented the situation described by the sentence under the ‘a few’ interpretation of *néhány*; it showed 2–4 participants, and the property or activity described by the predicate was true for all of them (see Figures 4 and 5). The other picture represented the ‘not all’ reading of *néhány*; it showed a larger number of participants (5–10 participants, roughly 2.5 times as many as the picture representing the ‘a few’ reading – see Figures 2 and 3), and, crucially, the property or activity described by the predicate held only for a subset of them. The assumption that 2–4 participants in a picture occupying half of a laptop screen are regarded as few by children was based on a pilot study.

(23) Néhány tehén foltos.
some cow spotted
'Some cows are spotted.'

(24) Néhány gyerek biciklizik.
some kid bicycles
'Some kids are bicycling.'

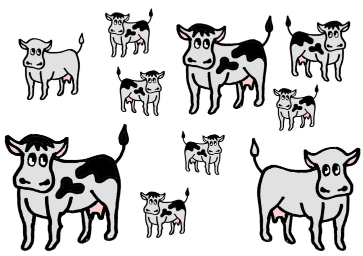

Figure 2: 'not all' reading of (23)

Figure 3: 'not all' reading of (24)

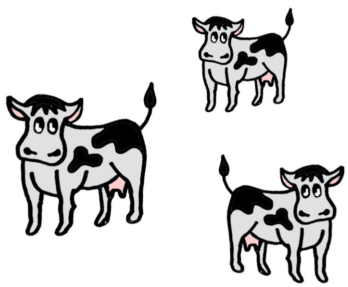

Figure 4: 'a few' reading of (23)

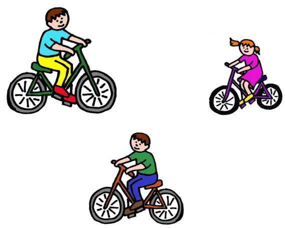

Figure 5: 'a few' reading of (24)

The filler stimuli involved quantifiers other than 'some', among them *minden* 'every', *csak négy* 'only four', *ötnél több* 'more than five'.

4.1.3 Procedure

The children were tested individually by the experimenter and a helper in a quiet room at their school. The pairs of pictures appeared on a computer screen, and they were accompanied by a sentence allegedly uttered by a puppet, recorded in advance. The child had to tell which of the two pictures the puppet was talking about. The child's answers were recorded both on paper, and by a video camera.

4.1.4 Results

Responses were encoded as binary data, 1 for 'a few', 0 for the 'not all' interpretation of *néhány*. The mean responses of the age groups are shown in Figure 6.

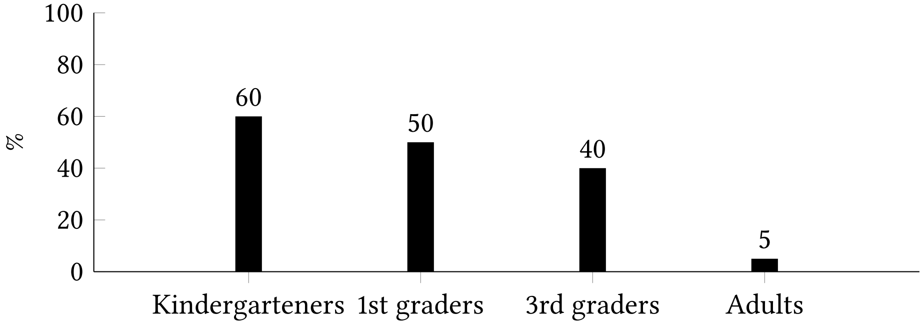

Figure 6: The proportion of 'a few' choices in Experiment 1

Binomial generalised mixed-effect models with random intercepts were run, with response as the dependent variable, group as the fixed effect, and participant and item as random effects. Calculations were carried out in R (R Core Team 2020), using `glmer()` from the lme4 package (Bates et al. 2015) and `Anova()` from the car package (Fox & Weisberg 2018) for the calculation of simulated p-values.

The effect of the group was highly significant ($\chi^2(3) = 25.356, p < 0.001$). Pairwise comparisons of the age groups revealed that the response patterns of adults differed significantly from those of kindergarteners ($z = 4.949$, $p < 0.001$), 1st graders ($z = 4.211$, $p < 0.001$), and 3rd graders ($z = 3.579$, $p < 0.001$), whereas that there was no significant difference among the performance of the three groups of children (all three $z > -1.897$, $p > 0.058$).

4.1.5 Discussion

Our experiment aimed to test how young children interpret *néhány* 'some' NPs. Our hypothesis is that *some*, and its Hungarian equivalent *néhány* have a partitive and a non-partitive reading. For adults, the interaction of the structural position, the prosody, the internal structure of the 'some'-phrase, and the selectional properties of the predicate usually support one of the readings and blocks the other one. For young children, however, the cognitively simpler non-partitive reading may be more easily accessible in all conditions than the partitive reading requiring the identification of two discourse referents (the set denoted by the quantified phrase, and a superset). Our experiment tested this hypothesis by a forced choice test, where subjects listened to sentences involving a topicalized, hence partitive, *néhány* 'some' phrase, and they were offered both the 'not all' and the 'a few' readings. The results confirmed that for adults, *néhány* occurring in a topicalized phrase clearly means 'not all'. For six-year-olds, on the contrary, the ‘a few’ reading is primary; it was chosen significantly more times than the ‘not all’ interpretation.

Although the mean results of all three age groups were relatively close to 50%, the great majority of children were apparently not guessing but followed clear strategies. The proportion of those giving very consistent answers, choosing the same type of interpretation in 5 or 6 cases out of 6 was 83% among the kindergarteners, 75% among the first graders, and 65% among the 3rd graders. The proportion of the children consistently opting for the ‘a few’ interpretation, and the proportion of those consistently choosing the ‘not all’ reading changed from age group to age group as shown in Table 1.

Table 1: Proportions of children giving consistent answers (5 or 6 identical choices out of 6)

	Kindergarteners	1st graders	3rd graders	Adults
‘a few’	54%	35%	25%	0%
‘not all’	29%	40%	40%	88%

In the older groups of children, both the proportion of the inconsistent answers and the proportion of consistent ‘not all’ choices was higher, which supports the hypothesis that the ‘a few’ reading appears first, and the partitive ‘not all’ reading emerges – and the ambiguity of *néhány* solidifies – with some delay.

The fact that children show a clear preference for the ‘a few’ interpretation around the age of six and for the ‘not all’ interpretation around the age of nine provides evidence against the view that their choices are based on the reading ‘some and possibly all’, the so-called logical meaning of *néhány/some*. This meaning is compatible with both members of the picture pairs, hence if the children had relied on the meaning ‘some and possibly all’, their choices would have been random.

The relevant distinction that children become sensitive to around the age of nine is the [±partitive] feature attributable to ‘some’. It is the recognition of the [+partitive] feature of topics that opens the way to realizing that ‘some’ and ‘all’ are scale members, and the use of ‘some’ implicates the falsehood of ‘all’.

4.2 Experiment 2: A truth value judgement task

Experiment 1 served to identify children’s default interpretation of topicalized *néhány* phrases; however, it left open the question whether the reading chosen by the children is the only accessible reading or the preferred reading for them. So as to answer this question, we carried out a second experiment. Experiment 2 also aimed to clarify whether children's interpretation of a *néhány* phrase is affected by its structural position and prosody, more precisely, by the [±partitive] feature associated with that position and stress pattern.

4.2.1 Participants

The children participating in Experiment 2 were the same as those participating in Experiment 1. We also tested an adult control group of 16 adults.

4.2.2 Materials and methods

The children had to judge the truth value of 23 sentence–picture pairs, 12 test cases and 11 fillers. The test sentences involved a *néhány* phrase in 2×2 conditions. The factors the effect of which we tested were (i) topic position (in SpecTopP, preceding the pitch accent), associated with a [+partitive] feature, versus non-topic position (in SpecPredP, bearing a pitch accent), associated with a [−partitive] feature in adult Hungarian, and (ii) 'a few' versus 'not all' reading shown in the visual stimulus. These factors yielded the following four conditions (C1–C4):

C1: [+topic] *néhány* NP, 'not all' reading, e.g.:

(25) [$_{\text{TopP}}$ Néhány szamár [$_{\text{PredP}}$ szürke.]]
some donkey grey
'Some donkeys are grey.'

C2: [+topic] *néhány* NP, 'a few' reading, e.g.:

(26) [$_{\text{TopP}}$ Néhány ceruza [$_{\text{PredP}}$ ki van hegyezve.]]
some pencil out is sharpened
'Some pencils have been sharpened.'

C3: [−topic] *néhány* NP, 'a few' reading, e.g.:

(27) [$_{\text{PredP}}$ Néhány barack nő az ág-on.]
some apricot grows the branch-on
'Some apricots are growing on the branch.'

C4: [−topic] *néhány* NP, 'not all' reading, e.g.:

(28) [$_{\text{PredP}}$ Néhány alma van a kosár-ban.]
some apple is the basket-in
'There are some apples in the basket.'

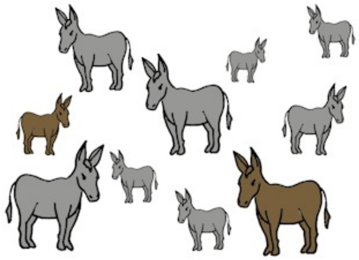

Figure 7: Picture accompanying (25)

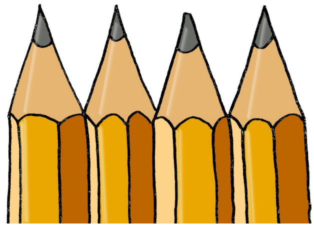

Figure 8: Picture accompanying (26)

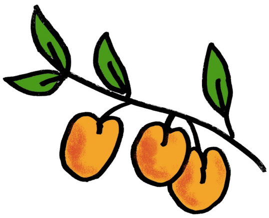

Figure 9: Picture accompanying (27)

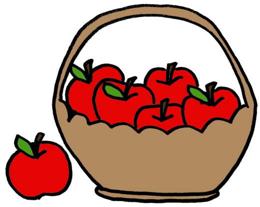

Figure 10: Picture accompanying (28)

Each condition was represented by 3 examples. The fillers were sentence involving quantifiers such as *minden* 'every', *legtöbb* 'most', *legalább három* 'at least three', *csak négy* 'only four', etc.

4.2.3 Procedure

Experiment 2 was carried out in the same session as Experiment 1. The pictures were presented to each child on a computer screen one by one, together with the corresponding sentence allegedly uttered by a puppet, recorded in advance. The child was told that the puppet explaining what she saw in each picture did not have her glasses on, hence she did not always see the picture properly. The child had to judge whether the puppet said correctly what the picture showed. The child's answers were recorded both on paper, and by video camera.

4.2.4 Results

The sentences were found to be true in the great majority of cases in all conditions. The proportions of yes answers in the four conditions are shown in Table 2.

Table 2: Acceptance rates of sentences with a *néhány* phrase in the four conditions

	C1:[+topic] 'not all'	C2:[+topic] 'a few'	C3:[−topic] 'a few'	C4:[−topic] 'not all'
Kindergarteners	78%	82%	83%	65%
1st graders	80%	70%	82%	77%
3rd graders	80%	62%	77%	77%
All children	79%	71%	81%	73%
Adults	69%	49%	98%	55%

Responses were encoded as binary data, 1 for 'true', 0 for 'false'. Binomial generalised mixed-effect models with random intercepts were run, with response as the dependent variable, the interaction of structural position ([+topic] versus [−topic]) and picture type ('a few' versus 'not all'), as well as group as fixed effects, with participant and item as random effects. Calculations were carried out in R (R Core Team 2020), using `glmer()` from the lme4 package (Bates et al. 2015) and `Anova()` from the car package (Fox & Weisberg 2018) for the calculation of simulated p-values.

While age group did not have a significant effect on the response patterns (all three $z > 1.350, p > 0.126$), the effects of sentence type ($z = -2.821, p = 0.005$), picture type ($z = -2.528, p = 0.011$) and the interaction of sentence type and picture type ($z = 2.710, p = 0.007$) were all significant. In the case of 'a few' pictures, the acceptance rate of sentences with a topicalized *néhány* phrase was lower, while that of sentences with a non-topical *néhány* phrase was exceptionally high. When 'not all' pictures were evaluated, the difference between the two sentence types was considerably smaller, but in this case, it was the sentence type with a topicalized *néhány* phrase that was accepted more frequently.

4.2.5 Discussion

Among the adults, the acceptance of non-topic *néhány* phrases under the 'a few' interpretation was practically unanimous. The acceptance of topicalized, hence partitive, *néhány* phrases under the 'not all' reading, however, was merely 69%, lower than expected. Those rejecting some of the sentence-picture combinations, e.g. that in (25), explained that for them, the topicalized *néhány* means 'a relatively small subset of', i.e., it has both the 'not all' and 'a few' meaning components. Example (25) would be true of Figure 7 if the subset of grey donkeys were smaller than the subset of brown donkeys. The acceptance of topicalized *néhány* phrases coupled with a visual representation corresponding to the 'a few' interpretation, as well as the acceptance of non-topic *néhány* phrases coupled with a visual representation corresponding to the 'not all' reading was stimulus dependent to a large extent; apparently, it depended on whether or not the participant could coerce the reading determined by the structural position of the *néhány* NP. For example, the topicalized *néhány ceruza* 'some pencils' in (26) coupled with a picture showing a few pencils (Figure 8) was accepted by fewer participants than example (29) coupled with Figure 11.

(29) [$_{\text{TopP}}$ Néhány gyerek [$_{\text{PredP}}$ tanul.]]
some child studies
'Some children are studying.'

Figure 11: Picture accompanying (29)

The adults accepting this sentence–picture combination explained that they can assume these children to represent the subset of a class where the rest of the children are not studying – i.e., they can coerce a partitive reading. In the case of a set of sharpened pencils it is harder to imagine the presence of a superset that is out of view.

Similarly, the non-topic *néhány* phrase in (28) under the 'not all' reading in Figure 10 was accepted by more adults than sentence (30) coupled with Figure 12 presumably because the apple near the basket can be considered to be outside the relevant domain of quantification more easily than the non-red pencils in the mug.[4]

[4]É. Kiss & Zétényi (2018) present experimental evidence demonstrating the interaction of the

(30) [$_{\text{PredP}}$ Néhány piros ceruza van a bögré-ben.]
some red pencil is the mug-in
'There are some red pencils in the mug.'

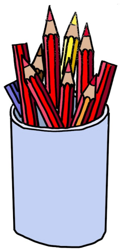

Figure 12: Picture accompanying (30)

The children, too, found non-topic *néhány* phrases under the 'a few' interpretation (C3) and topicalized *néhány* phrases under the 'not all' reading (C1) the most acceptable. Crucially, however, they also accepted both 71% of the topicalized *néhány* NPs with the 'a few' reading, and 73% of the non-topic *néhány* NPs with a 'not all' reading, and these acceptance rates are significantly different from the 49–55% acceptance rates of the adults. Whereas adults assign the 'a few' reading to non-topic *néhány* phrases, and tend to assign the 'not all' interpretation to topicalized *néhány* phrases, for kindergarteners and 1st graders, there is no significant difference between the acceptability of *néhány* phrases in the four conditions. We attested a significantly higher acceptance of the 'a few' reading in [−topic] contexts than in [+topic] contexts only among the 3rd graders. In the case of younger children, there is no significant correlation between the structural and prosodic conditions determining the partitivity feature of the *néhány* phrase and the interpretation they assign to it.

5 Conclusion

A series of previous experiments (e.g. Noveck 2001, Papafragou & Musolino 2003, Miller et al. 2005, Papafragou & Skordos 2016, Pouscoulous et al. 2007) found that children tend to accept sentences with a topical subject represented by a *some* NP (or its Greek, French etc. equivalent), e.g., *Some (of the) donkeys are grey*, in situations where the predicate holds of all the subject referents, i.e., where all the

visual representation of the domain of quantification and children's ability to carry out scalar implicature.

donkeys are grey. Our experiments carried out with Hungarian children have yielded similar results. Adults are believed to interpret such sentences based on Grice's Maxim of Quantity, assuming that the speaker has been as informative as possible. A situation where all the donkeys are grey could have been truthfully described by the sentence *All (of the) donkeys are grey*, hence the speaker's use of *some* indicates that s/he had reasons not to use a stronger term, e.g. *all*. Therefore, *Some (of the) donkeys are grey* gives rise to the scalar implicature that not all donkeys are grey. Children's failure to carry out such implicatures was initially attributed to their pragmatic inexperience; it was claimed that for them, pragmatics does not overwrite logic (Noveck 2001). This explanation, however, cannot account for the fact that children have much less difficulty with scalar implicatures involving definite numbers (cf. e.g., Papafragou & Musolino 2003, É. Kiss & Zétényi 2018). In Experiment 1 of Papafragou & Musolino (2003), children's success rate with a scalar implicature involving the numbers *two* and *three* was 65%, whereas their success rate with a scalar implicature involving *some* and *all* was merely 12.5%. In their Experiment 2, which involved some training and some contextual manipulations, the success rate of scalar implicatures rose to 90% in the case of *two* and *three*; however, it rose only to 52.5% in the case of *some* and *all*. These facts indicate that the particular way children relate *some* and *all* also involves a factor other than their ability to derive scalar implicatures.

The alternatives-based theory of Barner et al. (2011) claims that children's difficulties with scalar implicature in the case of specific scales are due to a failure to generate relevant alternatives for the given scale. Thus, although children may know already at the age of two that *some* and *all* denote different set relations, they do not know that they are members of the same scale. The hypothesis we tested shares an element of this claim: in our view, children do not realize that *some* and *all* are scale mates because they identify *some* with its non-partitive variant, which forms a scale with the non-partitive *many*.

The starting point of our explanation of children's interpretation of 'some' was that 'some' is inherently ambiguous; it has a [+partitive] meaning corresponding to 'not all', and a [−partitive] meaning corresponding to 'a few'. For adults, the structural position, the prosody, the internal structure of the 'some'-phrase, and/or the selectional properties of the predicate determine the partitivity of the 'some'-phrase in most cases; for instance, the subject-topic 'some'-phrases of the test sentences of former experiments are clearly [+partitive]. Young children, however, are not sensitive to the partitivity feature arising in various contexts, or they are not aware of its significance in the interpretation of 'some'. Children presumably acquire the easier, non-partitive reading first, and tend to overgeneralize it for a while. For English adults, the genitive construction in cases like *some* *of the donkeys are grey* would strongly suggest that the grey donkeys represent a proper subset of a relevant set of donkeys. However, *all of the donkeys* means the same as *all donkeys*, *each of the donkeys* means the same as *each donkey*, *which of the donkeys* means the same as *which donkey*, so it may not be obvious for children that the interpretation of *some of the donkeys* may be different from the interpretation of *some donkeys*.

We tested these assumptions with two experiments. The first experiment, a forced choice sentence-picture matching task, showed that six-year old Hungarian children significantly more often assign the 'a few' reading than the 'not all' reading to topicalized *néhány* NPs. Furthermore, the proportion of children who consistently (5 or 6 times out of 6) select the 'a few' reading is 54% among the six-year-olds, and is still 35% among the seven-and-half-year-olds, and 25% among the nine-and-half-year-olds. These results are in accord with the assumption that the reading that is first associated with 'some' by young children and which remains the default reading for them for some time is the non-partitive 'a few' interpretation.

The second experiment, a truth value judgement task aimed to clarify whether the 'a few' reading of *néhány* is the only reading for the majority of children, or it is merely its primary interpretation. We tested whether children can access both readings of *néhány*, and whether they are aware of the correlation between the structural position and prosody, and the interpretation of the *néhány* NP. It has turned out that children also accept the 'not all' interpretation of 'some', and the acceptance rate of both the 'a few' and the 'not all' readings is roughly the same irrespective of the partitivity feature of the 'some' NP in the given context. The acceptance of the 'not all' interpretation is not significantly higher in the case of topicalized *néhány* phrases than in the case of non-topic *néhány* phrases.

The two findings: children's initial bias towards the 'a few' interpretation of 'some', and their insensitivity to the partitivity feature of the 'some' NP can explain children's non-adult-like behaviour with respect to 'some' NPs. They accept the sentence 'Some (of) the donkeys are grey' in a situation where all of the donkeys are grey because 'some' means for them 'a relatively small number', or 'a non-empty set', i.e., they interpret the sentence as 'a relatively small number of donkeys are grey'. They realize that 'some' and 'all' can be scale members, and the use of 'some' can implicate the infelicity of 'all' only when, around the age of nine, they become aware of the partitivity of 'some'-phrases in topic position and in some other specific contexts.

Abbreviations

1	first person	PAST	past tense
3	third person	PRT	particle
ACC	accusative	SG	singular

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Chapter 19

Two kinds of 'much' in Greek

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The English element *much* has an NPI use (see Bolinger 1972, Israel 1996, Solt 2015). In Greek, the degree modifier *poly-* 'much' displays a polarity-sensitive distribution as well. Unlike its free counterpart *poly* 'a lot/much', the bound morpheme *poly-* 'much' functions as an NPI occurring only in antiveridical environments. The main research question that this study addresses is why the bound morpheme *poly-* 'much', but not its independent form *poly* 'a lot/much', is an NPI. In other words, why does *poly-* appear only in negative sentences, as opposed to *poly*, which appears both in negative and affirmative contexts? In my paper, I present a syntactic analysis for the licensing of the degree modifier *poly-* 'much' as an NPI. Following Giannakidou (1997, 2007) and Zeijlstra (2004, 2008), I argue that its polarity licensing happens syntactically as an Agree relation between its formal uninterpretable [uNeg] feature and the interpretable [Neg] feature of the antiveridical operator. I also posit that the two kinds of 'much' in Greek, i.e., the free *poly* and the bound *poly-*, are generated in different positions in the syntactic structure.

Keywords: negative polarity items, negation, much, nonveridicality, degree modifier, Greek

1 Introduction

Negative polarity items (NPIs) – a term attributed to Baker (1970) – are context-sensitive elements appearing in specific environments, like negation, but are excluded from the affirmative ones. Though Buyssens (1959) first lists items sensitive to negation, the scientific research on NPIs began with the works by Klima (1964), Horn (1972), Fauconnier (1975a,b), and Ladusaw (1979).

The element *much* is one of the classic NPIs in English:

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(1) a. Joanne did not read much last night.
b. * Joanne read much last night.

As the grammaticality of sentence (1a) shows, *much* appears under the scope of negation. However, affirmative environments, i.e., those lacking negation, affect the well-formedness of the sentence in (1b).

Its Greek counterpart, the free morpheme *poly* 'much/a lot' belongs to the category of adverbs of degree that show no restricted distribution, as seen in (2):

(2) a. I Ioanna dhen kimithike poly xthes vradi.
the Joanne not slept.3SG much last night
'Joanne didn't sleep much last night.'
b. I Ioanna kimithike poly xthes vradi.
the Joanne slept.3SG a.lot last night
'Joanne slept a lot last night.'

Regarding the degree of Joanne's sleeping, what the speaker implies by uttering (2a) is that she slept sufficiently, but not a lot, as she did in (2b). In other words, the degree of Joanne's sleeping in (2a) is less than a lot.

Like the free *poly* 'a lot/much', its bound counterpart, the item *poly-* 'much', is also used as a degree modifier in Greek. However, its distribution is restricted only to negative contexts, as the ungrammaticality of the affirmative sentence in (3b) shows, proving that *poly* is an NPI.

(3) a. I Ioanna dhen poly-kimithike xthes vradi.
the Joanne not much-slept.3SG last night
'Joanne didn't sleep much last night.'
b. * I Ioanna poly-kimithike xthes vradi.
the Joanne much-slept.3SG last night
Intended: 'Joanne slept a lot last night.'

By uttering (3a), what the speaker conveys is that Joanne slept only a little, contrary to (2a), where in that case Joanne slept sufficiently, but not a lot.

The fact that the morphologically constructed modification of verbs with the bound element *poly-* is licit only under the scope of negation has drawn some attention in the Greek literature (Delveroudi & Vassilaki 1999, Efthimiou & Gavriilidou 2003, Ralli 2004, Dimela & Melissaropoulou 2009). Focusing on the phonological, semantic and structural properties of the element, it has been pointed out that this bound element combines only with verbal bases in negative sentences to form compounds. Here, I will go one step further arguing that the bound degree modifier *poly-* 'much' is a strong NPI only being licensed by the antiveridical negation and *without*-clauses, as opposed to its free counterpart *poly* 'a lot/much'.

This study addresses two main research questions: (i) Why is the bound *poly-* 'much', but not its free form *poly* 'a lot/ much', an NPI? In other words, why does *poly-* appear only in negative sentences, as opposed to *poly*, which appears both in negative and affirmative environments? (ii) Why is the meaning of the bound *poly-* different from that of the free *poly*? In other words, why does *poly-* mean 'a little' but not 'sufficiently', as the free morpheme does?

The research is based on the (non)veridicality theory of polarity (Giannakidou 1997, 1998, 2001 et seq.), which accounts for elements exhibiting restrictions on their licensing environments, as the English *anyone* and the Greek *kanénas*, and places no categorial restrictions on the items showing NPI behavior.

The paper is organized as follows. In §2, I discuss briefly the (non)veridicality theory of polarity, the distinction between strong and weak NPIs (§2.1), and show that, based on this theory, the bound degree modifier *poly-* 'much' is a strong NPI (§2.2). In §3, I show that the bound *poly-* is licensed only locally in the domain of sentential negation (super strong licensing) (§3.1), and I claim that its licensing is accomplished syntactically due to the uninterpretable [uNeg] feature of *poly-* (§3.2). In §4, I answer the question how the meaning of *poly-* differs from the meaning of *poly* by giving the semantics of each element. §5 concludes.

2 Nonveridicality, NPIs, and the Greek *poly-*

2.1 The framework

The framework followed in the current research is the (NON)VERIDICALITY THEORY OF POLARITY (Giannakidou 1994, 1997, 2001 et seq.), which captures (i) the environments in which NPIs appear and (ii) the distinction between different kinds of NPIs. For years, it was difficult to identify the properties of NPIs and explain their polarity sensitive behavior. Under the (non)veridicality theory of polarity, which was motivated by the distribution of the NPIs *kanénas* 'anyone, anybody' (non-emphatic)/*KANENAS* 'no one, nobody' (emphatic) in Modern Greek and is supported crosslinguistically, Giannakidou provides a semantic account for the distribution of NPIs, i.e., for all the environments under which the property of (non)veridicality is applied.[1] (NON)VERIDICALITY is a semantic property under

[1]For a discussion on emphatic/non-emphatic *kanénas*, see Giannakidou (1997, 1998, 2000).

which the truth of a proposition p embedded under an operator F is entailed or presupposed:

(4) *Veridicality and nonveridicality* (Giannakidou 2002: 33)
   a. A propositional operator F is *veridical* iff Fp entails p: $Fp \rightarrow p$; otherwise, F is *nonveridical*.
   b. A nonveridical operator F is *antiveridical* iff Fp entails not p: $Fp \rightarrow \neg p$.

She also defines NPIs as linguistic expressions sensitive to (non)veridicality, that is, being licensed in non-veridical contexts:

(5) *Polarity item* (Giannakidou 2001: 669)
   A linguistic expression α is a polarity item iff:
   a. The distribution of α is limited by sensitivity to some semantic property β of the context of appearance, and
   b. β is non-veridical, or a subproperty thereof: $\beta \in$ {veridicality, nonveridicality, antiveridicality, modality, intensionality, extensionality, episodicity, downward entailingness}.

Under this definition, NPIs are taken to be elements that appear in non-veridical contexts and are excluded from affirmative environments. They can be divided into two classes: strong NPIs and weak NPIs. *Strong* NPIs are elements showing restricted distribution, being licensed only in antiveridical contexts, such as that of negation and *without*-clauses, and are excluded from non-veridical environments:

(6) *Strong NPI*
   An NPI is a strong NPI iff it appears only in antiveridical environments.

On the other hand, *weak* NPIs are elements that occur in non-veridical contexts, namely questions, conditionals, modal verbs, imperatives, generics, habituals, and disjunctions, in addition to antiveridical ones:

(7) *Weak NPI*
   An NPI is a weak NPI iff it can appear in nonveridical environments.

In Greek, the distinction between weak and strong NPIs is captured by non-emphatic NPIs, on the one hand, and emphatic NPIs and minimizers, on the other (Giannakidou 1997, 1998).[2] Non-emphatic NPIs are the unaccented *n*-words (e.g., *kanenas* 'anyone, anybody'), whereas the emphatic ones are the accented *n*-words (e.g., *KANENAS* 'no one, nobody').[3]

2.2 *Poly-* as a strong NPI

Given that the bound degree modifier *poly-* cannot appear in affirmative contexts, unlike its free counterpart *poly*, a question that arises now is what kind of NPI it is. I argue that, according to the (non)veridicality theory of polarity, *poly-* is a strong NPI exhibiting a restricted distribution: it appears with the antiveridical licensers of negation, *xoris* 'without' and *prin* 'before', but not with non-veridical licensers, namely imperatives, modal verbs, conditionals, questions, generics, habituals, and disjunctions.

2.2.1 Negation

Like all NPIs, *poly-* occurs with sentential negation marked by negative operators, like *dhen*, as in (8a), and is excluded from affirmative contexts, as in (8b) (repeated from 3):

(8) a. I Ioanna dhen poly-kimithike xthes vradi.
the Joanne not much-slept.3SG last night
'Joanne didn't sleep much last night.'

b. * I Ioanna poly-kimithike xthes vradi.
the Joanne much-slept.3SG last night
Intended: 'Joanne slept a lot last night.'

2.2.2 'Without'-clauses

Poly- also appears in *xoris* 'without'-clauses:

(9) I Ioanna egrapse dhiagonisma xoris na poly-diavasi.
the Joanne wrote.3SG exam without SBJV much-study.3SG
'Joanne took an exam without studying much.'

[2] As Giannakidou (1997, 1998) indicates, Greek minimizers differ from English ones (e.g., *drink a drop, sleep a wink*). Unlike the former, the latter exhibit wider distribution, appearing also in nonveridical contexts, such as questions and conditionals, among others.

[3] Veloudis (1983/1984) is the first one to note the emphatic accent of *n*-words in Greek.

2.2.3 'Before'-clauses

In addition, *poly-* occurs with the antiveridical *prin* 'before':[4]

(10) I Ioanna kimithike prin na poly-diavasi.
the Joanne slept.3SG before SBJV much-studied.3SG
'Joanne slept before studying much'

2.2.4 Imperatives

On the contrary, and like many strong NPIs, *poly-* does not appear in imperatives:

(11) * Poly-dhiavase ghia to diagonisma!
much-study.2SG.IMP for the exam
Intended: 'Study much for the exam!'

2.2.5 Modal verbs

Sentences with *poly-* under the scope of modal verbs are ill-formed:

(12) * I Ioanna bori na poly-diavasi.
the Joanne may SBJV much-study
Intended: 'Joanne may study much.'

2.2.6 Conditionals

Like other strong NPIs, *poly-* does not allow well-formed sentences when occurring in the antecedent of conditionals:

(13) * An I Ioanna poly-diavasi, tha pari A.
if the Joanne much-study.3SG will get A
Intended: 'If Joanne studies much, she will get an A.'

2.2.7 Questions

In *yes-no* questions, the bound *poly-* does not allow well-formed sentences:

(14) * Poly-dhiavase i Ioanna?
much-studied.3SG the Joanne
Intended: 'Did Joanne study much?'

[4]Giannakidou (1997, 1998) argues that *prin* 'before' is context-sensitive and can be analyzed as antiveridical with respect to its second argument (see Giannakidou 1998: 143).

2.2.8 Generics

Sentences with generics, which are about non-referential expressions, such as *kathe fititis* 'every student' in (15), cannot license the occurrence of *poly-*:

(15) * Kathe fititis poly-diavazi.
every student much-study.3SG
Intended: 'Every student studies much.'

2.2.9 Habituals

Habitual sentences with Q-adverbs of varying force (e.g., 'usually', 'often', 'rarely', 'sometimes', 'never') and *poly*-verbs are ill-formed:

(16) * I Ioanna sinithos poly-maghirevi.
the Joanne usually much-cook.3SG
Intended: 'Joanne usually cooks much.'

2.2.10 Disjunctions

The context of disjunctions, mainly in the sense of individual disjuncts taken separately, as in (17), comply with the bound degree modifier *poly-*:

(17) * I itan tixheros ke perase tin eksetasi i poly-dhiavase.
either was lucky and passed.3SG the exam or much-studied.3SG
'Either he was lucky and passed the exam or he studied much.'

Therefore, as its narrow distribution shows, *poly-* clearly belongs to the category of strong NPIs, only occurring under the scope of negation and the antiveridical *xoris* 'without' and *prin* 'before'.

3 The syntax of *poly* and *poly-*

3.1 Super strong licensing

Given that *poly-* 'much' is a strong NPI, a question that arises now, based on its restricted distribution, is whether it is licensed locally by negation (strong licensing) or it permits long-distance dependencies (weak licensing), in other words, whether *poly-* needs to be in a local relation with the negative operators or not. Giannakidou (1995, 1997, 1998) and Giannakidou & Quer (1995, 1997) associate strong NPIs with strong licensing: they cannot be licensed by the negation of the main clauses when appearing in subjunctive clauses embedded by *oti* 'that' and *pu* 'that', but they allow long-distance licensing when appearing in subjunctive clauses with *na*. Here, I argue that *poly-* is associated with super strong licensing, showing that it can only be licensed locally in the domain of sentential negation.

More specifically, *poly-* can only be licensed locally by the negative operator *dhen* when appearing in indicative embedded clauses with the complementizer *oti*, as (18) shows:

(18) a. Ipa oti dhen poly-dhiavases ghia tin eksetasi.
said.1SG that not much-studied.2SG for the exam
'I said that you didn't study much for the exam.'

b. * Dhen ipa oti poly-dhiavases ghia tin eksetasi.
not said.1SG that much-studied.2SG for the exam
'I didn't say that you studied much for the exam.'

Embedded clauses with the complementizer *pu* do not allow long-distance dependencies of *poly-* on the negative operator *dhen*:

(19) a. Mu ipe pu dhen poly-dhiavazis.
me told.1SG that not much-study.2SG
'He told me that you don't study much.'

b. * Dhen mu ipe pu poly-dhiavazis.
not me told.1SG that much-study.2SG
'He didn't tell me that you study much.'

Regarding subjunctive embedded domains with the complementizer *na*, where the negative operator *min* is used instead of *dhen*, Giannakidou (1997, 1998) shows that emphatics, which are strong NPIs, can be licensed even when the negative operator is in the main clause. However, unlike emphatics, *poly-* does not allow long-distance licensing when occurring in subjunctive clauses with *na*, as the ungrammaticality of (20b) shows:[5]

(20) a. Bori na min poly-dhiavases ghia tin eksetasi.
might SBJV not much-studied.2SG for the exam
'It may be the case that you didn't study much for the exam.'

[5] Giannakidou & Quer (1997) also point out cases of subjunctive embedded domains which are opaque, as in Catalan.

b. * Dhen bori na poly-dhiavases ghia tin eksetasi.
not might SBJV much-studied.2SG for the exam
‘It can’t be the case that you studied much for the exam.’

I conclude here that *poly-* is licensed only locally when occurring in *oti-* and *pu-* indicative and *na*-subjunctive embedded clauses, restricting its distribution to the boundaries of mono-clausal structures. On the other hand, given that its free counterpart, the degree modifier *poly* ‘a lot/much’, is not an NPI, it appears in *oti-* and *pu-* indicative and *na*-subjuctive embedded clauses, whether the negative operators *dhen* and *min* are in the main or embedded clause:

(21) a. Ipa oti dhen dhiavases poly ghia tin eksetasi.
said.1SG that not studied.2SG much for the exam.
‘I said that you didn’t study much for the exam.’

b. Dhen ipa oti dhiavases poly ghia tin eksetasi.
not said.1SG that studied.2SG much for the exam
‘I didn’t say that you studied much for the exam.’

(22) a. Mu ipe pu dhen dhiavazis poly.
me told.2SG that not study.2SG much
‘He told me that you don’t study much.’

b. Dhen mu ipe pu dhiavazis poly.
not me told.1SG that study.2SG much
‘He didn’t tell me that you study much.’

(23) a. Bori na min dhiavases poly ghia tin eksetasi.
might SBJV not studied.2SG much for the exam
‘It can be the case that you didn’t study much for the exam.’

b. Dhen bori na dhiavases poly ghia tin eksetasi.
not might SBJV much-studied.2SG for the exam
‘It can’t be the case that you studied much for the exam.’

3.2 *Poly* and *poly-* in structure

So far, I have shown that *poly-* ‘much’ is a strong NPI, being grammatical in a sentence where it is licensed by antiveridical operators, like negation and *without*-clauses. Moreover, its licensing by negative operators can only happen locally (super strong licensing). Here, I propose an analysis for its licensing which answers the first question set out above: although *poly-*, like all NPIs, is sensitive to its semantic environment, I argue that its licensing is accomplished syntactically.

Before I give the syntax of the bound *poly-* ‘much’, it is instructive to see the lexical features and the position of the free *poly* ‘a lot/much’ in syntactic structure, which is of the category of adverbs, as its lexical entry in (24) shows:

(24) *poly* $\begin{bmatrix} \textsc{cat} & : & [\text{Adv}] \\ \textsc{infl} & : & [-] \\ \textsc{sel} & : & [\langle - \rangle] \end{bmatrix}$

For a sentence with the free degree modifier *poly*, as in (25), I assume the syntactic derivation in Figure 1.

(25) O Petros dhen dhiavase poly.
the Peter not studied.3SG much
‘Peter didn’t study much.’

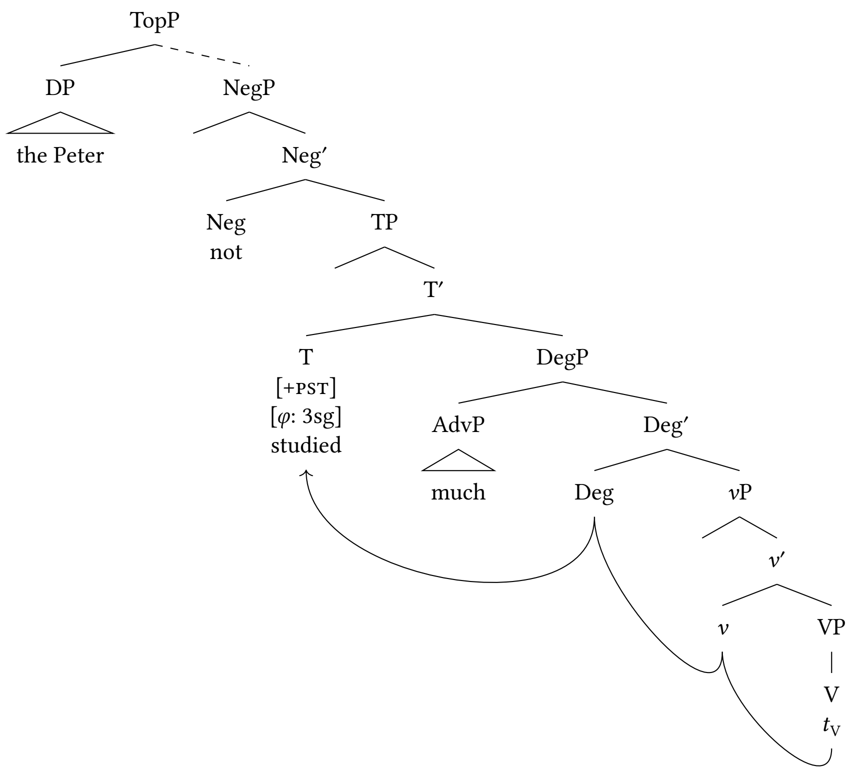

Figure 1: Syntactic representation of (25)

Following Cinque (1999), I argue that the free *poly* is generated in the specifier of the functional phrase Deg[ree]P, i.e., AdvP.[6] The negative operator *dhen* occupies the head of Neg[ation]P[7]. The verb moves, via Head Movement (Travis 1984), to *v* and then T to get subject-agreement and tense.[8] That *poly* sits in the specifier position of DegP comes from the fact that it is not incorporated with the verb, allowing the latter to move to T. Moreover, *poly* together with other elements, such as *para* ‘very’ in (26), form a complex head:

(26) O Petros dhen dhiavase para poly.
the Peter not studied.3sg very much
‘Peter didn’t study very much.’

On the other hand, as seen in §3.1, the bound degree modifier *poly-* ‘much’ needs to be licensed locally by antiveridical operators, such as negation. The licensing of *poly-*, like other Greek NPIs, is similar to the case of negative concord (NC). In NC languages, negation is expressed with more than one negative element in a clause (mainly, a negative marker and an *n*-word), although it is interpreted only once (Giannakidou 1997, 1998, 2002, Zeijlstra 2004, Giannakidou & Zeijlstra 2017). Working on the Greek NPI *oute* ‘even’, Giannakidou (2007) proposes that its licensing is related to the local relation it has with negation and the uninterpretable negative feature [uNeg] *oute* hosts. This feature, a characteristic it shares with other strong NPIs, needs to be checked by the interpretable [Neg] feature of sentential negation (Giannakidou 1997, 2007, Zeijlstra 2004). Following this account, I assume that *poly-* contains a formal uninterpretable feature [uNeg] that requires the presence of a matching categorial interpretable feature [Neg] in order for the sentence to be grammatical. This interpretable [Neg] feature is found in the negative operator *dhen* ‘not’, as the lexical entries of the elements show:

(27) $$\textit{dhen}\begin{bmatrix} \textsc{cat} & : & [\text{Neg [Neg]}] \\ \textsc{infl} & : & [-] \\ \textsc{sel} & : & [\langle \text{TP} \rangle] \end{bmatrix}$$

[6]The obligatory or optional presence of DegP in the clausal structure does not seem to have immediate consequences for the proposed analysis.

[7]In Greek, NegP is situated above TP (Agouraki 1991, Tsoulas 1993, Rivero 1994, Philippaki-Warburton 1994 among others).

[8]Following Spyropoulos & Revithiadou (2009), I assume that T is subject to fusion between T and Agr. I omit discussing other functional categories in the verbal projection, such as Voice and Aspect (see Merchant 2015 for relevant discussion). Moreover, the subject is in its surface position, i.e., in the specifier of Topic Phrase (TopP).

(28) $\textit{poly-}\begin{bmatrix} \textsc{cat} & : & [\text{Deg}] \\ \textsc{infl} & : & [\text{uNeg}] \\ \textsc{sel} & : & [\langle \nu\text{P} \rangle] \end{bmatrix}$

Unlike its free counterpart, the bound *poly-* belongs to the category of Deg. I argue that its licensing is accomplished syntactically via the operation of Agree (Chomsky 2000, 2001). The negative operator *dhen* ‘not’ with the interpretable [Neg] feature c-commands *poly-* with the uninterpretable [uNeg] feature. Given that, the [uNeg] feature is checked and eliminated by the [Neg] feature of *dhen*. Therefore, the agreement happens via c-command, as schematically illustrated in Figure 2.

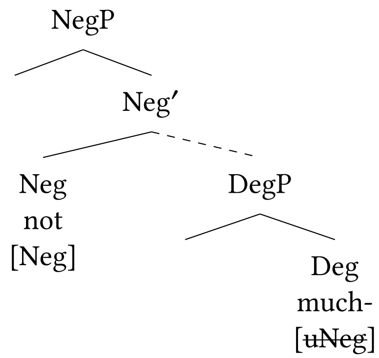

Figure 2: Licensing of *poly-*

As Figure 2 shows, *poly-* remains under the scope of negation. Its licensing happens in situ, thus no movement for checking is needed. Moreover, the fact that *poly-* with the uninterpretable [uNeg] feature is licensed by the interpretable [Neg] feature of negation can also explain the impossibility of *poly-* being licensed by non-veridical operators, such as questions and imperatives. Since non-veridical operators lack the [Neg] feature, the [uNeg] feature of *poly-* cannot be checked.[9]

Since *poly-* is also licensed by the antiveridical *xoris* ‘without’, I argue that the latter also has the interpretable [Neg] feature. However, the co-occurrence of the negative operator *dhen* and *xoris* ‘without’ in a sentence is impossible, showing

[9]The direction of probing in the assumed Agree operation is different from the one standardly assumed (cf. Chomsky 2000 et seq.): the element with the uninterpretable feature (probe), here *poly-*, is c-commanded by the element with the interpretable feature (goal), here *dhen* (see Zeijlstra 2004 et seq.).

that *poly-* with the uninterpretable [uNeg] feature needs the presence of only one element with an interpretable [Neg] feature in a sentence to be licensed:

(29) * I Ioanna dhen kimithike xoris na poly-fai.
the Joanne not slept.3SG without SBJV much-ate.3SG
Intended: ‘Joanne didn’t sleep without eating much.’

For a sentence with the bound *poly-*, as in (30), I propose the syntactic derivation in Figure 3.

(30) O Petros dhen poly-dhiavase.
the Peter not much-studied.3SG
‘Peter didn’t study much.’

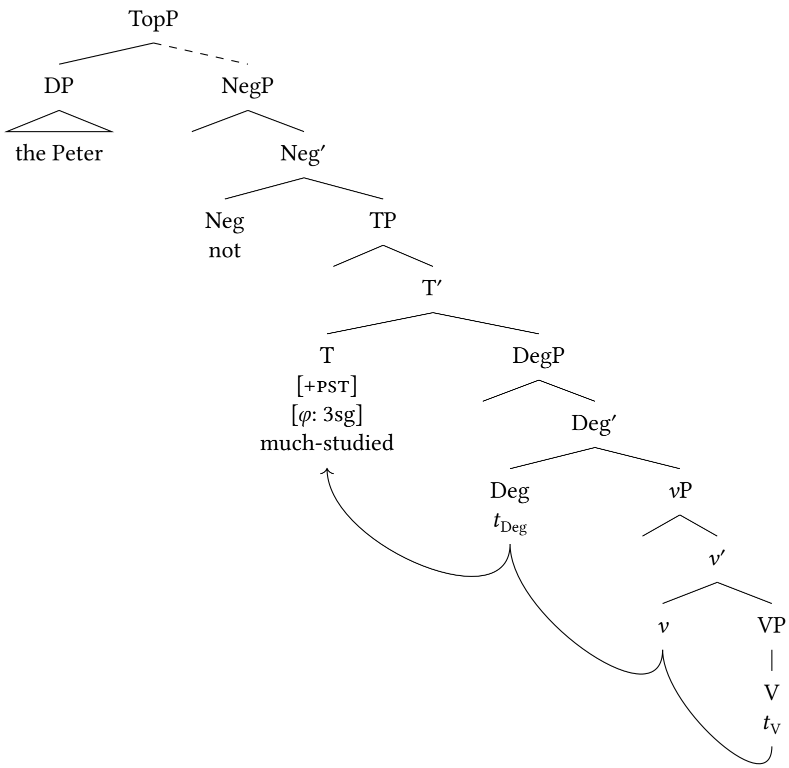

Figure 3: Syntactic representation of (30)

I argue that *poly-* is obligatorily generated in the head of the functional phrase DegP, unlike the free *poly*, which is generated in SpecDegP. Sitting in that position, *poly-* triggers the Head Movement of the verb to form a complex unit with it. I assume that the formation of the verbal complex happens as a subject of Head Movement (Travis 1984): the verb moves to the Deg-head, where the bound morpheme is generated, creating a complex unit. Later on, the complex head moves even higher, to T.[10]

So, how are *poly*-verbs formed? Rivero (1992) discusses this phenomenon of adverb-verb word formation in Modern Greek as a subject to Incorporation providing a syntactic account.[11] She proposes that adverbs functioning as complements, i.e., being internal to VP, can incorporate into the governing V-head considering this syntactic process an instance of Adverb Incorporation. However, treating adverbs that can be incorporated as VP-complements requires them to be obligatorily selected by the verb, which is not the case. If it was true that a verb subcategorizes for the adverb *poly-* as its complement, then we would expect *poly*-verbs not to take direct objects or sentences without the degree modifier *poly* to be ungrammatical. As seen in (31a), a verb like *thelo* 'want' also takes the DP *ti Maria* 'Mary' as its complement, whereas the absence of *poly* does not render the sentence in (31b) ungrammatical.

(31) a.

O	Yanis	dhen	theli	poly	ti	Maria.
the	John	not	wants	much	the	Mary

'John doesn't really want Mary.'

b.

O	Yanis	dhen	theli	ti	Maria.
the	John	not	wants	the	Mary

'John doesn't want Mary.'

Moreover, evidence that *poly*-verb formation does not derive from the unincorporated *poly* functioning as a complement to the verb comes from the fact that the formation of a *poly*-verb is ungrammatical in affirmative environments. more specifically, if we follow Rivero's account that the degree modifier *poly* 'much' incorporates into the verb *theli* 'wants' to form the complex unit *poly-theli*, then we expect to get the same results in positive sentences. However, this is not possible, as the ungrammaticality of (32b) shows:

[10] See Alexiadou & Anagnostopoulou (1998) and Merchant (2015) for V-to-T movement in Greek.

[11] A morphological analysis of the phenomenon of Incorporation in Modern Greek is proposed by Smirniotopoulos & Joseph (1998). See also Kakouriotis et al. (1997).

(32) a. O Yanis theli poly ti Maria.
the John wants much the Mary
'John really wants Mary.'

b. * O Yanis poly-theli ti Maria.
the John much-wants the Mary
Intended: 'John really wants Mary.'

Thus, this is evidence that the formation of *poly*-verbs is not a subject to Adverb Incorporation. In addition, this proves that the free degree modifier *poly* and the bound degree modifier *poly-* generate in different positions in the syntactic derivation and have different lexical entries, as discussed above, with the latter, but not the former, owning an inflectional uninterpretable [uNeg] feature.

4 The meaning of *poly* and *poly-*

In this section, I answer the second question my study addresses, i.e., why the meaning of the bound degree modifier *poly-* differs from that of the free degree modifier *poly*, arguing that this difference can be explained by the semantics of the morphemes themselves. In other words, since both kinds of 'much' in Greek are elements of category Deg but one of them projects fully to a DegP, whereas in the case of the other the projection stops at some lower level, this is related to the different meanings (values) such forms can be mapped to on a degree scale.

As I have already presented from the very beginning of this study, both Greek degree modifiers, the free *poly* and the bound *poly-*, occur under the scope of negation:

(33) a. O fititis dhen dhiavase poly.
the student not studied.3SG a.lot
'The student didn't study a lot.'

b. O fititis dhen poly-dhiavase.
the student not much-studied.3SG
'John doesn't really want Mary.'

However, its polarity-sensitive behavior identifies *poly-* as an NPI, something that also affects its meaning. To capture the difference, I assume the scale of degree for gradable predicates in (34):

(34) *Scale of degree*
⟨excessively, a lot, sufficiently, little, very little⟩

In the scale in question, the value SUFFICIENTLY is the threshold representing the value close to the norm. The scale of degree itself is sensitive to contextual factors, and the threshold SUFFICIENTLY, like all scalar predicates, does not have a fixed value, but rather it is context-sensitive (Kennedy 2007). By uttering (33a) with the free *poly* under the scope of negation, what the speaker means is that the student did not study a lot. Therefore, the degree of the student's studying is below the degree A LOT, close to the value SUFFICIENTLY. This means that the student studied sufficiently, but not a lot. On the other hand, by uttering the negative sentence in (33b) with the bound *poly-*, what the speaker actually means is that the student studied little or even less than little. Here it is not the case that the student studied much or sufficiently. Instead, the degree of the student's studying moves below the contextually dependent threshold, at the degree LITTLE, or even close to the lowest values on the scale.

In order to capture the difference in the meaning of the free *poly* and the bound *poly-*, I propose a semantic analysis under which there is a different denotation for each degree modifier. Starting with the free *poly* 'a lot/much', I provide the structure in Figure 4 as a simplified version of the sentence in (33a), where the subject is reconstructed to a lower position, i.e., below negation.

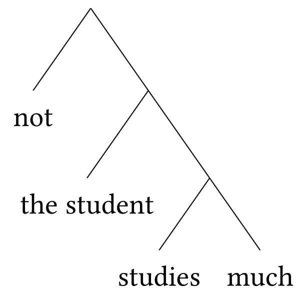

Figure 4: Simplified structure of sentence (33a)

I argue that the negative sentence in (33a) is true if and only if the degree of the student's studying is below the quantity of A LOT. Formally, the denotation for the free degree modifier *poly* is given in (35). The semantics is a construction that involves a degree. It corresponds to the well-known generalized quantifier-style denotation that can also capture the presence of individuals. The free *poly* is a relation that takes a scalar predicate P and an individual argument x and returns True if and only if there exists a degree d such that x P above the degree SUFFICIENTLY:

(35) $[\![\text{poly}]\!] = \lambda P \lambda x . \exists d[P(x)(d) \wedge (d > \textsc{sufficiently})]$

The analysis is built on the following denotations. In particular, the DP *o fititis* 'the student' denotes a unique student:[12]

(36) $[\![\text{o fititis}]\!] = \iota x[\textsc{student}(x)]$

The denotation I propose for intransitive verbs like *dhiavazo* 'study' is not the standard one. Here, intransitive verbs denote a function that takes an individual x and a degree d, which is assigned to the denotation of the free *poly*:

(37) $[\![\text{dhiavazi}]\!] = \lambda d \lambda x[\textsc{study}(x)(d)]$

(38) $[\![\text{dhiavazi poly}]\!] = \lambda x.\exists d[\textsc{study}(d)(x) \wedge (d > \textsc{sufficiently})]$

Finally, the standard denotation of the negative marker *dhen* 'not' is given in (39), where negation is a function that returns the opposite of the truth value of the proposition:

(39) $[\![\text{dhen}]\!] = \lambda p[\neg p]$

Given the denotations above, the compositional semantics of the sentence in (33a) with the free degree modifier *poly* is unremarkable and proceeds by function application and β-reduction as follows:

(40) $[\![\text{S}]\!] = \neg\exists d[\textsc{study}(\iota x[\textsc{student}(x)])(d) \wedge (d > \textsc{sufficiently})]$

The meaning of the negated sentence shows that the degree of the student's studying is not above the degree SUFFICIENTLY. Instead, it is equal to the degree SUFFICIENTLY or even below.

Moving to the bound *poly-*, I present in Figure 5 a simplified structure of the sentence in (33b), where the subject is reconstructed to a lower position, i.e., below the negative operator *dhen* 'not'.

The denotation I propose for the bound degree modifier *poly-* is given in (41). It is similar to that of the independent form, though the degree maps to a different part on the scale. In particular, *poly-* is a function that takes a scalar predicate P and an individual argument x and returns True iff there exists a degree d such that x P above the degree LITTLE.

(41) $[\![\text{poly-}]\!] = \lambda P \lambda x.\exists d[P(x)(d) \wedge (d > \textsc{little})]$

[12] The denotation for the DP *o fititis* is derived by the denotations of the definite determiner *o* and the noun *fititis* by function application and β-reduction:
(iii) $[\![\text{fititis}]\!] = \lambda x[\textsc{student}(x)]$
(iv) $[\![\text{o}]\!] = \lambda Q[\iota x[Q(x)]]$

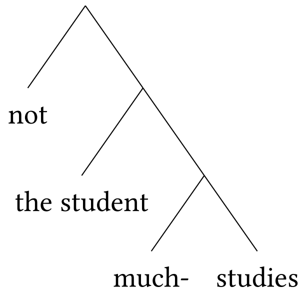

Figure 5: Simplified structure of sentence (33b)

The verbal complex *polydhiavazi* ‘much-studied’ has the following denotation:

(42) $[\![\text{polydhiavazi}]\!] = \lambda x.\exists d[\textsc{study}(d)(x) \wedge (d > \textsc{little})]$

Finally, given the denotation in (42), and assuming the same denotations for definite nouns in (36) and negation in (39), the compositional semantics of the sentence in (33b) proceeds by function application and β-reduction as follows:

(43) $[\![\text{S}]\!] = \neg\exists d[\textsc{study}(\iota x[\textsc{student}(x)])(d) \wedge (d > \textsc{little})]$

Given that the sentence combines with the negative operator, the direction of the degree of the bound modifier *poly-* changes and the degree maps to a value equal to A LITTLE on a scale like the one I provided in (34).

Therefore, my analysis derives the correct meaning for the Greek degree modifiers *poly* and *poly-*. The boundedness of the latter is captured not only syntactically, as seen in §3.2, but also semantically with the denotations I proposed.

5 Conclusion

In this paper I presented a syntactic analysis for the licensing of the Greek NPI *poly-* ‘much’, whereas the difference in meaning between the free degree modifier *poly* and the bound degree modifier *poly-* is captured semantically. My analysis made use of the (non)veridicality theory of polarity (Giannakidou 1994, 1997, 1998 et seq.). Based on that, I have shown that, while its free counterpart, the degree modifier *poly* ‘much/ a lot’, exhibits no restricted distribution, the bound element *poly-* ‘much’ shows polarity behavior belonging to the category of strong NPIs only being licensed by antiveridical operators.

To answer the question of its polarity-sensitive behavior, I argued that the bound *poly-* is associated with super strong licensing, i.e., it is licensed locally by an antiveridical operator. I claimed that its licensing is an Agree relation between its formal uninterpretable [uNeg] feature and the interpretable [Neg] feature of the antiveridical operator. In contrast, given that the free *poly* does not have a [uNeg] feature, it does not need to be licensed by negation, and thus, can appear in both negative and affirmative environments. Moreover, the syntactic analysis I proposed illustrates the operation of Head Movement that *poly-* needs to be attached to the verb stem. With respect to the second research question of this paper, i.e., the difference in meaning between *poly* and *poly-*, I provided distinct semantic denotations for each element indicating that the value of the NPI *poly-* is mapped to the lowest values on a degree scale.

Abbreviations

1/2/3	1st/2nd/3rd person	PST	past tense
CAT	category	SBJV	subjunctive
IMP	imperative	SEL	selection
INFL	inflection	SG	singular

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Chapter 20

Final words

Mojmír Dočekal & Marcin Wągiel
Masaryk University

In this monograph, we explored how the cognitive and grammatical modules of the human mind utilize number, numerals, and other categories related to the distinction between atoms and pluralities as conceptualized by humans and expressed in natural languages. All the chapters in this monograph belong in the formal part of linguistics despite them being based on different theoretical and methodological perspectives, and all of them bring new data and insights for the theories of plurality. Suppose we zoom out from the particular problems of current theories of plurality. In that case, we can schematically divide its agenda into two parts: nominal plurality and verbal plurality (sometimes called pluractionality). Both in the nominal and verbal domain, the interpretation of atomicity versus plurality is a topic of much discussion. This monograph provides new insights into both areas and linguistic territories related to the two central topics.

Even if formal linguistics uses tools of mathematics, logic and statistics, it is still an inductive enterprise, unlike logic or mathematics. And from this, it follows that our theories of plurality are only as good as the data upon which we built them. To slightly paraphrase the words of the statistician Michael J. Crawley: *All theories are wrong, but some are better than others*. In our case, after the basic building blocks of plurality theories were laid, a plethora of problems appear once we move beyond the set of English sentences or data patterns on which they were built. And we are finding ourselves exactly at this point: the torrent of new findings tells us that there is something wrong with our understanding of pluralities, and we must look for patches for and updates of our theories. The sources of new data are manifold: they come from understudied languages, cross-linguistic data patterns, experiments, big data (corpus) surveys, and many others.

Mojmír Dočekal & Marcin Wągiel. 2021. Final words. In Mojmír Dočekal & Marcin Wągiel (eds.), *Formal approaches to number in Slavic and beyond*, 481–483. Berlin: Language Science Press. DOI: 10.5281/zenodo.5082488

This monograph brings many valuable empirical patterns of this sort and shows how they bear upon the theoretical issues.

The monograph is divided into four parts in which different aspects of the theories of plurality are confronted with new empirical findings. We will now list a non-comprehensive list of big questions and then their respective sub-questions, which can be understood as some of the most important issues discussed in the individual chapters.

In the first part, we find papers focused on the notions of number, countability, and maximality. These contributions provide both empirical and theoretical insights into the cognitive and linguistic nature of these issues. Some of the questions behind the chapters in this part are at least the following ones: can experiments answer the question of the relationship between number as a linguistic category and number as a cognitive notion? How do verbal and nominal pluralities relate? What are the real linguistic markers of maximality and number? Which syntactic mechanisms express distributivity or plurality?

The second part of the monograph explores the core topics of theories of plurality – the possible interpretations of sentences containing plurality-denoting expressions, higher-order atoms, and many others. The questions tackled in this part are at least the following ones: how much must we revise our theories of plurality if we take seriously cross-linguistic patterns of (sine qua unexpected) cumulative readings? What can we learn about cumulative readings if we also take into account opaque contexts? What is the nature of collective interpretation once we move beyond such nouns as *team* and *swarm*?

The third part gathers contributions addressing the proper treatment of numerals, their modifiers, and classifiers (bridges between numerals and nouns). And we can interpret the chapters in this part as inspired by questions like these: Was Frege right in treating numerals as equinumerousity of concepts? How much must we update our theories in order to properly describe non-integers? How compositional are numerals in natural languages? What can we learn from the interaction of focus particles with superlative modifiers? Do our theories of the mass/count distinction still work once we take into account optional classifiers in languages such as Hungarian?

The last part of the monograph focuses on quantifiers other than numerals, indefinites, and some interactions of degree expressions with polarity licensing. The research behind the chapters in this part was driven by questions like these: to what extent do quantifier semantics predetermine the verification procedure of a human agent? And what can an eye tracker experiment with Polish speakers tell us about the issue? Why do some indefinites not yield implicatures (as predicted by our current theories)? And how much can we learn about that from Hungarian child acquisition data?

The previous four paragraphs aim at offering the interested reader insight into the nature of issues discussed in the monograph. The chapters build upon different frameworks: linguistic typology, theories of plurality confined within Frege's boundary, and psycholinguistics, where a lot of attention is paid to ideas in mind, something which Frege termed "Vorstellung" and put on the back burner of logic and mathematics. As stated in the introductory chapter, we are far away from a unification of these frameworks, if that is even possible. We can find a slightly parallel debate in the 20th-century philosophy of mathematics, the one between Frege, Russell, and Hilbert's formalism/logicism and Brouwer's intuitionism, which seems still unsettled today. But no matter how the biggest questions are answered, this monograph brings together people looking for possible solutions along with the frameworks they work in to scrutinize the existing theories and then confront them with the new data gathered experimentally, via big corpus searches, traditional intuition reflections, or cross-linguistic data surveys. A lot of attention was paid to Slavic: eleven chapters are based on data from various Slavic languages like Bosnian/Croatian/Montenegrin/Serbian, Czech, Macedonian, Polish, Russian, Slovak, and Slovenian. And it was one of the goals of this book to bring the Slavic data to the debates in theories of plurality. Among other languages which you can find discussed in the monograph are English, German, Greek, Hungarian, Japanese, Mandarin Chinese, and Wolof. The empirical landscape is colorful, as are the approaches which describe it. The result is the monograph in which you, an avid reader, just read the last chapter. All in all, it was a fascinating journey.

Name index

Formal approaches to number in Slavic and beyond

The goal of this collective monograph is to explore the relationship between the cognitive notion of NUMBER and various grammatical devices expressing this concept in natural language with a special focus on Slavic. The book aims at investigating different morphosyntactic and semantic categories including plurality and number-marking, individuation and countability, cumulativity, distributivity and collectivity, numerals, numeral modifiers and classifiers, as well as other quantifiers. It gathers 19 contributions tackling the main themes from different theoretical and methodological perspectives in order to contribute to our understanding of cross-linguistic patterns both in Slavic and non-Slavic languages.

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