Atomicity and Distributive Reference

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TESI DOCTORAL UPF / 2019

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Acknowledgements

There are so many people who contributed to this thesis by discussing ideas, by intentionally or unintentionally teaching me things, by giving me advice, by helping me manage life as a PhD student, or by doing any combination of these things – and often even more. I am very grateful to all of these people, some of whom I would like to mention by name.

First and foremost, I would like to thank Louise McNally for being an awesome supervisor. During these past four years, Louise would extend her best knowledge and advice on any situation from minor bureaucratic annoyances to the occasional existential crisis in research. I have learned so much from her (probably much more than I am aware of at this moment), and I feel particularly lucky for having her as part of my never-ending formation to become a linguist. Louise has inspired my research in many ways: by engaging in long discussions, by asking the questions that helped me see the problems more clearly, and by drawing my attention to connections I had not seen. She always took my ideas seriously, and also taught me how to do that myself – which turned out to be so much more important than I would have thought.

My interest in linguistics began at the University of Pécs when I was an undergrad. I am grateful for my teachers and my fellow students for showing me how fascinating languages are and how there are weird, yet intuitive theories to model grammar. I am in particularly thankful to Anita Viszket who helped me to discover my first linguistic problem, and to develop my first analysis many years ago. Without Anita, it might have never occurred to me to pursue a PhD in linguistics.

Doing the PhD probably would have been bleaker without my fellow students at UPF. I would like to thank Giorgia Zorzi for being incredibly welcoming and helpful right from Day 1 (actually, even before) and making my landing in a whole new life a less scary experience. I am also grateful to Giorgia for having been my constant comrade in our little causes to improve our PhD student lives; her attitude always transformed fruitless complaining into exciting projects. I would like to thank Toni Bassaganyas for the many interesting conversations about semantics and fun conversations about life. Toni had every quality that made him the perfect deskmate. I am utterly thankful to Raquel Veiga, Alexandra Navarrete, Sara Cañas, Laura Aina, Eréndira Cervantes, Ionuţ Sorodoc, Josep Auseni, Fengrong Yang, Dominika Slušná, Antonia Tovar, Zi Huang, Chenjie Yuan, Veronika Richtarcikova, and Eugenio Vigo for contributing in their own ways to our student community that I loved being a part of. I would also like to thank my office mates at various times, especially Iris Hübscher, Olga Kushch, Santiago González-Fuente, Alfonso Igualda, Berta Moya, Lieke van Maastricht, Sílvia Gabarró-Lopez, Anderson Almeida, Azli Ozkul, and Bahtiyar Makaroğlu for making the everyday life a touch brighter.

I am very grateful for the members of the GLiF for creating and maintaining a diverse and vivid linguistic environment at UPF, namely Josep Quer, Louise McNally, Gemma Barberà, Josep Maria Fontana, Jordina Sánchez, Aurelie Herbelot, Paula Menéndez-Benito, Kristina Gulordava, Wolfram Hinzen, Àlex Alsina, Matthijs Westera, and Carina Silberer. I owe special thanks to Laia Mayol and Gemma Boleda for always being available to meet, and for their helpful advice on any topic from experimental design to data management, and beyond. I would like to give a special mention to the GLiF members I got the chance to teach semantics with: Enric Vallduví, Julie Hunter, and Cristina Real Puigdollers, whom I would like to thank for teaching me about teaching and semantics and their intersection.

During my second year, I visited NYU for three months. I am grateful for Lucas Champollion for this opportunity and for being my mentor at NYU. My ideas were much more crude back then, and Lucas helped me

a lot to have a deeper understanding about formal semantics, plurality and distributivity. Our discussions fundamentally transformed the way I think about some problems and how I approach problems in general. I am thankful for all the other people who made my stay at NYU such a great experience, among them Hagen Blix, Maxime Tulling, Madeline Gilbert, Suhail Matar, Sora Yin, Ildikó Emese Szabó, Masha Esipova, Philip Shushurin, Adina Williams, Yining Nie, Paloma Jeretič, Craige Roberts, Anna Szabolcsi, Chris Barker, and Sam Bowman. A special thank you to Scott Grimm for hosting me for a short but eventful visit to the University of Rochester during my stay in the US.

Throughout the past four years I had the pleasure to meet people from and at various places whom I would like to thank for their respective input and impact, especially Urtzi Etxeberria, Maria Teresa Espinal, Olga Borik, Elena Castroviejo, Aritz Irurtzun, Laura Vela-Plo, Zoltan Zato, Rebecca Woods, Marcin Wągiel, Dària Serés, Flóra Lili Donáti, Karolina Zuchewicz, Rahul Balusu, Lelia Glass, and Brigitta Schvarcz. I would also like to thank the audiences at the 18th and the 19th Szklarska Poręba workshops. Special thanks go to Berit Gehrke for her instant kindness from the first time we met that made me feel welcome in the community, and for all the ways she helped me throughout the years. Huge thanks for my ultimate co-organizer, Katherine Fraser, for creating the Retreat for Students in Semantics and Pragmatics with me and for making it happen. I also thank all the attendees who made ReSSP an amazing event.

There are several people who directly contributed to the contents of this thesis with their help and advice. I am very thankful to Aina Garí Soler, Jakub Dotlatčil, Laia Mayol, Daniele Panizza, Simone Tassani, and Sándor Kemény for their help with the experimental design and the statistical analysis presented in Chapter 4. I would like to thank Jon Ander Mendia for the discussion of his ideas about nonatomic distributivity and typicality. Many thanks goes to Flóra Lili Donáti and Attila Horváth for their judgments on the Hungarian data presented in Chapter 5. I would also like to thank Alexandra Navarrete for helping me with the Catalan translation of the abstract, and Katherine Fraser for checking the English in parts of the thesis.

I gratefully acknowledge the financial support from the grants FFI2016-76045-P (AEI/MINEICO/FEDER, UE) and BES-2014-069070, the ICREA Foundation, AGAUR grants 2014SGR698 and 2017SGR1478, and the Translation and Language Sciences Academic Coordination Unit at UPF that made this research possible.

Finally, I thank the late Fifi, little Henrik from the barri, and Borzi (who is sleeping on his pillow as I am writing this) for their many cameos in the thesis, and for cheering me up many times during writing because I always pictured cute dachshunds when crafting the example sentences. I thank my friends and family who were the biggest source of joy in the past years, and whose support helped me to get through the hardest parts. I thank my parents for all the opportunities I had in life because of their support, encouragement, care, and love. I could not have made this without you. The biggest credit goes to my husband, Attila Horváth, for being by my side throughout all this. Thank you for everything.

Abstract

Mereological models are often used to account for distributive reference, which arises when the denotation of a linguistic expression holds of certain parts of the plurality to which it is applied. It is general praxis in the theory of distributivity to employ structural atoms, which are entities that lack proper parts, to represent the base entities of which pluralities are formed. This thesis offers a revision of the notion of atom used in the theory of distributivity and argues in favor of employing relative atoms, which are entities that are atomic only with respect to a certain property. With relative atoms, we can account for why atomic and nonatomic parts of a plurality can equally be involved in distributive reference, in accordance with newly obtained empirical evidence. We can also capture the unexpected ways in which Hungarian reduplicated numerals and reciprocal constructions interact.

Resum

Els models mereològics s'utilitzen sovint per explicar la referència distributiva, que apareix quan la denotació d'una expressió lingüística conté certes parts de la pluralitat a la qual s'aplica. El fet d'utilitzar àtoms estructurals, que són entitats sense parts pròpies, per representar les entitats bàsiques sobre les quals es formen les pluralitats és una pràctica habitual a la teoria de distributivitat. Aquesta tesi ofereix una revisió de la noció d'àtom utilitzada a la teoria de distributivitat i exposa arguments a favor de la utilització d'àtoms relatius, que són entitats atòmiques només en relació amb una propietat determinada. Gràcies als àtoms relatius podem explicar perquè les parts atòmiques i no atòmiques d'una pluralitat poden estar involucrades en la referència distributiva, segons proves empíriques obtingudes recentment. A més, podem reflectir les diferents maneres imprevistes amb què interactuen els numerals reduplicats i les construccions recíproques en hongarès.

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List of glosses

1	first person
2	second person
3	third person
ABL	ablative case
ACC	accusative case
ALL	allative case
CL	classifier
COM	comitative case
DAT	dative case
DECL	declarative mood
DEL	delative case
DIST	distributive case
DM	distributive marker
ILL	illative case
INE	inessive case
INF	infinitive
NOM	nominative case
O	object
PFV	perfective aspect
PL	plural
POSS	possessive marker
PRT	verbal particle/prefix
PST	past tense
S	subject
SG	singular
SUBL	sublative case
SUPE	superessive case

Chapter 1

INTRODUCTION

The notion of atom plays an important role in formal semantics, as it is often used to capture the distinction between semantically singular and plural expressions. Semantic singularity can be characterized as an expression referring to single entities; and semantic plurality an expression referring to a multitude of single entities. In the theory of mereology, this distinction is modeled as a difference between the structure of the entities referred to by different expressions (see Link 1983). That is, semantically singular expressions refer to atomic entities, entities that are indivisible or have no parts. Semantically plural expressions refer to plural entities, which have a complex structure, as they consist of multiple atoms. This approach is visually illustrated in Figure 1.1.

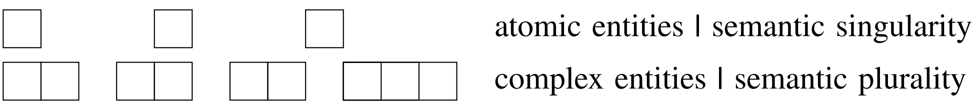

Figure 1.1: Mapping from structure to meaning

Although the assumption that semantic singularity/plurality is a reflection of structural properties of entities is quite intuitive, it has been argued that there is no one-to-one correspondence between the semantic properties of linguistic expressions and the structure of the entities they refer to (Krifka

1989, Krifka 1998). Rather, it is the property of linguistic expressions that they refer to entities *as if* they were atoms or structurally complex entities.

Take the noun *teapot* for example. This noun can be used to refer to an entity, a teapot, in the world. A teapot can have parts – it is not a monolith: it consists of a lid, a vessel and a handle, and potentially of other parts. Those things are parts of the entity described by *teapot*, however, the noun *teapot* cannot be used to refer to them separately. In sum, a teapot can be viewed as a structurally complex entity, as a plurality of *things*, but in relation to the noun *teapot*, this potentially complex entity appears as an atom and is treated as a semantic singularity. This is illustrated in Figure 1.2.

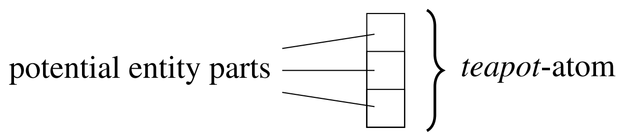

Figure 1.2: A structurally complex semantic singularity

Even though it is more accurate to think about semantic singularity and plurality as a property of how linguistic expressions relate to entities, it is common practice in formal semantics to define structural atoms and model the reference of linguistic expressions in terms of structural properties of the entities they refer to. This practice certainly helps to keep things simple and the formal apparatus manageable, but it also carries a fundamental assumption that entities have certain structural properties. The problem with such assumptions is that they are very hard to falsify; moreover whether a thing is atomic or not is probably something that linguistic inquiry is not set out to decide. Yet, it often happens that the assumed structural properties of entities (or even domains) is used as part of the reasoning in the analysis of some linguistic phenomena, which suggests that this assumption is treated as one of the building blocks in the architecture of argument.

In this thesis, I investigate what happens if we take the idea seriously that atomicity and nonatomicity are not exclusively properties of entities in our model, but rather of the way linguistic expressions can be used to refer to those entities. Exploring this idea has some obvious and mundane consequences, like the necessary re-tailoring some of the basic definitions in our semantics, but it also allows us to ask whether there are any theoretical benefits of assuming that semantic singularity and plurality can be captured without relying strictly on the structural properties of entities.

Atomicity and nonatomicity play an important role in understanding distributive reference. Distributive reference occurs when a description is predicated over a plurality, but holds of it in virtue of holding to the parts of that plurality. Consider the sentence in (1). Here, the property *contain two liters of tea* can be understood as a property of the teapots all together. In this case, the sentence (1) is understood as describing a situation where the amount of tea in all the teapots adds up to two liters. However, the property *contain two liters of tea* can also be understood as a property of individual teapots or some groups of teapots. In this latter case, we are considering the distributive interpretation of (1).

(1) The teapots contain two liters of tea.

Under the most common assumptions, the noun phrase *the teapots* is assumed to refer to a sum of entities, the sum of all the individual teapots (Link 1983, Landman 1989a, Landman 1989b, among many others). This entity has all of these individual teapots as its parts. It also has sums of teapots as parts: if the complex entity referred to by the noun phrase *the teapots* is the sum of four teapots, it is assumed that all the complex entities of three teapots and of two teapots are also part of this entity along with the individual teapots.

Under the assumption that semantic plurality corresponds to structural complexity of entities, and structurally complex entities consist of a multitude of structurally simple entities, we would have reason to assume that these structurally simple entities enjoy a special status among the parts of a structurally complex entity. After all, they are the only entities which do not have parts, as opposed to the the other parts of the complex entity which blend into a pool of structurally complex entities.

Following this line of thinking, we could assume that the sentence in (1) when understood distributively, is most easily understood to entail that *contain two liters of tea* holds of every individual teapot in question, instead of holding of some subgroups of teapots. This assumption is can be easily accommodated by presuming that individual teapots have some inherent property that grants them a special status.

By giving up the idea that semantic singularity and plurality corresponds to some structural property of entities, we give up the assumption that there are inherently special entities at all. Let us assume instead that there are entities that appear as atoms given one predicate or description, and as a plurality given another predicate or description. If we do this, we can understand the distributive interpretation of the sentence in (1) in the following way. The term *the teapots* applies to an entity that is complex with respect to the entities that are atomic with respect to the property *teapot*, i.e. the *teapot*-atoms. This complex entity has atomic and nonatomic parts given the property *teapot*. The property *contain two liters of tea* in turn, can apply to these entities regardless their structure with respect to the property *teapot*. Since we assume that the structure of entities can only be understood with respect to a certain predicate, the entities that are atoms with respect to the property *teapot* are not necessarily atomic with respect to the property *contain two liters of tea*. If *the teapots* in (1) refers to the sum of four individuals, those individuals are the *teapot*-atoms; if the property *contains two liters of tea* applies to the sum of teapot_1 and teapot_2 on the one hand, and the sum of teapot_3 and teapot_4 on the other, those two sums of teapots are the atoms of the property *contain two liters of tea*.

In sum, the distributive interpretation of (1) can be understood as parts of a plural entity referred to by the subject – that appear atomic or nonatomic with respect to the property described by the noun – appear as atomic with respect to the property described by the VP. This is, however, absolutely expected if the structure of entities can only be understood with respect to properties and descriptions.

In the case of (1), the distributive interpretation involved a plurality from the domain of individuals. However, our approach to the structure of entities can be extended to other domains. In this thesis, I am going to focus on the domain of events.

According to our approach, the semantic singularity or plurality of descriptions of events ultimately depends on the description itself. Take (2) for instance.

(2) Amelia and Marie called Valentina on the phone.

(2) can be understood as having distributive reference where the distribution is over a plurality of individuals, the sum of Amelia and Marie. (2) refers to a plurality of events of calling Valentina on the phone. According to description in (2), this plurality has two parts, one where Amelia called Valentina on the phone, and another where Marie called Valentina on the phone. These events are atomic with respect to the their participants. The event of Amelia calling Valentina does not have any parts where parts of Amelia called Valentina, just as the event Marie calling Valentina does not have any parts where parts of Marie called Valentina.

Based on (2), we can assume that the semantic singularity or plurality of event descriptions depends on the semantic singularity or plurality of the participants of the events described. This, however, is not always the case. Consider the sentence in (3).

(3) Amelia and Marie called Valentina on the phone each time.

(3) describes a plurality of events, as it states that Amelia and Marie called Valentina on the phone on multiple occasions. The atomic events with respect to this plurality are the events of Amelia and Marie calling Valentina on the phone. These events, however, might not be atomic with respect to the their participants, as it can potentially be the case that Amelia and Marie called Valentina individually. However, even if the events themselves are plural with respect to their participants, the plurality of events described by (3) does not have those events as its parts.

Based on (3), we can assume that in some cases, semantic singularity or plurality of event descriptions depends on the clausal description of the event. The single events of Amelia and Marie calling Valentina are atomic with respect to the plurality of events described by (3) given that they fit the description provided by the clause.

Nonetheless, it it reasonable to assume that the events of Amelia and Marie calling Valentina can be associated with the structure based on their participants, as these events might have parts where parts of the sum of Amelia and Marie called Valentina. These events, however, are subatomic with respect to the plurality of events described by (3).

Under the approach that (non)atomicity is a property of the relation between linguistic descriptions and entities, we can easily accommodate the idea that some event descriptions might be associated with multiple structures of events. Moreover, we can expect that there might be cases where both of the structures are accessed: when there is a plurality of events described by a sentence, and the sentences is understood as having distributive reference over that plurality, we can accommodate if the events involved in the distribution are subatomic with respect to the plurality.

The discussion of sentences (1) to (3) demonstrates that if we understand atomicity and nonatomicity, and semantic singularity and plurality *not* as corresponding to some structural property of entities, but rather as the property of the way predicates and descriptions apply to entities, we can consider some aspects of the distributive reference that otherwise might be overlooked. First, it helps us to entertain the idea that the structure of individuals relative to one property might not be relevant when another property also applies to these individuals. Second, it helps us capture the complexity of the entity structures accessed by event descriptions, which in turn invites us to consider whether the different structures can interact in distribution over events. These are the issues I will pursue in this thesis.

In order to do this, in Chapter 2, I lay out the theoretical background I will rely on throughout the thesis. I start by discussing the definitions of our mereological theory. I will then review some of its most influential and typical linguistic applications. I will devote a long discussion to how atoms are understood in mereology, and how that differs from the way how atoms are understood here. I will defend adopting the notion of relative atom over the notion of structural atom. Relative atoms are entities that behave as atoms with respect to a certain property or description, while the structural or absolute atoms are atoms by virtue of their inherent structural make-up.

In Chapter 3, I discuss distributive reference, focusing on how employing the notion of absolute atom shaped the theory of distributivity. I will discuss individual distributivity – when the distribution is over a plurality of individuals – and event distributivity – when the distribution is over a plurality of events. In the case of individual distributivity, distributive reference is most commonly understood in terms of the structure of the individuals involved in the distribution, hence atomic and nonatomic distributivity is often distinguished from each other (see Lasersohn 1998, Link 1998b, Winter 2001, Champollion 2017b, among many others). This distinction is assumed to manifest itself in the restricted availability of nonatomic distributive reference in sentences like (1), where distributive reference is not overtly marked. Yet there are some accounts that do not posit any restrictions on the availability of nonatomic distributive reference, hence make no distinction based on the (non)atomicity of individuals within individual distributivity (see Gillon 1987, Schwarzschild 1996). The mutual incompatibility of these two basic views on distributive reference leaves the question open whether or not atoms play a crucial role in distributive reference.

In the case of event distributivity, employing the notion of structural atom shaped the theory in a different way. On the one hand, atoms on the domain of events might not even be defined, in which case event distributivity is assumed to be inherently nonatomic (see Champollion 2016b). On the other hand, atoms on the domain event might be understood in terms of their description, atomic events are associated only with the structure that is formed based on the plurality of the atomic events (see Cable 2014). In this latter case, atomic events are not understood in strictly structural terms, however, they are treated essentially as structurally atomic, i.e. lacking any inner structure. In sum, the notion of structural atoms in the theory of event distributivity poses a conceptual issue, one that seems to be not directly relevant to the study of the phenomenon itself.

Chapter 4 is devoted to the in-depth discussion of nonatomic individual distributivity. As mentioned above, nonatomic distributivity is assumed to be a marginal or atypical phenomenon compared to atomic distributivity; however, when it has been analyzed, the reasons behind this assumed marginality have been left for speculation. Here I will present empirical evidence based on English suggesting that nonatomic and atomic distributive interpretations of sentences are available at virtually the same rate, which not only suggests that the availability of nonatomic distributivity should not be restricted compared to that of atomic distributive reference, but also goes against the claim that atoms play a crucial role in distributive reference. I will present an account that captures the data without having absolute atoms defined on the domain of individuals, based on Schwarzschild (1996).

In Chapter 5 I turn to event distributivity, which I am going to discuss through the case study of Hungarian reduplicated numerals. I will show that these items can contribute to both individual and event distributive readings of the sentences they occur in. I will argue that in the case of event distributive interpretations, Hungarian reduplicated numerals can access multiple structures associated with the event described by the sentence which I will demonstrate with reduplicated numerals in reciprocal constructions. To capture this ability of Hungarian reduplicated numerals, I define a relation called *containment* that is fine-grained enough to capture the relation between events across structures, and I build an analysis of Hungarian reduplicated numerals based on Cable (2014) that employs this newly defined *containment*-relation.

Finally, in Chapter 6 I summarize the most important findings of the thesis and lay out possible routes for further research.

Chapter 2

THE THEORY OF PARTS AND THE NOTION OF ATOMS

2.1 Introduction

In this chapter I lay out the theoretical background that I am going to rely on throughout the thesis. I start by discuss the definition of mereology, a theory often applied in linguistics to represent the denotation of plural expressions. I will discuss how the notion of *atom* is understood in the terms of mereology. Then I am going briefly review on how mereology is applied in linguistic analysis, focusing on the higher order properties that characterize predicates (and more complex expressions) based on the different mereological structures formed by the entities in their denotation.

Most of the chapter is concerned with the question of how the mereological notion of atom is and can be understood in linguistic terms. In terms of mereology, atomicity is a structural characteristic of entities whose defining property is that they have no proper parts. I argue that in linguistic terms, this notion of atom is untenable; entities might appear as atomic only in relation to the denotation of some natural language expression, and not by virtue of being structurally atomic. Finally, I will examine how natural language expressions refer to atoms in the domain of individuals and in the domain of events.

2.2 Mereology

Since Link (1983), semantic accounts of plural expressions commonly take the mereological approach to model their denotation. Mereology is the analysis of relationships between wholes and their parts, and it is often taken as an alternative to set theory, which, in turn, is the analysis of the relationship between sets and their members (Varzi 1996). Although the two systems potentially correspond to each other, the foundational difference between mereology and set theory is that the former is not committed to the existence of higher order entities[1], i.e. sets, while the latter clearly carries such a commitment.[2]

One might welcome or not the ontological parsimony of mereology, but that is not the main reason why mereology is so widely used in formal semantics. Rather, it has more to do with the fact that mereology, unlike set theory, is undetermined with respect to atomicity, which makes it suitable to describe both atomistic and atomless models. This property of mereology was first exploited in semantics to characterize the denotation of mass nouns (especially *cumulative reference*, see Quine 1960/2013 and Moravcsik 1973). Link (1983), however, was among the first ones to capture the similarities between the denotation of plurals and mass nouns using tools provided by mereology. The insights of Link (1983) inspired the discovery of systematic relations between the singular-plural and the mass-count opposition in the nominal domain, and between the telic-atelic opposition in the verbal domain using the theory of mereology (as in Bach 1986 and Krifka 1989; for more on the linguistic applications of mereology, see Champollion & Krifka 2016 and Champollion 2017a).

In formal linguistics, mereology has been standardly adapted in formal semantics to model the structure of the different domains of entities (but see Scha 1984, Hoeksema 1983, Schein 1993 and Schwarzschild 1996, a.o., as notable exceptions). The underlying assumption is that the domains involve not only singular but also plural entities which are re-

[1]Here I am using the term *entity* to refer to both individuals and eventualities.

[2]Mereology, however, is committed to the existence of plural entities, which are potentially as problematic as sets; see Varzi 2000 for discussion.

lated to each other by some well defined relations. In what follows, I will provide the main axioms and basic definitions used in mereology and I will discuss its basic applications in formal semantics, with a special emphasis on the notion of atom.

2.2.1 Basic axioms and definitions

The fundamental relationship in the core of mereology is $\leq$, the PART-OF relationship. The properties of this relation give the basic axioms of mereology in (1)–(3).[3]

(1) **Axiom** Reflexivity
$\forall x[x \leq x]$
Every entity *x* is such that *x* is part of itself.

(2) **Axiom** Antisymmetry
$\forall x \forall y[(x \leq y \ \wedge \ y \leq x) \rightarrow x = y]$
For any two entities x and y, if x is part of y and y is part of x, then x is identical to y.

(3) **Axiom** Transitivity
$\forall x \forall y \forall z[(x \leq y \ \wedge \ y \leq z) \rightarrow x \leq z]$
For any three entities x, y and z, if x is part of y and y is part of z, then x is part of z.

The first axiom in (1) says that the mereological part-of relation holds between any entity and itself; the second axiom in (2) states that the two distinct entities cannot be part-of each other; and finally, the third axiom in (3) says that any part of any part of an entity is part-of that entity.

The mereological relation defined by these axioms is of course distinct from what is can be meant by the two place predicate in natural language *be part of* (see Simons 1987: Chapter 3.2, Moltmann 1997 and Champol-

[3]The content of this subsection is heavily based on Varzi (1996), Casati & Varzi (1999), Varzi (2016), Champollion & Krifka (2016) and Champollion (2017b). For a more thorough overview of mereology the reader is referred to these works and the references therein.

lion 2017b: Chapter 2.3 for discussion). The natural language expression can refer to a relation that is not defined by the axioms in (1)–(3). Consider the following example:

(4) #The Earth is part of the Earth.

(4) is an arguably odd statement, and not because it is tautological, hence uninformative, but because the English predicate *be part of* poses a non-identity condition on its arguments. That is, this particular natural language predicate fails to refer to a reflexive relation.

It is considerably more difficult to find a natural language example where the predicate English *be part of* does not have the property of asymmetry. But consider the following mini discourse:

(5) a. Homer Simpson is part of the universe and the universe is part of Homer Simpson.
b. #Hence Homer Simpson is identical to the universe.

The context for (5) is the couch gag from episode 15, season 14 of the animated comedy *The Simpsons* (which is itself an allusion to the 1977 short film *Powers of Ten* by Charles and Ray Eames[4]), where the camera first shows the Simpsons family sitting on the couch. Then it starts to zoom out revealing first the house from above then the neighborhood, then the city and so on to the point where the camera leaves the Earth and continues to zoom out showing the solar system then stars and galaxies. Then the galaxies morph into atoms and, while still zooming out, the camera shows the molecules formed by the atoms, then DNA helices and so on. Then we see Homer's head, and finally we return to the scene where we started out.

In this somewhat paradoxical yet intelligible context, we can commit to the truth of the statement in (5a), but not necessarily to (5b). Hence we can conclude that the part relation referred to by the English *be part of* is not defined by the property of asymmetry.

As for the property of transitivity, consider the following example:

[4] `http://www.eamesoffice.com/the-work/powers-of-ten/`

(6) #The pocket is part of my blue pantsuit, and my blue pantsuit is part of my uniform, so the pocket is part of my uniform.

The conclusion in (6) does not necessarily hold despite the fact that there is no flaw in the premises. Without going into a detailed discussion why that is, we can argue that the pocket is part of my blue pantsuit merely because it is physically attached to it. Our world knowledge dictates that whenever a piece of clothing has a pocket that pocket is part of that piece of clothing. However, nothing inherent about my blue pantsuit makes it part of my uniform, but rather mere convention: my uniform is an arbitrary ensemble of attire. It seems like that if something belongs to an arbitrary collection then the parts of that things themselves do not necessarily belong to that collection as well. So we can conclude that the relation referred to by the predicate *be part of* is not defined by the property of transitivity, either.

Thus, we must distinguish the parthood relation defined in mereology from other notions of parthood referred to by natural language expressions as *be part of* in English. Here, however, I will refrain from discussing these other kinds of parthood relations[5] and will exclusively focus on the notion of parthood that is defined by (1)–(3).

Based on the axioms in (1)–(3), we can define the relations $<$ (proper part) and $\circ$ (overlap) in the following way:

(7) **Definition** Proper part

$x < y \overset{\text{def}}{=} x \leq y \ \wedge \ \neg(y \leq x)$

x is a proper part of y iff x is part of y and y is not part of x.

(8) **Definition** Overlap

$x \circ y \overset{\text{def}}{=} \exists z[z < x \ \wedge \ z < y]$

x overlaps y iff there exists a z such that z is a proper part of both x and y.

The proper part relation in (7) is basically an asymmetric part-of rela-

[5] See *functional part* in Varzi (1996) and (2016), *situated part* in Moltmann (1997) or *structured part* in Champollion & Krifka (2016).

tion; the overlap relation in (8) holds between every two entities that have common proper parts.

This basic system defined by the axioms (1)–(3) can be extended in various ways, and each of them results in a different theory (see Varzi 1996). Here we will not survey the different mereological theories, only add some axioms to the basic theory to end up with the system most often used in formal semantics (see Champollion 2010, Grimm 2012, Wągiel 2018, among others).

The first axiom we add to the basic theory is the supplementation axiom (see in Simons 1987: 27, Grimm 2012 and Varzi 2016: Chapter 3.2):

(9) **Axiom** Supplementation
$\forall x, y[x < y \rightarrow \exists z[z < y \ \wedge \ \neg z \circ x]]$
For any two entities x, y, such that x is a proper part of y, there exists an entity z such that z is a proper part of y and z and x does not overlap.

The supplementation axiom guarantees that if an entity has a proper part, there always must be a remainder, which is also a proper part of the entity, and the two parts do not overlap. In other words, by adding the supplementation axiom in (9) we ensure that entities cannot be decomposed into a single proper part.

Next we define the notion of sum, which is an entity that possibly has other entities as parts. There are at least three different ways to define a sum (see Varzi 2016: Chapter 4.2). Here I will depart from Varzi (1996) and Casati & Varzi (1999), and I will go with the definition that is most widely used in formal semantics which is from Tarski (1929).[6]

(10) **Definition** Sum
$sum(x, P) \overset{\text{def}}{=} \forall y[P(y) \rightarrow y \leq x] \ \wedge \ \forall z[z \leq x \rightarrow \exists z'[P(z') \ \wedge \ z \circ z']]$

[6]Notation following Champollion & Krifka (2016). Original (Definition III. in Tarski 1929: 25) is phrased as follows: "An individual *X* is called a *sum* of all elements of a class α of individuals if every element of α is part of X and if no part of X is disjoint from all elements of α."

x is the sum of all the elements in a set P iff for all y such that y is in P then y is part of x and for all z such that z is part of x there exists a z' such that z' is in P and z overlaps with z'.

(10) says that the sum of a set consists of everything in that set, and each of its parts overlap with something in the set.

We define two different ways of referring to sums: the first one is the *binary sum*, which refers to the entity which is the sum of two entities; the second one is the *generalized sum*, which refers to the unique entity which is the sum of every element in an arbitrary nonempty set.

(11) **Definition** Binary sum

$x \oplus y \stackrel{\text{def}}{=} \iota z\ sum(z, \{x, y\})$

(12) **Definition** Generalized sum

$\bigoplus P \stackrel{\text{def}}{=} \iota z\ sum(z, P)$, where P is a nonempty set.

The theory built so far allows distinct objects to be decomposed into the same proper parts. In linguistic applications of mereology, this is generally considered a problem if one wants to account for identity (or distinctness, for that matter) of entities in terms of parthood. However, the problem can be avoided by adding an appropriate axiom. The resulting theory is called extensional in that 1) its ontology is static – no temporal dimension is introduced, i.e. there is no *change* in the domain[7] –, and 2) every entity is assumed to be fully defined by its parts.

There are two different axioms that can achieve extensionality: the strong supplementation axiom (13) and the Uniqueness of Sums axiom (14):

(13) Possible axiom Strong Supplementation

$\forall x, y[\neg(x \leq y) \rightarrow \exists z[z \leq x \ \wedge \ \neg(z \circ y)]]$

For any two entities x, y such that x is not part of y there exists an entity z such that z is part of x and z does not overlap with y.

(14) Possible axiom Uniqueness of Sums

[7] For a temporal extension of mereology see Simons 1987: Part II.

$\forall P[P \neq \emptyset \rightarrow \exists! z \; sum(z, P)]$
For every set P such that P is a nonempty set there exists a unique entity z such that z is the sum of P.

Both the strong supplementation axiom and the Uniqueness of Sums axiom ensures extensionality as they both guarantee every entity to be fully defined by its parts. But the two axioms work in different ways: strong supplementation is top-down, as it defines extensionality by the part-of relation. It says that if some entity does not involve some other entity as its part then there is a remainder that the two entities do not share as a part. In other words, it states that two distinct entities cannot be decomposed into the same parts. The Uniqueness of Sums axiom, on the other hand, is bottom-up, as it approaches extensionality by the sum operation. It says that any set of entities has one and only one sum. Both axioms guarantee extensionality, that every entity in the theory is unique, i.e. two distinct entities do not consist of the same parts and if two entities consisting of the same parts are identical to each other. I am going to follow Champollion & Krifka (2016) and will adopt the Uniqueness of Sums axiom in (14) and render the theory applied here extensional.

The definitions and axioms of our theory are summarized in Table 2.1 and 2.2, respectively. They fully define the theory that is usually used in formal semantics to model the properties of entities in terms of the mereological part-of relation (see Champollion 2010, Grimm 2012, Champollion & Krifka 2016, Champollion 2017b and Wągiel 2018, among others).

	Name	Notation	Formula
D1	Proper part	$x < y$	$x \leq y \;\wedge\; \neg(y \leq x)$
D2	Overlap	$x \circ y$	$\exists z[z < x \;\wedge\; z < y]$
D3	Sum	$sum(x, P)$	$\forall y[P(y) \rightarrow y \leq x] \;\wedge$ $\forall z[z \leq x \rightarrow \exists z'[P(z') \;\wedge\; z \circ z']]$
D4	Binary sum	$x \oplus y$	$\iota z \; sum(z, \{x, y\})$
D5	Generalized sum	$\bigoplus P$	$\iota z \; sum(z, P)$

Table 2.1: Summary of the definitions

	Name	Formula
A1	Reflexivity	$\forall x[x \leq x]$
A2	Antisymmetry	$\forall x \forall y[(x \leq y \ \wedge \ y \leq x) \rightarrow x = y]$
A3	Transitivity	$\forall x \forall y \forall z[(x \leq y \ \wedge \ y \leq z) \rightarrow x \leq z]$
A4	Supplementation	$\forall x, y[x < y \rightarrow \exists z(z < y \ \wedge \ \neg z \circ x)]$
A5	Uniqueness of Sums	$\forall P[P \neq \emptyset \rightarrow \exists! z \ sum(z, P)]$

Table 2.2: Summary of the axioms

As Champollion & Krifka (2016), Varzi (2016) and Champollion (2017b), among many others, point out, the the theory defined above is isomorphic to a complete Boolean algebra without the bottom element (first shown by Tarski 1935) and a complete join semi-lattice, which also lacks a bottom element (Link 1983). The representation of a possible model in mereology (or mereological structure) can be found in Figure 2.1.

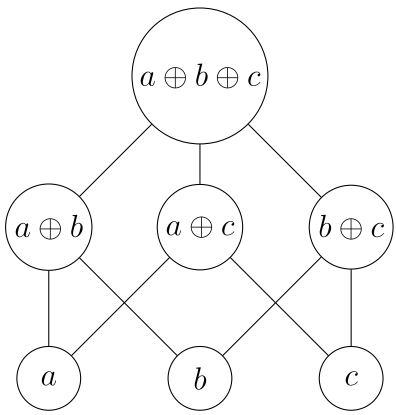

Figure 2.1: A possible model in mereology: the set $\{a, b, c\}$ closed under the $\oplus$-formation and ordered by the $\leq$-relation, no bottom element, represented as a Hasse diagram.

Models in mereology cannot have a bottom element – an element that is part of everything, like the empty set in set theory –; its existence is incompatible with the theory defined above.[8] Most importantly, as pointed out in Champollion (2017a), a null element contradicts the supplementation axiom in (9): if there is an entity that is part of every entity, every entity overlaps with every other entity which would render the supplementation axiom meaningless, since it relies on non-overlapping entities. Supplementation states that proper parthood entails having at least two non-overlapping parts, which would never be the case if there were an entity that overlaps with every other entity in the system.

Assuming a null element would also entail that the axiom Uniqueness of Sums in (14) has to be given up (a point also made in Champollion 2017a). Our definition of sum x of a set P in (10) gives us an entity that has every element in P as its parts, and whose parts must overlap with something in P. The second clause of the definition ensures that the sum of P does not involve anything else other than the elements in P. However, if we have a null element in our system, the second clause of the definition would be trivially satisfied by the null element because it is in the denotation of P and it overlaps with everything. That is, if there is a null element, our definition in (10) would only guarantee that the sum x of a set P has every element in P as its part, but could not guarantee that it only has elements in P in its parts. Since there can be potentially many entities that have all the elements in P as part and also have other parts, the Uniqueness of Sums axiom in (14) would have to be given up. To sum up, our axioms summarized in Table 2.2 are incompatible with the null element in the system.

2.2.2 Atoms, atomicity, atomlessness

This theory described above is not the only version of mereology that has been proposed, but it is one that is sufficient to be applied in formal semantics to model the denotation of plural expressions, see Champollion

[8] For a theory of plurality with a null entity ($\perp$) see Bylinina & Nouwen (2018) and the references therein.

& Krifka (2016).[9] Here I am not going to discuss other theories (for more on different mereological theories see Varzi 1996 and Varzi 2000), only one particular possible extension of our current theory.

It is possible to limit the models our mereology can describe by adding restrictions concerning the inner structure of the entities in the model. We can require the entities to be made up of entities that do not have proper parts (atomic mereology), or we can postulate every entity to have proper parts (atomless mereology). Before formally describing these options, I am going to discuss what an atom is in mereological terms.

The notion of sum defined in (10) allows us to refer to entities that have parts. These parts are not required to be different from the sum itself – the set P can be a singleton in which case the sum of the set is equal to its only element. However, if the sum is not equal to its parts – i.e. P is not a singleton –, the sum is a structurally complex entity, i.e. has multiple proper parts. It is straightforward to assume that there can be entities whose structure is simple, i.e. have no proper parts. These entities are called atoms, and they can be defined as in (15).

(15) **Definition** Atom

$\textsc{at}(x) \stackrel{\text{def}}{=} \neg\exists y[y < x]$

An entity x is an atom iff there exists no entity y such that y is a proper part of x.

The definition in (15) is the first one that is concerned with the inner structure of the entities that the theory can recognize. Atoms are special in that they have no proper parts, and the only part they have is themselves.

The theory defined in Section 2.2.1 is undetermined as to whether atoms exist and whether entities are necessarily made up of atoms or not (pointed out by Simons 1987, Varzi 1996, Casati & Varzi 1999, Champollion & Krifka 2016, Champollion 2017b, among others). The entities referred to by the variables in the axioms and definitions can have proper parts themselves, but can also be atoms.

[9]The theory defined above is very similar to the one called Classical Extensional Mereology in Hovda (2009).

It is of course possible to leave the theory as it is; there is nothing that requires us to specify the theory with respect to atomicity. However, we can also add one of the axioms in (16) and (17) to further specify the properties of our theory.

(16) **Axiom** (optional) Atomicity
$\forall x \exists y[\text{AT}(y) \;\wedge\; y \leq x]$
For every entity x there exists an entity y such that y is an atom an y is part of x.

(17) **Axiom** (optional) Atomlessness
$\forall x \exists y[y < x]$
For every entity x there exists an entity y such that y is a proper part of x.

If (16) is added to our theory, it will require all of the entities to have atomic parts, or, in other words, to be made up of atoms. On the other hand, if (17) is added, then it is required that every entity has proper parts, hence none of them can be atomic.[10]

It was pointed out both by Simons (1987) and Varzi (1996), that the question of atomicity is not independent of the model we want to describe: any finite model of the theory defined in Section 2.2.1 must be atomistic, as it consists of a finite number of entities. In turn, a model of an atomless theory must be infinite, because every entity has proper parts.

As the theory defined above is already apt to describe both atomic and atomless models, and deciding on adding either (16) and (17) poses an extra restriction on the model that we might not be able to justify. Moreover, in accordance with Champollion & Krifka (2016), I also think that the indeterminacy regarding the acceptable structures is what makes mereology

[10] Simons (1987: 42) formalizes a third possible axiom, which is the following:

(i) $\exists x[\text{AT}(x)] \;\wedge\; \exists x \forall y[y \leq x \rightarrow \exists z(z < y)]$

This is a hybrid solution, which states that there are both atoms and non-atoms in the models of mereology. According to Simons, this third option is rarely entertained, so here I am also not going to further consider adding (i) to the theory.

more appealing than set theory when it come to linguistic applications. In set theory, atoms are a given as the elements of sets, but in mereology, the inner structure of an entity is undetermined as default. When one does not want to commit to the existence of atoms in given structures, mereology, unlike set theory, does not force one to do so.

The question I am more interested in here is not so much concerned with the admissible structures, but rather with atoms as a special kind of entity, defined in (15). Even though the theory is not necessarily committed to their existence, atoms play an important role in the linguistic applications of mereology as they make use of it to account for some linguistic phenomena, like the mass-count or singular-plural distinction or distributive predication. But before examining the notion of atoms as used in the linguistic applications of mereology, I will give a general overview on how mereology is applied in linguistics to model structured domains of entities, focusing on the domain of individuals and events.

2.3 Linguistic applications of mereology: a short overview

Mereology has been applied in linguistics to model the reference of linguistic expressions. The original hypothesis behind the application of mereology is that some systematic linguistic phenomena that are understood in terms of the relation between grammatical constructions and the things they describe in the world can be captured in mereological terms. In other words, the assumption is that there is a systematic correspondence between certain linguistic phenomena and the mereological structures their reference forms. While this basic hypothesis has been fundamentally questioned, in this section I review the phenomena where it has been the most successful.

2.3.1 The domain of individuals

2.3.1.1 Cumulative and divisive reference

The mass-count distinction was the first linguistic phenomenon where implementing mereology was motivated. In 1960, Quine made the observation about mass terms like *water* that they refer cumulatively: "any sum of parts that is water is water" (Quine 1960/2013: 83).

The hypothesis that all mass nouns refer cumulatively (which was further developed into a mereological account of mass nouns in Moravcsik 1973) gave a very appealing semantic explanation of a distinction grammatically encoded in many languages. This encoding manifests itself primarily in nominal number marking and determiner selection. In English, mass nouns, unlike count nouns, refuse the plural number marking suffix -*s* when used to refer to concrete entities, see (18), and they are ungrammatical with numerals and some determiners which are grammatical with count nouns, see some examples in (19).

(18) a. #the waters in the cup(s)
b. the corkscrews in the basket(s)

(19) a. *three/*a/*every water(s)
b. three/a/every corkscrew(s)

The grammatical distinction illustrated in (18) and (19) was set to receive a purely semantic explanation based on Quine's observation, as it was assumed that the grammatical distinction lines up with some semantic properties of predicates. These properties were formalized as higher order properties (properties of properties) by Krifka (1989). The properties that are supposed to distinguish the reference of mass and count nouns, and account for their morphosyntactic differences according to Quine, are called cumulative reference (20) and divisive reference (21).

(20) **Definition** Cumulative reference
$\textsc{cum}(P) \overset{\text{def}}{=} \forall x, y[P(x) \wedge P(y) \rightarrow P(x \oplus y)]$
A predicate P has cumulative reference if for every x and every

y, if P holds of x and P holds of y, P also holds of the sum of x and y.

(21) **Definition** Divisive reference

$\textsc{div}(P) \stackrel{\text{def}}{=} \forall x, y[P(x) \wedge y \leq x \rightarrow P(y)]$

A predicate P has divisive reference if for every x and every y, if P holds of x and y is part of x, P also holds of y.

While these properties capture some intuitive distinctions between how mass nouns and count nouns refer, they by themselves are insufficient to fully characterize mass nouns (see Rothstein 2010 and Grimm 2012, among others). On the one hand, cumulative reference in (20) characterizes both mass nouns and plural count nouns (see discussion below), hence it obviously fails to capture a distinguishing characteristics of mass nouns. On the other hand, divisive reference in (21) is problematic as it gives rise to the notorious minimal parts problem (Taylor 1977). The problem resides in the fact that even the entities in the denotation of mass nouns have some parts that are in fact not in the denotation of the mass noun. In the case of the predicate *water*, while a hydrogen atom is clearly a part of it, the hydrogen atom itself is not in the denotation of *water*. This suggests that the divisive reference as defined in (21) fails to capture any systematic property of mass nouns.[11]

Even though cumulative and divisive reference as defined in (20) and (21), respectively, turned out to be insufficient to characterize mass nouns and hence to account for the grammatical distinction in (18) and (19), the discovery of these properties played a crucial role in the extension of the application of mereology in linguistic research.

2.3.1.2 The denotation of singular and plural count nouns

Link (1983) extended the linguistic application of mereology to the singular-plural opposition based on the observation that not only mass nouns, but

[11]For an in depth discussion on the minimal parts problem in multiple domains and a possible solution, see Champollion 2017b: Chapter 5.

also plurals have cumulative reference. Consider the examples in (22a)–(22b) contrasted with the one in (22c):

(22) a. If a is water and b is water then the sum of a and b is water.
b. If the things in this basket are corkscrews and the things in that basket are corkscrews, then the things in both baskets are corkscrews.
c. #If the thing in this basket is (a) corkscrew and the thing in that basket is (a) corkscrew then the things in both baskets are (a) corkscrew.

Link argues based on cases like (22) that the denotation of mass nouns and plurals form mereological structures, unlike the denotation of singular count nouns which denote sets of individuals instead. The innovation in Link (1983) is assuming a structured domain of individuals. While in classic Montagovian model theoretic semantics, atomic individuals are assumed to be of type e, and plurals are assumed to denote sets of individuals of type $\langle e, t\rangle$ (Bennett 1974, Hoeksema 1983), in Link's system both atomic and plural individuals are of type e. Moreover, the domain of individuals E is closed under sum formation and ordered by the part-of relation, forming a complete join semi-lattice. The set of atoms is a distinguished subset of the domain of individuals.[12]

In a bit more detail, the denotations of plural count nouns are formed based on the denotation of their singular counterparts: singular predicates, on the one hand, denote a set of individuals, plural predicates, on the other hand, denote sets of sums of individuals.

(23) a. If a is a corkscrew and b is a corkscrew then a and b are corkscrews.
b. If a and b are corkscrews and c and d are corkscrews, then a, b, c and d are corkscrews.

Based on this observation, Link proposes that the extension of plural pred-

[12]The domain of individuals in Link (1983) also involves the set of portions of matter and a materialization function h. I am going to leave those aside here.

icates is formed by closing the extension of the singular predicate under sum formation, so a plural predicate denotes the set of all the possible sums formed of the entities in the extension of the singular predicate. Formally, this process is done by the *-operator operating on the extension of the singular predicate. The formal definition of the *-operator (following Sternefeld 1998 and Nouwen 2016) is in (24) and a visual representation of the extension of a plural predicate is in Figure 2.2. In (25), there is an example how the extension of a singular predicate relates to that of the plural predicate.

(24) $*P$ is the smallest set, such that:

a. $P \subseteq *P$

b. $\forall x, y : x, y \in *P \rightarrow x \oplus y \in *P$

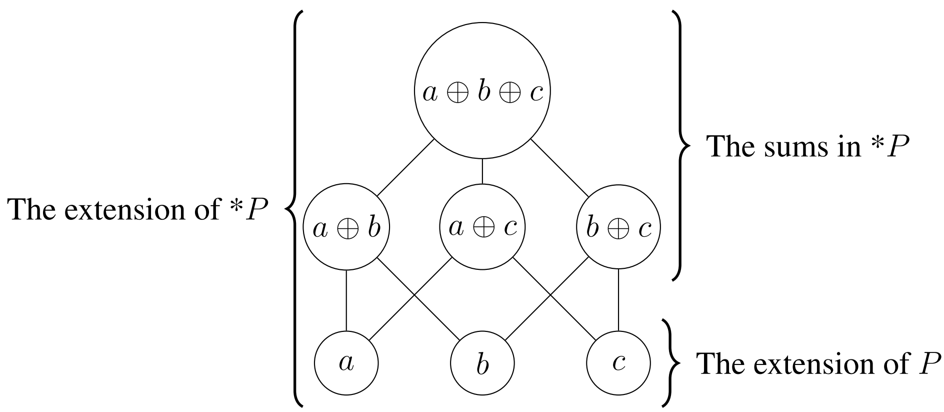

Figure 2.2: The semilattice formed of the extension of a plural predicate $*P$, where $P = \{a, b, c\}$, represented as a Hasse-diagram.

(25) a. $[\![\text{CORKSCREW}]\!] = \{a, b, c\}$

b. $[\![*\text{CORKSCREW}]\!] = \{a, b, c, a \oplus b, a \oplus c, b \oplus c, a \oplus b \oplus c\}$

Note that the view of plurals presented above diverges from the one in Link (1983) in a small but quite important way: for Link, the extension of plural predicates which is formed by the *-operator does not involve singular individuals but only sums of singular individuals. In fact, the set of atoms is a distinguished subset of the domain of individuals. This is the so-called exclusive view of plurals (see also Ojeda 1998, Chierchia 1998). Here I am taking the inclusive view of plurals, according to which the denotation of a plural predicate involves both singular and plural entities (see Krifka 1989, Sauerland 2003, Sauerland, Andersen & Yatsushiro 2005, Zweig 2008, and Chierchia 2010, among many others). While the inclusive view might strike one as unintuitive, the exclusive view proves to be too narrow and runs into serious problems. One of these problems was pointed out already in van Eijck (1983): if plural noun phrases only have sums in their denotation, the sentence in (26) would be true if there is only one book on the table, but that clearly is not the case. For this reason, I will take the standard approach and employ the inclusive view on plurals.[13]

(26) There are no books on the table.

For Link (1983), plurals and mass terms are similar in that they both have cumulative reference, but they differ in that plurals have atoms in their denotation, while mass terms do not. In Link (1983) atoms are the individuals in the denotation of the singular predicate. Those individuals also form a subdomain of atomic individuals within the domain of entities.

2.3.1.3 Beyond cumulative reference and divisive reference

Extending the mereological approach from the mass-count distinction to the singular-plural distinction led to the discoveries of further properties of predicates. As mentioned above, mass nouns and count nouns are sim-

[13] See Farkas & de Swart (2010) for an analysis of plurals where the plural morpheme is assumed to be polysemous – i.e. has both an inclusive and an exclusive interpretation – and the disambiguation happens according to the Strongest Meaning Hypothesis (Dalrymple et al. 1998). (26) is reanalyzed in this spirit assuming that the inclusive interpretation of the plural *books* results in a stronger claim in downward entailing contexts than on its exclusive interpretation.

ilar in that they both have cumulative reference. The difference between mass nouns and plural count nouns can be captured as follows: the denotation of plural count nouns has an atomic base, a set of individuals the denotation of the plural is generated from, while the denotation of mass nouns is baseless. That is, plural count nouns have atomic reference, as defined in (27) based on its definition in Krifka (1989). This property does not apply to mass nouns.

(27) **Definition** Atomic reference

$\text{ATM}(P) \stackrel{\text{def}}{=} \forall x[P(x) \rightarrow \exists y[y \leq x \ \wedge \ \text{AT}(y) \ \wedge \ P(y)]]$

A predicate P has atomic reference iff for every entity x such that P holds of x there exists an entity y such that y is a part of x and y is an atom and P holds of y.

In turn, the difference between singular and plural count nouns can be characterized as follows: the individuals in the denotation of singular count nouns are distinct individuals in the sense that they are not a proper part of any other individual in the denotation of the predicate. In contrast, the individuals in the denotation of plural count nouns can be a proper part of another individual (see Figure 2.2 for the visual representation of this difference between the denotation of singular and plural count nouns). This property of singular count nouns is captured in terms of quantized reference (see again Krifka 1989).

(28) **Definition** Quantized reference

$\text{QUA}(P) \stackrel{\text{def}}{=} \forall x, y[P(x) \ \wedge \ P(y) \rightarrow \neg y < x]$

A predicate P has quantized reference iff for every entity x and y such that P holds of x and P holds of y, y is not a proper part of x.

The combinations of the properties of atomic and quantized reference complemented with the properties of cumulative and divisive reference in (20) and (21) fully characterize singular and plural count nouns, and mass nouns; see Table 2.3. (Actually, any three of these properties fully characterize a noun type.)

	Sg. count nouns	Pl. count nouns	Mass nouns
Cumulative ref.	✗	✓	✓
Divisive ref.	✗	✗	✓
Atomic ref.	✓	✓	✗
Quantized ref.	✓	✗	✗

Table 2.3: Properties of different nominal predicates in English

Although the four properties seem to fully differentiate the categories of nouns, the hypothesis that the different morphosyntactic behaviour of nouns fully correlates with the properties of the structure of their reference has been given up. Chierchia (1998) shows that the morphosyntactic behaviour of nouns and the supposed structure of their reference do not line up (see also Rothstein 2010). There are nouns which have atomic reference but display mass morphosyntax, like *furniture* or *silverware*; and there are nouns that have divisive reference but display count morphosyntax, like *twig*, *fence*, *towel*, *line*, *thing*, *entity*, etc. Most importantly, these nouns seem to lack atoms in their denotation. To account for such cases, one needs a more sophisticated account of the properties of entities that count as atoms in the extension of a noun (see Chierchia 2010, Rothstein 2010, and Grimm 2012, among others) and a semantic theory of number (see Harbour 2008).

2.3.2 The domain of events

Very soon after Link (1983) proposed a structured domain for individuals, Bach (1986) set out the program to extend the theory to the domain of events.[14] The main idea is that the entities in the domain of events (V) form a mereological structure just like they do in the domain of individuals, namely the domain is closed under sum formation $\oplus$, and the entities in it are partially ordered by the part-of relation $\leq$.

The assumption that the domain of events forms a mereological structure is based on the assumption that the expressions used to refer to events

[14] I am using the term *event* broadly, as a synonym of Bach's *eventuality*.

display similar grammatical distinctions like the mass-count, and the singular-plural distinction. This suggests that the same properties that are used to describe nominal predicates and the way they refer to individuals can be used to describe verbal predicates (and other, more complex constructions) and the way they refer to events.

The mass-count distinction in the nominal domain has been related to the atelic-telic opposition in the verbal domain, suggesting that just like mass nouns, atelic verbal predicates can be characterized by the property of divisive reference (see Verkuyl 1972, Dowty 1979, Bach 1986, Krifka 1989, Moltmann 1997, Krifka 1998, Champollion 2017b, among many others). I am going to discuss the atelic-telic opposition in more detail in Section 2.5.1 in relation to the discussion of atomicity in the domain of events, and I will elaborate more on the application of the mereological approach in the domain of events there.

2.4 Atoms in the domain of individuals

Atoms play an important role in the mereological theory of plurals, as they provide the base for the extension of plural count nouns. However, it turns out that it is quite difficult to define atoms. In this section I will discuss the problems with applying the notion of atom as we defined it in (15) – which I will call *absolute atomicity* or *structural atomicity*, and I will argue for the application of a *relative* notion of atom (Krifka 1989) instead.

2.4.1 Absolute vs. relative atoms

In Section 2.2.2 I gave the definition of atom that is usually used in the theory of mereology, repeated here in (29), and renamed as "absolute atom". According to this definition, atoms are a special kind of entity which lack internal structure, as they have no proper parts.

(29) **Definition** Absolute atom (= (15))

$$\textsc{at}(x) \stackrel{\text{def}}{=} \neg\exists y[y < x]$$

> An entity x is an atom iff there exists no entity y such that y is a proper part of x.

This definition captures an intuitive way of thinking about atoms or atomic entities, but employing such an absolute notion leads to some unwanted commitments. If one applies the definition in (29), one commits to the existence of entities without any proper parts. In some cases this might be an innocent assumption (for example when we have a pre-defined model with a very small number of individuals in it), but most of the time committing to the existence of absolute atoms is an arbitrary decision lacking empirical support. While this decision clearly makes things simpler and neater on the surface, it also prevents the notion of atom from reflecting any insights about the inner or perceived structure of individuals that are designated as atoms. And even if the decision is arbitrary, it still carries the metaphysical commitment to the existence of entities without any proper parts. As a consequence, there are certain questions that inevitably arise whenever one settles on treating a certain entity being an atom. Is that entity really without any proper parts? How can one be positive about that?

Fortunately these are questions for metaphysics and epistemology. When mereology is applied in formal semantics, one does not have to, nor need to, engage in the question of the existence of atoms. In the linguistic application of mereology how things actually are carries limited significance; what matters more is how things are structured by language.[15]

The intuition that the difference between the denotation of singular

[15] I do not want to give the impression that I am advocating a view where the way things are in the world and the way they are structured by language are completely independent from each other. I think it is reasonable to assume that linguistically encoded structures are at least partially determined by how things are in the world via human perception. However, I do think that it is problematic to assume a direct mapping between how things are and how they are structured by language. Employing the absolute notion of atom in linguistic inquiry would ultimately entail the assumption that linguistically encoded structures represent real world structures. To avoid committing to this assumption, one crucial thing to do is to emphasize the distinction between "real" atoms, and atoms that are encoded by language.

and plural count nouns is the difference between the inner structure of the individuals that are in their respective denotations can be captured even without the notion of absolute atoms. Unlike plural count nouns, singular count nouns apply to certain individuals and usually do not apply to parts of those individuals.[16] So arguably, the individuals they apply to, even if are not structurally atomic according to the definition in (15), are atomic with respect to the denotation of a natural language predicate.

This way of approaching atoms gives us the relative notion of atom, and following Krifka (1989), it can be defined as follows.

(30) **Definition** Relative atom

$\textsc{at}_P(x) \overset{\text{def}}{=} P(x) \ \wedge \ \neg\exists y[y < x \ \wedge \ P(y)]$

An entity x is an atom relative to a property P if P holds of x and there is no other entity y such that y is a proper part of x and P holds of y.

The relative notion of atom in (30) defines how predicates relate to entities in their denotation: relative atoms are the smallest individuals in the denotation of a predicate in the sense that they have no parts which are also in the denotation of the same predicate.

Employing the relative notion of atom relaxes any ontological commitments regarding the structure of entities without losing any insights regarding the properties of different predicates discussed in the previous section. The property of atomic reference has to be modified slightly to accommodate the relative notion of atoms:

(31) **Definition** Relative atomic reference

$\textsc{atm}(P) \overset{\text{def}}{=} \forall x[P(x) \rightarrow \exists y[y \leq x \ \wedge \ \textsc{at}_P(y)]]$[17]

A predicate P has atomic reference iff for every entity x such that P holds of x there exists an entity y such that y is a part of x and y is an atom relative to P.

[16] For some problematic cases, see the previous section.

[17] This is the definition of atomic reference *simpliciter* from Krifka (1989), as absolute atoms are not defined there.

2.4.2 Atoms in Link (1983)

A curious feature of the theory of plurals in Link (1983) is that being an atom is equally characterized by the intrinsic structural property of absolute atoms in (29) and by the notion of relative atoms in (31). In other words, in the Linkian approach, absolute atoms and relative atoms necessarily coincide. This can be illustrated with the example in (32): while it is possible to treat both (32a) and (32b) as denoting a sum of individuals when the two expressions apply to the same thing in the world, Link argues for something completely different. For Link, (32a) denotes a sum of individuals, and (32b) denotes an atomic individual, even when the two expressions refer to the exact same "portion of matter" in the world.

(32) a. the cards
b. the deck of cards

Most importantly, this is an ontological distinction. Link points out that sum of individuals referred to by the expression *the cards* can have different properties as the atom referred to by the expression *the deck of cards*, as is demonstrated in the example in (33), where it is shown that (33a) and (33b) have different meanings. Assuming that an individual is consistent with respect to a property (it either has it or not), we must conclude that the *the cards* and *the deck of cards* can not refer to the same individual. The principle that says that two individuals are the same if and only if they have exactly the same properties is called Leibniz's Law.

(33) a. The cards on the table are numbered consecutively.
b. The decks of cards on the table are numbered consecutively.

According to this view, two distinct individuals can be comprised of the same portion of matter occupying the same space at the same time in the world. In the case of (32), the atomic individuals making up the sum referred to by the *the cards* are the matter that makes up the atomic individual referred to by *the deck of cards*.[18] Material constitution in Linkian

[18]The relation between individuals and the matter that constitutes them is called *m*-

terms is radically different from identity: although the cards and the deck of cards are constituted of the same matter, neither of them are identical to the matter. But more importantly, they are not identical to each other, either. For the deck of cards, the individual cards are just deck-of-cards matter, and not proper parts, as they are for the sum of cards. That is, in Link's system, we have at least as many atomic individuals as we can determine by applying Leibniz's Law and all of those atoms will be in the denotation of some natural language predicate.

2.4.3 Group nouns and relative atoms

The approach to atoms in Link (1983) is reflected in the treatment of group nouns, which are nouns whose denotation, even in their singular form, is associated with a plurality of individuals, like *committee*, *fellowship*, *family*, *group*, *deck*, *bunch* etc. It is generally assumed that the denotation of a group noun must be distinguished from the denotation of the plural noun denoting the plurality associated with the corresponding group noun. There are two basic ways to make this distinction: one can assume that group nouns denote sets of atomic individuals derived from plurals (see Landman 1989a, 1989b, de Vries 2015, a.o.). Or one can assume that group nouns denote sets of atoms just like plain singular count nouns (Barker 1992 and Schwarzschild 1996, a.o.). Link (1983) treats *deck* in the noun phrase *deck of cards* as a group noun in the latter way.

It has been observed that group nouns can combine with plural predicates, as shown in (34) and (35) (see Schwarzschild 1996, Pearson 2011, de Vries 2015, a.o.). This fact suggests that the denotation of group nouns involves pluralities rather than atoms, derived or not.

(34) Borzi gathered the deck of cards.

(35) The committee gathered.

Here I do not want to delve deep into how the denotation of group nouns

part in Link (1983). This relation is different from the *i*-part relation that holds between individuals.

is best analyzed, but I assume that for group nouns in general it is possible to access the plurality in associated with their referent. Furthermore I posit that group nouns differ from each other with respect to the extent their denotation is exhausted by the denotation of the plural noun phrase denoting the individuals associated with the group noun as its members. We can distinguish two kinds of group nouns based on this criterion: the ones whose denotation is typically exhausted by their members – I will refer to these as *deck*-kind group nouns, and the ones whose denotation is typically not exhausted by their members – I will refer to these as *committee*-kind group nouns.

To tell these two kinds of group nouns apart, I suggest the following test: when combining a definite group noun, on the one hand, and the corresponding definite plural, on the other, with a predicate that tells us the physical location of their denotation, we can infer whether or not the resulting statements convey essentially the same meaning as the statement where the same predicate is combined with the corresponding singular noun universally quantified.[19] If they do, it suggests that the referent of the definite group noun and the corresponding definite plural noun is the same, as they can be used interchangeably in this context. If they do not, it suggests that the definite group noun and the definite plural noun do not refer to the same individual.

In (36) and (37), I show that *deck* and *committee* can in fact be differentiated this way. I use squiggly arrows to express the relationship between the pairs of statements to indicate that it is a non-logical, context sensitive inference (see Winter & Scha 2015 and de Vries 2015 for using the same notation for inferences of similar nature).

(36) a. The cards are on the table $\rightsquigarrow$ Every card is on the table.
b. The deck of cards is on the table $\rightsquigarrow$ Every card is on the table.
c. $[\![$the cards$]\!]$ = $[\![$the deck of cards$]\!]$

[19] Throughout the dissertation, I ignore the non-maximality effect associated with definite plurals. Non-maximality refers to the phenomenon that plural predication in certain contexts allows for exceptions; see Brisson (1998), Križ (2015), a.o.

(37) a. The members of the committee are in the room $\rightsquigarrow$ Every member of the committee is in the room.

b. The committee is in the room $\not\rightsquigarrow$ Every member of the committee is in the room.

c. $[\![$the members of the committee$]\!] \neq [\![$the committee$]\!]$

Here I do not propose an account to explain the distinction between *deck*-kind and *committee*-kind group nouns detected in (36) and (37). I pointed out this distinction to demonstrate that there are contexts where the referent of the group noun and that of the corresponding definite plural noun can coincide.

However, I do not assume that group nouns and the corresponding count nouns have the exact same denotation, even in the case of *deck*-kind of group nouns. If I were to assume that, there would be no way to account for the difference in (33) pointed out by Link (1983). The crucial difference between the denotation of a *deck*-kind group noun and the denotation of the corresponding plural noun is that the denotation of the plural noun is derived from the denotation of the corresponding singular noun whereas the denotation the group noun is not. That is, even if *deck of cards* has an entity in its denotation that is plural with respect to the denotation of another predicate, it is still the smallest element in the denotation of *deck of cards*. In contrast with *cards*, the smallest elements in its denotation are the individual cards.

(38) a. $[\![\text{CARD}]\!] = \{a, b, c, d\}$

b. $[\![\text{CARDS}]\!] = [\![{}^*\text{CARD}]\!] = \{a, b, c, d, a \oplus b, a \oplus c, a \oplus d, b \oplus c, b \oplus d, c \oplus d, a \oplus b \oplus c, a \oplus b \oplus d, a \oplus c \oplus d, b \oplus c \oplus d, a \oplus b \oplus c \oplus d\}$

c. $[\![\text{THE CARDS}]\!] = [\![\bigoplus {}^*\text{CARD}]\!] = \{a \oplus b \oplus c \oplus d\}$

(39) $[\![\text{DECK OF CARDS}]\!] = [\![\text{THE DECK OF CARDS}]\!] = \{a \oplus b \oplus c \oplus d\}$

Under this view, it is expected that the behaviour of *deck*-kind of group nouns and the corresponding count noun will be different when combined with plural predicates, as shown in (33). There, the predicate *numbered consecutively* applies to the smallest elements in the denotation of the subject. In the case of *the cards*, the smallest elements are individual cards, while in the case of *the decks of cards*, they are certain sums of cards. Those are different individuals, so Leibniz's Law is not contradicted.

In sum, applying the notion of relative atom allows us to distinguish between the denotation of some group nouns and that of the corresponding plural nouns without having to assume that this distinction is rooted in the ontology. Here I will not discuss this issue any further, but I will briefly come back to it in Chapter 6.

2.4.4 The domain of individuals without absolute atoms

A supposed advantage of Link's approach to atoms is that it strictly guarantees extensionality even in less straightforward cases like (32) by collapsing the notion of absolute and relative atoms and allowing for the same portion of matter to make up distinct individuals at the same time. Its disadvantage is the abundant ontology with counterintuitively many individuals in it.

Now let us consider how abandoning the notion of absolute atoms and going with relative atoms instead might change the structure of the domain of individuals as defined in Link (1983). There, the set of atoms that provides the atomic base of the complete join semilattice constitutes a distinguished subset of the domain of individuals. The individuals there are assumed to be structurally atomic as well as atomic with respect to a predicate, hence the complete semilattice they form closed under the sum formation is defined both by the inner structure of the individuals and by being in the denotation of a certain predicate.

Without having the absolute atoms and the relative atoms necessarily coincide, the mereological structure formed by the individuals will be independent from the denotation of the predicates. That is, the smallest elements in the structure are determined independently from natural language expressions and Leibniz's Law, but rather by the principle based on which the same portion of matter cannot constitute two distinct individuals at the same time.[20]

[20]We still do not have to assume that the portion of matter and the individual that it

To demonstrate how the domain looks if absolute atoms and relative atoms do not coincide, let us take Link's cards again from the example (32). Now we can assume that both the expressions *the cards* and *the deck of cards* refer to the exact same individual when the two expressions pick out the exact same portion of matter in the world. Let us furthermore assume that that individual is a sum of cards. Now, the difference between the denotation of *cards* and *deck of cards* is that while the former has the cards and all their possible sums in its denotation, the latter only denotes certain sums of atomic cards, but no individual cards. (We know that a deck of cards consists of a certain number and certain kinds of cards, but the individual cards are not in the denotation of *deck of cards*.)

In other words, by only employing the relative notion of atoms, the denotation of different predicates potentially overlap. To retrieve the relative atoms in our domain, we can define the set of relative atoms as in (40).

(40) **Definition** The set of relative atoms

$\text{ATOM}(x) \stackrel{\text{def}}{=} \exists P[\text{AT}_P(x)]$

An individual x is in the set of atoms iff there is a predicate P such that x is a relative atom with respect to P.

Note that the atoms retrieved by (40) are not forming the atomic base of the domain of individuals, it will only give us all the individuals that are atomic with respect to a predicate. Even if the domain of individuals is undefined with respect to atomicity, it is still possible to acknowledge that there are individuals in it that behave as atoms in the denotation of some natural language predicate.

Moreover, employing the notion of relative atom does not compromise extensionality because it does not interfere with any of the axioms in Section 2.2.1. The notion of relative atoms builds on the intuition that the denotation of different predicates can overlap, at least partially. This does not violate anything established by the axioms. Those statements are concerned with the identity of the entities and the relations between them,

constitutes are identical.

but they do not prohibit entities to be members of more than one set. And the notion of relative atom builds on this basic assumption that the same entity can be the member of more than one set.

2.4.5 The conceptual gain of employing the notion of relative atoms

Some might find the efforts to distinguish structural atoms and relative atoms a gratuitous exercise, as it is possible to model the domain of individuals without making this distinction. While I do agree that it is not a necessity, relative atoms do have some conceptual advantages to absolute atoms.

As I showed in this section, the notion of relative atoms does not entail any commitments about the structure of the individuals that are considered as atoms. This is a welcome consequence as one might want to avoid making any ontological claims about the world based on language (cf. Link 1983). But more importantly, the notion of relative atoms is a reminder that being an atom is not an inherent property of the individual itself, but the way a given individual is related to a natural language predicate. The same individual can be an atom with respect to one predicate, but might be nonatomic (or even subatomic) with respect to another predicate, as we have seen in the case of *cards* and *deck of cards*.

This approach to atoms indicates that being an atom is neither a constant nor a defining property of individuals. In Chapter 3 and 4, I will discuss how absolute atoms are considered to play an important role in the study of distributivity, yet empirical evidence suggests that they do not play a crucial role in distributive readings. If we employ the relative notion of atoms, this result is not unexpected and can be accounted for naturally.

2.5 Atoms in the domain of events

In relation to the domain of individuals, our discussion presupposed an intuitive notion about what an atomic individual would be. This is because atomicity can capture the difference in the way we think about matter and stuff like *gold* and *garbage*, on the one hand, and things like *fork* or *pebble*, on the other. It is hard to use the same intuitions when it comes to atomicity in the domain of events.

I assume that this is partially because events can be described in various degrees of complexity, and the less complex description, the harder it is to decide whether there are atoms in the denotation of the linguistic expression serving as the description simply by applying the mereological notion of atoms. However, the more detailed the description, the clearer it is whether it describes a plurality of events or not.

Thus, I am going to argue for the application of the relative notion of atoms in the domain of events too, just like I did for the domain of individuals in the previous section. But unlike in the domain of individuals, I will show that the same description might provide an atomic description of an event along the lines of some property but nonatomic along the lines of another property. I will show that this is possible because certain descriptions relate events to entities from other domains (i.e. individuals, time, space, etc.).

2.5.1 Atomic events in the denotation of verbs

I adopt a Neo-Davidsonian event semantics (Parsons 1990), and I assume verbs denote a set of events, rather than relation between events and other entities. Under this assumption the verb *chase* denotes the set of chasing events, and the verb *catch* denotes a set of catching events. Moreover, I assume that verbs denote both events and their sums, that is, their denotation is closed under the sum formation. This is a common assumption (see Lasersohn 1989, Kratzer 2008, Champollion 2017b, among others), based on observations like if e_1 is chasing and e_2 is chasing then $e_1 \oplus e_2$ is chasing is a valid inference. That is, it is generally assumed that verbs have cumulative reference, as defined in (20). I will refer to this property of verbs as lexical cumulativity, following Kratzer (2008).

One of the consequences of lexical cumulativity is that we do not distinguish between singular and plural forms in the case of verbs.[21] As a result, we do not have to differentiate between singular and plural verbal predicates in our formal representation, like we did in the case of count nouns; see (41).

(41) $[\![\text{CHASE}]\!] = [\![{}^*\text{CHASE}]\!]$

Lexical cumulativity is commonly understood as verbs uniformly having plural denotation (see the discussions in Kratzer 2008 and Champollion 2017b). However, if we assume that the higher order properties defined in Section 2.3.2 characterize verbal predicates similarly to nominal predicates, lexical cumulativity in itself does not determine having plural denotation. Lexical cumulativity merely states that verbs have cumulative reference, and as we saw in Section 2.3.2, cumulative reference characterizes both plural and mass predicates.

To determine whether a predicate that has cumulative reference has a plural denotation or a mass denotation, we have to know whether it has atomic reference or divisive reference. These properties reveal how a predicate is related to the parts of the entities in its denotation.

If we look the verbs *chase* and *catch*, we can see that these verbs differ in whether they apply to the parts of the events in their denotation. The verb *chase* applies to the parts of the events in its denotation: if there is an event e which is a chasing event, the parts of this event are arguably also chasing events. This is not the case with the verb *catch*, because the parts of a catching event are not necessarily catching events themselves.

This distinction is atelic-telic opposition mentioned in Section 2.3.2. In mereological terms, atelic verbal predicates are the ones that have the property of divisive reference[22], like the verb *chase*, while telic predicates are the one that have the property of atomicity, like the verb *catch*. That is,

[21] This is only true in the case of verb roots.

[22] The minimal parts problem arises with verbal predicates too (Taylor 1977), but we can ignore that here for the purposes of the discussion.

the atelic-telic distinction on the verbal domain is assumed to be parallel to the mass-count distinction on the nominal domain.[23]

The atelic-telic distinction is understood along the lines of the temporal constitution of events accessed by verbal predicates. When we determine whether a verb like *chase* or *catch* applies to the parts of the events in its denotation, we understand parthood as relating events to each other based on their temporal properties.

In order to be able to model the temporal properties of verbs and other event descriptions, we have to define the domain of time intervals (*T*). Following Champollion (2017b), I assume that time intervals are one-dimensional entities of stretches of time *t*, like *from Monday to Friday*, *this afternoon*, or *between 10.06 AM and 10.13 AM*. Time intervals are linearly ordered in a precedence relation $\ll$. The entities in the domain of time intervals also form a mereological structure, and they are ordered by the part-of relation $\leq$. According to this last assumption, we assume that the interval denoted by *this afternoon* is a mereological sum of all the subintervals within the interval denoted by *this afternoon*.

Following Krifka (1992), I assume that events are mapped to their runtime via the temporal trace function τ. Temporal traces are homomorphisms from events to time intervals relative to the operation of sum formation.

(42) **Sum homomorphism for events and times** (Krifka 1992)
$\tau(e \oplus e') = \tau(e) \oplus \tau(e')$
The τ temporal trace of the sum of e and e' is the sum of the τ temporal trace of e and the τ temporal trace of e'.

Given the assumption of lexical cumulativity according to which the denotation of verbs is closed under sum formation, that is, they denote both events and their sums, and given that temporal traces are homomorphisms

[23] See Rothstein (2003) for an account on the atelic-telic opposition that does not assume a parallelism with the mass-count distinction on the nominal domain. For Rothstein, both telic and atelic predicates denote atomic events. The crucial difference between telic and atelic predicates is that telic predicates denote a set of individuated atomic events whereas atelic predicates do not.

with respect to sum formation, we can assume that temporal trace functions are also closed under sum formation. In other words, the temporal trace function τ can denote both time intervals and their sums; see (43).

(43) $[\![\tau(e)]\!] = [\![{}^*\tau(e)]\!]$

When discussing atoms in the denotation of verbs, we ultimately talk about events that are in the denotation of a given predicate which have no parts such that the temporal trace of the part is a part of the temporal trace of the events in the denotation of the verb, and the parts are in the denotation of the given verb. I call these atomic events *relative temporal event atoms* and define them formally as in (44).

(44) **Definition** Relative temporal event atom

$\textsc{at-temp}_V(e) \stackrel{\text{def}}{=} V(e) \wedge \neg\exists e'[e' < e \wedge \tau(e) < \tau(e) \wedge V(e')]$

An event e is an atom relative to a property V if V holds of e and there is no event e' such that e' is a proper part of e, the runtime of e' is a proper part of the runtime of e and V holds of e'.

Bare verbs can relate events in their denotation to entities in the domain of time intervals, that is why it is possible to identify atomic events relative to their temporal properties in the denotation of bare verbs.[24] In more complex event descriptions, events can be related to entities in the domain of individuals, and as we will see, atomicity in the domain of events can be understood with respect to their participants, too.

2.5.2 Atomic events and complex event descriptions

The linguistic descriptions of events often relate events to their participants, not just to time. I assume, following Parsons (1990), that events are related to their participants via thematic role functions (θ). Thematic roles map entities in the domain of events to entities in the domain of individuals. Here I do not define an exhaustive set of possible thematic

[24] Events can be related to entities in spatial domains. For the sake of simplicity, here I do not discuss the spatial properties of events.

roles as I am going to focus mostly on agent and theme. I follow Parsons (1990) and assume that the lexical semantics of the verb determines what kind thematic roles are assigned to its arguments. In the case of (45), the verb *chase* assigns the role of agent to its subject and the role of theme to its object.

(45) Borzi chased Henrik.

I make the standard assumption that declarative sentences existentially quantify over an event variable. Given these assumptions, the meaning of (45) can be represented as is in (46).

(46) $\exists e[\textsc{chase}(e) \ \wedge \ \textsc{ag}(e) = \text{b} \ \wedge \ \textsc{th}(e) = \text{h}]$

I assume that every event is related to at most one individual as playing a certain thematic role, i.e. every event has one agent, theme, or goal, etc. This assumption is often called the uniqueness of participants. Following Krifka (1998), I define uniqueness of participants as in (47).

(47) **Definition** Uniqueness of participants (Krifka 1998)
$\theta(e) = x \ \wedge \ \theta(e) = y \rightarrow x = y$
If x plays a theta role θ in e and y plays the theta role θ in e then x equals y.

As I mentioned in Section 2.3.2 and 2.5.1, events are closed under the sum formation. I assume the same for thematic roles. This property is called *summativity* in Krifka (1992) and *cumulativity generalized to two-place predicates* in Krifka (1998). Here I am going to refer to it as *cumulativity of thematic roles* (Champollion 2017b), but the definition in (48) is based on Krifka (1998).

(48) **Definition** Cumulativity of thematic roles
$\theta(e) = x \ \wedge \ \theta(e') = y \rightarrow \theta(e \oplus e') = x \oplus y$ (Krifka 1998)
If x bears the thematic role θ in e and y bears the thematic role θ in e' then the sum of x and y plays the thematic role θ in the sum of e and e'

Just like in the case of temporal trace functions, thematic roles are homomorphisms from events to individuals. In this case, thematic roles preserve the lattice structure with respect to sum formation (see Krifka 1998, Champollion 2017b).

(49) **Sum homomorphism of events an thematic roles** (Champollion 2017b)
$\theta(e \oplus e') = \theta(e) \oplus \theta(e')$
The θ thematic role of the sum of e and e' is the sum of the θ thematic role of e and the θ thematic role of e'.

Given these assumption and the lexical cumulativity of verbs, I assume that the denotation of thematic roles is closed under sum formation, similarly to the denotation of the temporal trace function.

(50) $[\![\theta(e)]\!] = [\![*\theta(e)]\!]$

Event descriptions that relate events not only their temporal traces but also to their participants introduce an extra dimension along which structural properties of events can be understood. In this sense, these event descriptions are multidimensional, as observed by Moltmann (1997), Zimmermann (2002), Champollion (2017b), and others. As a consequence, when we talk about atomic events in relation to these more complex events descriptions, we can do so along the temporal dimension or the dimension of participants, and the atoms we can identify along the different dimensions might not be the same events.

In the case of (51), where the subject is a plurality denoting expression, we can demonstrate this difference. Let's assume that the sentence makes a covert reference to the temporal trace of the event it describes, and it is some time interval t. Along its temporal dimension, the event described by (51) is nonatomic. We can argue as follows: if e is an event of Borzi and Fifi chasing Henrik at t, then the parts of e, such that their runtime is t', where $t' < t$, are also events of Borzi and Fifi chasing Henrik.

(51) Borzi and Fifi chased Henrik.

However, along the the dimension of participants, the event described in (51) appears to be plural, hence associated with atomic events. This time, the argument goes as follows: if e is an event of Borzi and Fifi chasing Henrik at t, then e has two parts e' and e'' such that e' is an event of Borzi chasing Henrik at t and e'' is an event of Fifi chasing Henrik at t. This is based on the assumption that Borzi is a part of Borzi and Fifi, and Fifi is part of Borzi and Fifi. The events e' and e'', in turn, have no parts such that they are events of chasing Henrik by parts of Borzi, or by parts of Fifi.

We can conclude that complex event descriptions, where events are related to both to entities on the domain of time intervals and the domain of entities, display different structural properties with respect to the different domains.[25] Hence, atomic events with respect to the temporal domain are potentially different from the atomic events with respect to the domain of individuals. To account for this possibility, I define relative atomic events with respect to participants as in (44).

(52) **Definition** Relative event atom wrt. its participants

$\text{AT-PTC}_V(e) \stackrel{\text{def}}{=} V(e) \wedge \neg\exists e'[e' < e \wedge \theta(e') < \theta(e) \wedge V(e')]$

An event e is an atom relative to a property V if V holds of e and there is no other event e' such that e' is a proper part of e, the individual that is assigned to e' by θ is a proper part of the individual assigned to e by θ and V holds of e'.

Based on our discussion of complex description of events so far, we could assume that whenever a certain participant of an event is a plural individual, the event has parts along the dimension of participants. However, this is not the case. It has been observed as early as Link (1983) and Scha (1984) that different verbal predicates allow for different entailments when combined with a plural denoting expression. Some verbs and verb phrases like *chase* or *take a breath* allow for distributive entailments, that

[25]Similar observations are captured by the property of *stratified reference* (Champollion 2010, Champollion 2015 and Champollion 2017b). Stratified reference is a higher order property that can capture distributive reference along different dimensions, like the dimensions of time and participants.

is, when they are applied with a plural denoting expression, it is always understood as the predicate applies to the atomic parts of that plurality. Other verbs and verbal predicates like *meet in the living room* or *surround* do not allow such distributive entailments.

Distributive entailments in terms of events mean that when a certain thematic role of an event is assigned to a plurality of individuals then it is entailed that there are multiple subevents whose same thematic role is assigned to the certain parts of that plurality of individuals. This has been demonstrated by the sentence in (51). In turn, sentences with verbs or complex verbal predicates which do not allow for distributive entailments denote atomic events. This is shown in (53), where the surrounding event described by the sentence has no subevents such that those are surrounding events whose agent is a part of the sum of Borzi and Fifi.

(53) Borzi and Fifi surrounded Henrik. $\not\Rightarrow$
Borzi surrounded Henrik and Fifi surrounded Henrik.

In (41) and (53), the distributive entailments or the lack thereof are determined by the lexical properties of the verb. However, it is not always the case that a verb or a complex verbal predicate determines this information on the lexical level; in many cases, the verb or complex verbal predicate tolerates the presence of such entailments but does not require them. Such a case can be found in (54).

(54) Borzi and Fifi carried Henrik.
   a. Borzi and Fifi carried Henrik in C_1 $\Rightarrow$ Borzi carried Henrik in C_1 and Fifi carried Henrik in C_1.
   b. Borzi and Fifi carried Henrik in C_2 $\not\Rightarrow$ Borzi carried Henrik in C_2 and Fifi carried Henrik in C_2.

(54) illustrates that the verb *carry* in itself does not determine the presence or absence of distributive entailments. The sentence that describes a carrying event whose agent is a plurality (the sum of Borzi and Fifi in this case) is compatible with a context where the distributive entailments are present (C_1), also where they are absent (C_2). The contrast between

chase and *surround* on the one hand, and *carry*, on the other, suggests that whether a complex event description describe atomic or plural events with respect to their participants is determined by lexical clues in some cases, and contextual clues in others.

2.5.3 Atomic parts of plural events

So far we have seen that plurality of events can be understood in terms of complex event descriptions with respect to the participants of the event according to the description. In this case, if a participant bearing a certain thematic role in the event is a plurality, there might be parts of the event where the same thematic role is assigned to parts of that plurality.

Here I argue that this is not the only way we can understand plurality in terms of events. There are cases where there are multiple events fitting the clausal description. These events are atomic with respect to the plurality that consists of the sum of the events fitting the clause description. Such a case can be found in (55).

(55) Borzi and Fifi carried Henrik on Monday and Tuesday/each time.

(55) describes an event that happened multiple times, i.e. a plurality of events. The atomic parts of that plurality are the events of Borzi and Fifi carrying Henrik. The single events of Borzi and Fifi carrying Henrik are atomic with respect to the plurality regardless whether they themselves have parts along the dimension of time or that of participants. That is, these events are atomic by virtue of fitting the clause description provided by (55). In a sense, their atomic status can be considered trivial: they are the events that have the participants and the temporal properties described by the clause, none of whose parts have the same participants and same temporal properties.

To identify atomic events with respect to the clause description, we have to assume that these events are individuated to begin with. In the case of (55), we assume that there are distinct events such that each of these event fit the description of Borzi and Fifi carrying Henrik. If there is an event of Borzi and Fifi carrying Henrik and there is *another* event of

Borzi and Fifi carrying Henrik, then there is a sum of these events whose atomic parts are events of Borzi and Fifi carrying Henrik. In this sense, the relation between atomic events with respect to the clause description and the plurality consisting of their sum can be expressed by the mereological part-of relation between the events only. The mereological structure formed by atomic events with respect to the clause description does not correspond to the mereological structure formed by the participants of the events.

2.6 Conclusions

In this chapter, I discussed the notion of atom which plays an important role in mereology, as well as its linguistic application. The notion of atom in mereology is understood in structural terms: atoms are entities that have no proper parts. This structural or absolute notion of atom is generally adopted in the linguistic applications of mereology. I argued that this has unwelcome consequences: by applying the absolute notion of atoms in linguistics, one commits to the existence of atomic entities, as well as makes the assumption that the structural properties of entities necessarily have linguistic relevance.

To avoid these problems, I adopted the notion of relative atom to be used in linguistic applications of mereology. My assumption is that while predicates and more complex expressions can denote atomic entities, those entities are only atomic with respect to the denotation of the linguistic expression. That is, for an entity to be atomic, I do not assume that it has to be atomic in structural terms, but only with respect to the denotation of a natural language expression.

I defined the notion of relative atoms on the domain of individuals and on the domain of events. In both cases, I relativized the notion of atoms with respect to a property or description. I showed that the notion of atoms in the domain of events is not only relativized with respect to a property, but also with respect to other domains. This is because linguistic description of events relate events to entities in other domains – the domain of time intervals, participants and locations. In this respect, events can be described as multidimensional entities. I defined relative event atoms with respect to the temporal domain and the domain of individuals. I also showed that events can be atomic with respect to a plurality given a description regardless them themselves having parts along the dimension of time or that of participants.

Thinking about atoms not as structurally monolithic entities, but as entities that *appear* as monolithic with respect to a property or a description, not only frees linguistic theory from unwanted ontological commitments, but, as I will show in Chapter 4 and Chapter 5, it also helps to account for some initially puzzling data. I will focus on the theory of distributivity which heavily relies on the importance of structural atoms in both the domains of individuals and events. In what comes next, I argue that relying on structural atoms limits the explanatory power of the theory of distributivity, and by applying the notion of relative atom, we can account for data that seems problematic or puzzling if we rely on the notion of structural atoms.

Chapter 3

DISTRIBUTIVE REFERENCE AND ATOMICITY

3.1 Introduction

In this chapter I discuss the notion of distributive reference and the role atomicity plays in the understanding of that notion. First, I will give a minimal definition of what I mean by distributive reference. Then I will discuss the ingredients of the relation established by distributive reference.

Distributive reference can be characterized as a relation between a plurality and an expression whose denotation is distributed over the parts of that plurality. In the theory of distributive reference, it is assumed that the structure of the entities in the denotation of the sorting key which are involved in the distributive relation plays a key role in characterizing the distributive relation. In this chapter, I will review how this assumption shaped the discussion of distributive reference, focusing on cases where the denotation of the sorting key is in the domain of individuals and events.

The goal of this chapter is to argue that the assumed relevance of the structure of the entities in the denotation of the sorting key is, at least partially, a side effect of applying the absolute notion of atoms to represent the structure of entities in different domains. As such, it prepares the ground for the discussion in Chapter 4 and Chapter 5, where I will provide detailed evidence for and analyses of distributive reference for a theory where atoms are not defined as an absolute notion.

3.2 A minimal definition of distributive reference

I use the term *distributive reference* in a broad way, to refer to the phenomenon in which a sentence involves an overt or covert reference to a plurality of entities and the denotation of another expression is distributed over the relevant parts of the plurality rather than holding of the plurality itself.[1]

In (1) for instance, there is an overt reference to a plurality of individuals denoted by *the guests*, and the sentence has distributive reference if the property described by the VP *call a taxi* does not apply to the guests as a group, but to some of its parts, i.e. to each guest or to each group of guests. In (2), there is an overt reference to a plurality of events denoted by *the parties*, and the sentence has distributive reference if the proposition described by the NP+VP *Marie called a taxi* holds of individual parties rather than the plurality of parties as a whole.

(1) The guests called a taxi at the end of the party.

(2) Marie called a taxi at the end of the parties.

Distributive reference is contrasted with non-distributive reference, which occurs when a sentence involves overt or covert reference to a plurality of entities and the denotation of a constituent holds for the plurality as a whole without necessarily holding of any parts of the plurality; see (3) and (4). Here I do not distinguish further categories within non-distributive

[1]It is not common in the literature to give a definition of distributivity as a phenomenon. The definition given here is extracted from the works cited throughout this chapter.

reference, such as collective and cumulative reference.[2] I am not going to discuss non-distributive reference in detail, but rather will mention it only when necessary.

(3) The guests called a taxi. ≈
'The guests as a group called a taxi'

(4) Marie called a taxi at the end of the parties. ≈
'Marie called a taxi once, at the end of all the parties'

Distributive reference is often associated with universal quantification over atomic parts of the plurality (see Scha 1984, Link 1983, Roberts 1987, Choe 1987, Landman 1989a, Link 1991, Lasersohn 1995, Winter 2001, Mendia 2015, among many others). This is based on the observation that in English, distributive reference is most typically achieved with the overt quantificational item *each* which results in universal quantification over individual parts of the plurality. Even if *each* is not overt in the sentence, as in (1) and (2), distributive reference is assumed to be identical to the meaning of sentences with an overt *each*, as illustrated in (5) and (6).

(5) The guests called a taxi. ≈
'Each individual guest called a taxi'

(6) Marie called a taxi at the end of the parties. ≈
'Marie called a taxi at the end of each party'

Even though the notion of distributive reference is often associated with atomic entities, it has been argued before that distributive reference can in fact involve nonatomic entities, based on cases like (7). This sentence can be understood as the predicate *called a taxi* applying to nonatomic entities with respect to the denotation of *guests* (see Gillon 1987, Schwarzschild 1996, Champollion 2016a, Glass 2018, a.o.).

(7) The guests called a taxi. ≈

[2]For a discussion on whether collectivity and cumulativity are distinct from each other and for references on the topic, see Glass (2018: Chapter 2).

‘Each individual guest called a taxi’ OR
‘Each group of guests called a taxi’

Defining distributive reference in a way that it involves nonatomic entities is neither a new nor a radical idea, as underappreciated it sometimes may be. That said, the central question of this dissertation is not whether the definition of distributive reference should allow nonatomic entities to be involved or not (based on (7), the answer is clearly yes). Rather, the question is to what extent is the criterion of atomicity is useful or relevant within the definition of distributive reference in the first place. To try to begin to answer that question, I introduce and discuss some further concepts related to distributive reference.

3.3 The ingredients of distributive reference

Here I take distributive reference to be an inherently relational concept. The relational notion of distributivity comes from Choe (1987), where distributive reference is understood as a dependency relation between the ‘sorting key’ and the ‘distributed share’.[3] In Choe’s terms, the distributive relation is essentially similar to universal quantification, where the sorting key denotes the entity that is the domain of the distribution, which must be a plurality, and the distributed share denotes the entity that is distributed over the sorting key; see (8).

(8) The guests called a taxi.
✻ Sorting key: ‘the guests’
✻ Distributed share: ‘a taxi’ (à la Choe 1987)

In Choe (1987), and in Choe (1991), both the sorting key and the distributed share are defined as entity-denoting expressions. However, as

[3]There are different ways to refer to these concepts. For a brief discussion of the terminology see Champollion (2017b: Chapter 4.4). Here for the sake of simplicity I adopt the terminology in Choe (1987), even though I use the terms slightly differently from their original meaning; see discussion below.

already shown in Section 3.2, distributivity does not always involve a relation between entities, it can also involve a relation between an entity and a property. In those cases, Choe's approach cannot identify the ingredients of distributivity, which is a problem if we would like to treat all cases of distributivity uniformly.

I will follow Champollion (2017b) and assume that the distributed share can denote properties rather than entities. By extending the notion of distributed share, the ingredients of distributivity of (8) are identified as in (9).

(9) The guests called a taxi.
✻ Sorting key: 'the guests'
✻ Distributed share: 'called a taxi' (à la Champollion 2017b)

Distinguishing between the sorting key and the distributed share is useful because it allows us to refer to the components of distributive reference independently from their syntactic roles and positions in the sentence. In this thesis, a substantial amount of the discussion will focus on cases where the sorting key is the plural subject and the distributed share is the VP; see Chapter 4. But, as shown in (11) and (12), the sorting key just as well can be the direct or indirect object in the sentence.

(10) The guests called a taxi.
✻ Sorting key: subject NP
✻ Distributed share: VP

(11) Amelia called Marie and Valentina on the phone.
✻ Sorting key: object NP
✻ Distributed share: subject NP + V + indirect object

(12) Marie wrote an email to Amelia and Valentina.
✻ Sorting key: indirect object NP
✻ Distributed share: subject NP + V + direct object NP

Identifying the ingredients of distributivity independently from their syntactic roles and positions is useful also because it allows us to identify the ingredients of distributive reference regardless how they are marked on the surface. In many languages, as in English, it is equally possible to mark the sorting key or the distributed share in a sentence; see (13) and (14). Although the constructions on the surface look different, and they have different syntactic structures, they are assumed to convey the same meaning. In other words, while (13) and (14) are compositionally different, they are supposed to have identical truth conditions, as the sorting key and distributed share are the same in both sentences.

(13) **Each** dog got a treat.
✻ the sorting key is marked

(14) The dogs **each** got a treat.
✻ the distributed share is marked

In terms of its ingredients, it is possible to understand distributive reference as the distributed share finding the smallest entities fitting its description that are parts of the plurality provided by the sorting key. Considering the discussion of relative atoms in the previous chapter, those entities are necessarily atomic with respect to the description provided by the distributed share simply because they are the smallest entities that fit the description provided by the distributed share. However, they may or may not be atomic with respect to the sorting key.

In the rest of this chapter, I am going to discuss distributive reference in terms of the ingredients presented in this section. First I am going to discuss how the distributed share finds its atoms, i.e. the linguistic and non-linguistic clues to distributive interpretation. Then, I am going to discuss whether the atoms found by the distributed share are atomic or not with respect to the denotation of the sorting key, focusing on cases where the sorting key is from the domain of individuals and the domain of events.

3.4 Clues to distributive interpretation

As I mentioned in the previous section, distributive reference can manifest itself in many different ways. In each case, however, there is some clue based on which we can infer that we are dealing with distributive reference. In this section, I review these clues.

I posit that distributive reference can arise based on two basic kinds of clues: the lexical meaning of the predicate, or contextual factors – by the term *contextual*, here I mean clues provided by both linguistic and extralinguistic context. If it is the lexical meaning of the predicate that is responsible for distributive reference, contextual factors cannot interfere and cancel it. However, if the lexical meaning of the predicate does not determine distributive reference – because it is compatible both with distributive and non-distributive interpretations – only contextual factors can be responsible for distributive reference. Within contextual factors, here I will review two: overt quantificational elements, and covert operators.

3.4.1 The lexical meaning of the predicate

In some cases, the lexical meaning of the predicate determines whether it applies to atomic or nonatomic entities[4] within the denotation of the nominal expression the predicate is applied to. Some predicates only apply to atomic entities, while others only apply to nonatomic entities, i.e. pluralities (see Link 1983, Scha 1984, and Winter 2001, a.o.).

In (15), there are examples for predicates that can only apply to atomic entities in the denotation of the nominal expression the predicates are applied to. This is due to world knowledge or the lexical meaning of the predicates, as they both describe properties that can only hold of individuals, but not sums: *bark* is something only individual dogs (and maybe other animals) can do, and *have grey hair* can also only apply to atomic dogs or anything with hair. The properties these predicates describe are not interpretable for sums.

(15) a. The dogs barked.
b. Borzi and Fifi have grey hair.

[4]In this discussion I really only talk about individuals as opposed to events, but I use the term *entity* for the sake of uniformity.

Conversely, the examples in (16) demonstrate that some predicates describe properties that can only hold of sums of individuals, i.e. pluralities. That is, again, due to world knowledge encoded in lexical meaning.

(16) a. The dogs gathered behind the butcher shop.
b. Borzi and Fifi bonded.

While the predicates in (15) and (16) differ with respect to what kind of individuals they can apply to, what they have in common is that they determine this information on the lexical level; it is inherent to the meaning of these predicates. Following Champollion (2010), I call the kind of distributivity when distributive reference is determined on the lexical level *lexical distributivity*.[5]

Lexical distributivity can be represented as meaning postulates, which are special restrictions on the model imposed by the predicates. In this spirit, lexical distributivity can be captured as certain predicates require to be interpreted as holding of each atomic part of the plurality they are applied to (see Scha 1984 and Hoeksema 1983). To demonstrate how meaning postulates work, I will represent the sentence in (15a), but in order to do that, first I give the semantics of definite NPs.

I follow Link (1983), Landman (1989a), a.o., and assume that the definite determiner is translated as the maximality operator applied to the predicate; see (18). The maximality operator σ, picks out the maximal element in the denotation of the predicate it is applied to; see (17).

(17) **Definition** Maximality operator
$\sigma x[P(x)] = \bigoplus P$

(18) $[\![\text{the}]\!] = \lambda P[\sigma x[P(x)]]$

Now we can represent the meaning of the sentence in (15a) as in (19a). By adding the meaning postulate in (19b), we ensure that the formula in (19a) is always interpreted as the predicate holds of all the atomic parts of the plurality it is applied to.

[5] This kind of distributivity is also called *predicate (P) distributivity* (Winter 1997) and *predicative distributivity* (Champollion 2017b).

(19) a. $^*\text{BARK}(\sigma x.^*\text{DOG}(x))$
b. $^*\text{BARK}(x) \;\wedge\; |x| > 1 \rightarrow \forall y[y < x \;\wedge\; \text{AT}_{\text{DOG}}(y) \rightarrow \text{BARK}(y)]$

A clear advantage of representing lexical distributivity as a meaning postulate is that it allows us to treat distributive and non-distributive predicates in a similar fashion. However, in many cases, predicates do not determine distributive reference lexically, and sentences with these predicates can only establish distributive reference via contextual clues.

3.4.2 Contextual clues

Here I assume that contextual clues to distributive reference are overt or covert quantificational elements in the sentence. Following Winter (1997), I will refer to this kind of distributivity as *quantificational distributivity*. The main difference between lexical and quantificational distributivity is that unlike lexical distributivity, quantificational distributivity is assumed to potentially involve different scope relations between arguments.

The most obvious cases of distributive reference via contextual clues are sentences with the quantificational item *each* which unambiguously signifies distributive reference, as in (20). But other quantificational items like *every*, *a few*, or *most* also convey distributive reference.[6]

[6]One might wonder whether adverbs like *individually* or *alone* (discussed in Moltmann 1997) are contextual clues to distributive reference or not. If such adverbs appear in a sentence where the main predication is over a plurality, these expressions seem to force distributive reference.

(i) Amelia and Valentina repaired a bike individually/alone.

However, here I will not discuss them as contextual clues to distributivity, for the following reason: adverbs like *individually* and *alone* can be present in the sentence even if it makes no reference to any plurality.

(ii) Amelia repaired a bike individually/alone.

I take that expressions like *individually* and *alone* are manner modifiers. While they

(20) a. The dogs **each** got a (potentially different) treat.
b. **Every/A few** dogs/**Most** dogs got a (potentially different) treat.

Distributive reference can arise without any overt quantificational items present in the sentence, as shown in (21). Following Champollion (2016a) I will refer to these cases as *covert* distributive reference, as opposed to *overt* distributive reference, when distributive reference is due to an overt marker in the sentence, as in (20).

(21) The dogs got a treat.

It is generally assumed that covert distributivity is quantificational distributivity, only the quantification is not overtly expressed in the sentence (see Roberts 1987, Link 1991 for the earliest references). The structural mechanism that is assumed to generate the distributive interpretation of sentences like (21) involves universal quantification over the denotation of the sorting key, just like in the other cases of distributivity we have seen so far.

However, there is a crucial difference between the overt quantificational distributivity in sentences like (20) and covert distributivity. In the cases of overt quantificational distributivity, the distributed share can only be related to atomic parts of the plurality provided by the sorting key, whereas in cases of covert distributivity, the entities in the sorting key can either be atomic or nonatomic. That is, we can understand (21) describing a situation where each dog got a treat, see (22a) or where some groups of dogs got a treat, see (22b) (see also (7) in Section 3.2).

(22) a. The dogs each got a treat.
b. Each group of dogs got a treat.

Based on (21), we can assume that contextual clues can not only establish distributive reference, but they can also determine whether the entities

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seem to modify the meaning of the predicate so that it must apply distributively, their meaning contribution is not exhausted by that effect, so I will not discuss these adverbs here.

in the denotation of the distributed share are atomic or nonatomic with respect to the denotation of the sorting key.

Contextual clues to distributive reference can also determine the domain from which the denotation of the sorting key is drawn. This has been observed in cases where the distributive relation is established by the so-called distributive numerals (Gil 1982). Distributive numerals are present in many languages and form a diverse group based on their morphosyntactic properties (Gil 2013), but their signature semantic feature is assumed to be that they can have their sorting key either from the domain of individuals, or the domain of events. This is demonstrated in (23) from Hungarian, where the distributive interpretation[7] is induced by the distributive numeral *három-három kisérő*, lit. 'three-three chaperone'. As a result, the sorting key of the distributive relation expressed by (23) can be of the domain of individuals, see (23a), or from the domain of events, see (23b).[8] I will discuss the sorting key in Section 3.5 in more detail.

(23) *A diák-ok* ***három-három*** *kisérő-vel utaztak.*
the student-PL **three-three** chaperone-COM travel.PST.3PL

a. 'The students traveled with three chaperones each'
✻ Sorting key: the students
✻ Distributed share: traveled with three chaperones

b. 'On each occasion, the students traveled with three chaperones'
✻ Sorting key: contextually salient occasions
✻ Distributed share: the students traveled with three chaperones

In the rest of this chapter, I am going to focus on cases of covert distributive reference as in (21) and distributive reference established by dis-

[7]Event though the term *interpretation* alludes to ambiguity, here I use it as a theoretically neutral term, as the term *understanding* is used in Lasersohn (1990), Nouwen (2016) and Glass (2018).

[8]Hungarian distributive numerals are assumed to not to give rise to event distributive interpretation, see Farkas 1997, Szabolcsi 2010, Csirmaz & Szabolcsi 2012, Farkas 2015. I argue against that assumption at length in Chapter 5.

tributive numerals (Hungarian reduplicated numerals in particular), as in (23). While the two cases differ in some crucial respects, they provide an excellent basis to examine how the mereological structure associated with the sorting key is assumed to determine some crucial properties of the distributive relation it is part of.

3.5 (Non)atomicity and the sorting key

In a distributive relation, the sorting key is always assumed to be a plurality of entities. Given our discussion in the previous chapter, in a mereological set-up this entails that the plurality provided by the sorting key has parts, some of them atomic, some of them nonatomic. Whether one employs the relative notion of atom or not, these parts might be (non)atomic only with respect to a property that characterizes the sorting key, or might be structurally (non)atomic, in which case their (non)atomicity corresponds to their internal structure.

Since we understand the distributive relation as the distributed share finding its atoms among the parts of the plurality provided by the sorting key, and given that this plurality has both atomic and nonatomic entities as its parts, it follows that the atoms in the denotation of the distributed share might not be atoms with respect to the sorting key. One fundamental assumption in the theory of distributivity is that the atomicity of the entities in the denotation of the distributed share with respect to the sorting key is a defining feature of distributive reference. This assumption has its origins in the way atoms were defined in Link (1983): as discussed at length in Chapter 2, there atoms are understood in absolute terms, and the denotations of count nouns are associated with atoms (in the case of singular count nouns, they denoted atomic individuals; in the case of plural count nouns, the entities in their denotation had them as atomic parts). In distributive reference, these atoms played an important role: they were assumed to be the only kind of individuals involved in distributive reference.

Since Link (1983), it has been observed and generally accepted that not only atomic individuals can be involved in distributive reference, as shown in (21). Nonetheless, the assumption that the (non)atomicity of the individuals involved in distributivity plays an important role in the theory of distributivity has been upheld (see Champollion 2016a and 2016b).

The assumption carries over to cases where the sorting key is from the domain of events (as in (23)), even though the atomic-nonatomic variation, as in (21), has not been observed in distributive reference involving events. Still, the theory of distributivity requires distributive reference to be defined along the lines of (non)atomicity. In the domain of events, atomicity might not be defined (see Krifka 1998, Champollion 2017b), or, as we have seen in Chapter 2, might be defined in various ways. That is, understanding atomicity in terms of distributive reference involving events might rather be a consequence of theoretical commitment, and not motivated as the same way it is with individuals.

In the rest of this chapter, I will review how the discussion of distributive reference has been shaped by the assumption that the (non)atomicity of entities involved in the distribution is an important feature of distributive reference. I organize the discussion based on the domain of the sorting key: first, I discuss the domain of individuals. I will refer to the related sort of distributivity as *individual distributivity*.[9] Then I will discuss the domain of events, and what I refer to as *event distributivity*.

3.5.1 Individual distributivity and (non)atomicity

As stated above, in the case of covert distributive reference the distributive relation can involve both atomic and nonatomic individuals with respect to the plurality provided by the sorting key. The two different kinds of distributive reference are often referred to as atomic distributivity and nonatomic distributivity, respectively, see (24).

(24) The trees form a triangle. $\approx$

a. 'Each tree forms a triangle' atomic

[9] The phenomenon is also discussed as *participant key reading* (Balusu 2006) or *participant distributivity* (Cable 2014).

b. ‘Certain groups of the trees form a triangle’ nonatomic

Atomic and nonatomic distributivity are accounted for by the same mechanism, by a silent verbal operator taking scope over the VP. The crucial difference is in the structure of the individuals referenced in the semantics of the verbal operator. To account for atomic distributivity, the operator is defined in a way that it modifies the meaning of the VP so that it applies to every atomic individual in the denotation of the plural subject. However, in the case of nonatomic distributivity, the structure of the individuals referenced by the semantics of the operator has to be a bit more sophisticated than that, as we will see below.

3.5.1.1 Atomic individual distributivity

As mentioned in Section 3.4.2, the classic analysis of how atomic distributivity arises in sentences like (24) is in Roberts (1987) and Link (1991)[10] who assume that it is due to a covert distributivity operator taking scope over the VP. This assumption is based on the observation that the distributivity in (24) is essentially the same as the distributivity that arises by the means of a quantificational lexical item in the sentence, as demonstrated in (25).

(25) The trees form a triangle. $\approx$
The trees *each* form a triangle.

The silent verbal operator is called the D-operator. The semantics of the D-operator in (26) – which is the same as the semantics of the overt adverbial *each* – makes an overt reference to structural atoms assumed to be in the denotation of the plural NP to which the VP is applied. The structure assumed for (24) is in (27a), and the truth conditions are in (27b).

(26) **Definition** D-operator
$[\![D]\!] = \lambda P \lambda x \forall y[y \leq x \ \wedge \ \textsc{at}(y) \rightarrow P(y)]$

[10]Link (1991) was written before Roberts (1987). Roberts herself cites the unpublished version of Link (1991).

The D-operator takes a predicate P and an individual x and it modifies P in a way that it holds of every atomic part y of x.

(27) a. [[The trees] [*D* [form a triangle]]]
b. $\sigma x[{*}\textsc{tree}(x) \wedge \forall y[y \leq x \wedge \textsc{at}(y) \rightarrow \textsc{form-a-triangle}(y)]]$

One important consequence of accounting for atomic distributivity as in (27) is that we expect sentences with covert distributive reference to be ambiguous between the distributive and the non-distributive readings, see (28).

(28) The trees form a triangle $\approx$
a. The trees *each* form a triangle. dist.
b. The trees *together* form a triangle. nondist.

Since distributivity in (24) is captured by structural means, namely by assuming the silent D-operator taking scope over the VP, nondistributivity is assumed to have its sources in the structure, too. Most often it is assumed that nondistributivity is merely due to the absence of the D-operator, but there are approaches that capture nondistributivity by additional operations (Landman 2000). In either way, according to the D-operator approach, sentences like (24) are assumed to be structurally ambiguous, having exactly two possible readings.

3.5.1.2 Nonatomic individual distributivity

The most widely accepted way to account for nonatomic distributivity is in Schwarzschild (1996), where a modified version of the D-operator is proposed. The new operator is called Part, and it is defined in a way that it is flexible enough to account for nonatomic distributive reference; see (29). The innovation in Schwarzschild's Part is that it does not modify the meaning of the VP so that it applies to individuals of a certain structure. Instead, it merely states that the individuals the VP is applied to have to be provided by the context. Otherwise the mechanism of Part is the same as that of D.

(29) **Definition** Part-operator

$[\![Part]\!] = \lambda P \lambda x \forall y[y \leq x \ \wedge \ y \in C(x) \rightarrow P(y)]$, where $C(x)$ is a cover over the individual x

The Part-operator take a predicate P and an individual x and modifies P in a way that it will hold of every y such that y is in a contextually salient cover C over x.

To ensure context-dependency, the definition of the covert distributivity operator Part in (29) refers to free cover. *Cover* is originally a set theoretical concept – in Schwarzschild (1996) set theory is applied to model the domain of individuals – which can be defined as follows: the cover C of a set X is a set of subsets of X where every element of X is included in a subset in C, and the subsets in C may overlap.

The notion of cover can be redefined in mereological terms. The mereological definition of cover can be given as follows: $C(x)$ is a cover over the entity x if $C(x)$ is a set of parts of x where every atomic part of x is part of a member of $C(x)$, and the members of $C(x)$ may overlap. (See formal definitions of covers both in both set theoretical and mereological terms in Chapter 4, Section 4.2.1.)

In Schwarzschild's Part-operator the variable C is left unbound which means that its value is given by the context. As a result, it is assumed that the meaning of sentences like (24) can only be evaluated with respect to a given context.

(30) a. [[The trees] [*Part* [form a triangle]]]

b. $\sigma x[{}^*\text{TREE}(x) \wedge \forall y[y \leq x \wedge y \in C(x) \rightarrow \text{FORM-A-TRIANGLE}(y)]]$

c. 'Each contextually salient group of trees form a triangle'

A crucial difference between the D-operator and the Part-operator approach – other than the structure of entities referenced in their semantics – is that Part is assumed to apply in the structure of the sentence on all its possible interpretations. In other words, according to the Part-operator based approach, sentences similar to (24) are not ambiguous: their nondistributive, atomic and nonatomic distributive reference all correspond to the same syntactic structure.

3.5.1.3 Theoretical and empirical loose ends

Even though Part was designed to eliminate the atomic-nonatomic distinction as it accounts for both atomic distributive and nonatomic distributive interpretations, it has not become general praxis to employ the Part-operator to analyze covert distributivity. The issue with Part is that it is assumed to overgenerate: due to its unrestrictedness, it predicts nonatomic distributive reference even in cases where that interpretation is assumed to be unavailable (see this kind of criticism in Lasersohn 1989, Lasersohn 1995, Link 1998b, Winter 2001 among others), which suggests that atomicity of individuals in fact is a crucial aspect of distributive reference. The availability of (non)atomic distributivity is, however, first and foremost an empirical issue about the possible meanings of certain sentences, and not a theoretical one. And as it is an empirical issue, it cannot be resolved without empirical evidence.

Another issue with the D and Part approaches to covert distributive reference is that the semantics of both operators inherently assume the the existence of absolute atoms. While the D-operator wears this fact on its sleeve, and references absolute atoms in its very definition (see (26)), the Part-operator alludes to them via the definition of covers. Presupposing the existence of absolute atoms is not an inherent problem with any account; it is only a problem if absolute atoms are not defined within our formal toolkit, which they are not in our case.

Both of these issues are going to be addressed at length in Chapter 4. There, I am going to present an account of covert distributive reference that does not presuppose the existence of absolute atoms, and I will report the results of an experiment on the availability of nonatomic distributivity.

3.5.2 Event distributivity and (non)atomicity

Turning to event distributivity, the structure of entities involved in the distributive relation raises different kinds of questions than it does in individual distributivity. In individual distributivity, the questions are related to how to best represent the distinction between atomic and nonatomic distributivity and how nonatomic distributivity arises. With event distributivity, however, no such distinction has been observed.

Instead, the question of atomicity in relation to event distributivity is connected to how the domain of events and the related domains, like that of time, are defined, and how the meaning of sentences involving event distributive reference should be modeled. That is, atomicity in case of event distributivity is less of an empirical issue, and more of a theoretical one. As such, accounts of event distributive reference might not even address the question of atomicity explicitly, though they tend to make assumptions regarding the structure of events involved in distributive reference.

3.5.2.1 Atomic vs. nonatomic event distributivity

In several accounts of distributive numerals in different languages, e.g. Oh (2001), Balusu (2006) and Cable (2014), it is assumed that distributive reference over events involves atomic entities. While in Oh (2001) and Balusu (2006) this assumption collateral is and follows from their employment of the appropriate versions of the D-operator to account for event distributivity, Cable (2014) explicitly treats the events in the denotation of the sorting key to be atomic.

Even though these accounts differ in their key characteristics, what they have in common is the way they paraphrase the sentences with a distributive numeral when understood as conveying event distributive reference; see (31)–(33).

(31) *John-kwa Mary-ka kabang sey-kay-**ssik**-ul*
John-and Mary-NOM suitcase three-CL-**DM**-ACC
wunpanha-ess-ta.
carry-PST-DECL
a. 'John and Mary carried three suitcases each'
b. 'John and Mary carried three suitcases each time' (Korean, Oh 2001)

(32) *ii pilla-lu* ***renDu renDu*** *kootu-lu-ni cuus-ee-ru*
these kid-PL **two two** monkey-PL-ACC see-PST-3PL

a. 'These kids saw two monkeys each'
b. 'These kids saw two monkeys in each time/location' (Telugu, Balusu 2006)

(33) ***Nás'gigáa*** *x̱áat has aawasháat.*
three.DM fish PL.3O.PFV.3S.catch

a. 'They caught three fish each'
b. 'They caught three fish each time' (Tlingit, Cable 2014)

On their event distributive interpretation, it is assumed that the sorting key in (31)–(33) is a plurality of contextually salient events, such that in each of these events a given number of entities participated – where the given number is signaled by the distributive numeral. These events are assumed to be atomic parts of the plurality, not because they are defined that way in the model. In Balusu (2006), it is explicitly argued that the dimensions along which the events are individuated, like time and space, are mass-like, so atomicity cannot inherently be interpreted with respect to time and space; instead, the temporal and spatial regions associated with the "atomic" events are chunked into recognizable units in the context.

Here I make no assumptions how events are individuated as atomic or distinct from each other. For our purposes, it is enough to acknowledge that when event distributivity is assumed to be atomic, it is not because it is assumed that the events involved in the distributive relation are atomic in the structural sense. Rather, because they behave as atoms given the clausal description provided by the sentence (see discussion in Chapter 2, Section 2.5.3). In this sense, the accounts that treat event distributivity as atomic arguably employ a notion of relative atom.

In turn, in Champollion (2016b) it is assumed that event distributivity is nonatomic. That is because Champollion assumes that in cases of event distributivity – which he refers to as *occasion readings* – the sorting key is from the domain of times or locations, and because these domains are defined as nonatomic, event distributivity is automatically nonatomic as well. Because nonatomic distributivity can only be accounted for by the

Part-operator, Champollion employs a repurposed version of it to account for instances of event distributivity.

The key reason why Champollion assumes that the denotation of the sorting key in occasion distributive interpretations is from the domain of time (or space) lies in the way the relevant interpretation is paraphrased. See the relevant example from (Champollion 2016b) in (34).

(34) *Die Jung-en haben* ***jeweils*** *zwei Aff-en gesehen.*
the boy-PL have **DM** two monkey-PL see.PST

a. 'The boys saw two monkeys each.'

b. 'The boys saw two monkey on each salient occasion' (German, Champollion 2016a)

According to Champollion (2016b), for (34) to be understood as occasion distributive, there must be some salient occasions whose temporal or spatial traces provide the sorting key for the distributive relation expressed by (34). These occasions are not trivially related to the event denoted by the sentence, in the sense that the occurrence of the occasions and the events is independent from each other and contingent on the context. In the paraphrase Champollion gives for (34), he relates the monkey seeing events to zoo visits, whose runtime is divided up in the context in a way that in each interval the boys saw two monkeys in it.

One can confirm that the interpretation assumed by Champollion (2016a) for what we can call the event distributive interpretation established by the German distributive item *jeweils* is different from the event distributive interpretation involving distributive numerals in Oh (2001), Balusu (2006) and Cable (2014). In the former case, it is assumed that the sorting key of the distributive relation is a plurality of contextually salient events that are different from the event described by the sentence. In the latter case, the sorting key is assumed to be a trivial sum of the events described by the sentence. The difference can easily be seen due to the fact that these accounts describe different lexical items in different languages. However, assuming that they all describe the same linguistic phenomenon – event distributivity – the difference implies that there is no agreement how this phenomenon should be accounted for.

3.5.2.2 Theoretical loose ends

Given our discussion of atoms in Chapter 2, the fundamental difference between the atomic and nonatomic approaches to event distributive reference lies with the understanding of atoms of the domain of events. As we have seen, accounts that assume that event distributivity involves relation between atomic events and the distributed share do not do that along the assumption that there are event that are structurally atomic, having no proper parts. Instead, they allude to a more flexible notion of atoms: some entities that are viewed as atomic given some properties and the context.

In turn, when event distributivity is described as nonatomic, it is because the structure of entities in the denotation of the sorting key are assumed to have a certain structure, i.e. having no atomic parts. However, this structure is pre-defined within the theory, so we cannot expect it to have any explanatory power.

The goal of this thesis is to develop an analysis of linguistic phenomena that relies on ontological assumptions as little as possible. Hence, I am going to assume that event distributivity is atomic, but applying the notion of relative atoms. In Chapter 5, I am going to discuss Hungarian reduplicated indefinites, and I will develop an analysis for event distributive reference that relies on the relative notion of atoms on the domain of events. I will show that by applying the relative notion of atoms on the domain of events, and by acknowledging that atoms on the domain of events can be formed relative either to the description provided by the clause or to their temporal properties and to their participants, it is possible to account for data in Hungarian that is problematic for all existing accounts of event distributivity.

3.6 Conclusions

In this chapter I have discussed the notion of distributive reference, with special attention to the structure of the entities involved. I focused on individual distributive reference – when the denotation of the sorting key is from the domain of individuals – and on event distributive reference

– where the denotation of the sorting key is from the domain of events, and reviewed some of the most well-known accounts with respect to their assumptions regarding the structure of the entities they assume can be involved in distributive reference.

I showed that the notion of absolute atoms influenced the understanding of individual and event distributive reference in different ways. In the case of individual distributivity, it motivated the atomic-nonatomic distributivity distinction. This distinction acknowledges that both atomic and nonatomic individuals in the denotation of the sorting key can be involved in distributive relations.

In the theory of individual distributivity, atomic distributive interpretations are often assumed to be the default for sentences where the distributive reference occurs merely via a contextual inference, whereas nonatomic distributive interpretations are viewed as marginal. This assumption is easily accommodated by employing the notion of absolute atoms. In the next chapter, I will provide empirical data that suggests atomic and nonatomic distributive interpretations are available to the same extent. This indicates that the (non)atomicity of individuals does not play as a crucial role as usually assumed, which, in turn, can be easily accommodated by employing the relative notion of atom.

In the case of event distributivity, the atomic vs. nonatomic distinction is merely a consequence of the application of different notions of atoms. I showed that the accounts that assume that event distributivity is atomic identify the atomic events with respect to the clause description, and in this sense, they employ the relative notion of atom. In Chapter 5, I will show that Hungarian reduplicated numerals can establish event distributivity that involves events that are subatomic with respect to the plurality provided by the event description, and as such, we need to rely on more fine-grained structures associated with events (see Chapter 2) to properly account for all cases of event distributivity.

Chapter 4

ATOMICITY AND INDIVIDUAL DISTRIBUTIVITY

4.1 Introduction

In the previous chapter, I discussed the fact that distributive reference can involve atomic and nonatomic individuals, where atomicity is understood with respect to the denotation of the sorting key. While atomic distributivity is assumed to be available without virtually any restrictions, there is no general consensus in the literature whether any restrictions apply to the availability of nonatomic distributivity and if they do, what those restrictions are. These questions arise in relation to a certain kind of sentence, the one that is assumed to involve quantification by means of a covert distributivity operator, as in (1).

(1) The students baked a cake.

First and foremost, sentences like (1) pose an empirical problem, as it has been doubted that these sentences can have an interpretation where the predication is over nonatomic parts of the denotation of the sorting key (Lasersohn 1989, Lasersohn 1995, Link 1998b a.o.). Even if this interpretation is assumed to be possible, the circumstances under which such an interpretation is available are not well understood (Winter 2001).

Despite these empirical issues, the theory of distributive reference is ready to accommodate both the availability and the unavailability of the nonatomic distributive interpretation of sentences like (1) by having both the D-operator for atomic distributive reference (Link 1991, Roberts 1987) and the Part-operator for both atomic and nonatomic distributive reference (Schwarzschild 1996) at hand (see discussion in Section 3.5.1 in the previous chapter). If the D-operator is applied in the structure of a sentence like (1) then the predicate is understood as holding of each atomic part of the plurality denoted by the subject. The D-operator works essentially in the same way as universal quantification. However, if the Part-operator is applied in the same structure, the parts of the plurality to which the predicate is applied depend on the context. In other words, the Part-operator introduces a pragmatic layer into the derivation of the meaning of sentences like (1).

The analysis of (non)atomic distributive reference is directly related to how the entities in our domain of individuals are defined – whether there are absolute atoms or only relative atoms. The D/Part-operators are defined with respect to absolute atoms in the domain, as in Link (1983). According to this assumption, atoms in the denotation of a predicate are simple individuals that have no parts, and constitute a set and form the atomic base of the mereological structure in the domain of individuals (see Chapter 2). Both the D and Part operator are defined in a way that they recognize structurally atomic individuals. However, if the domain is defined without them, these operators will need to be redefined. In this section I present an analysis of distributivity that does not rely on the notion of absolute atoms, but still does the job of both the D and the Part operators.

The empirical question mentioned above, however, cannot be resolved merely by re-gearing the distributivity operators so that they do not expect absolute atoms in the domain. To find answers for the empirical question posed by sentences like (1), I designed and conducted a two-part experiment to test for the availability of nonatomic distributive interpretations of sentences like (1) and whether the contextual (non)atomicity of the individuals involved in the distribution affected speakers' judgments. I report on the results of the experiment in this chapter.

The contents of this chapter are based on Wohlmuth (2018) where I first published the results of the experiments. Even though the experiments reported here are the same, I have reinterpreted the results to some degree and I also further developed the discussion of the theoretical issues, presented here in Section 4.3.3.

4.2 Nonatomic distributive reference without restricitons

In this section, I am going to present the two most prominent proposals where nonatomic distributive reference is possible for every sentence where the predication is over a plural denoting expression, namely Gillon (1987) and Schwarzschild (1996). While these approaches had fundamental influence on the discussion about the semantics of distributive reference and plurality in natural language, they also received substantial criticism, mainly for overstating the availability of nonatomic distributive reference. I am going to discuss the criticisms of these proposals as well.

4.2.1 Cover interpretations – Gillon (1987)

The main precursor of the Part-operator developed in Schwarzschild (1996), and any subsequent accounts relying on Schwarzschild (1996), is Gillon (1987). Gillon tries to define the general truth schema for sentences of the structure $[[\mathrm{NP}_{\mathrm{PL}}][\mathrm{VP}]]$, where the main predication is over a plurality denoting expression, as in (2). Here, I will refer to these sentence as *plural sentences*. Gillon argues for one of the weakest possible options, namely that plural sentences are true as long as the plurality can be divided up into potentially overlapping parts (covers) of which the predicate holds.

(2) The composers wrote musicals.

Gillon (1987) assumes that plural sentences can be interpreted collectively – when the predicate holds of the plurality denoted by the plural noun phrase as a whole – and distributively. *Distributive* in Gillon's terms plainly refers to the atomic distributive interpretation of a sentence. The main question for Gillon is whether there are other interpretations available and if so, what the range of possible interpretations is.

Focusing on sentences like (2), Gillon considers two basic options for the general truth schema for plural sentences, the partition hypothesis and the cover hypothesis. According to the partition hypothesis, which dates back to Higginbotham (1981), plural sentences can be true as long as there is a partition over the denotation of the plural NP, such that the VP is true of every element of that partition.

The notion of partition is defined in set-theoretical terms in (3), and in mereological terms in (4). For the purposes of this discussion, it bears no significance whether one uses a set-theoretical or a mereological set-up, but since Gillon develops his account within set theory, I give the definition here in terms of set theory, too.

(3) **Definition** Partition (set theory)
P_A is a partition over a set A iff $P_A \subseteq \mathcal{P}(A) \ \wedge \ \bigcup P_A = A \ \wedge \ \forall X, Y \in P_A[X \cap Y = \emptyset]$
P_A is a partition over a set A iff P_A is a subset of the power set of A and the union of the sets in P_A is A, and for every X and Y such that X and Y are in P_A, X and Y do not intersect.

(4) **Definition** Partition (mereology)
P_a is a partition over a plural individual a iff $\forall x[x \in P_a \rightarrow x \leq a \ \wedge \ \bigoplus P_a = a \ \wedge \ \forall y, z[y, z \in P_a \rightarrow \neg y \circ z]]$
P_a is a partition over a plural individual a iff for every x, such that x is in P_a, x is part of a, and the sum of all elements in P_a is equal to a, and for every y and z such that y and z are in P_a, y and z do not overlap.

Based on the partition hypothesis, a sentence like (2) is true as long as there is a partition over the denotation of the plural subject *the composers* where the VP *wrote musicals* is true of each members of the partition.

The cover hypothesis, on the other hand, attributed to Langendoen (1978) and L. Carlson (1982), states that plural sentences can be true if instead of a partition, there is a cover over the denotation of the NP such that the VP holds for each member of that cover. A *cover* is a less restrictive version of a partition, where the members can overlap. See the definition in set theoretical terms in (5), and in mereological terms in (6).

(5) **Definition** Cover (set theory)
C_A covers a set A iff $C_A \subseteq \mathcal{P}(A) \wedge \bigcup C_A = A$
C_A is a cover over a set A iff C_A is a subset of the powerset of A and the union of all the sets in C_A is A.

(6) **Definition** Cover (mereology)
C_a covers a plural individual a iff $\forall x[x \in C_a \rightarrow x \leq a \wedge \bigoplus C_a = a]$
C_a covers a plural individual a iff for every x such that x is in C_a, x is part of a and the sum of all the elements in C_a is a.

According to the cover hypothesis, (2) is true as long as there is a cover over the denotation of the plural subject *the composers*, such that the VP holds for each member of that cover.

While the partition and the cover hypotheses predict somewhat different truth conditions for plural sentences, both options allow for what I refer to as non-atomic distributive interpretations. So for Gillon the main question is not whether there are other possible readings than collective and atomic distributive, but whether or not it is possible to predicate over overlapping entities in the denotation of a plural referring expression.

Gillon argues that the truth schema for the sentences in question should reside to the notion of cover instead of the notion of partition. His argument goes as follows: if we consider the sentence in (2), and assume that the plural NP *the composers* refers to Richard Rodgers, Oscar Hammerstein II, and Lorenz Hart, and we evaluate the sentence in the actual world, the sentence is, in fact, true. In the actual world, Rodgers, Hammerstein and Hart did not write musicals either together or by themselves. What they did do is that Rodgers and Hammerstein on the one hand, and Rodgers and Hart on the other, collaborated on writing musicals. According to Gillon, the VP *write musicals* applies to Rodgers and Hammerstein on the one hand, and Rodgers and Hart on the other. These individuals (or sets) are non-atomic with respect to the plurality (or set) Rodgers+Hammerstein+Hart, and they do overlap. Hence plural sentences are true as long as there is a cover over the denotation of the plural NP such that for each element of the cover the VP holds.

However, the truth schema based on the cover hypothesis is too weak; it predicts that the truth conditions of plural sentences can be satisfied by any cover. That is, (2) is predicted to have an interpretation where the cover contains the sets of individual composers and a set containing all three. This is a problem, according to Gillon, and to avoid it, he restricts the truth schema to minimal covers. A minimal cover over a set (or individual) A is a set that is a cover over A but none of whose subsets are a cover of A; see definition is in (7).

(7) **Definition** Minimal cover

C_A is a minimal cover over a set A iff C_A covers A and $\forall X[X$ covers A and $X \subseteq C_A \rightarrow X = C_A]$

C_A is a minimal cover over a set A iff C_A covers A and every set X such that X covers A and X is a subset of C_A then X is equal to C_A.

To sum up, Gillon (1987) not only assumes that a nonatomic distributive interpretation (also known as the *cover interpretation* and the *intermediate interpretation*) is possible, but also posits that it involves a minimal cover over the denotation of the plural NP with potentially overlapping elements. As we will see in what comes next, the ideas in Gillon (1987) were both widely criticized and yet taken as the foundation of different accounts of distributive reference.

4.2.2 Contra Gillon (1987)

The proposal in Gillon (1987) received serious criticism for two main reasons. First, it has been questioned whether the data Gillon based his claims on are accurate to motivate the cover hypothesis (see Lasersohn 1989, Lasersohn 1995, Link 1983, a.o.). As we will see below, it is possible, and maybe even desirable, to account for the meaning of sentences with VPs like *write musicals* without appealing to the notion of distributive reference. Second, one of the basic assumptions in Gillon (1987) is that the assumed ambiguity of sentences like (1) and (2) (collective vs. distributive) stems in the meaning of the plural NP, as opposed to that of the VP (see Link 1983, Roberts 1987, Lasersohn 1989, Link 1991, Landman 1995, Lasersohn 1995, Landman 2000, Champollion 2010, Champollion 2017b, a.o.). As we will see, the NP-ambiguity hypothesis has been virtually discarded since Dowty (1987), hence the approach in Gillon (1987) was also dismissed for that reason.

4.2.2.1 Contra the cover hypothesis

As for the first line of criticism, it has been shown that despite what is suggested in Gillon (1987), not *all* plural sentences can have a nonatomic distributive or cover interpretation. For instance, the sentences in (8) and (9) reportedly can only be understood as collective or atomic distributive.

(8) [*Context*: There are three TAs at the linguistics department, Bill, Mary and Jane, and each of them were paid $7000 last year.]
#The TAs were paid exactly $14 000 last year. (Lasersohn 1989)

(9) [*Context*: Rodgers and Hammerstein wrote a musical together, and Rodgers and Hart wrote another musical together. No other musicals were written.]
#Rodgers, Hammerstein and Hart wrote a musical. (Link 1998b)

These sentences are assumed to lack the nonatomic distributive interpretation even though there is a verifying cover available in the context. In the case of (8), the predicate *were paid exactly $14 000 last year* holds of any two TAs, so there is a cover over the plurality denoted by *the TAs*, such that the predicate holds for each member of that cover. Yet, (8) reportedly lacks the so-called cover interpretation, just like (9).

The examples in (8) and (9) suggest that the cover interpretation depends on the verbal predicate at least partially. Consider Gillon's example in (2) and Link's in (9): they form a minimal pair with respect to the form of the predicate.[1] Since only (2) is supposed to be true in a nonatomic distributive scenario, it is reasonable to assume that the truth conditions of a sentence is not independent from the form of its VP. This, however, cannot be captured by the truth schema proposed in Gillon (1987).

Both Lasersohn (1989) and Link (1998b) assume that the flexibility in meaning exhibited by sentences like (2) is due to the lexical properties of the predicates *write musicals*. Lasersohn (1989) (and Lasersohn 1995) assumes it is the lexical cumulativity (see Chapter 2, Section 2.5.1) of the predicate *write*, which he implements as a meaning postulate; see (10). Link (1998b) assumes that the VP *write musicals* has cumulative reference[2], because both the predicate *write* and *musicals* have cumulative reference.

(10) $$[\![write]\!](x, y) \wedge [\![write]\!](w, z) \rightarrow [\![write]\!](x \oplus w, y \oplus z)$$

Regardless how it is formalized, Lasersohn (1989) and Link (1998b) (and others like Winter 2001 and Champollion 2016a) argue that the cover interpretation of sentences like (2) is essentially a lexical effect brought about by the verbal predicate. From this it follows that the truth schema proposed by Gillon (1987) does not capture the truth conditions for plural sentences in general, merely of plural sentences of a certain kind.

Ultimately, the problem with the approach presented in Gillon (1987) is that the sentence it uses in support of a cover interpretation can be accounted for without the notion of distributive reference. In our terms, sentences like (2) do not even involve distributive reference at all. As

[1]This is true only under the assumption that conjoined proper names and definite plurals, when referring to the same individuals, have the same denotation.

[2]Link (1998b) and Link (1983) refers to the property of cumulative reference as *homogeneous reference*, see definition (T.11) in Link (1983).

discussed in Chapter 3, Section 3.2, distributive reference occurs when a sentence involves an overt or covert reference to a plurality of entities and the denotation of another expression is distributed over the relevant parts of the plurality rather than holding of the plurality itself. However, in (2), the predicate *wrote musicals* holds for the plurality denoted by the plural subject *the composers*, even if the composers wrote musicals individually, in pairs or in any other arrangement (see Winter 2001 on this point).[3]

In turn, in sentences like (8) and (9), when we do deal with distributive reference because the predicate describes a property that does not hold for the plurality in the given context, the cover/nonatomic distributive interpretation suddenly does not seem to be available anymore. In (8), the predicate *were paid exactly $14 000 last year* holds for any two TAs, but not the sum of all TAs, and in (9) the predicate *wrote a musical* holds for certain pairs of individuals denoted by *Rodgers, Hammerstein and Hart*, but, again, not for their sum.

4.2.2.2 Contra the NP-ambiguity hypothesis

As for the second line of criticism, Gillon assumed that the source of ambiguity of sentences like (2) – or like (8) and (9), for that matter – is located in the noun phrase; Gillon assumes that the different readings of sentences like (2) are due to the different interpretations the plural NP might have. This assumption was challenged by Dowty (1987), who pointed out that in sentences with conjoined VPs, it is possible to obtain collective interpretation of one of the VPs, and distributive interpretation for the other. For example, in (11), the first VP *are a happy couple* is understood collectively of John and Mary, while the second VP *are well-adjusted individuals* is understood distributively. Such cases are hard to account for under the NP-ambiguity analysis. Thus, it is generally assumed that the source of covert distributivity is located in the VP.

[3]Erbach (2018) provides empirical data that suggest plural sentences with bare plural objects are not immediately disambiguated as collective or distributive when presented in an ambiguous context. This can be viewed as further support for the assumption that sentences like (2) present a phenomenon different from distributive reference.

(11) John and Mary are a happy couple and are well-adjusted individuals, too.

Both this objection to Gillon (1987) and the one discussed in the previous section have been used in support of a D-operator based approach (Roberts 1987, Link 1991, see Chapter 3), as D only generates atomic distributive interpretations and it is located in the VP.

That said, the NP-ambiguity hypothesis was defended in Gillon (1990) and Gillon (1996) by assuming that in cases of VP-conjunction like in (11), the different VPs are evaluated with respect to different pluralities denoted by the subject. Moreover, it is pointed out in Winter (2001: Chapter 6.3) that the VP-ambiguity hypothesis also potentially runs into problems; see (12).

(12) The women I mentioned and [Mary and John] had a baby last week. (Winter 2001)

In (12), the subject is a complex conjoined NP, and there is only one VP. According to the VP-ambiguity hypothesis, (12) can be understood as the VP *had a baby last week* applying either collectively or distributively to the conjoined NPs. However, it is possible to understand the sentence as the VP applying to the first NP *the women I mentioned* distributively, and to the second NP *Mary and John* collectively. Even though such cases cannot be accounted for by the VP-ambiguity hypothesis, the NP-ambiguity hypothesis did not gain traction and VP-ambiguity has not been seriously questioned in the past three decades.

4.2.3 Context sensitivity – Schwarzschild (1996)

We have seen in the previous section that based on sentences like (8) and (9), nonatomic distributive interpretations were deemed to be of limited availability. However, the possibility of such interpretations cannot be entirely dismissed: in his reply to Lasersohn (1989), Gillon claims in Gillon (1990) that (8) can be easily “repaired” by issuing some changes in the context.

(13) [*Context*: At the department, for every course there are two TAs assigned. The budget for the salary of the TAs is \$14,000 per course. The money can be distributed among the TAs of each course proportionally based on the workload, it is up for the TA team to decide how they divide up the money among themselves. As a result, probably no TA gets paid exactly \$14,000.]
The TAs were payed their \$14,000 last year. (based on Gillon 1990)

Gillon (1990) claims that (13) can be truthfully asserted in the given context, where the sentence must be interpreted as having nonatomic distributive reference. This, however, raises the question: how is it possible that the same sentence lacks nonatomic distributive reference given one context, but has it in another, where in both contexts a cover over the plurality denoted by the subject NP is made available?

According to Schwarzschild (1996), this happens because the cover has to be salient in the context in some way. To implement this idea, Schwarzschild proposed the Part-operator whose definition I gave in (29) in Chapter 3, repeated here as (14).

(14) $[\![Part]\!] = \lambda P \lambda x \forall y[y \leq x \wedge y \in C(x) \rightarrow P(y)]$, where $C(x)$ is a contextually salient cover over the plurality *x*

As already discussed in Section 3.5.1.2 in the previous chapter, the crucial thing about Part is that there is a free variable in it, *C*, which is a free cover that gets its value from the context. That is, according to the definition of Part, what parts of the plurality are involved in the distribution is always determined by pragmatic factors.

The view of nonatomic distributivity conveyed by the Part-operator based approach is radically different from the one promoted by Gillon (1987) and (1990). There, a sentence with a plural subject is assumed to be true as long as there is a cover over the plurality whose members the VP holds true of. On Schwarzschild's account, the mere existence of this cover is not sufficient; it also has to be salient in the context in order for the sentence to have a nonatomic distributive interpretation.

4.2.4 Contra the Part-operator

Even though Schwarzschild's *Part*-operator offers a one-size-fits-all solution to account for the full range of interpretations from atomic distributive to collective, it received criticism from Winter (2001) for not clarifying what the relevant pragmatic factors are that potentially determine the availability of nonatomic distributive interpretations. I think this criticism is highly relevant. The Part-operator approach might reveal why in cases like (13) the nonatomic distributive interpretation is available, but it fails to provide an explanation why is it reportedly unavailable in other cases, like (8) or (9), even though the context makes the relevant covers accessible.

4.3 Partial accounts of nonatomic distributivity

Recognizing the problem with the Part-operator, but still aiming to account for nonatomic distributive reference in cases when it does arise, subsequent accounts tried to spell out some of the circumstances under which nonatomic distributive reference does seem available. In this section, I am going to discuss three of such accounts – Mendia (2015), Champollion (2016a) and Wohlmuth (2017) – that offer solutions that are very different from each other.

Interestingly, however, the judgments on the data from Lasersohn (1989), Link (1998b) and others are generally taken at face value, and subsequent accounts were developed taking these judgments for granted. As far as I am aware, these judgments have not been challenged, nor has there been any attempt to collect empirical data to check whether these judgments are shared by native English speakers on a larger scale. While these judgments might as well match the intuitions of other native speakers, until there is no empirical evidence to support them, there will an empirical gap in any accounts taking judgments like (8) and (9) into consideration. An attempt to redress the situation, a survey experiment about the availability of nonatomic distributive reference, will be discussed later in this chapter.

4.3.1 Typicality – Mendia (2015)

The main hypothesis in Mendia (2015) is that not all cases of nonatomic distributivity are equal, and at least some of them can be accounted for without an operator like Part. Consider the examples in (15) and (16). Both sentences can be understood as nonatomic distributive, hence can be considered in support of the application of the Part operator.

(15) The shoes cost \$50. (Lasersohn 1998)

(16) [*Context*: At the end of the summer vacation, students have to go to the school to pick up their books for the upcoming year. The books are sorted into packages for each grade. Every package has a uniform price.]
The books cost \$50.

However, if we replace the definite plural subjects in (15) and (16) with a quantifier of our choice, the nonatomic distributive interpretation disappears in the resulting sentence in the case of (16), but not (15).

(17) $\left.\begin{array}{l}\text{Most}\\ \text{Many}\\ \text{Some}\\ \text{No}\end{array}\right\}$ shoes cost \$50. ✓nonat.

(18) $\left.\begin{array}{l}\text{Most}\\ \text{Many}\\ \text{Some}\\ \text{No}\end{array}\right\}$ books cost \$50. ✗nonat.

The puzzle is this: both (15) and (16) can have a nonatomic distributive interpretation given the appropriate context. However, if we take (17) and (18), in their respective supporting contexts, we see the following contrast: while the sentences in (17) still can be understood as talking about the nonatomic groupings in the denotation of the plural subject, the ones in (18) cannot.

To account for the data in (15)–(18), Mendia (2015) relies on the notion of typicality. The basic assumption is that based on world knowledge, the denotation of certain plural nouns can include *groups* of a specific cardinality in which they typically occur. Groups are atoms that are derived from pluralities; see Landman (1989a), Landman (1989b), Landman (2000).

Typical group atoms are created by the typical group function, which can be defined as in (19) below.[4] Θ_P is the function that assigns a typicality value to individuals of certain cardinality in the denotation of a predicate P (Mendia borrows the Θ function from Kerem, Friedmann & Winter 2011). $\uparrow$ is the group formation operator from Landman (2000) which maps individuals to their group atom counterpart.

(19) **Definition** Typical Group Function
$\textsc{TypG} = \lambda P \lambda y \forall x[{}^*P(x) \ \wedge \ |x| = n \ \wedge \ \Theta_P(n) > \Theta_P(1) \rightarrow \exists y[x \neq y \ \wedge \ y = \uparrow (x)]]$

According to (19), the TYPG modifies the denotation of a plural predicate such that it will contain group-atoms that are formed of plural individuals of typical cardinality in the denotation of the predicate. The typical group atoms created by the TYPG function are accessible for quantification, so if a noun has typical groups in its denotation then the nonatomic distributive interpretation can arise even with a quantifier, as is demonstrated in (17). However, if there are no typical group atoms in the denotation of the noun, then the nonatomic distributive interpretation is unavailable in a similar environment; see (18).

The main point in Mendia (2015) is that (15) can be accounted for by only postulating the D-operator, as the typical group atoms are atoms. When (15) is understood as the predicate applying to pairs of shoes then

[4]The definition in (19) is different from the one in Mendia (2015). (19) is based on Mendia p.c.

the quantification is over typical groups of shoes which are pairs of shoes. However, when TYPG is not applied in the denotation of the *shoes*, the verbal predicate modified by the D-operator applies to each atomic shoe.

Mendia (2015) provides an intuitive solution to the puzzle posed by (15)–(18) and shows that with the notion of typicality it is possible to analyze some sentences that appear to have nonatomic distributive reference as atomic distributive. However, this account cannot be extended to cases where nonatomic distributive interpretation arises despite the subject NP having no typical groups in its denotation, as in (16). That is, even with the notion of typicality we need to stipulate something like the Part-operator to account for the whole range of data.

4.3.2 Division of labor – Champollion (2016a)

To account for the nonatomic distributive interpretation of sentences like (15) and (16), Champollion (2016a) proposes a dual system with both silent distributivity operators employed, where the D-operator takes care of atomic distributivity and the Part-operator, nonatomic distributivity. The motivation for proposing such a split system is the contrast observed in the availability of the two interpretations. To account for this contrast, Champollion (2016a) proposes that the availability of the different interpretations is parallel to the availability of the two operators that are assumed to account for the two interpretations. The D-operator is supposed to be available without any restrictions, while the Part-operator can only apply if there is a supporting context.[5]

While this approach can explain why atomic distributive interpretations seem to be generally more readily available than nonatomic distributive ones, it falls short on accounting for the circumstances under which

[5]It is acknowledged by Champollion himself that the Part-operator is powerful enough to account for both atomic and nonatomic readings by itself, and he offers an alternative explanation for the preference for atomic distributive readings in count domains. His ultimate motivation for employing both the D-operator and the Part-operator is to draw a parallelism between the silent verbal operators and overt lexical items of similar mechanism, see Champollion (2016b), but further discussion of this issue is outside of the scope of this discussion.

nonatomic distributive reference becomes available, just like Schwarzschild (1996) did. That is, we still cannot explain why the nonatomic distributive interpretation is available in (13), (15) and (16), but unavailable in (8) and (9). In this respect, the split system does not improve on the account in Schwarzschild (1996).

Moreover, the dual system seems to face another serious problem. According to Champollion (2016a), (15), repeated below as (20), has a nonatomic distributive interpretation because a cover with pairs of shoes in each of its cells is salient in the context. The context in this case is basically world knowledge.

(20) The shoes cost $50. = (15)

Even though prima facie (20) is a clear-cut case to motivate an operator like Part, it counts as an irregular case within the system proposed in Champollion (2016a). For (20) to be understood as having atomic distributive reference – as in '*Each* shoe costs $50' – definitely more context is needed than for the nonatomic distributive interpretation.

Since the base assumption for the split system in Champollion (2016a) is that atomic distributive interpretation, and thus the D-operator, is available without restrictions, it should be easily accessible even in cases like (20), but evidently it is not. Instead, it seems like that for cases like (20), the nonatomic distributive interpretation is the default, and the atomic distributive interpretation is restricted to a special context. So the split system is not only problematic for not specifying the pragmatic factors that make nonatomic distributive interpretation available, but it also makes unattested predictions about its availability in general.

4.3.3 The form of the plural NP – Wohlmuth (2017)

While both Mendia (2015) and Champollion (2016a) acknowledge that nonatomic distributive reference is restricted in availability, they do not set out to explore how. The cases they are interested in, like (20), are the ones where nonatomic distributive reference appears to be default. And, as shown by Mendia (2015), those cases can be accounted for without appealing to an operator like Part. However, the real power of the Part operator as proposed by Schwarzschild (1996) is that it can account for nonatomic distributive reference virtually in any case where the D-operator can apply. That is, the main hypothesis it puts forth is that no sentence *lacks* a nonatomic distributive interpretation per se; sentences can only be presented in contexts that do not support their nonatomic distributive interpretation. This hypothesis is virtually left unchallenged by these accounts, and while Champollion (2016a) restricts the availability of the Part-operator to a supporting context, it does not go into detail about what a supporting context might entail.

As a result, it is still unclear whether sentences like (1), repeated here as (21), and (22) can have a nonatomic distributive interpretation or not. These sentences have a plural subject and an indefinite singular object and do not activate any special piece of world knowledge like (20) does. While it is assumed that their atomic distributive interpretation is possible, their nonatomic distributive interpretation is predicted, yet doubted.

(21) The guests called a taxi. = (1)

(22) The students baked a cake.

Focusing on sentences like (21) and (22), in Wohlmuth (2017) and later in Wohlmuth (2018), I outlined an account where the main hypothesis was that availability of nonatomic distributive interpretations is at least partially depending on the form of the plural subject: it is only available if the subject is formed by a plural nominal predicate, but unavailable otherwise, i.e. when the subject is conjoined proper names.

The direct motivation behind this hypothesis is that the availability of nonatomic distributive reference appears to be connected to the special semantic and pragmatic properties of definite plurals, like vagueness and anaphoricity, see Gillon (1990), Winter (2000), Malamud (2006) and many others.[6] Based on this, the hypothesis is that the form of the sub-

[6]This assumption appears indirectly in Mendia (2015), and even in Schwarzschild (1996), where all sentences presented in support of nonatomic distributivity contain definite plural subjects. However, in discussion of the unavailability of the nonatomic dis-

ject also plays a role in the availability of nonatomic distributivity in the following way.

(23) a. The students baked a cake. ✓at., ✓nonat.
b. Eleanor, Finn, Gillian and Harry baked a cake. ✓at., ✗nonat.

If the judgments in (23) are correct, it would suggest that the context sensitivity enters in the nominal domain and not in the verbal domain, as most previous accounts presumed. Moreover, it would suggest that common nouns have more flexible denotations than conjoined proper names insofar as their denotation can be modified by the context. According to the pattern in (23), (8), but not (9), has a nonatomic distributive interpretation given that it is presented in the appropriate context.

To concretize the intuition illustrated by (23), I defined an operator called *Pack* that operates within the structure of the NP which gives the contextually salient groupings of the individuals in the denotation of the subject. I posited that Pack can only apply in the structure of common nouns, but not of conjoined proper names; see the definition in (24).

(24) **Definition** Pack-operator
$[\![\text{PACK}]\!] = \lambda P \lambda x[P(x) \ \wedge \ x \in C(\bigoplus P)]$
The operator Pack applies to a predicate P and returns every x such that x is in P and x is in a contextually salient cover C over the sum of P.

I assume that Pack is applies in the structure of the NP after it is pluralized, hence its denotation is closed under the sum formation. When Pack is applied in the structure of the NP, it modifies its denotation in a way that it picks out the contextually salient groupings of the denotation of the plural NP. I call these contextually salient elements *minimal elements*, see the definition in (25).

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tributive reading, the form of the subject in the sentences is more diverse, and the definite plural subject is often replaced by conjoined proper names (see Link 1998b).

(25) **Definition** Minimal element

$\textsc{min}(x) \stackrel{\text{def}}{=} \exists P[P(x) \wedge \neg\exists y[y < x \wedge P(y)]]$

The entity x is a minimal element iff there is a property P such that P holds of x and there is no entity y such that y is part of x and P holds of y.

Minimal elements are essentially relative atoms (see Chapter 2) in that they are the smallest individuals in the denotation of a given predicate, but unlike relative atoms, minimal elements do not presuppose the existence of a (natural language) predicate with respect to which they are minimal (cf. the definition of relative atoms in (30), Chapter 2). In other words, in our system, referring to atoms requires us to refer to the predicate with respect to which individuals are atomic; with the notion of minimal elements in (25), we can refer to atoms without having to refer to the predicate with respect to which they are atomic.

Minimal elements can be the relative atoms created by the Pack-operator based on the context. The idea is that a predicate P or $*P$ have certain individuals as relative atoms in its denotation, while ${}^{\text{Pack}}(*P)$ can have potentially different (structurally more complex) individuals as its relative atoms, which are the minimal elements in our terms.[7]

Pack applies in the structure of the NP right after the *-operator, creating another layer of atoms, which are the minimal elements. In this sense, the denotation of ${}^{\text{Pack}}(*P)$ is basically the denotation of a singular predicate. In order to create a plural predicate, ${}^{\text{Pack}}(*P)$ the *-operator has to be applied again. The denotation of $*({}^{\text{Pack}}(*P))$ will contain the minimal elements in ${}^{\text{Pack}}(*P)$ and also all their possible sums. This process is illustrated in (26a)–(26d). Since the denotation of ${}^{\text{Pack}}(*P)$ is a subset of $*P$ and all the elements in P are part of some element in ${}^{\text{Pack}}(*P)$, the maximal element in $*({}^{\text{Pack}}(*P))$ and $*P$ is always the same.

[7] It is necessary to differentiate between relative atoms in the denotation of a simple predicate and the minimal elements in the denotation of a predicate modified by the Pack-operator. The most obvious reason for this is counting: in a system with relative atoms and minimal elements, we want counting words to access relative atoms, but not minimal elements.

(26) a. $[\![P]\!] = \{a, b, c, d\}$
b. $[\![*P]\!] = \{a, b, c, d, a \oplus b, a \oplus c, a \oplus d, b \oplus c, b \oplus d, c \oplus d, a \oplus b \oplus c, a \oplus b \oplus d, a \oplus c \oplus d, b \oplus c \oplus d, a \oplus b \oplus c \oplus d\}$
c. $[\![{}^{\text{Pack}}(*P)]\!] = \{a \oplus b, c \oplus d\}$
d. $[\![*({}^{\text{Pack}}(*P))]\!] = \{a \oplus b, c \oplus d, a \oplus b \oplus c \oplus d\}$
e. $[\![\bigoplus(*P)]\!] = [\![\bigoplus(*({}^{\text{Pack}}(*P)))]\!] = \{a \oplus b \oplus c \oplus d\}$

The crucial difference between the denotation of $*P$ and that of $*({}^{\text{Pack}}(*P))$ is that they have different individuals in their atomic layer. The atomic individuals relative to $*({}^{\text{Pack}}(*P))$ are constructed of the atomic individuals relative to $*P$. But that is okay, since we do not require atoms to be atomic in the absolute sense, but only relative to a given predicate. In this case, that predicate is ${}^{\text{Pack}}(*P)$.

Pack is defined in a way that it can only apply in the structure of NPs. This way, the denotation of conjoined proper names is assumed to be unaffected by the context; hence minimal elements will always correspond to atomic parts of the plurality referred to by conjoined proper names.

The nominal domain in sentences like (22) can only provide the salient groupings of the individuals in the denotation of the NP, so I assume that when the predication is distributive, a silent operator takes scope over the verb, just as in the other verbal operator based approaches of distributivity discussed earlier. I defined a slightly modified version of the D and the Part operator dubbed the D_{MIN}-operator; see (27). The D_{MIN}-operator, unlike D and Part, does not specify what individuals in the denotation of the plural NP the predicate applies to. Instead, it modifies the meaning of the verbal predicate in a way that it applies to every minimal element part of the plurality denoted by the subject.

(27) **Definition** D_{MIN}-operator
$[\![\text{D}_{\text{MIN}}]\!] = \lambda P \lambda x \forall y[y \leq x \wedge \text{MIN}(y) \rightarrow P(y)]$

One of the consequences of defining the distributivity operator as in (27) is that we can no longer maintain the assumption that the silent distributivity operator has the same meaning as the overt adverbial *each*. *Each* requires the parts the predicate in its scope applies to to be atomic with respect to a nominal predicate. I formalize this requirement of adverbial or floated *each* as in (28).

(28) **Definition** adverbial/floated *each*
$[\![\text{each}]\!] = \lambda P \lambda x : \exists Q[Q \neq P \;\wedge\; Q(x)]\forall y[y \leq x \wedge \text{AT}_Q(y) \rightarrow P(y)]$

Our definition of (floating or adverbial) *each* in (28) requires the (verbal) predicate P in its scope to apply to every part y of a plurality x such that y is atomic with respect to a predicate Q. I assume that x is in the denotation of Q and that Q is distinct from P are presupposed by *each*. I represent presuppositions as a restriction of the λ-bound variable, set off with a colon in the formula (see Asher 2011 for a similar notational convention). This way we can ensure that every y is an atomic part of x with respect to the same predicate.

At this point, I have to say something about proper names, as all the definitions above are given in terms of predicates and individuals to which these predicates apply. I assume proper names denote individuals and their denotation is represented as individual constants.

As a consequence, the individuals denoted by proper names are not related to any predicate like the individuals denoted by common nouns are. This is a problem, because the D_{MIN}-operator in (27) and for *each* in (28) are defined in a way that they can only be understood in terms of predicates. That is, neither of them are suitable to account for distributive reference involving conjoined proper names.

To avoid this problem, I assume that the property of being an atom applies to every individual denoted by a proper name of singular form. In turn, the individuals in denotation of proper names of plural form have the property of being plural atoms. I formulate these assumptions as conditions on the denotation of proper names, see (29) and (30).

(29) $\forall \alpha : \alpha$ is a proper name in singular form $[\![\alpha]\!] \in \text{AT}$

(30) $\forall \alpha : \alpha$ is a proper name in plural form $[\![\alpha]\!] \in {}^*\text{AT}$

By assuming that every individual denoted by a proper name has the property of being an atom, they can be represented as relative atoms, as they are atomic with respect to the property of being an atom. Hence, our definitions of the D_{MIN}-operator in (27) and for *each* in (28) can work with proper names as well.

The system presented here predicts the distinction established in (23). If the subject is a common noun[8] – a definite plural common noun in the case of (23a) – the Pack operator can apply, hence whether the sentence has atomic or nonatomic distributive reference is determined by the context. If the subject is conjoined proper names, Pack cannot apply, thus the individuals involved in the distribution can only be minimal elements with respect to the property of being an atom.

In addition to predicting the pattern in (23), the Pack–D_{MIN} approach to distributive reference is also suitable for setups where absolute atoms are not defined. Both the D-operator and the Part-operator presuppose the existence of absolute atoms, although in different ways. While the D-operator makes explicit reference to such individuals, the Part-operator's requirement for absolute atoms is more subtle. It makes no explicit reference to absolute atoms, but the notion of cover it employs is defined with respect to a plural individual and not to a plural individual in the denotation of a given predicate. This detail can be problematic if we assume that an individual can have parts but also can be the smallest individual in the denotation of a predicate (as we do if we work with relative atoms). For a (potentially plural) individual x to be in a cover over a plural individual y, x only has to be contextually salient and a part of y, even if x is not in the denotation of the predicate that denotes y. Hence even the Part-operator exploits the notion of absolute atoms and is not adequate in a setup where absolute atoms are not defined.

The Pack–D_{MIN} makes no use of absolute atoms. Minimal elements are defined in a way that they in effect coincide with the notion of relative atoms. Relative atoms are essentially minimal elements in the denotation of natural language predicates by default. But they are not the only kind of minimal elements; others can be constructed by the context in virtue of

[8]Here I only discussed definite plurals, but the predictions hold for other plural denoting expressions like indefinite plural NPs.

the application of the Pack operator. Whether the minimal elements are in-built or constructed, the silent distributivity operator D_{MIN} is insensitive to that detail: all it cares about is that individuals to which the VP in its scope applies are minimal. In this sense, the D_{MIN}-operator helps the VP in its scope to find its (relative) atoms, but does not care whether those atoms are atomic or not with respect to any other predicate.

Moreover, as the Pack–D_{MIN} approach still employs a verbal operator to account for distributive reference, it avoids the problem of conjoined VPs with collective and distributive reference discussed in Section 4.2.2, which arises if one assumes that the source of distributive reference is in the noun phrase only. However, I should discuss cases where both the conjoined VPs are understood distributively, but one as nonatomic distributive and the other as atomic distributive, as the mechanism of the Pack–D_{MIN} approach faces possible challenges.

Sentences where the distributive reference of one of the VPs comes from the lexical semantics of the verb (see Chapter 3), as in (31), pose no problem, as we can assume that these verbs simply apply to atomic individuals in the denotation of the plural subject they combine with.

(31) The students baked a pizza and slept.

However, sentences where the distributive reference is assumed to be achieved by a silent verbal operator applying to both of the VPs, as in (32), the Pack–D_{MIN} approach faces some issues. If we assume that the VPs are applied to the one overt subject, there is no way to predict an interpretation where one of the VPs are understood atomic distributively and the other one nonatomic distributively (assuming that such an interpretation is available). Here I will refer to this interpretation of sentences like (32) as *mixed interpretation*.

(32) The students baked a pizza and had a beer.

Accounting for the mixed interpretation of sentences like (32) pose no problem for the Part-approach in Schwarzschild (1996), or even the D-Part approach in Champollion (2016a), as these accounts do not posit that the plural subject is involved in the distributive interpretation other than supplying the plurality to distribute over. However, the Pack–D_{MIN} approach struggles to account for such mixed interpretations, as Pack can only provide one kind of contextually salient grouping of the individuals denoted by the noun.

To overcome the potential problem for the Pack–D_{MIN} approach posed by the mixed interpretation of sentences like (32), I assume that the two VPs are evaluated with respect to different pluralities (see Gillon 1990), and assuming a the structure for (32) as in (33).

(33) [[[The [[PACK[students]]]]$_1$ [D_{MIN}[baked a pizza]]][and [[PACK[pro$_1$]] [D_{MIN}[had a beer]]]]]

In sum, the account developed in Wohlmuth (2017) and (2018) is suitable for a setup *sans* absolute atoms, but it also makes very similar predictions about the availability of nonatomic distributive reference as Schwarzschild (1996) (and the subsequent accounts), with the only difference about the form of the plural subject being a factor. However, these predictions, just like the predictions of previous accounts of nonatomic distributivity, are not based on empirical data, and as such, might not reflect the intuitions of native speakers.

4.4 Experiments

To fill this empirical gap regarding the availability of nonatomic distributivity, I designed a survey experiment and distributed it online to native speakers of English. The goal of this experiment, here referred to as Experiment 1, was two-fold. Firstly, it meant to test whether sentences with a plural subject and a singular indefinite object have a nonatomic distributive reading, and, secondly, it also meant to test the predictions of the Pack–D_{MIN} approach in Wohlmuth (2017) and (2018), namely that the form of the subject has an effect of the availability on the nonatomic distributive reading.

After conducting Experiment 1 and obtaining data on the availability of nonatomic distributive interpretations, I did a follow-up experiment, here referred to as Experiment 2, to see if speakers access atomic distributive reference more easily than nonatomic distributive reference. I discuss the design and the results of these experiments below.

4.4.1 Experiment 1

When creating the design for Experiment 1, I worked with the assumptions in (34) and the hypotheses in (35).

(34) **Assumptions** Experiment 1

a. Nonatomic distributivity is available if the grouping of the individuals is salient in the context; see Schwarzschild (1996).

b. The meaning of sentences with a plural subject and a bare plural object is underspecified, so they are true in a nonatomic distributive context; see Lasersohn (1989), Schwarzschild (1996), Link (1998b), Winter (2001), Champollion (2016a), among many others.

(35) **Hypotheses** Experiment 1

a. If the reading of sentences with a plural subject and a singular indefinite object merely depends on the context, they are true in a nonatomic distributive context; see Schwarzschild (1996).

b. If the nonatomic distributive reading of sentences with a plural subject and a singular indefinite object also depends on the form of the subject, as it is predicted in Wohlmuth (2017), sentences with a conjoined proper name subject will not be true, unlike those with a plural common noun subject.

With these assumptions and hypotheses in mind, I designed a survey experiment where sentences with different subjects and objects had to be judged for truthfulness given a nonatomic distributive context presented as a short text.[9]

[9]The general design of the experiment was evaluated and approved by the Parc de

4.4.1.1 Materials

The test material consisted of sixteen short texts and four possible test sentences for each text (64 sentences in total). Each text described a nonatomic distributive scenario, where pairs of individuals carried out a certain type of event. In each text, the relevant characters were four – all of them were introduced by name and also as part of the extension of the same common noun (no other individual in the context was introduced as part of the common noun's extension).

The four possible sentences were constructed according to the two two-level variables that were tested in the experiment (2 x 2 within subjects design). The first variable was the form of the subject with two possible levels (*definite plural common noun* and *conjoined proper name*), and the second variable was the verb phrase, also with two possible versions (*bare plural object* and *indefinite singular object*). To avoid possible confounds due to the possibility of generic vs. episodic interpretations, each sentence contained an episodic spatio-temporal modifier. A summary of the set of tested conditions for each text can be found in Table 4.1, and an example in (36).

	Context	Subject	Object
CONDITION 1	nonat. dist.	definite plural	bare plural
CONDITION 2		conjoined proper names	bare plural
CONDITION 3		definite plural	indefinite singular
CONDITION 4		conjoined proper names	indefinite singular

Table 4.1: Summary of tested conditions in Experiment 1

(36) Mrs. Brady had only four students in home economics class this year, Eleanor, Finn, Gillian and Harry. Today's lesson was cake baking. After a short introduction, Mrs. Brady split the class into two groups for the actual baking. Eleanor and Finn worked together on the one hand, and Gillian and Harry on the other. At

Salut MAR - Clinical Research Ethical Committee of Universitat Pompeu Fabra.

the end the cakes turned out to be so good that they were served after the football game in the afternoon.

a. *Today in home economics class, the students baked cakes.*
b. *Today in home economics class, Eleanor, Finn, Gillian and Harry baked cakes.*
c. *Today in home economics class, the students baked a cake.*
d. *Today in home economics class, Eleanor, Finn, Gillian and Harry baked a cake.*

The predicates in the sentences were such that their lexical meaning is not specified with respect to collectivity or distributivity, an therefore they could possibly contribute to nonatomic distributive readings. To avoid bias, the exact predicates that were tested were not mentioned in the corresponding texts.

To avoid the repetition of the short texts, the test material was distributed over four different lists. A list consisted of the sixteen texts with one of the four possible sentences, with the four conditions appearing four times. The sixteen critical items were presented among eight filler items – whose structure was identical to that of the critical items – and their order was pseudorandomized.

The materials used in Experiment 1 can be found in Appendix A.1.

4.4.1.2 Procedure and predictions

The experiment was implemented as an online survey using Qualtrics. Participants were presented with one item per page: one text and the corresponding sentence set off from the text, and the test question. The task was to rate the sentence in the given context in terms of truthfulness on a scale from 1 to 6, where 1 corresponded to *absolutely untruthful*, and 6 as *absolutely truthful*. 'Truthfulness' was introduced at the beginning of the experiment as an extended notion of truth in order to accommodate possible uncertainty regarding the meaning of sentences with plurals. Each participant saw only one of the four lists – the lists were presented randomly and were distributed evenly among the participants.

The predictions for Experiment 1 were the following.

(37) **Predictions** Experiment 1

a. Since the meaning of the sentences with a bare plural object was assumed to be vague, Condition 1 and 2 sentences were expected to be rated 6, i.e. 'absolutely truthful' in the nonatomic distributive contexts, regardless the form of the subject.

b. Condition 3 sentences were predicted to be rated as high as Condition 1 and and 2 sentences, provided that they have a nonatomic distributive interpretation.

c. Finally, Condition 4 sentences were predicted to get a lower rating compared to Condition 3 sentences according to the assumption that conjoined proper names do not support a groups of group interpretation.

4.4.1.3 Participants and exclusion process

64 participants were recruited on Prolific Academic. The distribution of the survey was restricted to native speakers of English. Participants had to report within the survey that their first language is English.

6 participants were rejected without payment due to unreliable responses. One of the rejected participants completed the survey in an extremely short time (the estimated completion time was 20 minutes, and this participant finished in 5 minutes 44 seconds) and failed all of the false fillers. The other five participants were rejected based on their poor performance on fillers: they failed to differentiate between the false and true fillers. Retrospectively, the method of rejection based on the performance on the fillers seemed too strict, given the small number of fillers, and it was revised for Experiment 2.

58 participants were paid £2 for participation. I excluded 5 additional participants based on other aspects of their performance on the fillers, so for the analysis, I used data from 53 participants.

Originally, I wanted to exclude participants who got three or more fillers wrong. Among the eight fillers, four were false, and four were true, and I expected the false ones to get low ratings (between 1–3) and the true ones get high ratings (between 4–6), so I considered a wrong answer to the false fillers to be between 4–6, and for the true fillers, between 1–3.

However, after obtaining the data of the fillers it turned out that one of the false fillers, in (38), received unexpectedly high ratings: 33 of the 64 participants gave a rating from the wrong range, between 4 and 6, so it was decided to exclude the responses of this particular item for the exclusion process which was modified in Experiment 2.

(38) My friends, Abby and Bobby, wanted to not slack off and be bored the whole summer and rather do something new and productive with their time. Somewhat randomly they decided to jointly make a short film using stop-motion technique. Despite their complete lack of experience they managed to finish it by the end of August, and it turned out to be pretty good.
This summer, my friends each produced a stop-motion video.

Having been left with only seven filler items, I revised the criterion of exclusion, and I excluded every participant who got two or more fillers wrong ignoring their response to item in (38).

4.4.1.4 Results

The data was analyzed in an ordinal regression model, with response (from 1 to 6) as the dependent variable, the type of subject and object as the fixed effects, and participants and items as the random effects. Calculations were carried out in R, using the the clmm() function from the "ordinal" package. The results can be found in Figure 4.1. The results show that while speakers accept sentences with a bare plural object as truthful in nonatomic distributive contexts, they tend to downgrade sentences with a singular indefinite object. The analysis revealed that only the type of the VP has a significant effect on participants' responses (p<.001), and there was no significant effect due to the type of the subject (p=.304).

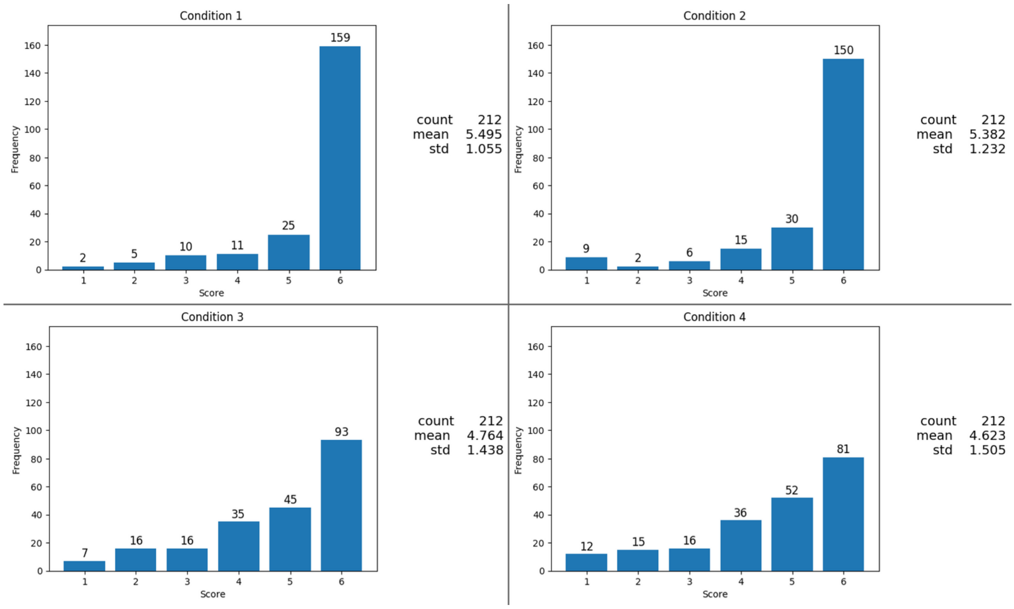


Figure 4.1: The frequency of scores for each condition in Experiment 1

4.4.1.5 Discussion

The results of Experiment 1 demonstrate that sentences with a plural subject and a bare plural object are accepted as true in a nonatomic distributive context, which confirms prediction (37a). However, the acceptance of sentences with singular indefinite objects is not so straightforward: given that the majority of the responses were in the higher range (between 4 and 6) and the most frequent response to sentences with a singular indefinite object was 6, speakers definitely do not reject these sentences in a nonatomic distributive context. Nonetheless, their judgments show more variability than with the sentences with a bare plural object; therefore, prediction (37b) is not fully confirmed. Finally, the results of the experiment suggest that the form of the subject does not play a role in speakers' judgment, so prediction (37c) is not confirmed.

4.4.2 Experiment 2

The experiment discussed below was a follow-up to Experiment 1 to see if the VP-effect found there is associated with the granularity of the distribution, i.e. nonatomicity, or rather distributivity itself.[10]

4.4.2.1 Previous experiments on the availability of atomic distributivity

Experimental studies suggest that speakers access the atomic distributive interpretation of sentences with a plural subject and an indefinite singular object at a lower rate than their collective reading, see Pagliarini, Fiorin & Dotlačil (2012) for Italian and Syrett & Musolino (2013) for English. These results are echoed in Experiment 1, where it was found that on their distributive interpretation, sentences with a plural subject and a singular indefinite object are accepted at a lower rate than the ones where the object is a bare plural. However, the results of Experiment 1 in isolation do not indicate whether the effect found there, and the one found in Pagliarini, Fiorin & Dotlačil (2012) and Syrett & Musolino (2013) is the same – i.e. associated with distributivity – or different – i.e. associated with atomicity.

In order to determine what the effect found in Experiment 1 is associated with, I designed a follow-up experiment. The design of this experiment was similar to that of Experiment 1, except here I tested sentences with a plural subject and a singular indefinite object both in atomic and nonatomic contexts. I assumed that if the effect found in the previous experiments in the literature is different from the one found in Experiment 1, the context will have an effect on the rating of the sentences. Also, to see if the form of the subject has an effect on speakers' judgment of sentences in atomic versus nonatomic contexts, I tested both definite plural and conjoined proper name subjects.

[10] I would like to thank Jakub Dotlačil for drawing my attention to this question.

4.4.2.2 Materials

The test material consisted of 16 pairs of short texts and two corresponding sentences for each context pair – 32 texts and 32 sentences in total. Each text pair consisted of an atomic distributive and a nonatomic distributive version of a scenario. The nonatomic distributive versions were the same ones used in Experiment 1. The atomic distributive versions were similar to their nonatomic distributive counterparts, but instead of describing a situation where pairs of individuals performed a certain event, it described the same event being performed by each individual separately. The further characteristics of the texts were the same as in Experiment 1.

The corresponding pairs of sentences were constructed based on the same two-level subject variables, as in Experiment 1: *definite plural* and *conjoined proper name*. Hence Experiment 2 had a very similar design to Experiment 1 (2 x 2 within subjects), but instead of having both variables in the sentence, here one of them was in the short text. The summary of the tested conditions can be found in Table 4.2, and an example of the pair of short texts in (39), with the corresponding test sentences in (40).

	Context	Subject	Object
CONDITION 1	at. dist.	definite plural	indef. singular
CONDITION 2	at. dist.	conjoined proper names	
CONDITION 3	nonat. dist.	definite plural	
CONDITION 4	nonat. dist.	conjoined proper names	

Table 4.2: Summary of tested conditions in Experiment 2

(39) a. [atomic distributive context] Mrs. Brady had only four students in home economics class this year, Eleanor, Finn, Gillian and Harry. Today's lesson was cake baking. After a short introduction, the students started the actual baking, working on different recipes. In the end the cakes turned out to be so good that they were served after the football game in the afternoon.

b. [nonatomic distributive context] Mrs. Brady had only four students in home economics class this year, Eleanor, Finn, Gillian and Harry. Today's lesson was cake baking. After a short introduction, Mrs. Brady split the class into two groups for the actual baking. Eleanor and Finn worked together on the one hand, and Gillian and Harry on the other. In the end the cakes turned out to be so good that they were served after the football game in the afternoon.

(40) a. *Today in home economics class, the students baked a cake.*
b. *Today in home economics class, Eleanor, Finn, Gillian and Harry baked a cake.*

The material was divided into four different lists where only one condition per item was presented, just as in Experiment 1. A list consisted of sixteen texts with one of the two possible sentences, with the four conditions appearing four times. And as in Experiment 1, the sixteen critical items were presented among eight filler items – whose structure was identical to that of the critical items – and their order was pseudorandomized.

The materials used only in Experiment 2 are in Appendix A.2.

4.4.2.3 Procedure and predictions

The procedure was identical to that of Experiment 1. The predictions for Experiment 2 were the following.

(41) **Predictions** Experiment 2

a. If the effect detected in Experiment 1 is associated with the (non)atomicity of the individuals involved in the distribution, speakers will downgrade Condition 3 and 4 items compared to Condition 1 and 2 items.
b. If conjoined proper names do not support groups of groups interpretations, Condition 4 items will get lower ratings than Condition 3 items.

4.4.2.4 Participants and exclusion process

66 participants were recruited on Prolific Academic. The distribution of the survey was restricted to native speakers of English and participants also had to declare within the survey that their first language is English.

4 participants were rejected without payment due to their short completion time (the estimated completion time was 20 minutes, and their completion time was between 2 minutes 05 seconds and 4 minutes 10 seconds). Performance on the fillers did not play a role in the rejection of these 4 participants.

62 participants were paid £2 for participation. For the analysis, I used only data from the subset of the paid 62 participants who gave good responses on the fillers (52 participants).

Since the problematic filler item in Experiment 1 was modified for Experiment 2, this time no fillers were ignored for the exclusion process. All participants who got three or more fillers wrong were excluded. Just like in Experiment 1, among the eight fillers, four were false, and four were true, and I expected the false ones to get low ratings (between 1–3) and the true ones get high ratings (between 4–6) so I considered a wrong answer to the false fillers to be rated between 4–6, and for the true fillers, between 1–3.

4.4.2.5 Results

The results of Experiment 2 can be found in Figure 4.2. The data was analyzed in an ordinal regression model, with response (from 1 to 6) as the dependent variable, the type of context and subject as the fixed effects, and participants and items as the random effects. Calculations were carried out in R, using the the clmm() function from the "ordinal" package. The analysis revealed that neither the context (p=.674), nor the type of the subject (p=.223) is a significant factor affecting speakers' judgments.

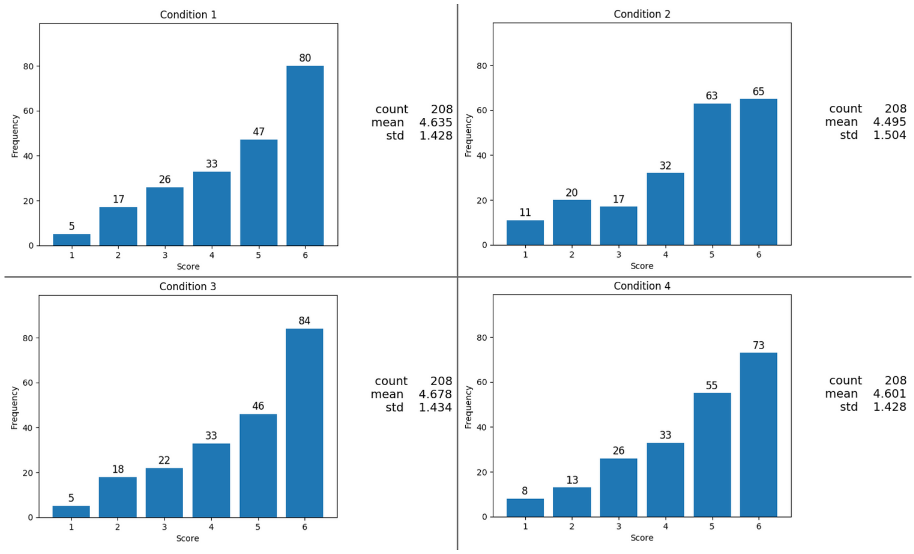


Figure 4.2: The frequency of scores for each condition in Experiment 2

4.4.2.6 Discussion

Based on the results of Experiment 2, we can conclude that speakers do not differentiate between atomic and nonatomic distributive reference; hence prediction (41a) is not confirmed. This suggests that the VP-effect found in Experiment 1 is associated with distributivity rather than (non)-atomicity of the individuals involved in the distribution. Moreover, the results indicate, just like in Experiment 1, that the form of the subject does not influence the availability of the nonatomic distributive reading, thus prediction (41b) is once again not confirmed.

4.5 General discussion

In this section, I discuss the goals and the results of the experiments given the assumptions I presented in Section 4.2–4.3. Then I consider some of the limitations of the study.

4.5.1 Discussion of the goals and results

The goals of the two experiments presented above were three-fold: first and foremost, the experiments were meant to collect data on the availability of nonatomic distributive reference in sentences with a plural subject and an indefinite singular object. Second, they also meant to test whether there is a difference in the availability of atomic and nonatomic distributive reference. And finally, their third goal was to test whether the form of the subject has an affect on the availability of nonatomic distributive interpretations.

4.5.1.1 The availability of nonatomic distributive reference

The primary goal of the two experiments discussed above was to obtain data on the availability of nonatomic distributive reference in case of sentences with a plural subject and a singular indefinite object, like (22), restated below as (42), when they are presented in a supporting context.

(42) The students baked a cake. = (22)

According to our discussion in Chapter 3, the distributive interpretation of these sentences involves a silent verbal operator that modifies the meaning of the VP so that it is applied to every atomic, or contextually salient part of the plurality denoted by the plural subject.

However, based on the literature, it is unclear whether such sentences should have nonatomic distributive reference, when the VP *baked a cake* holds for some groups of individuals that are parts of the plurality referred to by the plural subject *the students*. Some accounts outright reject the possibility of such interpretations of such sentences (Lasersohn 1989, Lasersohn 1995), while others suggest that it is available under the appropriate circumstances (Schwarzschild 1996, Champollion 2016a). But these circumstances are left undescribed (see point made by Winter 2001).

In the experiments I tested a weak hypothesis, namely that merely mentioning the relevant groupings of the individuals in the denotation of the plural subject, hence making them salient in the context, makes the nonatomic interpretation available for sentences like (42). I consider this hypothesis weaker than the one put forth in Mendia (2015) (and also suggested by Champollion 2016a), according to which the salient groupings are made available by world knowledge, hence are not affected by the immediate context of the sentence. I have not tested this stronger hypothesis in the experiments.

Based on the results of the experiments, the weaker hypothesis about the availability of nonatomic reference is supported, and speakers are able to infer a nonatomic distributive interpretation of sentences like (42), where the salient groupings of the individuals are specifically mentioned.

However, the results of the experiments also suggest that sentences where the object is a bare plural, like (43), are accepted by speakers to a higher rate compared to sentences with a singular indefinite object in the same nonatomic distributive scenario. This supports the claim that that the meanings of sentences with a bare plural object and those with a singular indefinite object are obtained by different means (see Lasersohn 1989, 1995, Winter 2001, Champollion 2016a, a.o., cf. Gillon 1987, 1990).

(43) The students baked cakes.

The results of the experiment mirror the results obtained from previous experiments about the availability of atomic distributivity contrasted with that of collectivity, like Pagliarini, Fiorin & Dotlačil (2012) and Syrett & Musolino (2013). Both studies report that the distributive interpretation is accessed by speakers to a lower rate than the collective interpretation. Experiment 1 reproduced this effect, moreover, the results reported here also suggest that this effect is associated with the form of the VP.

4.5.1.2 Atomic vs. nonatomic distributive reference

The second goal of the experiments was to obtain data on whether the atomic and the nonatomic interpretation of sentences like (42) are accessed to a different degree by speakers. Most of the accounts discussed above assume that the availability of nonatomic distributivity is limited compared to that of atomic distributivity. This assumption is based on another, more fundamental assumption dating back at least to Link (1983), namely that the smallest individuals in the denotation of a plural predicate (let those be absolute atoms or relative atoms with respect to the predicate) are of prominence when it comes to distributive reference.

The results obtained from Experiment 2 show that speakers access atomic and nonatomic interpretations of sentences like (42) virtually to the same rate: no detectable difference was found between the rate of acceptance of sentences like (42) on its atomic or nonatomic distributive reading when presented in an atomic or a nonatomic distributive scenario.

This finding suggests the structure of the entities involved in distributive reference does not play as an important a role as it has been assumed in the past. That is, whether the individuals involved in the distribution are singular or plural with respect to the denotation of the subject does not play a crucial role in speakers' judgment.

This is reflected in the Pack-D_{MIN} approach to distributive reference presented in Section 4.3.3, where the main idea was that the silent distributivity operator does not specify the structure of the individuals the VP applies to, but only spells out that the VP applies to *certain* individuals, instead of applying to individuals cumulatively, as it is assumed in the case of bare verbs and VPs with bare plural objects (see discussion in Section 4.2.2). Since minimal elements are defined essentially the same way as relative atoms, this approach captures that the denotation of the VP is parallel to the denotation of count nouns.

4.5.1.3 The role of the form of the subject

The third goal of the experiments was to test the predictions of Pack-D_{MIN} approach (Wohlmuth 2017, and further developed above in Section 4.3.3) where it was stipulated that the form of the subject has an effect on the availability of nonatomic distributive reference. This stipulation was concretized in an account where the contextually salient individuals involved in the distribution are supplied by a silent operator over the structure of the plural subject, whose availability is restricted to common nouns. Hence the prediction is that the sentences where the plural subject is expressed by a plural predicate can have nonatomic distributive reference, while those where the subject is expressed by conjoined proper names, even if that expression refers to the same individuals, cannot.

The results of the experiments suggest that speakers do not make a distinction based on the form of the subject, hence this prediction of Wohlmuth (2017) was not borne out. To accommodate these results, I modify the account presented in Section 4.3.3 so that it can predict that common nouns and proper names behave similarly in terms of distributive reference.

In order to do that, first I define a typed version of the mereological part relation; see (44).

(44) **Definition** Typed parthood

$x \leq_P y \stackrel{\text{def}}{=} P(x) \ \wedge \ P(y) \ \wedge x \leq y$

An entity x is a P-part of an entity y if for both x and y P holds, and x is part of y.

According to our definition in (44), two entities can be related via the typed part relation as long as they are in the denotation of the same predicate and the entities are related via the mereological parthood. Now, I define the silent verbal operator, D_{REL}, to account for covert distributive reference.

(45) $[\![D_{\text{REL}}]\!] = \lambda P \lambda x : \exists Q[Q \neq P \ \wedge \ Q(x)] \forall y : [\text{AT}_P(y)][y \leq_Q x \ \wedge \ y \in C(x) \rightarrow P(y)]$

D_{REL} is an operator that, when applied to a predicate P, modifies the meaning of the predicate such that P applies to every contextually salient Q-part y of a plurality x. The application of D_{REL} presupposes that there is a predicate Q, not equal to P, that applies to the plurality x, and that y is atomic with respect to P. By this last presupposition, we can ensure that D_{REL} can only apply in contexts where it is already common ground, or accommodated that certain parts y of a plurality x play the role of atoms with respect to P, the predicate D_{REL} is applied to.

The D_{REL}-approach to distributivity does not assume that the form of the nominal expression that provides the sorting key of the distributive relation has an effect on the possible interpretation(s) of the structure where the D_{REL}-operator is applied. Instead, the main hypothesis is that the application of the D_{REL}-operator is only felicitous in contexts where the it is clear that the verbal predicate holds of certain parts of the plurality. That is, for a sentence like (42) to be understood distributively, it has to be uttered in a context where it is already accommodated that which individuals (or which groupings of individuals) are atomic with respect to the verbal predicate; this piece of information cannot conveyed by the sentence alone.

The predictions of Schwarzschild (1996) and the D_{REL}-approach presented here are very similar. However, as I showed above, a conceptual benefit the D_{REL}-approach is that, unlike the Part approach in Schwarzschild (1996), it does not presuppose the existence of absolute atoms on the domain of individuals. That is, it provides a way to account for (atomic and nonatomic) distributive reference without having to make an ontological assumption about the structure of individuals.

4.5.2 Limitations of the experiments

Some features of the experiments' design inherently carry some limitations which have to be taken into account upon interpreting the results. Here, I highlight some of these.

First, the judgments were given on a 6-point scale, so they are not as straightforwardly indicative of the sentences' truth value as the judgments given on the classical binary scale. While it is clear that the two extremes on the 6-point scale correspond to the two values of a categorical judgment, responses given in the middle are not transformable into either of the categorical values. By using such a fine-grained scale, there is no way to know how a 5 differs from a 6: maybe it is the difference between computing the meaning generated by some silent operators vs. not, but it can reflect some another form of reasoning. This is not straightforwardly indicated by the experiments. The analyses discussed in the previous section provide different ways to account for the results, but one cannot exclude the possibility that there might be other ways to account for the data obtained by the experiments.

Second, the detailed scenarios described in the texts give a substantial amount of information which could potentially push speakers' judgments towards higher values on the scale, so that it is not possible to tell whether speakers are just generous or neglectful when giving the higher scores, or whether they do access a genuine nonatomic distributive interpretation of the sentences. That said, the results do seem to support accounts that do not limit the availability of nonatomic distributive reference drastically.

Even though the scale or the detailed description of the scenarios definitely had an effect on speakers' judgments, it would be hard to argue that the results are just byproducts of some features of the experiments' design. For each condition with a singular indefinite object, the most frequent score given was 6, which means that speakers judged these sentences 'absolutely truthful' more frequently than anything else. This suggests that speakers do accept sentences with a plural subject and a singular indefinite object on their nonatomic distributive reading, given that they had many other options to chose from on our fine-grained scale. However, the other 5 points of the scale overall were used more frequently in conditions where the object is a singular indefinite than in those where the object is a bare plural, so despite the detailed descriptions, participants reported various judgments. This indicates that the detailed descriptions did not have a crucial effect on the results.

Finally, in the experiments I only tested partitions, not minimal covers as are used in the semantics of both the Part and the Pack operators. This is an important caveat, because interpretations involving a cover over a plurality require even more flexibility than the ones involving a partition, hence they can potentially be harder to obtain. Whether speakers are flexible enough to allow for cover readings is not indicated by the results of the experiments.

4.6 Conclusions

In this chapter, I discussed the notion of nonatomic distributive reference. I reviewed the early proposals concerning what parts of a plurality can be involved in the distributions (Gillon 1987, Gillon 1990), and also some more recent ones (Schwarzschild 1996, Mendia 2015, Champollion 2016a and Wohlmuth 2017). I concluded that the biggest problem surrounding the notion of nonatomic distributive reference is the lack of empirical data on the availability of this interpretation. While there is a relative abundance of proposals accounting for nonatomic distributive reference, its availability is often assumed to be very limited or even doubted (Lasersohn 1989, Lasersohn 1995, Link 1998b, Winter 2001, a.o.).

Although the results of the experiments presented in this chapter suggest that nonatomic distributive reference can arise if sentences are presented in a supporting context, they also provide basis for further assumptions about the structure of the individuals involved in the distribution. While it has been generally assumed that nonatomic distributive reference is secondary to atomic distributive reference – complying with the assumption that atomic parts of a plurality are prominent compared to other, plural parts, the results of the experiments suggest that speakers do not make this distinction.

This finding supports accounts that do not posit that the structure of individuals involved in the distribution plays a distinguished role in distributive reference, like Schwarzschild (1996) and Wohlmuth (2017). I also showed in this chapter that the account in Wohlmuth (2017), and its upgraded version presented here is a viable alternative to the account presented in Schwarzschild (1996) for domains that do not utilize the notion of absolute atoms, see Chapter 2.

Additional files

The results of the experiments reported in Section 4.4, along with the materials presented in Appendix A can be found at `http://hdl.handle.net/10230/35842`.

Chapter 5

ATOMICITY AND EVENT DISTRIBUTIVITY

5.1 Introduction

In the previous chapter, I discussed the relevance of (non)atomicity in relation with individual distributivity, and I presented empirical data that suggest that the (non)atomicity of the individuals involved in the distribution does not play a major role in the emergence of distributive reference, contrary to what has been assumed in the literature.

In this chapter, I am discussing the relevance of (non)atomicity in relation with event distributivity through the case study of Hungarian reduplicated numerals. Hungarian reduplicated numerals are indefinite NPs that are formed by the reduplication of the cardinal numeral heading a common noun, see (1) and (2).[1] Note that in Hungarian, the noun in such constructions lacks plural marking regardless the cardinality expressed by the numeral.

[1]Determiner reduplication in Hungarian is not restricted to numerals; it is possible to form reduplicated indefinites by the reduplication of the determiners *más*, lit. 'different', *külön*, lit. 'separate' (see Farkas 1997, Farkas 2015). However, here I am going to limit the discussion to Hungarian reduplicated numerals, like the ones in (2).

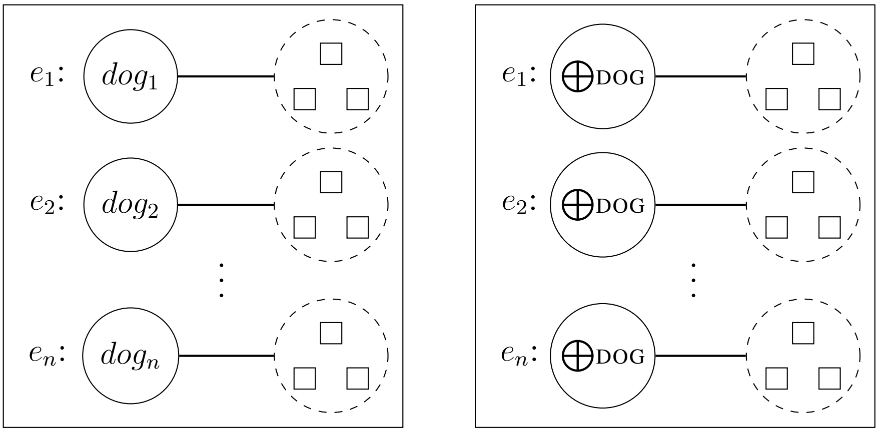
(1) **Unmarked numeral** Hungarian
egy/hat/ezer kutya
one/six/thousand dog
'one dog/six dogs/one thousand dogs'

(2) **Reduplicated numeral** Hungarian
egy-egy/hat-hat/ezer-ezer *kutya*
one-one/six-six/thousand-thousand dog

Hungarian reduplicated numerals are members of the class of distributive numerals: they are a kind of numeral series derived from cardinal numerals, and their signature feature is that they force a distributive interpretation of the sentence they occur in (Gil 1982, Gil 2013). Moreover, Hungarian reduplicated numerals mark the number of entities distributed over the entities denoted by the sorting key (Choe 1987, see Chapter 3). The sentence in (3) with the reduplicated numeral *három-három ember*, lit. 'three-three human' illustrates this property: the sentence lacks a cumulative (hence nondistributive) interpretation (see (3a)), and only can be understood distributively.

(3) *Ez-ek a kutyá-k megmentettek* ***három-három*** *ember-t.*
this-PL the dog-PL rescue.PST.3PL three-three human-ACC
a. UNAVAILABLE: 'These dogs rescued three people in total'
b. OUT OF THE BLUE: 'These dogs rescued three people each'
c. WITH CONTEXT: 'These dogs rescued three people on each salient occasion'

Moreover, as already mentioned in Chapter 3, example (23), (3) supports two kinds of distributive interpretations: one in which the sorting key is the plural subject from the domain of individuals (see (3b)), and one in which it is from the domain of events or occasions (see (3c)). It is generally assumed that this latter interpretation is only available if the context supplies the salient plurality of events to distribute over (see Zimmermann 2002, Farkas 2015, Champollion 2016b, a.o.). The situations satisfied by the individual and event distributive interpretations of (3) are represented in the diagrams in Figure 5.1.



(a) Individual dist. interpretation of (3)

(b) Event distributive interpretation of (3)

Figure 5.1: Situations satisfied by (3). The circles represent dogs, the rectangles represent people; the dashed circles around the shapes indicate that the meaning of the sentence is underspecified with respect to the single events being (non)distributive.

The sentence in (3) and its possible interpretations contrast with (4), where the unmarked indefinite *három ember*, lit. 'three human' supports a cumulative interpretation (see (4a)). (4) also supports a distributive interpretation; however, its availability is limited. While in (3), both an individual and an event distributive interpretation is possible, (4) can only have an individual distributive interpretation, given a supporting context; see (4b). (4) lacks the interpretation where the distribution is over salient events, as shown in (4c).

(4) *Ez-ek a kutyá-k megmentettek három ember-t.*
this-PL the dog-PL rescue.PST.3PL three person-ACC
a. OUT OF THE BLUE: 'These dogs rescued three people in total'
b. WITH CONTEXT: 'These dogs rescued three people each'
c. UNAVAILABLE: 'These dogs rescued three people each time'

Hungarian reduplicated numerals are associated with various linguistic phenomena, and there are various accounts in the literature focusing on some of the issues raised by Hungarian reduplicated numerals, and the various phenomena related to them.

First, while they force a distributive reading of the sentences they occur in, Hungarian reduplicated numerals mark the distributed share rather than the sorting key; hence these elements are connected to the phenomena discussed under the term *distance distributivity*. The most fundamental question posed by these elements is how the distributive interpretation of sentences containing these items arises. Some, like Oh (2001) and Balusu (2006), posit that distributive reference is not directly contributed by the distance distributivity item (the reduplicated numeral, in our case), but by a silent distributivity operator that is associated with it. Others, like Zimmermann (2002), Champollion (2012), Dotlačil (2012), Cable (2014) and Champollion (2016b), assume that distributivity is directly contributed by the these items, proposing sophisticated semantic mechanisms to ensure compositionality.

Second, Hungarian reduplicated numerals not only seem to enforce a distributive interpretation, but are also assumed to be subjected to a (co-)variation condition, based on which they must be interpreted with respect to another plurality in the sentence or in the context. Hence these elements are connected to the phenomena discussed under the term *dependent indefinite*, see Farkas (1997), Farkas (2002), Henderson (2012), Farkas (2015) and Kuhn (2017). As these dependency relations between expressions go beyond structural relations (i.e. scope), their analysis is argued to require richer semantic setups, namely some form of a dynamic semantic framework.

These accounts are not uniform: they differ from each other regarding their assumptions, predictions and implementations not only across, but also within the category they were mentioned in above. Nonetheless, they all provide crucial insights about some aspects of Hungarian reduplicated numerals. In this chapter, however, I argue that none of them describes Hungarian reduplicated numerals fully: even though all of them can account for the data in (3), they struggle to predict the meaning of sentences like (5), and how the Hungarian reduplicated numeral contributes to it.

(5) *A verseny-en egyszerre* ***egy-egy*** *csapat*
the tournament-SUPE at.a.time one-one team
versenyzett egymás-sal.[2]
compete.PST.3SG each.other-COM
OUT OF THE BLUE: 'At the tournament, two teams competed at a time, one against the other'

As expected, in (5) the reduplicated numeral *egy-egy csapat*, lit. 'one-one team' forces a distributive interpretation, marking the number of entities – teams, in this case – distributed over the plurality denoted by the sorting key. The sorting key is not expressed overtly in (5), but on the most salient interpretation, it is arguably from the domain of events. Since the sentence describes a reciprocal event denoted by *versenyez egymással* lit. 'compete with each other', we can stipulate that the sorting key can either be a plurality of reciprocal events of competing, or a plurality of unidirectional competing events which are entailed by the reciprocal (see Dimitriadis 2008, Winter 2018, a.o.).

The reduplicated numeral in (5) cannot mark the number of entities distributed over the sorting key in either case. Assuming that the sorting key is a plurality of reciprocal competing events, the interpretation we get for (5) is nonsensical, namely that in each atomic reciprocal competing event one team competed with each other. On the other hand, if we assume that the sorting key is a plurality of unidirectional competing events, the interpretation we get for (5) is not attested, namely that in each event one team competed.

In this chapter, I will argue that the problem posed by sentences like (5) is rooted in the assumption that the distributive reference induced by

[2]The example is constructed based on an attested sentence found here: `https://www.mohacsiujsag.hu/mohacs/hir/helyi-hireink/szombaton-sarkanyhajoverseny-nevezoket-jelentkezoket-varnak`. Last accessed: 3 Jan, 2019. In the original sentence, the verb is in present tense; changing it to past tense should not affect any substantial claims made in relation to the sentence.

the Hungarian reduplicated numerals involves the mereological part-of relation between events as primitive entities. In the case of reciprocal VP constructions, we can posit that the reciprocal events they denote are atomic, or they are sums of unidirectional events. Cases like (5) show that neither of these options is viable for the analysis of Hungarian reduplicated numerals.

In this chapter, I propose that Hungarian reduplicated numerals do not operate with the mereological part-of relation in the event distributive interpretation they enforce. Instead, these expressions are sensitive to the *containment* relation, which I define as a relation between events based on their participants and runtime. That is, Hungarian reduplicated numerals are sensitive to the mereological structures formed by events both in connection to their participants and to their runtime.

5.2 Empirical landscape

In this section I discuss the basic distribution of Hungarian reduplicated numerals and I start to explore how these items contribute to the meaning of the sentences they occur in.

5.2.1 Reduplicated numerals in intransitive constructions

Hungarian reduplicated numerals can occur as subjects of intransitive constructions. The sentence is infelicitous out of the blue, see (6a). For (6) to be felicitous, the relevant plurality has to be salient in the context, see (6b). Similar judgments can be found in Farkas (2015).

(6) ***Négy-négy*** *lámpa világított.*
four-four lamp glow.PST.3SG
a. OUT OF THE BLUE: infelicitous
b. WITH CONTEXT: 'On each salient occasion, four lights were on'

If there is an adjunct in the sentence denoting a plurality, it can play the role of the sorting key; see (7a). However, given the appropriate context, the sorting key can be a salient plurality, as shown in (7b). In this latter case, the distributive numeral signals the number of entities involved in each salient occasion, and it has a cumulative interpretation with respect to the plurality denoted by the adjunct.

(7) *A szobá-k-ban **négy-négy** lámpa világított.*
the room-PL-INE **four-four** lamp glow.PST.3SG
a. OUT OF THE BLUE: 'In each room, four lights were on'
b. WITH CONTEXT: 'On each salient occasion, (a total of) four lights were on in the rooms'

The sorting key can be provided by a quantificational adjunct, as in (8). In these cases, the context cannot supply the relevant occasions to play the role of the sorting key. Without another plurality denoting expression in the sentence, the reduplicated numeral must signal the number of entities distributed over the denotation of the adjunct.

(8) *Mindig / Minden reggel / Reggel-enként / Reggel-ente*
always / every morning / morning-DIST / morning-DIST
***négy-négy** lámpa világított.*
four-four lamp glow.PST.3SG
'Always/Every morning/Each morning, four lights were on'

In sum, reduplicated numerals can appear in intransitive constructions. The sorting key can be provided by an overt adjunct in the sentence, or by the context – unless the adjunct is quantificational, in which case the sorting key must be denoted by the adjunct. Even though the context can supply the sorting key in other cases, interpretations involving distribution over a contextually salient plurality are less prominent, and they are generally harder to get. As expected, the data in (6)–(8) show that Hungarian reduplicated numerals signal the number of entities distributed over each element in the denotation of the sorting key.

5.2.2 Reduplicated numerals in transitive constructions

Hungarian reduplicated numerals can occur as objects in transitive constructions. If the subject denotes a single entity, the context must supply the salient plurality to act as the sorting key; otherwise, the sentence is infelicitous, see (9).

(9) *Borzi megmentett* ***két-két*** *ember-t.*
Borzi rescue.PST.3SG **two-two** human-ACC
a. OUT OF THE BLUE: Infelicitous
b. WITH CONTEXT: 'On each occasion, Borzi rescued two people'

Most typically, Hungarian reduplicated numerals co-occur with a plural denoting expression as the subject; see (10). The most salient interpretation of these sentences is the one where the denotation of the reduplicated numeral is distributed over the denotation of the subject, which thus plays the role of the sorting key, as in (10a). However, in the appropriate context, (10) can have an interpretation where the distribution is over salient occasions; see (10b).

(10) *A kutyá-k megmentettek* ***három-három*** *ember-t.*
the dog-PL rescue.PST.3PL **three-three** human-ACC
a. OUT OF THE BLUE: 'The dogs rescued three people each'
b. WITH CONTEXT: 'On each occasion, the dogs rescued three people'

The subject can be a universal quantifier, as in (11). In such cases if there is no plurality denoting expression in the sentence, the subject must denote the sorting key, just as in sentences like (8).

(11) *Minden kutya megmentett* ***három-három*** *ember-t.*
every dog rescue.PST.3SG **three-three** human-ACC
'Every dog rescued three people'

Hungarian reduplicated numerals can be subjects of transitive constructions; in these cases, the object can be an unmarked indefinite, as in (12), or a reduplicated numeral, as in (13), below. For these sentences to be felicitous, the sorting key must be provided by the context.

If the object is an unmarked indefinite, it can refer cumulatively with respect to the denotation of the reduplicated numeral. In this case, the unmarked numeral can signal the number of entities denoted by the object across contextually salient occasions, as in (12b), or within each occasion, as in (12c).

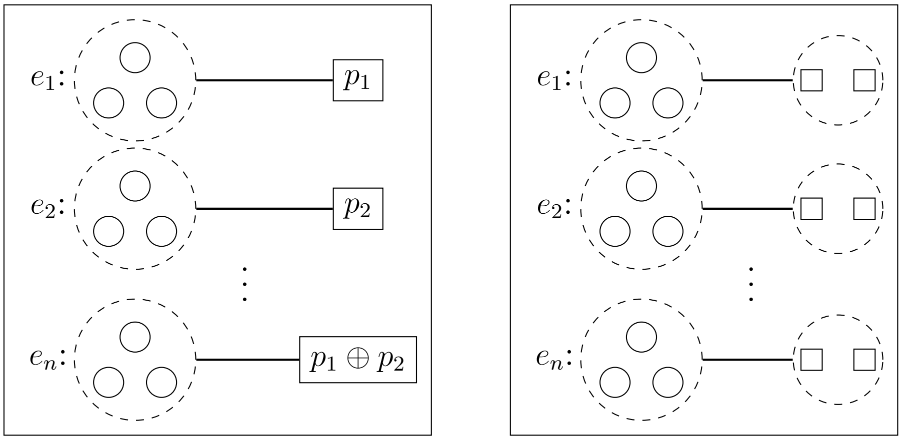
(12)	***Három-három***	*kutya*	*megmentett*	*két*	*ember-t.*
	three-three	dog	rescue.PST.3SG	two	human-ACC

a. OUT OF THE BLUE: Infelicitous
b. WITH CONTEXT: 'On each occasion, three dogs rescued some people, and the total number of people rescued by the dogs is two'
c. WITH CONTEXT:'On each occasion, three dogs rescued two people'

If the object is a reduplicated numeral, then it can signal the number of entities on each contextually salient occasion, as in (13b), or it can signal the number of entities with respect to each entity denoted by the reduplicated numeral subject, as in (13c). However, it cannot signal the total number of entities across occasions, as the unmarked numeral can in (12). Possible scenarios in which (12) and (13) can be true are represented in Figure 5.2.

(13)	***Három-három***	*kutya*	*megmentett*	***két-két***	*ember-t.*
	three-three	dog	rescue.PST.3SG	**two-two**	human-ACC

a. OUT OF THE BLUE: Infelicitous
b. WITH CONTEXT: 'On each occasion, three dogs rescued two people'
c. WITH CONTEXT: 'On each occasion, three dogs rescued two people each'



(a) A possible scenario for (12), but not (13)

(b) A possible scenario for both (12) and (13)

Figure 5.2: Possible scenarios for (12) and (13); the circles represent dogs, the rectangles represent people; the dashed circles around the shapes indicate that the meaning of the sentence is underspecified with respect to the single events being (non)distributive.

In sum, reduplicated numerals can occur in transitive constructions as the object or as the subject, or as both. When the subject is a reduplicated numeral, there must be a salient plurality in the context that serves as the sorting key. The sorting key can be provided by the context in all cases, except when there is a quantificational expression in the sentence, given there is no other plurality denoting expression in the sentence, in which case the quantificational expression must serve as the sorting. And again, as expected, the data in (9)–(13) show that Hungarian reduplicated numerals signal the number of entities distributed over the elements in the denotation of the sorting key.

5.3 The core semantic contribution of Hungarian reduplicated numerals

In this section I discuss the semantic contribution of Hungarian reduplicated numerals. I am going to take the examples in (6)–(13) as my base data to do this, and as I go, I will add more data points to this base. First, I will argue that Hungarian reduplicated numerals are examples of *share-based distributivity*. I use this term for cases where a distributive relation is established by marking the distributed share without the specification of the sorting key in the relation. After that, I will address some claims about what the semantics of Hungarian reduplicated numerals entails, and I will argue that they reveal some pragmatic properties of these items, and thus we do not have to account for them in our semantic analysis in the following section.

5.3.1 Share-based distributivity

The meaning contribution of Hungarian reduplicated numerals is usually assumed to force a distributive interpretation, since the sentences they occur in lack a nondistributive – or, more precisely, a cumulative – interpretation, one in which the reduplicated numeral signals the total number of entities involved in the event denoted by the sentence. This was the main difference detected between sentences with and without reduplicated numerals in the introduction to this chapter, illustrated by (3) and (4), repeated as (14) and (15) below.

(14) *Ez-ek a kutyá-k megmentettek* ***három-három*** *ember-t.*
this-PL the dog-PL rescue.PST.3PL three-three human-ACC

a. UNAVAILABLE: 'These dogs rescued three people in total'
b. OUT OF THE BLUE: 'These dogs rescued three people each'
c. WITH CONTEXT: 'These dogs rescued three people on each salient occasion'

(15) *Ez-ek a kutyá-k megmentettek három ember-t.*
this-PL the dog-PL rescue.PST.3PL three person-ACC

a. OUT OF THE BLUE: 'These dogs rescued three people in total'
b. WITH CONTEXT: 'These dogs rescued three people each'
c. UNAVAILABLE: 'These dogs rescued three people each time'

Here, however, I am focusing on the second, and just as important, difference between sentences with and without reduplicated numerals illustrated by the examples in (14) and (15), namely, that the sentences with an unmarked numeral lack the so-called event distributive interpretation.

This difference suggests that we are dealing with a different kind of distributivity with reduplicated numerals and with unmarked numerals. With unmarked numerals, the sorting key can be only from the domain of individuals, and it has to be overtly expressed in the sentence. This is the kind of distributivity that the distributivity operators from Chapter 3 and 4 were originally defined to take care of. However, with reduplicated numerals, the sorting key can be either from the domain of individuals or from that of events, and in the latter case, the sorting key does not have to be overtly expressed in the sentence.[3]

It is often assumed that distributive numerals establish a distributive relation where the sorting key is specified. In some accounts, sentences with a distributive numeral are taken to be ambiguous between the individual and event distributive readings and this ambiguity is associated with the distributive numeral (Gil 1982, Oh 2001, a.o.). In others, distributive numerals are assumed to contribute to an event distributive interpretation of the sentence, and a possible individual distributive interpretation is derived from the event distributive one (Balusu 2006). These assumptions capture fundamental intuitions about the semantic contribution of Hungarian reduplicated numerals; however, as I argue below, it also misses a crucial generalization involving these expressions.

We can argue that Hungarian reduplicated numerals do not themselves

[3]This fact in itself does not mean that Hungarian reduplicated numerals cannot be analyzed by means of the D-operator (see such analyses in Oh 2001 for Korean and Balusu 2006 for Telugu), but it is reason enough to think about other ways to analyze the data.

specify the sorting key over which their denotation is distributed.[4] This assumption is supported by the fact that they can only mark the distributed share and but not the sorting key. This fact suggests that the meaning contribution of these elements should not be captured in the same way as the meaning contribution of distributive markers that mark – and hence, fully specify – the sorting key. So instead of assuming that Hungarian reduplicated numerals plug in the number of entities in the distributed share in a full-blown distributive relation, I assume that these expression themselves establish the distributive relation by virtue of marking the distributed share. The sorting key of the distributive relation is not specified by the reduplicated numerals, but they require the context to supply a salient plurality that plays the role of the sorting key; otherwise the sentence is infelicitous. This plurality can be the participants, temporal traces or spatial traces of the event described by the sentence.[5]

Here I call cases where the distributive relation is established by marking the distributed share as *share-based distributivity*. Since Hungarian reduplicated numerals contribute to the distributive interpretation of the sentence without specifying the sorting key in the distributive relation, I treat them as share-based distributive elements which I define as in (16).

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[4]This approach to the meaning contribution of distributive numerals is rooted in the account in Cable (2014), although here I am presenting this approach in a way that is not found in Cable (2014).

[5]Even though here I am not discussing the spatial domain, reduplicated numerals can in fact distribute over spatial traces of the main event, as shown in the example in (i), found on page 5 of the document here: `https://docplayer.hu/13958763-40-allegorikus-jelenet-pasztor-alakjaval.html`.

(i) *A fal előtt* ***három-három****, növény-ek-kel befuttatott szobor.*
the wall in.front.of **three-three**, plant-PL-COM cover.PST.3SG sculpture
'In front of the wall, there are three sculptures, covered with plants'

In (i), there is no overt expression that could provide the sorting key of the distributive relation established by the reduplicated numeral. However, the sentence is presented in the context of the image below, which makes it clear that the distribution is over the spatial properties of the event described by the sentence: there are three statues on each side of the wall.

(16) **Definition** *Share-based distributive element*
A share-based distributive element establishes the distributive interpretation of the sentence it occurs in by marking the constituent that plays the role of the distributed share. It does not specify the sorting key in the relation, but requires the context to supply a salient plurality to play the role of the sorting key.

Treating Hungarian reduplicated numerals as share-distributive elements is supported by the examples discussed in this chapter so far: all the sentences with reduplicated numerals are understood in a way that they mark the number of entities participating in some subevent of the event denoted by the sentence. Whether those subevents are individuated by their participants or by their temporal traces does not change this inference; the distributive reference of the sentence is established even without the identification of the sorting key.

According to the share-based distributivity view, sentences with Hungarian reduplicated numerals are not ambiguous between individual and event distributivity; they are merely underspecified as to what is the plurality the plays the role of the sorting key (see also Cable 2014). As stated above, Hungarian reduplicated numerals require the sorting key to be contextually provided; otherwise, the sentence they occur in is infelicitous.

For the reasons of space, here I refrain from adding the spatial domain, but it should be a trivial extension of the analysis proposed here.

In contexts where the role of the sorting key is played by participants in the main event denoted by the sentence, the sentence receives what I have described as an individual distributive interpretation, as illustrated by (7a), repeated as (17a) below. Conversely, in contexts where the sorting key is played by either the temporal or spatial traces of the main event described by the sentence, it receives an event distributive interpretation[6], as show in (7b), repeated here as (17b).

(17) *A szobá-k-ban* ***négy-négy*** *lámpa világított.*
the room-PL-INE **four-four** lamp glow.PST3SG
a. 'In each room, four lights were on'
b. 'On each salient occasion, (a total of) four lights were on in the rooms'

It must be pointed out that the individual distributive interpretation of sentences where there is an overt plurality denoting expression in the sentence is much more easily accessible than the event distributive interpretation, like in (17) and (14) above. I assume that it is because the overtly expressed plurality makes a certain division over the main event instantly salient: the one where the subevents are individuated by the participants. Still, it is possible to override the individual distributive interpretation, and depending on the context, even in such cases an event distributive interpretation can be made available. Based on this, I posit that the sorting key is always the plurality that is the most salient in the context when the distributive relation is established by a Hungarian reduplicated numeral.

This hypothesis seems to be contradicted by sentences where the there is a universally quantified expression acting as the sorting key, as in (8) or in (11); s the latter repeated as (18) below. Seemingly, such sentences can only have an individual distributive interpretation, hence it is usually assumed that the meaning of such sentences is essentially identical to that of sentences where the reduplicated numeral is replaced with an unmarked one, as in (19).

[6]Following Oh (2001), Cable (2014) and others, I do not differentiate between the temporal and the spatial key readings within the event distributive interpretations.

(18) *Minden kutya megmentett* ***három-három*** *ember-t.*
every dog rescue.PST.3SG **three-three** human-ACC
'Every dog rescued three people'

(19) *Minden kutya megmentett három ember-t.*
every dog rescue.PST.3SG three human-ACC
'Every dog rescued three people'

We could simply assume that in (18), the sorting key must be identified as the participants denoted by the universal quantifier in the sentence, and it would still be possible to maintain the assumption about Hungarian reduplicated numerals are share-based distributive elements. However, I argue that even in cases like (18), the sorting key of the distributive relation established by the reduplicated numeral can be contextually provided.

This can be shown by looking at sentences where there is a plurality denoting expression on the side of the universal quantifier, like in (20) and (21). (20), where the direct object is a reduplicated numeral *egy-egy falat*, lit. 'one-one treat', can have an interpretation where the indirect object *a látogatók*, lit. 'the visitors' is understood cumulatively with respect to the treats, as in (20a). This sentence also has an interpretation where the indirect object understood distributively with respect to the reduplicated numeral; see (20b). However, (21), where the direct object is an unmarked indefinite, only has an interpretation where the indirect object is understood cumulatively with respect to the reduplicated numeral; see (21a). The interpretation of (21) where treats are distributed over visitors is marginal if not unavailable; see (21b).

(20) *Minden kutya kapott* ***egy-egy*** *falat-ot a*
every dog get.PST.3SG **one-one** treat-ACC the
látogató-k-tól.
visitor-PL-ABL

a. 'Every dog got a treat from the visitors'
b. 'Every dog got a treat from each of the visitors'

(21) *Minden kutya kapott egy falat-ot a látogató-k-tól.*
every dog get.PST.3SG one treat-ACC the visitor-PL-ABL

a. 'Every dog got a treat from the visitors'
b. ??'Every dog got a treat from each of the visitors'

The contrast between the preference for the possible interpretations of (20) and (21) shows that Hungarian reduplicated numerals can easily establish distributive relations outside of the universal quantification given there is a plurality denoting expression in the sentence, while unmarked numerals are less able to do so. Moreover, the contrast between the possible interpretations of (18) and (20) confirm that for Hungarian reduplicated numerals, the sorting key of the distributive relation they establish is contextually provided.

5.3.2 Some disconfirmed claims about Hungarian reduplicated numerals

In this subsection, I review some claims in Farkas (1997), (2002), and (2015) about Hungarian reduplicated numerals, specifically that they come with a co-variation condition and they do not form a semantically homogeneous group. Here I argue that the co-variation condition is part of the pragmatic profile of Hungarian reduplicated numerals, and what appears to be semantic heterogeneity is a pragmatic effect of certain contexts Hungarian reduplicated numerals can occur in.

5.3.2.1 Obligatory co-variation

Farkas (1997), *et seq.*, posits that Hungarian reduplicated numerals come with a co-variation condition. According to this assumption, they not only force a distributive interpretation of the sentence they occur in, but their interpretation must co-vary with the entities in the denotation of the sorting key.

The most important consequence of posing a co-variation condition on reduplicated numerals is that it makes the truth value of the sentence dependent on the values that the variable introduced by the reduplicated receives. That is, the sentence in (22) is assumed to be true if there were at least two different paintings chosen by the individual poets or on each occasion (depending on what plays the role of the sorting key). If it was the same painting across poets or occasions, (22) should be false.

(22) *Az költő-k kiválasztottak* ***egy-egy*** *festmény-t[,*
the poet-PL choose.PST.3PL **one-one** painting-ACC[,
ami-ről utána verse-t írtak].
which-DEL after poem-ACC wrote]

a. OUT OF THE BLUE: 'The poets chose a painting each [which they wrote a poem about afterwards]'

b. WITH CONTEXT: 'On each occasion, the poets chose a painting [which they wrote a poem about afterwards]'

However, the truth value of (22) is arguably independent from whether it was the same painting chosen across poets or occasions, or not. This is demonstrated in (23): the truth of (22) cannot be denied on the basis that it was in fact the same painting chosen by the poets, see (23a) and (23b). What is asserted in (22) is that for each relevant element in the denotation of the sorting key, there was a painting chosen. This is what can be denied, as shown in (23c) and (23d).

(23) A utters (22). Then B replies:

a. #Well, that's not true. Each of them chose *Lo que el agua me dió*.

b. #Well, that's not true. They chose *Lo que el agua me dió* each time.

c. Well, that's not true. Some of them chose a sculpture instead of a painting.

d. Well, that's not true. They chose a sculpture instead of a painting on some occasions.

Even though the truth value of sentences with a reduplicated numeral is independent from co-variation, it must be acknowledged that (22) is distinctly downgraded if it is uttered in a situation where in fact the same painting was chosen across painters or occasions, and the speaker is aware of that fact or it is relevant in the situation. This together with (23) suggests that the co-variation condition is a pragmatic requirement imposed by Hungarian reduplicated numerals, and not a semantic one.

Similar claims have been made for Telugu by Balusu (2006) and for Basque by Cabredo Hofherr & Etxeberria (2017): in those languages, too, the co-variation requirement is assumed to be pragmatic in nature and not semantic. In Balusu (2006), it is analyzed as a quasi-implicature and in Cabredo Hofherr & Etxeberria (2017), as an ignorance/indifference condition. As the pragmatics of Hungarian reduplicated numerals is outside of our scope here, I remain agnostic as to how the co-variation requirement is best implemented. I merely claim that it is a pragmatic condition and will not account for it in the semantics of Hungarian reduplicated numerals.

5.3.2.2 Reduplicated existentials and reduplicated numerals have different semantics

Throughout this chapter, I used the term *reduplicated numeral* to refer to any common noun headed by a reduplicated cardinal numeral. I made no distinction within this class of expressions. In Farkas (1997) and Farkas (2015), however, we find a distinction between so-called reduplicated existentials, where the base cardinal numeral of the reduplicated indefinite is the indefinite article/numeral *egy*, lit. 'a/one', and reduplicated numerals, where the base cardinal numeral is a numeral other than *egy*.

The distinction between reduplicated existentials and numerals is based on the distribution of these items. Farkas observes that reduplicated numerals seem to be banned in some environments where reduplicated existentials are fine, and she posits that this difference is rooted in the semantics of these items: reduplicated existentials accept their sorting key from any domain, whereas reduplicated numerals only accept a sorting key from the domain of individuals.[7]

To support this, first Farkas provides examples where Hungarian reduplicated indefinites are in the scope of quantificational adverbs that quan-

[7]In Farkas's term, reduplicated numerals are not licensed in these environments.

tify over entities from the temporal or spatial domains. In these environments, reduplicated numerals are supposed to be out, but reduplicated existentials are OK, see (24) and (25).[8]

(24) *A politikus néha/mindig megtapsolt*
the politician sometimes/always applaud.PST.3SG
egy-egy/*két-két *ellenzéki hozzászólás-t.*
one-one/two-two opposition comment-ACC
'Sometimes/always, the politician applauded an opposition comment'

(25) *Helyenként* ***egy-egy/*két-két*** *rendőr leállított.*
place-DIST **one-one/two-two** policeman stop.PST.3SG
'In several places a policeman stopped me'

Here I argue that reduplicated numerals in sentences like (25) and (24) should be downgraded not in the terms of grammaticality, but felicity – they are merely infelicitous rather than ungrammatical. Both (24) and (25) with the reduplicated numeral *két-két N*, lit. 'two-two N' describe highly implausible situations which are hard to accommodate out of the blue.[9] For these sentences to be natural out of the blue, the context should be such that opposition comments are applauded in twos or threes, and policemen stop people also in groups with the cardinality higher than one (at least under some typical circumstances). However, in absence of such contexts, (24) and (25) with the reduplicated numeral *két-két N*, lit. 'two-two N' sound odd[10], while with the existential *egy-egy N*, lit. 'one-one N', they are OK, as they do not impose such requirements on the context.

Moreover, it is possible to find naturally occurring examples where

[8](12) and (13) in Farkas (2015). I report the original judgments here.

[9]Farkas provides furthers examples with other temporal adverbs; see (10) and (11) in Farkas (2015). I do not review those here, as they are structurally rather complex and they would divert the focus of our discussion. However, the points made in relation to (24) and (25) apply to those examples, too.

[10]My informants reported different judgments on (25) with *két-két N*: one of them did not accept it, unless the quantificational adverb refers to specific, salient places, while the other accepted the sentence without any such restriction.

there is a temporal or spatial quantificational adverb and a reduplicated numeral (in Farkas' terms), see sentences in (26)–(29).

(26) *Még a közönség fej-e fölé is kilőnek*
even the audience head-POSS.3SG above too fire.3PL
néha ***két-két*** *rakétá-t.*[11]
sometimes **two-two** rocket-ACC
'Sometimes they even fire two rockets [fireworks] above the audience'

(27) *Mindig* ***két-két*** *lap-ot használunk egyszerre.*[12]
always **two-two** sheet-ACC use.1PL at.a.time
'We always use two sheets [of filo pastry] at a time'

(28) *Ahogy a tükörkép-é-vel szemez, tekintet-e*
as the reflection-POSS3-COM stare.3SG, gaze-POSS3
elidőz bőr-é-n, s néhol ***két-két***
dwell.3SG skin-POSS3-SUPE, and here.and.there **two-two**
lyukacská-t vél felfedezni szemfog
little.hole-ACC think.3SG discover.INF eye.tooth
távolság-ban.[13]
distance-INE
'As he is staring at his own reflection, his gaze dwells on his skin, and he seems to discover two little holes here and there, eye tooth distance away from each other'

(29) *Itt párhuzamosan fut mindenütt* ***két-két*** *kábel, sőt*
here parallel run.3SG everywhere **two-two** cable, even

[11] https://magyarnarancs.hu/zene2/sziget_-_tankcsapda-72033. Last accessed 20 February, 2019.
[12] https://magyarnarancs.hu/gasztro/marokkoi-mhanncha-103945. Last accessed: 26 Feb, 2019.
[13] https://www.wattpad.com/449640890-4-vámpír-mellett-az-élet-1-rész. Last accessed: 20 Feb, 2019.

egy idő után már nyolc-nyolc kábel tornyosul egymás
a time after yet eight-eight cable tower.3SG each.other
felett.[14]
above
'Here, pairs of cables run parallel everywhere, and after a bit, there are eight [pairs of] cables towering above each other'

In (26)–(29), the quantificational adverbs do not quantifier over previously mentioned or established salient plurality of times or locations, yet the reduplicated numeral *két-két N*, lit. 'two-two N' can occur. I assume this is because in each case the situation described by the sentence is either likely to involve at least two individuals of the kind denoted by the reduplicated numeral (like in (28) and (29)) or the number of such individuals is completely contingent on the context (like in (26) and (27)).

Second, Farkas claims that reduplicated numerals, unlike reduplicated existentials, cannot occur if the sorting key is a plurality of events provided by the context. To support this claim, Farkas provides the example in (30).[15]

(30) Context: We are discussing how things are going at the department generally. The students usually do well.
Egy-egy/*Két-két *diák megbukik, de ez ritkán fordul*
one-one/two-two student fail.3SG, but this rarely happen.3SG
elő.
PRT
'From time to time a students fails, but this rarely happens'

Again, we can argue that the oddness of (30) with the reduplicated numeral has a pragmatic basis. The problem with the reduplicated numeral is that the context is set up in a way that we are talking about how generally things are. Based on what we know about the world, students fail individually. In (30), there is nothing in the context that would indicate

[14] `http://epiteszforum.hu/m43-autopalya-tisza-hid-vilagitasa`. Last accessed: 20 Feb, 2019.

[15] Example (16) in Farkas (2015).

how pairs of students are more salient than individual students when it comes to failing, hence the reduplicated numeral *két-két diák*, lit. 'two-two student' is odd.

It is also possible to construct examples where reduplicated numerals formed of the cardinal numeral 'two' or higher are preferred over 'one/a' for the same reason why 'one/a' is preferred in (30). I provide two examples in (31).

(31) Context: We are discussing how things are going at the department. The students usually don't engage in group activities outside of the university.

a. ***Egy-egy/Két-két/Négy-négy*** *diák összeül*
one-one/two-two/four-four student sit.together.3SG
sakkozni, de ez ritkán fordul elő.
play.chess.INF, but this rarely happen.3SG PRT
'Students in twos/fours get together to play chess, but this rarely happens'

b. ***?Egy-egy/Két-két/Négy-négy*** *diák lejátszik egy kör*
one-one/two-two/four-four student play.3SG one round
strandröpi-t, de ez ritkán fordul elő.
beach.volleyball-ACC, but this rarely happen.3SG PRT
'Groups of two/four students play a round of beach volleyball, but this rarely happens'

In (31a), arguably the option that works best is the reduplicated numeral *two-two diák*, lit 'two-two students', as playing chess is something that is usually done by two people. However, the *egy-egy diák*, lit. 'one-one student' and *négy-négy diák*, lit. 'four-four diák' work, too. In (31b), the best option is *négy-négy diák*, lit. 'four-four students, because beach volleyball is by groups of four – although here *két-két diák*, lit. 'two-two student' is also fine, but *egy-egy diák* lit. 'one-one student' is definitely downgraded.

In both (31a) and (31b) – and I argue that also in (30) – we are playing with a specific piece of world knowledge activated by the lexical meaning of the predicate, namely how many individuals are involved in a typical event denoted by it. There is no additional information in the context that would indicate that the interpreter should not rely on this automatically available knowledge. From this assumption it follows that in these cases, the acceptability of the reduplicated numeral depends on whether or not the cardinal numeral that is reduplicated corresponds to the number of individuals that are typically involved in a given event.

Farkas (2015) provides a third argument in favor of distinguishing between reduplicated existentials and numerals which is based on their interaction with pluractionals. That discussion would take us too much afield, so I will not review that argument here. But the data and the arguments provided here should be enough to motivate not treating reduplicated numerals as a heterogeneous class.[16]

5.3.3 Interim summary

In this section, I showed that the semantic contribution of Hungarian reduplicated numerals can be characterized as share-based distributivity. Share-based distributivity occurs when the distributive relation is established by the marking of the distributed share. In such cases, the sorting key of the distributive relation is contextually provided.

I also presented arguments against the claims that Hungarian reduplicated numerals are subjected to a co-variation condition and that they

[16]Dékány & Csirmaz 2018 reports (pp. 1064) that in the Csango dialect *egy-egy*, lit. 'one-one' can co-occur with an unmarked numeral; see (i). The *egy-egy* N construction, like *egy-egy négy kerék*, lit. 'one-one four wheel' in (i), in the Csango dialect is supposed to be interpreted as the N-N construction (plain reduplicated numerals) in standard Hungarian.

(i) *Minden autó-nak van* ***egy-egy*** *négy kerek-e.*
every car-DAT is **one-one** four wheel-POSS.3SG
'Every car has four wheels'

Although standard Hungarian lacks the *egy-egy* N construction, it suggests that reduplicated numerals might not be a homogeneous group in every Hungarian dialect. I leave the investigation of this issue for future research.

form a semantically heterogeneous group (see Farkas 1997, *et. seq.*). I concluded that the co-variation condition is a pragmatic requirement, as co-variation or the lack thereof does not affect the truth conditions of sentences with Hungarian reduplicated numerals. As for the distinction between reduplicated existentials and numerals, I argued that it is a contextual effect, as it is displayed only in certain contexts, but not in others. Thus, a semantic analysis of Hungarian reduplicated numerals does not have to account for either of these assumed properties.

5.4 Hungarian reduplicated numerals and reciprocals

Although Hungarian reduplicated numerals do not themselves specify the sorting key of the distributive relation they establish, there are cases where some interpretation is more salient than the other. In this section, I am going to discuss when the most salient interpretation is event distributive.

In Chapter 3, Section 3.5.2, I discussed that event distributivity is generally assumed to be a kind of atomic distributivity, meaning that the events in the denotation of the sorting key are assumed to be atomic. However, Hungarian reduplicated numerals challenge that kind of assumption, as they can occur in reciprocal constructions, as shown in (5) in the introduction of this chapter. I argue that these cases reveal that Hungarian reduplicated numerals are sensitive to both the temporal dimension and the participant dimension of events, and can establish relations among events and what we can consider their subatomic parts.

5.4.1 Event distributivity and atomicity

There are cases where the most salient interpretation of sentences with a reduplicated numeral is the event distributive interpretation, as there are no plurality-denoting expressions in the sentence that could play the role of the sorting key. Such a case is (9), repeated here as (32).

(32) *Borzi megmentett* ***két-két*** *ember-t.*
Borzi rescue.PST.3SG **two-two** human-ACC

a. OUT OF THE BLUE: Infelicitous
b. WITH CONTEXT: 'On each occasion, Borzi rescued two people'

The event distributive interpretation of (32) features the subevents established by the reduplicated numerals *két-két ember* lit. 'two-two human' to be associated with contextually salient occasions individuated by the temporal (or spatial) traces of the main event denoted by the sentence.

As discussed in Chapter 3, there is no consensus whether event distributivity is atomic or nonatomic, that is, whether the entities in the denotation of the sorting key that are in relation with the distributed share are atomic or nonatomic parts of the plurality that plays the role of the sorting key. When event distributivity is assumed to be nonatomic, as in Champollion (2016b), it is because the domain of the sorting key is assumed to be nonatomic. In this approach, the distributive relation described by the sentence is between entities from the domain of time or space as the sorting key, and the distributed share. As time and space are usually defined to be nonatomic (or defined as neither atomic nor nonatomic; see Krifka 1998), the distributive relation involving entities from such domains as the sorting key also must be nonatomic.

When event distributivity is assumed to be atomic, as in Oh (2001), Balusu (2006) and Cable (2014). The event distributive interpretation is approached in a somewhat different way. Instead of conceptualizing event distributivity involving a sorting key of the domain of time or space, it is assumed to be a plurality of events. As discussed in Chapter 2, a plurality always entails a plurality of atoms, but these atoms are not necessarily atomic themselves, they are atomic at least with respect to the plurality. In the case of sentences with distributive numerals, these atomic events are described by the clause itself, where the reduplicated numeral signals the number of entities in each atomic event.

This second kind of approach to event distributivity is closer to the view advocated in the thesis: according to this approach event distributivity is not viewed as atomic because the events in the sorting key have a certain inner structure, but because they are atomic relative to a description (see discussion in Chapter 3, Section 3.5.2).

In this spirit, it is possible to conceptualize event distributive interpretations of sentences where the distributed share is marked by a Hungarian reduplicated numeral as follows: while the sentence describes a plurality of events denoted by the verb or VP, the reduplicated numeral signals the number of (certain) participants in the atomic parts of the plural event. These events are atomic with respect to the plural event because they are the smallest parts that fit the description provided by the sentence. According to this approach, a sentence like (32) on its event distributive interpretation means something like in (33).

(33) 'There is a plural rescuing event by Borzi and in each atomic part of this plural event two people were rescued'

Note that the events that are considered atomic in the event distributive interpretation of a sentence do not have to appear atomic in other descriptions of the same event. (34) might also truthfully describe the situation where (32) is true; however, in (34), every relevant rescuing event by Borzi has only one person as its theme.

(34) Borzi rescued each person.

In sum, I assume that event distributive interpretations of sentences where the distributed share is marked by a Hungarian reduplicated numeral involve distribution over atomic parts of a plural event, and as such, are instances of atomic distributivity. These parts are atomic by virtue of being the smallest events fitting the description provided by the sentence, and not by virtue of being structurally atomic.

5.4.2 The challenge posed by reciprocals

As mentioned in Section 5.1, Hungarian reduplicated numerals can occur in reciprocal constructions; see (5), repeated as (35) below.

(35) *A verseny-en egyszerre* ***egy-egy*** *csapat*
the torunament-SUPE at.a.time one-one team
versenyzett egymás-sal.
compete.PST.3SG each.other-COM
OUT OF THE BLUE: 'At the tournament, two teams competed at a time, one against the other'

On its most salient interpretation, (35) true as long as there was at least one reciprocal competing event in which two teams participated, one competing against the other and vice versa.

The problem that sentences like (35) pose can be characterized as follows: on its most salient interpretation, (35) is understood as event distributive, where the reduplicated numeral marks the distributed share. As discussed above, it is assumed that in such cases the reduplicated numeral signal the number of participants in the atomic parts of the plural event denoted by the sentence. However, in (35), the sentence describes reciprocal competing events, which can be thought of as having either atomic reciprocal events or the non-reciprocal unidirectional events[17] as their atomic parts. Applying what has been said so far about event distributive interpretation and reduplicated numerals, we can predict the following interpretations for (35).

(36) a. ATOMIC RECIPROCAL EVENTS: 'There is a plurality of reciprocal competing events and in each atomic reciprocal competing event one team competed'
b. ATOMIC UNIDIRECTIONAL EVENTS 'There is a plurality of reciprocal competing events and in each atomic unidirec-

[17] I use the term *unidirectional event* as in Winter (2018), to refer to events where participants are clearly differentiated by the thematic roles they bear in the event. In the case of *compete*, a unidirectional competing event between *a* and *b* is where *a* competed with *b* without *b* competing with *a* (or vice versa). Unidirectional events are contrasted with bidirectional events in Winter (2018). In bidirectional events, participants are not differentiated by the thematic role they bear in the event. In the case of *compete*, a bidirectional competing event is where *a* competed with *b* and *b* competed with *a* in the same event. I refer to bidirectional events as *reciprocal events* here.

tional competing event one team competed.'

Neither of the options in (36) can capture the actual truth conditions for (35). The problem with the truth conditions in (36a) is that reciprocal events are like collective events in that they need a plurality as their participant, hence the truth conditions in (36a) are nonsensical. On the other hand, while the truth conditions in (36b) make sense, there the problem is that (35) does not make reference to unidirectional competing events where one team participated.

As (36) demonstrates, sentences like (35) pose a serious problem: no matter how we conceptualize the denotation of reciprocal constructions, the truth-conditions that we can predict for sentences like (35) with our current assumptions and toolkit are going to be incorrect. To redress this problem, I propose that sentences with a reciprocal should be treated as denoting atomic reciprocal events which themselves have no mereological parts, but are associated with non-reciprocal events of the same kind. The relationship between reciprocal and non-reciprocal events of the same kind can be defined as a mereological relation between the subatomic properties (participants, runtime) of events, but not events themselves. I propose that Hungarian reduplicated numerals are sensitive to this relation instead of the standard mereological part-of relation.

5.4.3 Events and reciprocal constructions

On the most naive and broad approach, reciprocals are simple or complex predicates that require one of their argument to have a plural denotation and describe a relation that holds between the parts of that plurality. Sentences with reciprocals display a large variety of interpretations on the level of relations they describe (see Langendoen 1978 and Dalrymple et al. 1998, among many others), but they are always assumed to describe a plurality of one-way relations among the parts of a plurality.[18]

[18] Reciprocal constructions can describe a single symmetric relation among parts of a plurality, like in the case of *meet*; see discussion below. However, even these symmetric relations can be broken down into a plurality of one-way relations.

On the level of events, the default view is that some reciprocals describe atomic events, like in (37), while others describe a plurality of non-reciprocal, or unidirectional events, as in (38) (see G. Carlson 1998, Dimitriadis 2008 and Winter 2018, a.o.).

(37) Borzi and Fifi met.

(38) Borzi and Fifi saw each other.

Detailed argumentation to motivate this distinction comes from Dimitriadis (2008): the reciprocal seeing event described by (38) always entails a plurality of unidirectional seeing events, one one event of Borzi seeing Fifi, and another of Fifi seeing Borzi. These events might even be distinct based on their temporal and spatial properties. However, the reciprocal meeting event described by (37) does not entail a plurality of unidirectional meeting events. According to Dimitriadis (2008), if there is an event of Borzi and Fifi meeting, the *same* event must be Borzi meeting Fifi and Fifi meeting Borzi.

The argument by Dimitriadis (2008) has its origins in G. Carlson (1998), who argued that some reciprocals individuate a plurality of events while others do not based on the observation that they admit different patterns of counting of events described by the sentence. As shown in (39), (37) does not individuate a plurality of meeting events. However, (40) shows that based on (38), we can in fact infer the existence of a plurality of seeing events.

(39) Borzi and Fifi met $\not\Rightarrow$
There were two events of meeting (one event of Borzi meeting Fifi and another event of Fifi meeting Borzi)

(40) Borzi and Fifi saw each other $\Rightarrow$
There were two events of seeing (one event of Borzi seeing Fifi and another event of Fifi seeing Borzi)

Counting patterns have been used to show that reciprocals where the reciprocity is associated with some lexical property of the predicate, as in (37), are fundamentally different from reciprocal constructions where the source of reciprocity is the reciprocal pronoun *each other*, as in (38). The crucial difference is assumed to be that in lexical reciprocals describe atomic reciprocal events, whereas reciprocals constructed by *each other* always describe a plurality of non-reciprocal events.

It has been overlooked that counting patterns also support treating all reciprocal constructions uniformly, as all of them describing atomic reciprocal events. Consider the sentence in (41): there, the modifier *twice* gives us the total number of reciprocal seeing events involving Borzi and Fifi, and never the unidirectional seeing events involving the same individuals. However, in cases where the sentence has (genuine) distributive reference, as in (42), the modifier *twice* cannot give the total number of events described by the sentence, but rather only the number of events per individuals in the sorting key.

(41) Borzi and Fifi saw each other twice.

(42) Borzi and Fifi (each) got a treat twice.

Modification also provides evidence that supports the assumptions that reciprocals formed by the reciprocal pronoun describe atomic events. Consider (43) (a modified version of (29-a) in Moltmann 1992): there, *on two rainy days* cannot modify the non-reciprocal seeing events. If it could, the sentence could be understood as Borzi saw Fifi on two rainy days, and Fifi saw Borzi on potentially different two rainy days, but (43) does not have such an interpretation. Instead, the sentence can only be understood in a way that the modifier *on two rainy days* modifies the reciprocal seeing events.

(43) Borzi and Fifi saw each other on two rainy days. $\not\Rightarrow$
'Borzi saw Fifi on two rainy days, and Fifi saw Borzi on two rainy days'

This, again, can be contrasted with sentences with distributive reference, like (44), where the modifier *on two rainy days* can only modify the events associated with each individual.

(44) Borzi and Fifi (each) got a treat on two rainy days. $\Rightarrow$
‘Borzi got a treat on two rainy days, and Fifi got a treat on two rainy days’

To further support the assumption that reciprocals formed by the reciprocal pronoun do not describe sums of non-reciprocal events but rather atomic reciprocal events, consider the sentences in (45) and (46). (45b) is entailed by (45a). This is expected under the assumption of the cumulativity of thematic roles, as defined in Chapter 2, Section 2.5.2. However, (46b) is not entailed by (46a), suggesting that we should distinguish between the sum of two seeing events and a reciprocal seeing event (cf. Link 1998a).

(45) a. Borzi barked in the kitchen and Fifi barked in the living room.
b. Borzi and Fifi barked in the kitchen and the living room (respectively).

(46) a. Borzi saw Fifi in the kitchen and Fifi saw Borzi in the living room.
b. Borzi and Fifi saw each other in the kitchen and the living room (#respectively).

Based on the data presented in (41)–(46), it is reasonable to assume that all reciprocals describe atomic reciprocal events (see Moltmann (1992) and Dotlačil (2010) for arguments on a similar line). That is, the primary entailment pattern for sentences like (37) and (38) one should not disregard when discussing reciprocals is the one in (47) and (48).

(47) Borzi and Fifi met $\Rightarrow$
There was a reciprocal meeting event in which Borzi met Fifi and Fifi met Borzi

(48) Borzi and Fifi saw each other $\Rightarrow$
There was a reciprocal seeing event in which Borzi saw Fifi and Fifi saw Borzi

The entailments in (47) and (48) highlight a uniform pattern across sentences with reciprocals: that they describe atomic reciprocal events. However, treating sentences with reciprocals as describing atomic reciprocal events does not make the entailments in (39) and (40) invalid; reciprocal events, albeit atomic, are related to non-reciprocal events. I am going to discuss this relation in the next section.

5.4.4 Reciprocal events and subatomic parts

Dimitriadis (2008) employs the relation called *event specification* from Link (1998a) to express the relation between atomic reciprocal events described by the collective use of predicates like *meet*, and the events described by the transitive uses of the same predicate. Event specification is not defined formally, but assumed to express the relation between different descriptions of the *same* event. According to Dimitriadis (2008), the event e in (49a) is specified both by e' in (49b) and e'' in (49c).

(49) a. e : Borzi and Fifi met
b. e' : Borzi met Fifi
c. e'' : Fifi met Borzi

Event specification expresses relations between event descriptions, but not events themselves, as its core assumption is that events that are related by specification are identical to each other. As a result, specification cannot express the relation between reciprocal events and the non-reciprocal events they entail if they have different subatomic properties – i.e. participants, temporal or spatial traces. In other words, it cannot express the relation between a reciprocal seeing event the non-reciprocal seeing events entailed by any given reciprocal seeing event.

This is, of course not a problem for Dimitriadis (2008), as there the basic assumption is that some reciprocal events are atomic while others are not, and event specification is a perfect tool to capture the difference between a reciprocal meeting event and a reciprocal seeing event. Here, however, our goal is to capture the underlying uniformity of the two.

I assume that *every* reciprocal construction describes atomic reciprocal events, and *every* atomic reciprocal event is related to at least two non-reciprocal events, which I will call *subevents*. The relation between atomic reciprocal events and the non-reciprocal subevents can be captured in terms of the participants and the runtime[19] of the events: the sum of participants of the non-reciprocal subevents is always part of the participants of the reciprocal event, and the runtime of the non-reciprocal subevent is always part of the runtime of the reciprocal event. I call this relation between events *containment*. I define a non-proper ($\trianglelefteq$) and a proper ($\triangleleft$) version of this relation, just like we did with parthood in Chapter 2, Section 2.2.1.

(50) **Definition** Containment

$e' \trianglelefteq e \overset{\text{def}}{=} \exists V[V(e) \;\wedge\; V(e') \;\wedge\; \tau(e') \leq \tau(e) \;\wedge\; \theta(e') \leq \theta(e)]$

An event e' is contained by an event e iff there exists a predicate V such that V holds for both e' and e, and the runtime of e' is part of the runtime of e, and the entity assigned the thematic role θ of e' is part of the entity assigned the thematic role θ of e.

(51) **Definition** Proper containment

$e' \triangleleft e \overset{\text{def}}{=} \exists V[V(e) \;\wedge\; V(e') \;\wedge\; \tau(e') < \tau(e) \;\wedge\; \theta(e') < \theta(e)]$

An event e' is properly contained by an event e iff there exists a predicate V such that V holds for both e' and e, and the runtime of e' is a proper part of the runtime of e, and the entity assigned the thematic role θ of e' is a proper part of the entity assigned the thematic role θ of e.

Both the plain and the proper version of containment relates events based on the mereological part-of relation between their participants and runtime. Not just any events, though: there are potentially countless events whose participants and runtime are related via parthood. However, containment only relates events that can be described by the same predicate. This is ensured in the definitions by requiring there to be a predicate V that applies to the events e' and e that are related by containment.

[19] Location, too, if one has a system where the domain of space is defined.

Containment relates events that form a mereological structure with respect to some predicate. It is reasonable to assume that events that are described by a certain predicate and whose participants and runtime are mereologically related, themselves form a mereological structure. However, it easily can be the case that a linguistic description describes certain events, but not others, even if these events form a mereological structure with respect to another predicate. In such cases, the mereological part-of relation cannot be used to relate the events in question; however, containment can. In this sense, containment is an extended notion of mereological parthood.

Unlike event specification, containment can express the relation between reciprocal events and their non-reciprocal subevents in all cases. In the cases like *see*, the relation expressed by containment is straightforward: a reciprocal seeing event will contain its non-reciprocal subevents, as the participants of the non-reciprocal ones are part of that of the reciprocal seeing event, just like their runtimes. Moreover, both the reciprocal and the non-reciprocal seeing events are kinds of seeing events, hence can be described by the predicate *see*, but reciprocal seeing events can also be described by reciprocal sentences, while the non-reciprocal ones cannot.

The containment relation can also describe the relation between reciprocal events and their non-reciprocal subevents even if the subevents are not individuated, as we saw with *meet*. As containment, unlike proper containment, is a symmetric relation, it can relate events that cannot be differentiated based on their participant or temporal properties. In my approach, the ultimate difference between a reciprocal event described by the predicate *meet* event and a reciprocal event described by the predicate *see* is that in the case of *meet*, the non-reciprocal meeting events contained by the reciprocal one must have the same participants and runtime, whereas in the case of *see*, the non-reciprocal seeing events contained by the reciprocal seeing event can be individuated at least by their runtime.

5.4.5 Subatomic event distributivity

Having shown that sentences with reciprocals describe atomic reciprocal events, and that atomic reciprocal events are related to non-reciprocal subevents via the containment relation, I argue that Hungarian reduplicated numerals can be involved in cases of subatomic event distributivity. Consider (35), repeated here as (52) below. In this example, the Hungarian reduplicated numerals do not signal the number of the teams participated in the atomic reciprocal competing events, but rather in the contained non-reciprocal subevents. Moreover, it signals the number of teams *bearing a certain thematic role* in that subevent.

(52) *A* *verseny-en* *egyszerre* ***egy-egy*** *csapat*
the tournament-SUPE at.a.time **one-one** team
versenyzett *egymás-sal.*
compete.PST.3SG each.other-COM
OUT OF THE BLUE: 'At the tournament, two teams competed at a time, one against the other'

Since reciprocal events are the atomic parts of the event(s) described by a reciprocal sentence, the non-reciprocal subevents are subatomic parts of the reciprocal events. And since Hungarian reduplicated numerals can relate reciprocal events to their non-reciprocal subevents in the distributive relation they establish, Hungarian reduplicated numerals can be involved in subatomic distributivity.

To further motivate the distinction between reciprocal events vs. non-reciprocal subevents and to show the difference between atomic and subatomic distributivity, I constructed the sentence in (53). The only difference between (52) and (53) is that the reduplicated numeral *egy-egy csapat*, lit. 'one-one team' is replaced with another reduplicated numeral *két-két csapat*, lit. 'two-two team'. (53), just like (52), supports an interpretation where the reduplicated numeral gives the number of teams associated with the non-reciprocal competing events. The crucial difference is that unlike the reduplicated numeral in (52), the one in (53) can also be associated with reciprocal events, as the base numeral, *két csapat*, lit. 'two team' has a plural denotation. In addition, because of that, (53) supports another interpretation, where the reduplicated numeral gives the number of teams associated with the reciprocal competing events.

(53) *A verseny-en egyszerre **két-két** csapat*
the tournament-SUPE at.a.time **two-two** team
versenyzett egymás-sal.
compete.PST.3SG each.other-COM

a. OUT OF THE BLUE: 'At the tournament, four teams competed at a time, two against two'
b. OUT OF THE BLUE: 'At the tournament, two teams competed against each other at a time'

To sum up, based on the data involving Hungarian reduplicated numerals and reciprocals, these expressions should be analyzed as possibly giving rise to a subatomic event distributive interpretation. As I will discuss in the next section, having the containment relation already defined, this can be done relatively straightforwardly.

5.5 The analysis

My analysis of Hungarian reduplicated numerals is a modified version of the account of distributive numerals in Tlingit proposed by Cable (2014). The biggest advantage of this account is that it does not treat the sentences with Tlingit distributive numerals as being ambiguous between individual-distributive and event-distributive reading. Rather, it analyses the meaning of such sentences as being compatible with both readings. As I have shown in this chapter, this approach is suitable for the data with Hungarian reduplicated numerals, as it seems like sentences with Hungarian reduplicated numerals are also compatible with both individual and event distributive interpretations without themselves specifying the sorting key of the distributive relation.

5.5.1 The main ingredients of Cable (2014)

Cable (2014) develops a compositional account for the distributive numerals in Tlingit. I will adopt this analysis for Hungarian reduplicated numerals. However, the original analysis relies on the mereological part-of relation between events, so I am going to redefine the building blocks of the analysis for Hungarian reduplicated numerals employing containment. In this way, we can account for Hungarian reduplicated numerals in reciprocal constructions.

First, I define the predicate PARTICIPANT. PARTICIPANT is a relation that holds between an event and any individual that participates in that event by bearing any of the thematic roles associated with the event. I use the definition from Cable (2014).

(54) **Definition** PARTICIPANT
PARTICIPANT$(e, x) \stackrel{\text{def}}{=} x$ bears a thematic relation to $e \leftrightarrow x$ is Agent of e, or x is Theme of e, x is Goal of e... ((52) in Cable 2014)

I continue with the definition of the *Partition*-function that maps events to sets of events. The basis of the definition is Cable's *Part*-function, (71) in Cable (2014), which maps events to a set of events in which none of the events overlap, where this latter property is defined in terms of the mereological part-of relation between events as primitive entities. In the definition of the *Partition*-function in (55), I substitute the mereological part-of relation with the containment relation.

(55) **Definition** *Partition*-function
$Partition(e) = \{e' : e' \trianglelefteq e\}$, such that
a. $\bigoplus Partition(e) = e$, and
b. $\forall e' \forall e''[e', e'' \in Partition(e) \wedge \neg\exists e'''[e''' \triangleleft e' \wedge e''' \triangleleft e'']]$

The *Partition*-function maps an event e to a set of events e', such that every e' is contained by e; moreover, the sum of all elements in the set equals e, and none of the events in the set overlaps in terms of containment. That is, there is no event in the set such that it is contained by two distinct events in the set.

I follow Cable (2014), and assume that the *Partition*-function has to be contextually salient and yield a cognitively natural partition over the event it is applied to. This is necessary to avoid having the partition to be based on the hair color of the participants, or other factors that could potentially yield a partition over an event, but that are not salient enough in a neutral context (see discussion in Balusu 2006).

Next, I define the binary σ-operator, again relying on the definition in Cable (2014), where the binary σ-operator is defined in his (53). Just as I did with the *Partition*-function in (55), I modify the original definition by substituting the mereological part-of relation with the containment relation for events.

(56) **Definition** The binary σ-operator

a. Pair addition: $\langle x', x'' \rangle \oplus \langle y', y'' \rangle \stackrel{\text{def}}{=} \langle x' \oplus y', x'' \oplus y'' \rangle$

b. $\sigma_{\langle x,y \rangle}[Q(x)(y)] \stackrel{\text{def}}{=}$ the pair$\langle \alpha, \beta \rangle$, such that$\langle \alpha, \beta \rangle \in {}^*\{\langle x, y \rangle : Q(x)(y)\}$, and if $\langle \gamma, \delta \rangle \in {}^*\{\langle x, y \rangle : Q(x)(y)\}$ then $\gamma \leq \alpha$ OR $\gamma \trianglelefteq \alpha$, and $\delta \leq \beta$ OR $\delta \trianglelefteq \beta$

In (56a), the sum operation is defined for pairs, which is basically the cumulativity property applied to pairs of entities of arbitrary domains (see also Krifka 1992 and Kratzer 2008). The binary σ-operator defined in (56b) then applied to a two-place relation $Q(x)(y)$ yields the maximal pair $\langle \alpha, \beta \rangle$ in the denotation of Q such that for every pair $\langle \gamma, \delta \rangle$ in the denotation of Q, γ is part of or contained by α, and δ is part of or contained by β. The reason to define the binary σ-operator using both the part-of and the containment relation is that we have replaced the mereological part-of relation between events with the containment; however, we have kept the mereological part-of relation for individuals (and entities from other domains).

With the $Partition$-function and the binary σ-operator redefined relying on the containment relation, we have all the missing ingredients to the semantic analysis for Hungarian reduplicated numerals.

5.5.2 The semantics of Hungarian reduplicated numerals

The semantics of Hungarian reduplicated indefinites is given in (57). This is a slightly modified version of the adnominal distributive numeral in (72) in Cable (2014): Cable's definition is for the suffix attached to cardinal numerals in determiner position to form a distributive numerals. Hungarian reduplicated numerals are obviously not formed by a suffix, but by the reduplication of the numeral, so I modified the original definition accordingly. Moreover, I use the typed part-of relation defined in Chapter 4 in (44) between entities to acknowledge that individuals related by the part-of relation must be in the denotation of the same predicate.

On the surface, there are no other changes to the original definition in Cable (2014), however, I utilize our redefined versions of the $Partition$-function and the binary σ-operator, resulting in a semantics of Hungarian reduplicated numerals built on the containment-relation.

(57) The semantics of Hungarian reduplicated numerals[20]
$[\![\text{N-N}]\!] = \lambda Q_{\langle et \rangle} \lambda V_{\langle e,\epsilon t \rangle} \lambda e_\epsilon \exists x_e [Q(x) \wedge V(x)(e) \wedge \langle e, x \rangle = \sigma_{\langle e',x' \rangle}[x' \leq_Q x \wedge |x'| = \text{N} \wedge e' \in Partition(e) \wedge \text{PARTICIPANT}(e', x')]]$

According to (57), a Hungarian reduplicated numeral N-N takes a predicate Q and a predicate V, where the latter holds of individuals and events, and returns a predicate over events. This predicate of events holds of an event e if there is an individual x such that Q holds of x, and the relation V holds between e and x; and if the pair $\langle e, x \rangle$ is the sum of pairs $\langle e', x' \rangle$ such that x' is a Q-part of x and the cardinality of x' is N, and e' is in a salient partition over e and x' is a participant in e'.

Now that we have the semantics for Hungarian reduplicated numerals, we can represent the meaning of the examples in Section 5.2. Here I will analyze the sentences with the least number of adjuncts of each type. The derivation of the sentences with Hungarian reduplicated numerals are illustrated on (58) and (60), and can be found in Appendix B.

[20] I follow the custom notation, and use x_e for variables ranging over entities, and e_ϵ for variables ranging over events.

I start by analyzing (6), repeated as (58) below, where the reduplicated numeral is in the subject position.

(58) ***Négy-négy*** *lámpa világított.* (=(6))
four-four lamp glow.PST.3SG

(59) $\exists e \exists x[{}^{*}\text{LAMP}(x) \wedge \text{GLOW}(e) \wedge \text{AG}(e) = x \wedge \langle e, x\rangle = \sigma_{\langle e', x'\rangle}[x' \leq_{*\text{LAMP}} x \wedge |x'| = 4 \wedge e' \in Partition(e) \wedge \text{PARTICIPANT}(e', x')]]$

According to (59), (58) is true as long as there is a plurality of lamps x and an event e of glowing[21] whose agent is x, and x can be divided into groups of four lamps such that each group participated in a contextually salient subevent of e. Even though our analysis does not specify what thematic role these groups of four lamps bear in the subevents e' – see the definition of PARTICIPANT in (54) – we can assume that if the lamps x is the agent in e, then the parts of the lamps x' are also the agents in the subevents of e.

The most important detail of the analysis in (58) is that it does not require us to specify the sorting key – it merely states that the event described by the sentence can be partitioned into subevents where four lamps glowed (were turned on). Based on the structure of the sentence and world knowledge, this partition can only be based on the temporal or spatial properties of the event. However, our analysis in (58) ensures that this is not contributed by the reduplicated numeral itself; this is merely a contextual inference.

Moving on to the analysis of a sentences where the Hungarian reduplicated numeral is in the object position, let us see first a case where the subject denotes a single individual, as in (9), repeated here as (60).

[21] To give the analysis of the meaning of the sentence in (6) I decided to resort to an English translation of the Hungarian sentence that preserves the argument structure of the Hungarian verb, hence the unnaturally sounding *glow* instead of *be on*. The former verbs is a 1-place predicate whose only argument is the agent of the event it describes, whereas the only argument of *be on* is the theme or patient.

(60) *Borzi megmentett* ***két-két*** *ember-t.* (=(9))
Borzi rescue.PST.3SG **two-two** human-ACC

(61) $\exists e \exists x[{*}\text{PERSON}(x) \wedge \text{RESCUE}(e) \wedge \text{AG}(e) = \text{b} \wedge \text{TH}(e) = x \wedge \langle e, x\rangle = \sigma_{\langle e', x'\rangle}[x' \leq_{*\text{PERSON}} x \wedge |x'| = 2 \wedge e' \in Partititon(e) \wedge \text{PARTICIPANT}(e', x')]]$

The formula in (61) states that (60) is true as long as there is a plurality of people x, and a rescuing event e by Borzi whose theme is x, and x can be divided up into pairs of people such that each pair participated in a contextually salient subevent of e.

Our analysis assigns similar truth conditions for (10), repeated below as (62), where the subject denotes a plurality of individuals. Crucially, we can represent the contribution of the reduplicated numeral to be identical to that in (9) (or in any other sentence); the only difference is that there is a plurality in the sentence that can serve as the basis of the partition over the event described by the sentence. Again, that is not directly represented in the formula in (63), but treated as a contextual inference.

(62) *A kutyá-k megmentettek* ***három-három*** *ember-t.* (=(10))
the dog-PL rescue.PST.3PL **three-three** human-ACC

(63) $\exists e \exists x[{*}\text{PERSON}(x) \wedge \text{RESCUE}(e) \wedge \text{AG}(e) = \sigma y.{*}\text{DOG}(y) \wedge \text{TH}(e) = x \wedge \langle e, x\rangle = \sigma_{\langle e', x'\rangle}[x' \leq_{*\text{PERSON}} x \wedge |x'| = 3 \wedge e' \in Partititon(e) \wedge \text{PARTICIPANT}(e', x')]]$

Now let us turn to sentences where both the subject and the object contain reduplicated numerals, like (13) repeated as (64) below.

(64) ***Három-három*** *kutya megmentett* ***két-két*** *ember-t.* (=(13))
three-three dog rescue.PST.3SG **two-two** human-ACC

(65) $\exists e \exists x \exists y[{*}\textsc{dog}(x) \wedge {*}\textsc{person}(y) \wedge \textsc{rescue}(e) \wedge \textsc{ag}(e) = x \wedge \textsc{th}(e) = y \wedge \langle e, x\rangle = \sigma_{\langle e', x'\rangle}[x' \leq_{\textsc{dog}} x \wedge |x'| = 3 \wedge e' \in Partititon(e) \wedge \textsc{participant}(e', x')] \wedge \langle e, y\rangle = \sigma_{\langle e'', y'\rangle}[y' \leq_{{*}\textsc{person}} y \wedge |y'| = 3 \wedge e'' \in Partititon(e) \wedge \textsc{participant}(e'', y')]]$

According to (65), (64) is true as long as there is a plurality of dogs x and a plurality of people y and a rescuing event e by x whose theme is y; and x can be divided up into groups of three dogs, and y into pairs of people such that each group of dogs participated in a contextually salient subevent of e and the pairs of people also participated in a subevent of e.

I assume that the partitions evoked by the different instances of reduplicated numeral in the same sentence do not have to be the same. This way, we can predict an interpretation of (64) where the pairs of people are understood distributively with respect to the trios of dogs. In this case, the partition over e for the reduplicated numeral *három-három kutya*, lit. 'three-three dog' is going to have subevents which are plural with respect to the subevents in the partition over e for the reduplicated numeral *két-két ember*, lit. 'two-two dog', as in (66).

(66) ***Három-három*** *kutya egyenként megmentett* ***két-két*** *ember-t.*
three-three dog individually rescue.PST.3SG **two-two** human-ACC
'On each salient occasion, three dogs rescued two people each'

Lastly, I turn to cases where the Hungarian reduplicated numeral is in the scope of an overt universal quantifier. It has been previously assumed that in these cases the sorting key must be the individuals denoted by the universal quantifier (see Balusu 2006, Szabolcsi 2010, Farkas 2015, a.o.). However, as I argued in Section 5.3, even in such cases the sorting key can be provided by another plurality-denoting expression in the sentence. That is, even if the Hungarian reduplicated numeral is in the scope of a universal quantifier, the sorting key is (can be) contextually provided.

In this spirit, I analyze the sentence in (18), repeated here as (67) as in (68) below.

(67) *Minden kutya megmentett* ***három-három*** *ember-t.* (=(11))
every dog rescue.PST.3SG **three-three** human-ACC

(68) $\forall x[\text{DOG}(x) \rightarrow \exists e \exists y[{*}\text{PERSON}(y) \wedge \text{RESCUE}(e) \wedge \text{AG}(e) = x \wedge \text{TH}(e) = y \wedge \langle e, y\rangle = \sigma_{\langle e', y'\rangle}[y' \leq_{*\text{PERSON}} y \wedge |y'| = 3 \wedge e' \in Partititon(e) \wedge \text{PARTICIPANT}(e', y')]]]$

According to (68), (67) is true as long as for every dog x there is a rescuing event e by x where a plurality of people were rescued and this plurality can be divided up into groups of threes such that each group participated in a contextually salient subevent of e.

These truth conditions are immediately suitable in cases where the sorting key of the distributive relation established by the Hungarian reduplicated numeral is different from the individuals denoted by the universal quantifier. However, if the sorting key is contributed by the universal quantifier, we run into a problem, as the truth conditions in (68) state that for each dog there is an event over which a partition is made according to the reduplicated numeral.

To avoid this problem, I follow Balusu (2006), and assume that the partition over the event created by our *Partition*-function can yield a trivial partition over an event (where the event itself is in the only cell of the partition). However, this option can only be allowed if the Hungarian reduplicated numeral is in the scope of a universal quantifier, otherwise the partition must be non-trivial. This is because in cases where the reduplicated numeral is not in the scope of a universal quantifier, the sentences are in fact false if there is only one event in the only cell of the partition.

5.5.3 An analysis of reciprocals

To analyze reciprocal sentences with Hungarian reduplicated numerals, first I provide the semantics of the reciprocal pronoun in (69), inspired by the analysis of reciprocal constructions in Moltmann (1992). Here I only consider the reciprocal pronoun in object position. In (69), I employ the typed parthood introduced in Chapter 4, Section 4.5.1.3, and I assume that lambda bound entity x in (69) comes with a presupposition that there is a predicate P such that P holds of x. This presupposition is set off with a colon in the formula.

(69) $[\![\text{each other}_{\text{D-OBJ}}]\!] = \lambda V_{\langle e,\epsilon t\rangle}\lambda x_e : \exists P_{\langle et\rangle}[P(x)]\lambda e_\epsilon \exists y_e[V(e)(y) \ \wedge \ x = y \ \wedge \exists x', x'' <_P x[\neg x' \circ x''] \ \wedge \ \exists e', e'' \trianglelefteq e[\{e', e''\} \in Rec^x_V]]$

According to (69), the reciprocal pronoun in direct object position takes a predicate V that holds of individuals and events, and an entity x, and returns a predicate over events. This predicate holds of an event e if there is an individual y, such that the relation V holds between e and y, and y is equal to x; and if x can be divided up into two non-overlapping parts with respect to a predicate P, and the event e contains two subevents, such that those subevents are in the set I here call Rec^x_V, which is defined in (70).

(70) **Definition** Rec^x_V

$Rec^x_V \overset{\text{def}}{=} \{E : \bigoplus \textsc{participant}(E) = x \ \wedge \ \forall e \in E[V(e)] \ \wedge \ \forall x'[x' \leq x \rightarrow \exists x''[x'' \leq x \wedge x' \leq x'' \ \wedge \ \exists e' \exists \theta[e' \in E \ \wedge \theta(e') = x'']]] \ \wedge \ \neg\exists e'' \in E[\theta_1(e'') = \theta_2(e'')]$,
and E is consistent with the reciprocal interpretation of $V\}$

Rec^x_V is a set such that it contains every set E such that the sum of participants in E equals x, V holds of every event e in E, and for each part x' of x, there is an x'' such that x'' is part of x and x' is part of x'' and some event e' in E assigns a theta role to x''; and there is no event e'' in E such that two theta roles of e'' are assigned to the same individual; and finally, E is consistent with the reciprocal interpretation of V.

What I defined in (70) is the set of all the sets of events such that are compatible with the reciprocal interpretation of V given individual x such that x is the sum of all the participants in the events in each set, and every part of x is part of some x'' (also part of x) such that x'' plays a theta role in some event in E. Rec^x_V is defined very loosely: the only real requirement imposed on the events in the set is that none of them assigns two different theta roles to the same individuals (assuming V takes two arguments). I do not impose more specific restriction on the events in the set(s), as I assume that they are determined by the lexical meaning of the predicate itself (Dalrymple et al. 1998, Sabato & Winter 2012), and possibly by other factors (like typicality of the different situations described by the predicate, see Kerem, Friedmann & Winter 2011, Poortman et al. 2018).[22]

By keeping the definition of Rec_V^x as vague as in (70), we can treat reciprocals uniformly, while accounting for the dissimilarities, too. In our terms, (71) and (72) is uniform in that both denote a (potentially plural) reciprocal event whose agent and theme are the dogs, and this reciprocal event is associated with a set of (sub)events such that none of those (sub)events assign the role of the agent and theme to the same individual, which must be part of the plurality denoted by *the dogs*. The differences between the meaning of (71) and (72), in turn, are due to the lexical meaning of the verbal predicates *bark* and *follow*, and the possible situations they can describe on their reciprocal interpretation.

(71) The dogs barked at each other.

(72) The dogs followed each other.

The price to pay for the uniform treatment of all reciprocals is that we cannot say anything really informative about the specific meaning of reciprocal sentences. In other words, our loose treatment of reciprocals can tell that (71) and (72) are potentially different in meaning, but we have no formal way to capture how. However, for the purposes of the discussion here, it is sufficient to assume that the sets in Rec_V^x must correspond to one of the possible interpretations assigned to reciprocals in Dalrymple et al. (1998), given that it is compatible with the meaning of the main predicate of the sentence.

[22]Note that the papers mentioned do not talk about reciprocals in terms of events, but in terms of relations. For the sake of simplicity, here I assume that there is a one-to-one correspondence between relations and events denoted by the main predicate of the reciprocal construction.

Given our assumptions about the reciprocal pronoun in (69) and about the set of events associated with the verb and its arguments in a reciprocal construction in (70), we can an represent the meaning of (52), repeated as (73) below, in (74). The derivation of (73) can be found in Appendix B.

(73) *A verseny-en egyszerre* ***egy-egy*** *csapat*
the tournament-SUPE at.a.time **one-one** team
versenyzett egymás-sal. (=(52))
compete.PST.3SG each.other-COM

(74) $\exists e \exists x \exists y[{*}\text{TEAM}(x) \wedge \text{COMPETE}(e) \wedge \text{AG}(e) = x \wedge \text{TH}(e) = y \wedge x = y \wedge \exists x', x'' <_{*\text{TEAM}} x[\neg x' \circ x''] \wedge \exists e', e'' \trianglelefteq e[\{e', e''\} \in Rec^{x}_{\text{COMPETE}}] \wedge \langle e, x\rangle = \sigma_{\langle e''', x'''\rangle}[x''' \leq_{*\text{TEAM}} x \wedge |x'''| = 1 \wedge e''' \in Partition(e) \wedge \text{PARTICIPANT}(e''', x''')]]$

According to (74)[23], (73) is true as long as there is a plurality x of teams and there is a competing event e such that x is both the agent and the theme of e, and e has various contained subevents such that the set of these subevents is among the sets of events associated with the verbal predicate *compete* applied to x on its reciprocal interpretation. Moreover, x can be divided up into single teams such that each of them participated in some contextually salient subevent of e.

Our analysis in (74) treats the meaning contribution of the reciprocal pronoun and the reduplicated numeral separately. I assume that the reciprocal pronoun signals a specific subevent structure connected to the event denoted by the main predicate in the sentence: the contained, non-reciprocal subevents connected to the reciprocal event denoted by the reciprocal construction. These subevents are selected by the Hungarian reduplicated numeral, hence we can account for the interpretation where the number of teams participating in each subevent bearing a certain thematic role. We can assume that since the teams were both the agents

[23]For simplicity, I ignored the contribution of *egyszerre*, lit. 'at a time/at the same time'. While this item unambiguously conveys that there were no two simultaneous competing events, it makes no substantial contribution to the meaning of the sentence that concerns us here.

and the themes in the reciprocal event, the reduplicated numeral can be associated both with the agent and the theme roles in the non-reciprocal subevents. As a result, we end up with the actual interpretation of (73), namely that for each reciprocal competing event two teams competed, one against the other and vice versa.[24]

However, the non-reciprocal subevent structure made salient by the reciprocal is not the only possible subevent structure in the case of reciprocal events. As I argued in Section 5.4.3, reciprocal constructions denote reciprocal events, and these reciprocal events can form their own mereological structure.

In (73), the salient non-reciprocal subevent structure is selected by the reduplicated numeral, but only because selecting the selecting the reciprocal events would end up in nonsensical truth conditions (as in 'in each reciprocal competing event, one team participated'). However, in (53), repeated here as (75) with the reduplicated numeral *két-két csapat*, lit. 'two-two team', both structures are available.

(75) *A verseny-en egyszerre* ***két-két*** *csapat*
the tournament-SUPE at.a.time **two-two** team
versenyzett egymás-sal. (=(53))
compete.PST.3SG each.other-COM

(76) $\exists e \exists x \exists y[{}^{*}\textsc{team}(x) \wedge \textsc{compete}(e) \wedge \textsc{ag}(e) = x \wedge \textsc{th}(e) = y \wedge x = y \wedge \exists x', x'' <_{{}^{*}\textsc{team}} x[\neg x' \circ x''] \wedge \exists e', e'' \trianglelefteq e[\{e', e''\} \in Rec^{x}_{\textsc{compete}}] \wedge \langle e, x\rangle = \sigma_{\langle e''', x'''\rangle}[x''' \leq_{{}^{*}\textsc{team}} x \wedge |x'''| = 2 \wedge e''' \in Partition(e) \wedge \textsc{participant}(e''', x''')]]$

The truth conditions on (76) are almost identical to the ones in (74), except for the number of teams per salient subevents, which is two in

[24] We can argue for a different mechanism to end up with the same interpretation based on (74). We can assume that PARTICIPANT can be resolved either as AG or TH. In this case, what our formula in (74) says is that each salient subevent of e has one team as its, let's say, agent. Now we can argue that based on our world knowledge, any individual that is the agent of a non-reciprocal subevent of a reciprocal competing event must also be the theme of some other non-reciprocal subevent. Since in our case every agent is one team, it follows that every theme must be one team as well.

this case. Since two teams can be involved in both reciprocal competing events and as agent or theme of non-reciprocal subevents of the reciprocal competing events, the final interpretation of (75) depends on the context, i.e. which one of the possible partitions is salient according to the context of utterance. Hence we can account for the assumption that (75) can be understood either as ‘in each reciprocal competing event, two teams participated’ (which is essentially the same interpretation as for (73)), or as ‘for each reciprocal competing event, four team participated, two against two’.

5.6 Other analyses of related phenomena

As mentioned in the introduction of this chapter, Hungarian reduplicated numerals are in the intersection of various related phenomena (distance distributivity, distributive numerals, dependent indefinites), and as a result, every account that addresses one of the phenomena is a potential candidate to account for the semantics of reduplicated numerals. In this section, I briefly review my core assumptions about Hungarian reduplicated numerals, as a reiteration of the motivations of the account presented above, and I also briefly discuss some other accounts that could potentially account for our data.

The core assumptions of the analysis presented in Section 5.5 are that 1) Hungarian reduplicated numerals are share-based distributivity items, and that 2) they can relate events that are in the denotation of a description to other events that are not. The first assumption is based on the fact that Hungarian reduplicated numerals can only mark the distributed share of the distributive relation they establish and are notoriously ambivalent as to what the sorting key of the relation is. The second assumption is based on the fact that Hungarian reduplicated numerals can be involved in reciprocal constructions even if the number of individuals associated with the distributed share marked by the reduplicated numeral does not satisfy the plurality requirement of the reciprocal construction.

The only analysis that can capture the first assumption is Cable (2014), as this is the only one that does not assume that the meaning contribution of distributive numerals is due to the reduplicated numeral being in the semantic scope of another expression (cf. Gil 1982, Choe 1987, Farkas 1997, Oh 2001, Zimmermann 2002, Balusu 2006, Henderson 2012, Champollion 2016b, a.o.). Instead, Cable (2014) assumes that distributive numerals merely establish that there is a plurality of events such that each of these events has a participant denoted by the noun headed by the distributive numeral whose cardinality equals the cardinal base of the numeral. Whether these events are individuated based on their participants or their spatio-temporal properties is not part of the meaning contribution of the distributive numeral. In other words, by applying the analysis in Cable (2014), it is possible to capture that Hungarian reduplicated numerals are share-based distributivity items.

However, that Hungarian reduplicated numerals are share-based distributivity items, even though it is based on a linguistic fact, is merely a conceptual speculation. One could easily argue that sentences with Hungarian reduplicated numerals are in fact ambiguous between individual and event distributive interpretations simply because these items can mark the distributed share in both kinds of distributive relations. In this case, the assumption is that Hungarian reduplicated numerals mark the distributed share in a run-of-the-mill distributive relation; and the sorting key in this relation can be either from the domain of individuals or from that of events (or, instead of events, time intervals). And, as we have seen above, there are quite an abundance of analyses that can accommodate these assumptions.

One can assume that Hungarian reduplicated numerals must be syntactically licensed by a distributivity operator (distributing over either individuals or events), as in Oh (2001), or alternatively that they are associated with a distributive operator, as in Balusu (2006).[25] Alternatively, one can assume that Hungarian reduplicated numerals directly contribute to the distributive interpretation of the sentence, in which case it is possible to analyze these items following Zimmermann (2002) or Champol-

[25]Unlike Oh (2001), Balusu (2006) assumes that this distributivity operator always distributes over events, even in the cases of individual distributive readings.

lion (2016b) (and others). If we apply any of these accounts, we would assume that Hungarian reduplicated numerals are expressions denoting the distributed share which are looking for the expression that denotes the sorting key and the predicate that denotes the relation between the two, and the reduplicated numeral finds them during the derivation of the sentence.[26] A third option, one can assume that Hungarian reduplicated numerals are items that impose some constraints on how the variable introduced by them is evaluated, in which case one can analyze them as dependent indefinites (see Farkas (1997) *et seq.*, Henderson 2012, Kuhn 2017, a.o.).[27]

However, none of these approaches and accounts offer a straightforward way to analyze reciprocal sentences with Hungarian reduplicated numerals, like (73). The first and probably the most challenging problem is that according to all of these accounts, Hungarian reduplicated numerals must take narrow scope with respect to another (overt or covert) expression in the sentence or context. As a result, combining a reduplicated numeral with the reciprocal pronoun is virtually impossible in cases where the cardinal base of the reduplicated numeral is *egy*, lit. 'one', since the reciprocal pronoun comes with a plurality requirement on its antecedent. Moreover, it is not obvious how these accounts could accommodate the fact that Hungarian reduplicated numerals can be associated with reciprocal events denoted by the sentence and the non-reciprocal subevents in the denotation of the verb. This latter problem is also intertwined with the obligatory narrow scope imposed on Hungarian reduplicated numerals assumed by these accounts. The one in Champollion (2016b) provides sophisticated compositional mechanisms for distance distributivity items, and unlike Oh (2001), Zimmermann 2002 and Balusu (2006) and others, it does not assume a sentence-wide scope for the sorting key, so it can potentially overcome the second problem.

The account in Cable (2014), however, does not face these problems.

[26]Note that the technical details of the accounts in Zimmermann (2002) and Champollion (2016b) are radically different, but that discussion is out of our scope here.

[27]In Section 5.3.2, I argued that in the case of Hungarian reduplicated numerals this constraint cannot be co-variation.

First, it assumes that distributive numerals have plural denotation, so the plurality requirement of the reciprocal pronoun is satisfied in a straightforward way. Second, it assumes that distributive numerals signal the number of individuals in contextually salient events. So, to account for the fact that Hungarian reduplicated numerals can signal the number either of reciprocal events or non-reciprocal subevents, all we have to assume is that reciprocal constructions are associated with two distinct event structures: one formed by the reciprocal events, and another formed by the non-reciprocal subevents associated with reciprocal event. To capture the fact that Hungarian reduplicated numerals can access both structures, I defined the containment relation, which can represent the relation between the events in both structures.

That said, I do not assume that the other approaches and accounts that can be potentially applied to Hungarian numerals cannot be modified in order to accommodate the Hungarian data. Above I presented one possible way to do that.

5.7 Conclusions

In this chapter, I discussed Hungarian reduplicated numerals which are a kind of distributive numerals (Gil 2013). As such, Hungarian reduplicated numerals force a distributive interpretation of the sentence they occur in. I have argued that Hungarian reduplicated numerals are share-based distributivity items, in that they establish the distributive relation by marking the distributed share without specifying the sorting key of the relation, and they require the context to provide the sorting key of the relation.

The sorting key of the distributive relation established by Hungarian reduplicated numerals can be from the domain of individuals or the domain of events. In this chapter, I focused on cases where the sorting key is from the domain of events. I have shown that Hungarian reduplicated numerals can occur in reciprocal constructions where they can signal the number of entities participating in atomic reciprocal events or unidirectional events associated with reciprocal events. Based on this, I argued that Hungarian reduplicated numerals can relate events that do not form one mereological structure, and I defined a relation here I called *containment* to represent this relation.

Chapter 6

CONCLUSIONS AND OUTLOOK

In this thesis, I defended the notion of relative atom against the notion on absolute or structural atom in the study of distributivity. Relative atoms are entities that are atomic with respect to a property or a description, whereas absolute or structural atoms are entities that have the property of being atomic by virtue of having no proper parts.

The notion of relative atom is not new – it has been around at least since Krifka (1989) – nor is unused – it is the default approach to atoms in the theory of countability (see Chierchia 2010, Rothstein 2010, Grimm 2012, Landman 2016, and Filip & Sutton 2017, among many others). In the latter line of literature, the notion of atom is generally considered problematic, and it is usually further relativized with respect to the context (see Chierchia 2010, Rothstein 2010) or to a characterizing property (see maximally strongly self-connected in Grimm 2012, or non-overlap in Landman 2016).

In contrast, in the theory of distributivity, atoms are usually treated as well-defined entities having a certain structural property, namely, lacking proper parts (Link 1983). The use of this simplified notion of atom in the theory of distributivity is in part justified by the fact that the study of distributivity is primarily concerned with pluralities. Pluralities presuppose atoms, that is, if there is a plurality there must be some atoms of which the plurality is formed. Moreover, the theory of distributivity is concerned with cases when the denotation of certain expressions hold of parts of a plurality, so “What is an atom?” is not a central question in this line of research.

Applying the notion of structural atom in the theory of distributivity is not necessarily a problem in and of itself. However, in trying to understand why is it that the atomic and nonatomic distributive interpretation of sentences are available at virtually the same rate (Chapter 4), or trying to model the interaction between Hungarian reduplicated numerals and reciprocal constructions (Chapter 5), the question “What is an atom?” becomes highly relevant, as applying the structural notion of atom does not help in understanding either of these issues.

In Chapter 2, I discussed the domain of individuals and events with and without the notion of structural atom. I argued that in the domain of individuals, applying the notion of structural atom results in counterintuitively many entities. If we employ the notion of structural atom, semantic singularity and plurality gets reduced to some structural property of entities. As a consequence, the referent of a semantically singular expression, like *the deck of cards*, can never be identical to that of a semantically plural expression, like *the cards*, as the entities they refer to must have different structural properties (Link 1983). I have shown that by applying the notion of relative atom – and hence treating atomicity not as a structural property of entities but as the way linguistic expressions refer to entities – we do not have to posit an ontological difference between the referents of semantically singular and plural expressions, yet we can account for the relevant differences between these expressions. Under this view, semantic plurality is found when a linguistic expression denotes both entities and their parts, whereas semantic singularity is found when a linguistic expression denotes entities but not their parts (see a similar approach in Krifka 1989).

In the domain of events, the notion of structural atom does not help the identification of atomic entities, as events can be related to entities in other domains (the domain of individuals, time and space), and atomicity of events can be understood in relation to the entities in these other domains. Moreover, atomicity of events can be understood with respect to event descriptions, i.e. when an event appears to be atomic by virtue of fitting a certain description, By employing the relative notion of atom, we can acknowledge the rich structures associated with events. In Chapter 2, I merely introduced these various structures and made some assumptions about how they are accessed by different event descriptions. There is clearly more work to be done to understand how these structures relate to each other, and how they are best represented formally.

In Chapter 3, I discussed how the notion of structural atom shaped the theory of distributivity. As I mentioned above, understanding the data in the theory of distributivity normally relies on the notion of structural atoms; this notion is the base of the fundamental distinction between atomic and nonatomic distributivity. This distinction is supposed to help navigate between the different kinds of distributivity based on the structure of the parts of the plurality that are involved in the distribution, but instead, this distinction results in some theoretical and empirical puzzles. In the case of individual distributivity (when the plurality involved in the distribution is from the domain of individuals), sometimes it is assumed that the atomic distributive interpretation is readily available for sentences with a plural subject and a singular indefinite object like (1), whereas the nonatomic distributive interpretation is assumed to be unavailable or restricted (see Lasersohn 1989, Winter 2001, Champollion 2017a, a.o.). Other accounts, like Schwarzschild 1996, pose no extra restrictions on the availability of nonatomic distributive interpretations, hence do not differentiate between atomic and nonatomic distributivity.

(1) The guests called a taxi.

So while theories of distributivity employing the notion of structural atoms produced the distinction between atomic and nonatomic distributivity, there is no empirical evidence as to whether this distinction is made by speakers; hence it is not clear the phenomenon should be accounted for.

In the case of event distributivity (when the plurality involved in the distribution is from the domain of events), the theory of distributivity applying the structural notion of atom raises a conceptual issue rather than an empirical one. As I mentioned above, identifying atoms in the domain of events is problematic if we appeal only to the notion of absolute atom. For this reason, we cannot straightforwardly appeal to atomic distributivity when analyzing event distributivity. In Chapter 3, I have shown that the atomic vs. nonatomic distinction within event distributivity depends on how we define the domain from which the plurality is drawn that is involved in the distribution. If we maintain the assumption that any plurality must be made up of atoms, and pluralities can be formed of entities from domains for which structural atoms are not defined, applying the notion of relative atom might be crucial to understand how distributive reference arises involving pluralities from such domains.

In Chapter 3, I considered some theoretical problems brought about by the application of structural atoms in the theory of distributivity. In Chapter 4 and 5, I turned to the discussion of the empirical core of the thesis. In Chapter 4, I discussed an two-part experiment I conducted to obtain data on the availability of nonatomic distributive interpretation of sentences like (1), and also to see whether there is a difference between atomic and nonatomic distributive interpretations in terms of their availability. The results of the experiments suggest that speakers generally accept sentences like (1) if presented in a nonatomic distributive scenario (although at a lower rate compared to sentences where the object is a bare plural noun); and that speakers accept these sentences virtually at the same rate when presented in an atomic or a nonatomic distributive context.

These findings support accounts of individual distributivity that do not make a formal distinction between atomic and nonatomic distributive interpretations, like Schwarzschild (1996), over the accounts that do, like Lasersohn (1998), Winter (2001), Champollion (2017a). However, the account in Schwarzschild (1996) relies on the notion of structural atom. To avoid relying on structural atoms, I proposed an analysis that is in line with the findings of the experiments and also makes use of the notion of relative atom. Applying the notion of relative atom allows us to to model individual distributivity in the following way: in a sentence like

(1), the sum of individuals referred to by the definite plural *the guests* has parts that are atomic with respect to the property *guests*, and also has parts that are nonatomic with respect to the property *guests*. On the atomic/nonatomic distributive interpretation of the sentence, the property *call a taxi* might hold of individuals that are atomic or nonatomic with respect to the property *guests*, but in either of those cases, those individuals will be atomic with respect to the property *call a taxi*. I implemented this insight in my analysis of distributive reference in Chapter 4. Another core assumption of the analysis is that it restricts the availability of distributive interpretations of sentences like (1) to contexts where it is already accommodated which individuals are the atoms with respect to the verbal predicate, to capture the intuition that this information cannot be provided by the sentence itself.

By viewing the parts of a plurality that a predicate holds of in cases of individual distributivity as relative atoms with respect to the given predicate, we can ask what principles these atoms obey. That is, we can apply the insights brought about the research done within the theory of countability. Exploring the differences between atoms with respect to nominal vs. verbal predicates might help us to better understand the nature of counting, and what kind of entities can be involved in counting, as we probably want to avoid the counting of relative atoms involved in distributive reference. In future research, relative atoms brought about by the distributive interpretations of sentences like (1) must be tried against the analyses of atomicity to learn more about the nature of these relative atoms.

In Chapter 5 I turned to the discussion of event distributivity through the case study of Hungarian reduplicated numerals in reciprocal constructions. I have argued that Hungarian reduplicated numerals are best analyzed as share-based distributivity elements (inspired by the analysis of distributive numerals in Cable 2014, which I adopted and modified in this thesis); on this view, reduplicated numerals mark the distributive share of the distributive relation as opposed to the sorting key, and as such, they themselves do not specify the sorting key of the distributive relation. The key characteristic of distributive relations established by a share-based distributive element is that the sorting key of the relation must be contextually provided. By assuming that Hungarian reduplicated numerals are share-based distributive elements, we can account for the difference between the distributive relation involving reduplicated numerals vs. unmarked numerals. The sorting key in the distributive relation where the distributed share is marked by a Hungarian reduplicated numeral can be either from the domain of individuals or the domain of events. In contrast, the sorting key of the distributive relation where the distributed share is marked by an unmarked numeral can only be from the domain of individuals.

As the sorting key in the distributive relation established by Hungarian reduplicated numerals can be either from the domain of individuals or the domain of events, the sentences with Hungarian reduplicated numerals can either have an individual distributive or an event distributive interpretation, depending on the linguistic and non-linguistic context. Following Cable (2014), I argued that we can capture the meaning contribution of Hungarian reduplicated numerals as signaling the number of entities denoted by the noun in their complement associated with the atomic parts either of a plurality of individuals or a plurality of events.

As I mentioned above, to recognize atomic entities in the domain of events, one should employ the notion of relative atom, and since linguistic descriptions might relate events to entities in other domains, atomicity of events can be determined in relation to these entities, or event the description itself. As I have shown in Chapter 5, the meaning of sentences with Hungarian reduplicated numerals seem to exploit such a rich system of atomic events. Interestingly, Hungarian reduplicated numerals can occur in reciprocal constructions, in which case they can give rise to an interpretation where they signal the number of individuals associated with the non-reciprocal sub-events, instead of the reciprocal events described by the sentence. I have argued that reciprocal events and their non-reciprocal sub-events should not be modeled as being mereologically related to each other, as reciprocal events are not mere sums of non-reciprocal events. Thus, modeling the meaning contribution of Hungarian reduplicated numerals should not rely on the mereological part-of relation between events. Instead, I proposed a relation I here called *containment* that relates events based on the mereological part relations between their participants and their runtime. Unlike the mereological part-of relation, the containment relation can recognize the relation between events in the different structures they can be associated with, hence it is fit to model the meaning contribution of Hungarian reduplicated numerals in reciprocal constructions and beyond.

There is a lot of work to be done in order to better understand the phenomena discussed in Chapter 5. Future research should focus on cross-linguistic inquiry to see whether distributive numerals in other languages interact with reciprocal constructions in a similar way Hungarian reduplicated numerals do. If they do, it should be tested whether the analysis presented in Chapter 5 can be extended to distributive numerals in other languages. If they do not, our analysis should explain how Hungarian reduplicated numerals differ from distributive numerals in other languages, or how reciprocal constructions in Hungarian are different from those in other languages.

Finally, there are cases with Hungarian reduplicated numerals that are problematic for the analysis presented in Chapter 5; see (2)–(4). In (2), the reduplicated numeral has a conjoined NP in its complement, and signals the number of entities in the denotation of the respective noun phrases involved in the event described by the sentence. That is, the distributive effect associated with the reduplicated numeral is very local, involving only the conjoined NP in its complement. This is something the analysis in Chapter 5 cannot account for.

(2) *Vettem* ***három-három*** *dinnyé-t, almá-t és*
buy.PST.1SG **three-three** melon-ACC, apple-ACC and
karfiol-t.
cauliflower-ACC
'I bought three melons, three apples and three heads of cauliflower'

In (3), the reduplicated numeral seem to be associated with an implicit universal quantifier. This is unexpected, as the analysis in Chapter 5 treats Hungarian reduplicated numerals as share-markers. But as (3) demonstrates, under some circumstances, Hungarian reduplicated numerals can also take the role of the sorting key.

(3) ***Két-két*** *gyerek-re tíz perc figyelem jutott.*
two-two child-SUBL ten minute attention go.PST.3SG
'Every two kids/Every pair of kids got ten minutes of attention'

In (4), there is a low quantity inference associated with the reduplicated numeral, as (4) would be infelicitous, or maybe even false in a context where many politicians went down because of similar scandals, even if the number of politicians is one for each scandal. That is, under some circumstances Hungarian reduplicated numerals (or at least *egy-egy*, lit. 'one-one') can be associated with a low quantity inference which is not predicted by the analysis presented in Chapter 5.

(4) ***Egy-egy*** *politikus már bele-bukott hasonló*
one-one politician already PRT-fail.PST.3SG similar
botrány-ba.
scandal-ILL
'Some politicians have already gone down because of similar scandals'

The cases presented in (2)–(4) are not marginal cases in the sense that they rarely occur or they would be hard to give a judgment on. This means that a proper analysis of Hungarian reduplicated numerals should account for them. Future research should determine how the analysis presented in Chapter 5 should be modified or extended to account for the data in (2)–(4).

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Appendix A

MATERIALS OF THE EXPERIMENTS

A.1 Experiment 1

A.1.1 Critical items

(1) This afternoon, four friends, Anna, Bo, Carla and Diane decided to try out creative writing. There were many genres to choose from, but they opted for poetry first. Originally, the girls wanted to work individually, but since they had no experience in creative writing, the task proved harder than expected. So, the girls decided to work in pairs. Anna worked with Bo, and Carla worked with Diane, and by the end, the former pair had produced "Ode to a cupcake" and the latter, a sonnet entitled "My cat is a rose".

a. *This afternoon, the girls wrote poems.*
b. *This afternoon, Anna, Bo, Carla and Diane wrote poems.*
c. *This afternoon, the girls wrote a poem.*
d. *This afternoon, Anna, Bo, Carla and Diane wrote a poem.*

(2) On Saturday, the Smith and the Jones families hosted a small gathering together in the park. After the guests left, the two families stayed to clean up the venue. The adults washed the grill and the

dishes, and the kids were asked to take care of the two tables they used, making sure that they leave the venue as spotless as it was when they arrived. Since Abel and Betty, the Smith kids, hate Chuck and Dwayne, the Jones kids, and vice versa, they didn't even want to think about cooperating, so they decided to work separately. After they finished with the tables, the kids helped their parents.

a. *After the gathering, the kids cleaned tables.*
b. *After the gathering, Abel, Betty, Chuck and Dwayne cleaned tables.*
c. *After the gathering, the kids cleaned a table.*
d. *After the gathering, Abel, Betty, Chuck and Dwayne cleaned a table.*

(3) John, after spending years in a moldy, windowless apartment, is finally moving to a two-bedroom flat near the river. He had four guests, Annette, Bill, Claire and Dimitri, over the last night for a celebratory last supper. They were also the ones to help John to move the next day: John has lower back pain and cannot lift heavy objects. After dinner they decided to quickly check whether the two larger boxes were packed lightly enough to be carried by two people. Annette and Bill checked the blue one; and Claire and Dimitri, the white one. They found both boxes light enough, so they continued having fun.

a. *After the dinner, the guests lifted boxes.*
b. *After the dinner, Annette, Bill, Claire and Dimitri lifted boxes.*
c. *After the dinner, the guests lifted a box.*
d. *After the dinner, Annette, Bill, Claire and Dimitri lifted a box.*

(4) Avram, Bill, Carrie and Donald are teenagers whose hobby is riding go-karts at the nearby track. They occasionally race with each other. One day they decided to make their own kart. Since they couldn't agree on the technical details of the vehicle, they split up so that Avram and Carrie worked together on the one hand, and Bill and Donald on the other. After weeks of hard work they are

finally finished and ready to test whose go-kart is faster.

a. *In the last few weeks, the teenagers built go-karts.*
b. *In the last few weeks, Avram, Bill, Carrie and Donald built go-karts.*
c. *In the last few months, the teenagers built a go-kart.*
d. *In the last few weeks, Avram, Bill, Carrie and Donald built a go-kart.*

(5) It was a strange morning at the bike repair shop. Two customers rushed in separately with a very similar problem: their very expensive and special bikes were broken and they needed fixing immediately. The first customer had a rare and delicate Schwinn off-road bike, and the other one a custom-made Cannondale tandem. Since otherwise it was a slow day, Hank, the owner, could give the jobs to his best mechanics: Al and Betsy worked on the Schwinn; Cyrill and Denise got the Cannondale. By the end of the day both bikes were fixed and the customers were extremely satisfied.

a. *Today, the mechanics repaired bikes.*
b. *Today, Al, Betsy, Cyrill and Denise repaired bikes.*
c. *Today, the mechanics repaired a bike.*
d. *Today, Al, Betsy, Cyrill and Denise repaired a bike.*

(6) DesignGreen is a newly founded architectural design studio where Alice, Brent, Claude and Dora work as the architects. In its first month, the company was already very successful: they were hired for two major projects. Since each project was too big to be handled by a single person, Brent and Alice shared the public library project; and Dora and Claude, the sports pavilion. They struggled for months with the projects but completed the designs on time, and now both projects are in the development phase, which is handled by another company.

a. *In the last few months, the architects designed buildings.*
b. *In the last few months, Alice, Brent, Claude and Dora designed buildings.*

c. *In the last few months, the architects designed a building.*

d. *In the last few months, Alice, Brent, Claude and Dora designed a building.*

(7) Mary has a big house and she rents the empty rooms to people who work in the city. On Friday evening she had some after dinner beers on the porch. Eugene and Francine, and Gabe and Holly, two couples who rented two rooms in the house, were coming home from work and joined her for some drinks. Since there were only two free chairs, Francine sat on Eugene's lap and Holly on Gabe's. They sat like this for awhile, but the chairs couldn't support their weight anymore, and both collapsed almost at the same time. Everybody laughed and the continued the after-work get together sitting on the floor.

a. *While sitting on the porch, the tenants broke chairs.*

b. *While sitting on the porch, Eugene, Francine, Gabe and Holly broke chairs.*

c. *While sitting on the porch, the tenants broke a chair.*

d. *While sitting on the porch, Eugene, Francine, Gabe and Holly broke a chair.*

(8) Sisters Eunice, Fabiola, Guadalupe and Hilda are nuns at the nearby monastery. On Wednesday they had a day trip to the city to attend a meeting at the cathedral. They finished early and they wanted to grab a bite before returning home, so they went to a pizzeria to have lunch. There they decided to share: Eunice and Guadalupe had a mushroom-ham pizza, Fabiola and Hilda had a margherita. After they finished the lunch they headed back to the monastery.

a. *On Wednesday, for lunch the nuns ate pizzas.*

b. *On Wednesday for lunch, Eunice, Fabiola, Guadalupe and Hilda ate pizzas.*

c. *On Wednesday for lunch, the nuns ate a pizza.*

d. *On Wednesday for lunch, Eunice, Fabiola, Guadalupe and Hilda ate a pizza.*

(9) Phyllis had a dinner party with four of her friends, Edgar, Flo-

rence, Gary and Harriet, who are two couples. They had a lot to celebrate: both Edgar and Florence, on the one hand, and Gary and Harriet, on the other, completed the adoption process this year and the couples would soon be building new families. The whole night was full of joy, and Phyllis was very glad to share her friends' happiness.

a. *This year, Phyllis' friends adopted children.*
b. *This year, Edgar, Florence, Gary and Harriet adopted children.*
c. *This year, Phyllis' friends adopted a child.*
d. *This year, Edgar, Florence, Gary and Harriet adopted a child.*

(10) Last week there was a campaign at the ad agency through which employees could donate unused company equipment for charity. Elza and Fabio, who are secretaries in accounting, gave away a 2-year old Dell laptop in perfect condition, and Gabby and Hector, who are secretaries in the creative department, gave their still fairly new and powerful HP desktop PC. Altogether the campaign was a great success, and the agency decided to repeat it the following year.

a. *Last week, the secretaries donated computers.*
b. *Last week, Elza, Fabio, Gabby and Hector donated computers.*
c. *Last week, the secretaries donated a computer.*
d. *Last week, Elza, Fabio, Gabby and Hector donated a computer.*

(11) Edward and Freddie go hunting together. They usually rent a car to go to the woods to hunt, but Edward made some calculations and concluded that it would be more economical if they had their own car, so they purchased one together last month. Glenn and Howard, fellow hunters, decided to do as Edward and Freddie, and got a car together a few days after. Now they all use their own cars to get to the woods, instead of renting.

a. *Last month, the hunters bought cars.*

b. *Last month, Edward, Freddie, Glenn and Howard bought cars.*
c. *Last month, the hunters bought a car.*
d. *Last month, Edward, Freddie, Glenn and Howard bought a car.*

(12) Mrs. Brady had only four students in home economics class this year, Eleanor, Finn, Gillian and Harry. Today's lesson was cake baking. After a short introduction, Mrs. Brady split the class into two groups for the actual baking. Eleanor and Finn worked together on the one hand, and Gillian and Harry on the other. At the end the cakes turned out to be so good that they were served after the football game in the afternoon.

a. *Today in home economics class, the students baked cakes.*
b. *Today in home economics class, Eleanor, Finn, Gillian and Harry baked cakes.*
c. *Today in home economics class, the students baked a cake.*
d. *Today in home economics class, Eleanor, Finn, Gillian and Harry baked a cake.*

(13) Erica, Felix, Grant and Hazel are teenagers who get together once week to do arts and crafts. Last month they tried knitting, and thought a scarf would be easiest for beginners. But they decided to make it with a twist: they would do it in pairs, knitting on both ends of the scarf. Erica and Hazel made a black and white one; Felix and Grant, a multicolor one with random patterns. They had a lot of fun knitting but now they don't know who should keep each scarf.

a. *Last month, the teenagers knitted scarves.*
b. *Last month, Erica, Felix, Grant and Hazel knitted scarves.*
c. *Last month, the teenagers knitted a scarf.*
d. *Last month, Erica, Felix, Grant and Hazel knitted a scarf.*

(14) Recently there was an open call for short opera compositions at the local art institute, and Eric, who plays the cello in a string quartet, wanted to apply. Since he was not a composer and never

wrote music before, he asked Fae, the viola player in his quartet, if she wanted to apply with him. Fae really liked the idea, so they teamed up. Hailie and Gerard, the two violinists in the quartet, also thought it would be a nice idea and they also teamed up to write a piece. They all met the submission deadline, which was yesterday.

a. *Recently, the string players composed operas.*
b. *Recently, Eric, Fae, Hailie and Gerard composed operas.*
c. *Recently, the string players composed an opera.*
d. *Recently, Eric, Fae, Hailie and Gerard composed an opera.*

(15) On Saturday afternoon, Mary's and Tiffany's kids had a play date at Tiffany's house, and the children – Ingrid, Jason, Kyle and Leslie – went upstairs to play. Kyle and Leslie were very excited because today they would get to play with their new transformable robot toys for the first time. Leslie had Optimal Prime and Kyle had Megadrone. The toys needed to be put together first, but Leslie and Kyle didn't want to share with Ingrid and Jason. They started to fight and the parents had to intervene. In the end, Kyle and Ingrid put together Megadrone, and Leslie and Jason, Optimal Prime. By the time they finished they were already bored with the toy robots, so they started to play something else.

a. *On Saturday afternoon, the children assembled toy robots.*
b. *On Saturday afternoon, Kyle, Ingrid, Leslie and Jason assembled toy robots.*
c. *On Saturday afternoon, the children assembled a toy robot.*
d. *On Saturday afternoon, Kyle, Ingrid, Leslie and Jason assembled a toy robot.*

(16) Isaac, Jack, Kaleb and Leo have been taking the same History class at their high school. As part of their assessment they had to do their last project in pairs: Isaac had to work with Kaleb, and Jack with Leo. They had to do a lot of research and they had very little time to do it, but they all managed to finish today, and the projects were well received.

a. *Today, the boys finished projects.*
b. *Today, Isaac, Jack, Kaleb and Leo finished projects.*
c. *Today, the boys finished a project.*
d. *Today, Isaac, Jack, Kaleb and Leo finished a project.*

A.1.2 Fillers

(17) My friends, Abby and Bobby, wanted to not slack off and be bored the whole summer and rather do something new and productive with their time. Somewhat randomly they decided to jointly make a short film using stop-motion technique. Despite their complete lack of experience they managed to finish it by the end of August, and it turned out to be pretty good.
This summer, my friends each produced a stop-motion video.

(18) Anthony, Betty, and Camille wanted to go shopping on Friday afternoon. All of them needed new clothes, but Anthony and Camille also needed some kitchenware and home decor products, so for them the mall nearby wasn't an option, since it only has clothing stores. They decided to go to the shopping center on the outskirts of town. After some discussion Betty agreed to join them, and they all took the bus to the shopping center. After spending the whole afternoon shopping, they had a coffee together and went home.
On Friday afternoon, Anthony, Betty and Camille went to a shopping center separately.

(19) Friday evening Arthur and Tamara went to the opening of a new posh restaurant. Arthur decided to try the restaurant's signature burger, and Tamara, a big fan of French cuisine, chose the beef bourguignon. Although they had to wait a pretty long time for their meals, they both were very happy with their orders and agreed to return soon.
At the new posh restaurant, both Arthur and Tamara ordered a hamburger.

(20) On Wednesday afternoon Eve and Farrah were walking home from school together and they were talking about their latest assignment. Soon Eve reached her place and Farah was continuing on her way alone when she saw an unpacked Miles Davis CD on the ground. She picked it up and she decided to ask around the neighborhood to find out who had lost it.
On Wednesday afternoon, Eve and Farrah found a CD.

(21) On a sunny Saturday, a small group of friends went for a hike in a national park outside the city. They took the trail that runs by the river for a while, heads up towards the Taga peak, and then loops back down to make a full circle. In the middle of the hike some people got a little behind, but they later caught up to the others while still on the mountain. They arrived at a clearing together where they spotted a herd of deer. They were fascinated by the sight and on their way home they all agreed that this was the most memorable moment of their hike.
During their hike, the hikers saw deer.

(22) This afternoon was extraordinary in the Saint Philomena Hospital: two women gave birth to twins at almost exactly the same time. One of the twin births was scheduled, and the mother was already assigned to an obstetrician, Dr. Albright. But the other mother was brought in by an ambulance because the babies arrived a bit earlier than anticipated. Dr. Bukowski was available and she assisted at the emergency twin birth. Luckily, everything went well, and all the babies and the mothers are happy and healthy.
This afternoon in the hospital, both Dr. Albright and Dr. Bukowski delivered twins.

(23) On Saturday some people gathered in a room at the civic center to attend on a one-day workshop on love and trust. The workshop was led by a coach, there was a lot of discussion about the topic, and the attendees also participated in exercises. At the end of the day, all of the participants gave a hug to everyone else in the

room as an act of appreciation
At the end of workshop, everyone hugged each other.

(24) On Sunday afternoon Evelyn, Fiona, George and Herbert got together for their regular card game party. Usually they play bridge, but George suggested they play something else this time. They decided to play poker. Fiona said she could not stay long this time, so they went home after one game.
On Sunday afternoon, Evelyn, Fiona, George and Herbert played a game of poker.

A.2 Experiment 2

A.2.1 Critical items

The atomic distributive versions of the scenarios from Experiment 1 that were used in Experiment 2. Only the (c)-(d) sentences from Experiment 1 were used in Experiment 2.

(25) This afternoon, four friends, Anna, Bo, Carla and Diane decided to try out creative writing. There were many genres to choose from, but they opted for poetry first. Originally, the girls wanted to work in pairs, but they couldn't agree on the details, so they ended up working individually. Anna produced "Ode to a cupcake"; Bo, "My cat is a rose." Carla composed "Where flowers grow", and Diane put together an untitled free verse.

(26) On Saturday, the Smith and the Jones families hosted a small gathering together in the park. After the guests left, the two families stayed to clean up the venue. The adults washed the grill and the dishes, and the kids, Abel, Betty, Chuck and Dwayne, were asked to take care of the four tables they used, making sure that they left the venue as spotless as it was when they arrived. The kids agreed to divide the task among themselves evenly, and to make it a bit more interesting, they competed to see who would

finish first. After they finished with their table cleaning contest, the kids helped their parents.

(27) After spending years in a moldy, windowless apartment, John is finally moving to a two-bedroom flat near the river. He had four guests, Annette, Bill, Claire and Dimitri, over the last night for a celebratory last supper. They were also the ones to help John to move the next day: John has lower back pain and cannot lift heavy objects. After dinner they decided to quickly check whether the four larger boxes were packed lightly enough to be carried by one person. Annette checked the one with the kitchen stuff in it, and Bill the one with books, while Claire checked the one with documents and Dimitri the box full of tools. They found the boxes light enough, so they went back to having fun.

(28) Avram, Bill, Carrie and Donald are teenagers whose hobby is riding go-karts at the nearby track. They occasionally race with each other. One day they decided to make their own kart. Since they couldn't agree on the technical details of the vehicle, they split up to work on their own ideas. After weeks of hard work they are finally finished and ready to test which of the four go-karts is faster.

(29) It was a strange morning at the bike repair shop. Two customers rushed in separately with a very similar problem: each of them had two very expensive and special bikes that were broken and needed fixing immediately. The first customer had two rare Schwinn off-road bikes, and the other one a custom-made Cannondale tandem and a Peugeot racing bike. Since otherwise it was a slow day, Hank, the owner, could give the jobs to his best mechanics: Al worked on one of the Schwinn bikes, Betsy on the Cannondale tandem; Cyrill got the Peugeot, and Denise got the other Schwinn. By the end of the day all the bikes were fixed and the customers were extremely satisfied.

(30) DesignGreen is a newly founded architectural design studio where Alice, Brent, Claude and Dora work as the architects. In its

first month, the company was already very successful: they were hired for four projects. Since the projects were small enough to be handled by a single person all the architects got one of the projects. Brent took the green home project, Alice the public library; Dora got the art studio project and Claude the sports pavilion. They all completed the designs on time, and now the projects are in the development phase, which is handled by another company.

(31) Mary has a big house and she rents her empty rooms to people who work in the city. On Friday evening she had some after-dinner beers on the porch. Eugene and Francine, and Gabe and Holly, two couples who rented rooms in the house, were coming home from work and joined her for some drinks. The tenants sat on the wooden chairs, while Mary sat on the steps. They were chatting and drinking when the tenants' seats suddenly collapsed almost at the same time. It turned out that Mary had a termite problem, so she called the exterminators immediately.

(32) Sisters Eunice, Fabiola, Guadalupe and Hilda are nuns at the nearby monastery. On Wednesday they had a day trip to the city to attend a meeting at the cathedral. They finished early and they wanted to grab a bite before returning home, so they went to a pizzeria to have lunch. They all ordered their favorites: Eunice had a mushroom-ham pizza; Guadalupe, a margherita. Fabiola ate a Quattro Stagioni and Hilda a vegetarian pizza. After they finished the lunch they headed back to the monastery.

(33) Phyllis had a dinner party with four of her friends, Edgar, Florence, Gary and Harriet. All of them know Phyllis from the agency where they applied for adoption: they are all single people who wanted to adopt, and Phyllis guided them through the process. They had a lot to celebrate: recently they found out that all of their applications were accepted this year and all of them would soon be building new families. The whole night was full of joy, and Phyllis was very glad to share her friends' happiness.

(34) Last week there was a campaign at the ad agency through which employees could donate unused company equipment for charity. Elza, Fabio, Gabby and Hector are secretaries who all participated in the campaign. Elza gave her old Dell desktop PC; Fabio gave away an unused HP PC. Gabby found a nearly new laptop to offer, and Hector gave his used Mac. The campaign was a great success, and the agency has decided to repeat it next year.

(35) Edward goes hunting in the mountains nearby. He usually rents a car to go, but he made some calculations and concluded that it would be more economical if he had his own car, so he purchased one last month. He told about his new investment to his fellow hunters, Freddie, Glenn and Howard, at the club and they all decided to do as Edward and got a car within a week. Now they all use their own cars to get to the woods, instead of renting.

(36) Mrs. Brady had only four students in home economics class this year, Eleanor, Finn, Gillian and Harry. Today's lesson was cake baking. After a short introduction, the students started the actual baking, working on different recipes. In the end the cakes turned out to be so good that they were served after the football game in the afternoon.

(37) Erica, Felix, Grant and Hazel are teenagers who get together once week to do arts and crafts. Last month they tried knitting, and thought a scarf would be easiest for beginners. Erica made a black and white one; Felix one with stripes. Grant ended up to make one with random patterns, and Grant a plain blue one. They had a lot of fun knitting and now that they are finished they are very happy that they are better prepared for the winter.

(38) Recently there was an open call for short opera compositions at the local art institute for single authors only. Eric, who plays the cello in a string quartet, wanted to apply. He was not a composer and had never written music before, but he thought it would be fun to try. He told his fellow musicians in his quartet, Fae, Hailie and Gerard, about his idea, and they all got very excited and

also decided to enter the contest. They all found the task a bit challenging but they all met the submission deadline, which was yesterday.

(39) On Saturday afternoon, Mary's and Tiffany's kids had a play date at Tiffany's house, and the children – Ingrid, Jason, Kyle and Leslie – went upstairs to play. They were very excited because today they would get to play with their new transformable robot toys for the first time. Leslie had Optimal Prime, Kyle had Megadrone, Jason had Bumblebot, and Leslie had Ironwheel. The toys needed to be put together first, so the kids started building them. By the time they finished they were already bored with the toy robots, so they started to play something else.

(40) Isaac, Jack, Kaleb and Leo are in the same group in their History class at their high school. As part of their assessment they had to do their last project individually. The project required a lot of research and they had very little time to do it, but they all managed to finish today, and the projects were well received.

A.2.2 Fillers

The filler items used in Experiment 2 were the same ones from Experiment 1, except for the problematic item in (17) which was replaced with (41).

(41) My friends, Abby and Bobby, wanted to not slack off and be bored the whole summer and rather do something new and productive with their time. Somewhat randomly they decided to team up and create a short film together using stop-motion technique. Despite their complete lack of experience they managed to finish it by the end of August, and it turned out to be pretty good.
This summer, my friends each made a stop-motion video.

Appendix B

DERIVATIONS

General assumptions

I assume that thematic roles compose with the verb first, and then with noun (see Henderson 2012). Because I assume that thematic roles are functions from events to individuals (see Chapter 1), of type $\langle \epsilon, e \rangle$, there is a type-mismatch, hence the following type shifter applies to the thematic role (Champollion 2017b).

(1) **Definition** Type shifter
$\lambda\theta_{\langle \epsilon,e \rangle}\lambda V_{\langle \epsilon,t \rangle}\lambda x_e \lambda e_\epsilon[V(e) \ \wedge \ \theta(e) = x]$

I assume that existential closure applies once the verb is combined with all its arguments.

(2) **Definition** Existential closure
$\lambda V_{\langle \epsilon,t \rangle}\exists e[V(e)]$

Here I ignore the DP/NP hypothesis, and represent nouns as NPs uniformly.

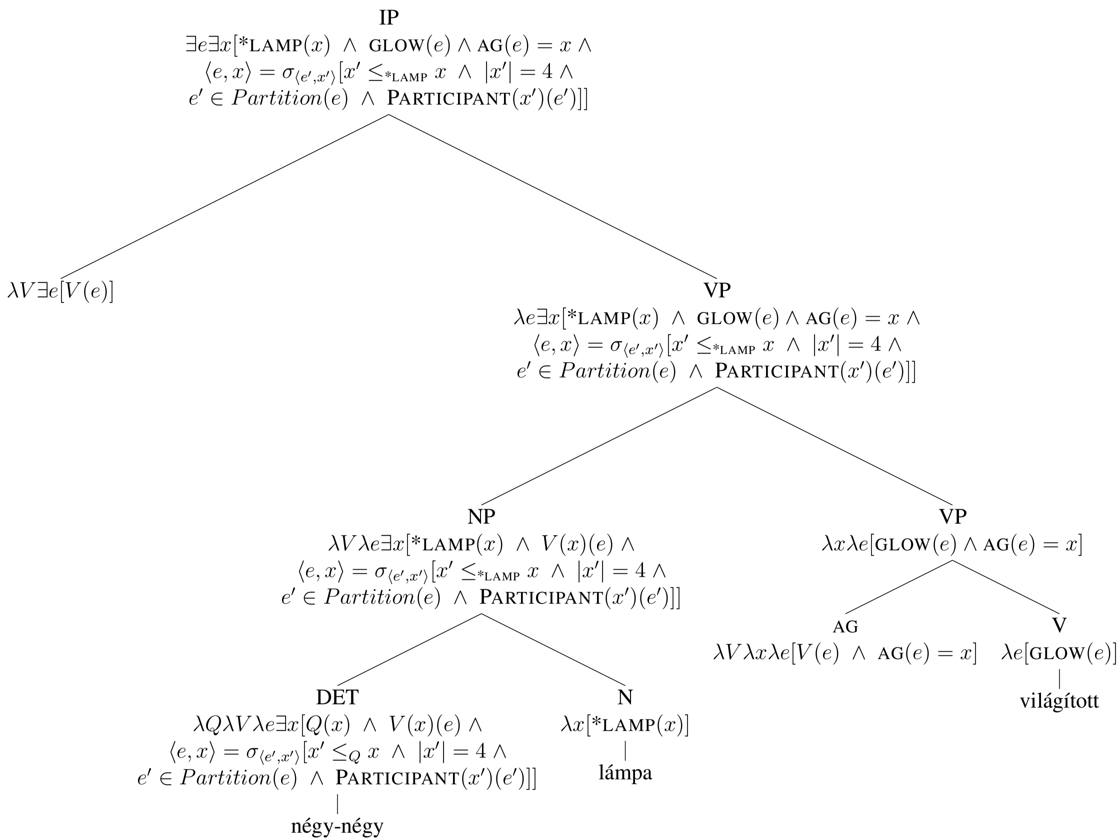

Figure B.1: Deriving *Négy-négy lámpa világított*

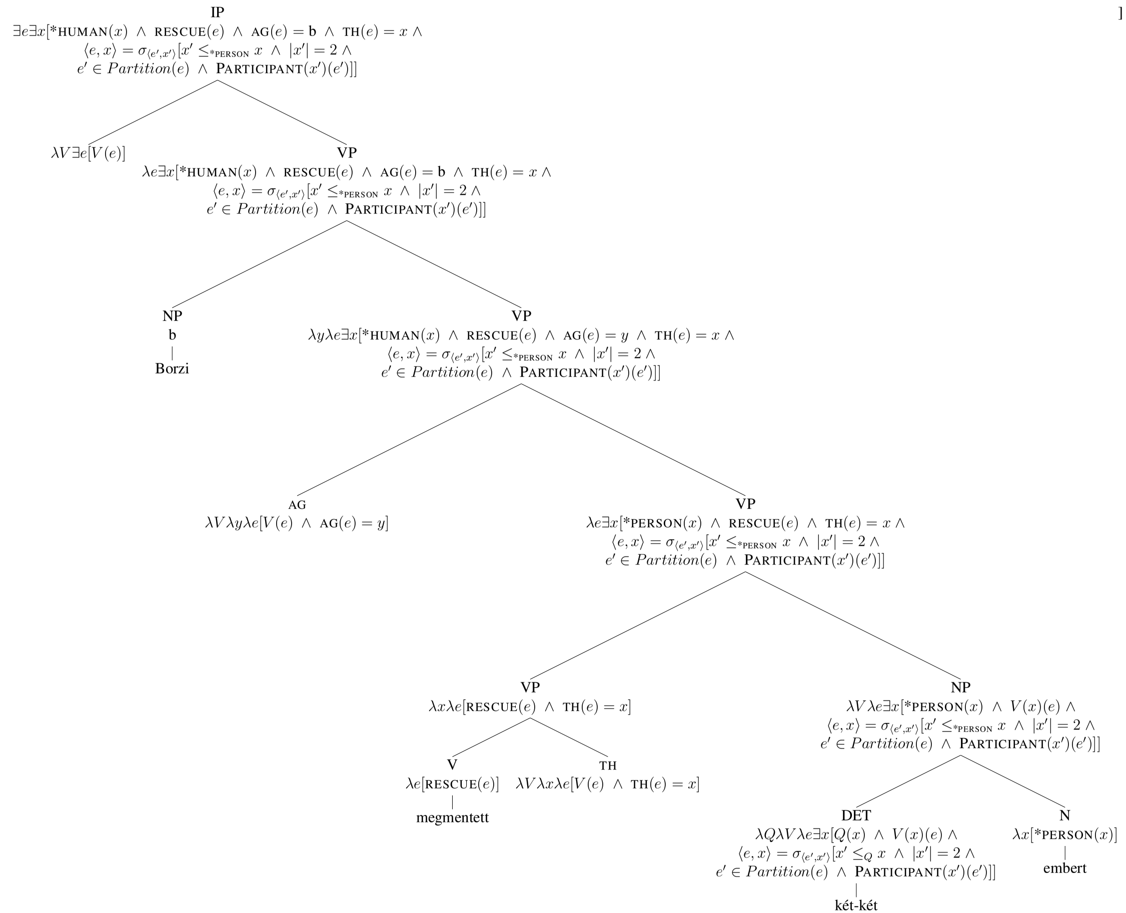

Figure B.2: Deriving *Borzi megmentett két-két embert*

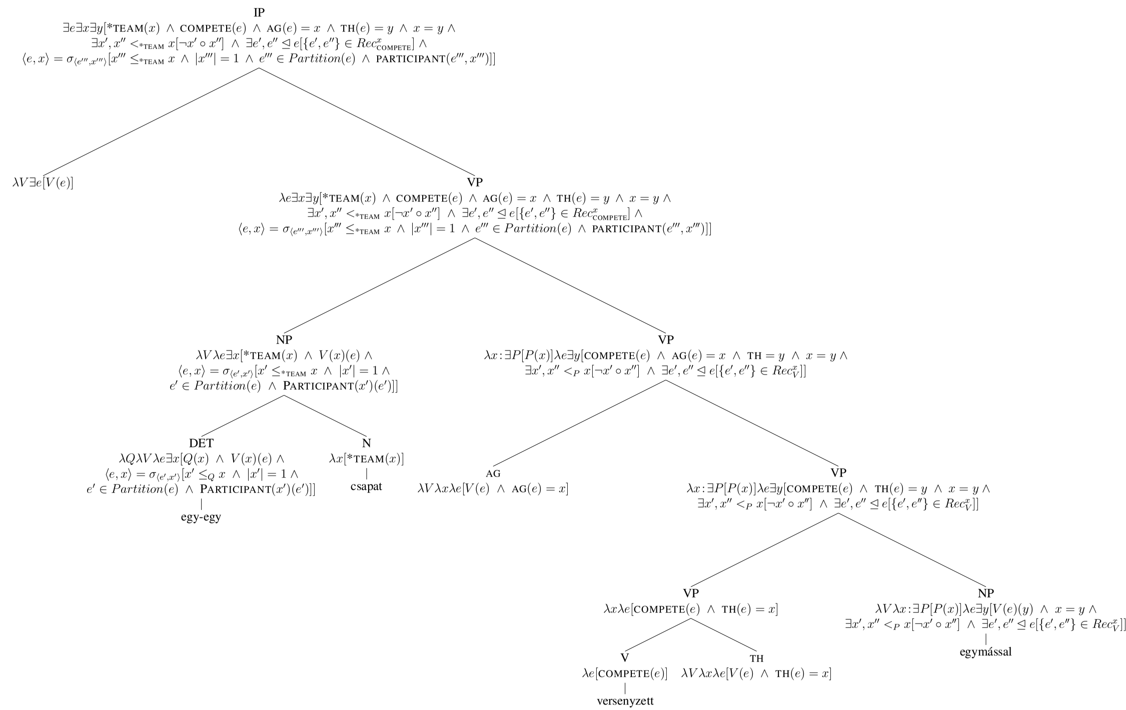

Figure B.3: Deriving *Egy-egy csapat versenyzett egymással*