11

Conclusion

This chapter concludes the book by summarizing its main insights and results in a chapter-by-chapter summary (Section 11.1) and by offering some suggestions for further research (Section 11.2).

11.1 Chapter-by-chapter summary

In this book, I have developed a new approach to the semantics of distributivity, aspect, and measurement, three domains which are traditionally addressed by separate areas of research within formal semantics. By triangulating between these domains, I have arrived at a unifying perspective from which I made theoretical and empirical contributions to the study of the formal semantics of natural language.

My main theoretical contribution, introduced in Chapter 1 and laid out throughout the book, is the notion of stratified reference, a concept that requires a predicate that applies to an entity—be it a substance, an event or a plural individual—to also apply to the parts into which this entity can be decomposed along some dimension and down to some level of granularity. The concept is general enough to subsume a wide range of previous proposals, yet formally precise enough to make testable predictions and to transfer insights across traditional boundaries. The resulting framework, strata theory, is intended as a bridge that spans a number of semantic oppositions: singular/plural, count/mass, telic/atelic, and collective/distributive. While it has often been observed that these semantic oppositions are similar, and proposals have been made to bring some of them under the same umbrella, this work is the first one to propose a fully unified account. Intuitively, the concept that underlies each of these oppositions is the difference between boundedness and unboundedness. Singular, count, telic, and collective predicates are all delimited or bounded, in ways that set them apart
from plural, mass, atelic, and distributive predicates. When it comes to formally describing what boundedness amounts to, characterizations in the semantic literature have tended to be limited to one domain: aspect, distributivity, or measurement only. Stratified reference provides a characterization that works in all of these domains. It builds on the same background assumptions as many previous theories and frameworks based on classical extensional mereology and algebraic semantics (Lønning 1987, Link 1998a, Krifka 1998, Landman 2000). These theories and assumptions are presented in explicit and distilled form in Chapter 2, with a focus on areas in which no consensus has been reached, such as the meaning of the plural morpheme, the question whether the meanings of verbs are inherently pluralized, the formal properties of thematic roles, and the compositional process. This chapter is intended as a reference point for future researchers and as an introduction to the relevant parts of the formal semantic literature.

My main empirical contribution is the observation that a large class of nominal and verbal constructions impose analogous unboundedness constraints on a predicate denoted by one of their constituents. A representative selection of what I have called distributive constructions—namely for-adverbials, pseudopartitives, and adverbial each—is described in Chapter 3 and onwards. The chapter includes simplified Logical Forms for these constructions that provide a scaffold on which the theory in the rest of the book is built. Distributive constructions give us an empirical handle on the conceptual question of how to characterize unboundedness. For example, the fact that for an hour can modify the unbounded predicate eat apples but not the bounded predicate eat thirty apples makes it possible to constrain the space of options for formal definitions of unboundedness by studying the algebraic properties of these and related predicates (Krifka 1998). Stratified reference emerges from a systematic investigation of these constructions and of previous theories that account for their behavior within the framework of algebraic semantics.

Since unboundedness is a property of predicates, and since predicates are properties, it is natural to think of unboundedness as a higher-order property. Indeed, previous work in algebraic semantics has used higher-order properties such as cumulative or divisive reference to characterize different facets of unboundedness (Link 1998a, Krifka 1998, and others). Such properties are a useful stepping stone towards a formal characterization of unboundedness, but they
are too rigid to provide a nuanced understanding of the differences between these facets. For example, distributivity and atelicity can both be seen as facets of unboundedness; but one and the same predicate can be atelic without being distributive or vice versa, or distributive with respect to one thematic role but not another. Chapter 4 presents stratified reference as a formalization of unboundedness and as a means to capture the parallels between the semantic oppositions in a uniform way. After giving a brief overview over the empirical phenomena that have been discussed under the rubric of distributivity, the notion of stratified reference is gradually developed as a generalized notion of distributivity. It is then used to formulate constraints that capture the behavior of distributive constructions and meaning postulates that predict distributive entailments of lexical predicates.

Two factors make it possible to identify a single formal property that describes unboundedness in all its facets. The first factor consists in using the same descriptive terms for constituents that behave analogously across syntactically and semantically distinct distributive constructions. The terms Key and Share from the literature on distributivity turn out useful for this purpose, as does the newly coined term Map. The second factor is the combination of a common approach in semantics—namely, using higher-order properties—with a common approach in syntax—namely, using parameters. This leads to the conceptualization of stratified reference as a parametrized higher-order property. Stratified reference builds on the basic intuition behind algebraic semantic accounts, namely that atelicity, distributivity and related concepts can be defined in terms of a predicate applying to the parts of an event or entity, but generalizes it by adding parameters that allow us to explicitly model varying dimensions and granularities. These parameters turn out to provide an appropriate middle ground between rigidity and flexibility that captures the ways in which distributive constructions differ without losing track of their common core. Following Piñón 2015 and Schwarzschild 2015, I have taken a further step away from ordinary higher-order properties by restricting stratified reference to the parts of a single entity \( x \), rather than requiring it to apply to all entities to which the predicate applies. In effect, these moves made stratified reference into a relation that is higher-order on its predicate argument and on its two parameters and first-order on its entity argument. However, since its purpose is still conceptually close to higher-order properties, I will refer to it as the property-based perspective on
stratified reference:

(1) **Property-based perspective:**

\[
\text{StratifiedReference}_{\text{dimension, granularity}}(\text{Predicate})(x) \overset{\text{def}}{=} \exists y. \left( \text{Predicate}(y) \land \text{granularity}(\text{dimension}(y)) \right)
\]

The *granularity parameter* allows us to model the varying amounts to which distributivity will reach down to subparts in distributive constructions: to atoms or small subgroups in some cases, and to contextually salient levels of granularity in others. This parameter is motivated in part by the need to account for the minimal-parts problem, as was done in Chapter 5. This problem arises from the fact that some eventualities and substances fail to distribute at very small scales because they have parts that are too small to satisfy certain mass terms and atelic predicates. This is a challenge for characterizations of atelicity that look at all smaller events (as in the case of divisive reference, Krifka 1998) or intervals (as in the case of the subinterval property, Dowty 1979). Nondivisive atelic predicates such as *waltz* and *pass on from generation to generation* make it necessary to relativize these concepts, for example by equipping them with a minimal-length threshold so that they ignore what happens at very short intervals below this threshold.

By making a virtue out of necessity and elevating this threshold to a central part of the theory—the granularity parameter—it becomes possible to avoid the minimal-parts problem. Different settings of the parameter lead to nuanced predications concerning the interaction between the respective predicate and the length of the interval denoted by the complement of *for*. By varying the parameter, we may use stratified reference both to describe the length of the smallest events that count as waltzing or passing on from generation to generation, and to describe the requirements that *for*-adverbials impose on the properties they modify. I did not fully recognize these two tasks as conceptually distinct until the response articles to Champollion 2015c, particularly Piñón 2015 and Schwarzschild 2015, helped me realize it. If a *for*-adverbial is like a sieve and the events in the denotation of the predicate it modifies are like grains of sand, the first task amounts to describing the size of the grains, and the second amounts to describing the size of the holes in the sieve (Champollion 2015b). As a part of the description of the constraint imposed by *for*-adverbials, stratified reference
describes the size of the holes. This is what Chapter 5 focuses on. As a component of meaning postulates that describe what we know about predicates, stratified reference can describe the size of the grains that pass through the sieve. Some predicates like *waltz* will be fine-grained, other predicates like *pass on from generation to generation* will be more coarse-grained.

The *dimension parameter* captures the view that unboundedness may occur in time, in space, or along a measure function or a thematic role. Because of its traditional focus on cross-domain generalizations, mereology-based algebraic semantics lends itself well to a formal implementation of this view. In particular, various functions can be treated as of one and the same kind: thematic roles such as *agent* and *theme*, measure functions such as *temperature* and *volume*, and event properties such as *runtime* and *spatial extent*. As we have seen in Chapter 6, the latter parallel makes it straightforward to account for analogies between temporal measure adverbials (such as *run for an hour* vs. *run all the way to the store for an hour*) and spatial measure adverbials (such as *meander for a mile* vs. *end for a mile*) previously noted by Moltmann (1991) and Gawron (2009). More generally, the dimension parameter captures the fact that a distributive construction will typically impose only one kind of unboundedness at a time. For example, the fact that temporally unbounded predicates can be modified by temporal *for*-adverbials even when they contain a spatially bounded constituent (as in *flow from the jar to the floor for ten minutes*) is unsurprising on this view, and differences in interpretation between temporal and spatial *for*-adverbials (as in *push carts all the way to the store for fifty minutes versus for fifty meters*) find a natural explanation.

Theories of aspect are typically not designed as ways to explain what is wrong with measure constructions like *three degrees of water* or *three pounds of book*. However, relevant connections have occasionally been noted (Krifka 1998, Schwarzschild 2006). The parallel becomes intuitive once we think of the verb phrase *run for three hours* in connection with the pseudopartitive *three hours of running*. Chapter 7 has exploited the formal parallel between the domains of aspect and measurement developed in Chapter 4 to explain the linguistic relevance of the difference between intensive measure functions like *temperature* and extensive ones like *runtime*. Treating the two constructions as semantically equivalent made it possible to push the limits of theories designed for only one of the two domains to which they are traditionally seen as belonging. Stratified
reference correctly predicts that distributive constructions disallow measure functions that generally return the same value on an entity and on its parts. For example, just as \textit{run for three hours} requires \textit{run} to apply to temporally shorter parts of the event to which \textit{run} applies, *\textit{three pounds of book} would require \textit{book} to apply to lighter parts of the entity to which \textit{book} applies, and *\textit{three degrees Celsius of water} would require the existence of colder parts of the entity to which \textit{water} applies. The fact that stratified reference relativizes unboundedness to just one dimension or measure function at a time made it possible to subsume the insight of Schwarzschild 2006 and to account for examples like \textit{five feet of snow} in spite of the fact that not every part of a five-foot snow layer of snow is less than five feet in height.

Throughout this book, I have used stratified reference for various purposes: to characterize the distributivity constraint in those constructions that impose it; to specify meaning postulates for words that exhibit distributivity down to various levels of granularity; and as a formalization of atomic and nonatomic distributivity operators. Starting in Chapter 8, I shifted from viewing stratified reference as a parametrized higher-order property to viewing it as a parametrized unary distributivity operator on predicates:

\begin{equation}
\text{Operator-based perspective:} \\
\text{StratifiedReference}_{\text{dimension, granularity}}(\text{Predicate}) \overset{\text{def}}{=} \lambda x. \; x \in ^*\lambda y. \left( \text{Predicate}(y) \land \text{granularity}(\text{dimension}(y)) \right)
\end{equation}

Since the two definitions sketched in (1) and (2) are equivalent, the move from the property-based perspective to the operator-based perspective is largely conceptual. The main difference results from whether stratified reference is implemented as a presuppositional requirement or as a predicate modifier. In both cases, the dimension and granularity parameters can be instantiated in whatever ways may be appropriate for different constructions and theoretical assumptions. Varying the value of the dimension parameter amounts to distributing over various thematic roles and spatiotemporal dimensions. Varying the value of the granularity parameter amounts to choosing between distributing over atomic entities like singular individuals and nonatomic entities like pluralities and temporal intervals. Chapter 8 exploited the operator-based perspective to synthesize and expand previous accounts of how verb phrases such as \textit{build a raft}...
optionally acquire a distributive interpretation by covert distributivity operators. In particular, the differences between the atomic operator in Link 1987b, Roberts 1987, the nonatomic operator in Schwarzschild 1996, and their generalizations in Lasersohn 1998b, can be modeled and clarified by shifting the values of the dimension and granularity parameters. Furthermore, setting the dimension parameter to \textit{runtime} made it possible to transfer the notion of covert distributivity as a verb phrase shifter into the temporal domain, and making the granularity parameter anaphoric to a salient predicate helped export Schwarzschild’s claim that nonatomic distributivity requires salient covers to that domain. This resulted in a new perspective on the puzzling scopal behavior of indefinites and numerals in the scope of \textit{for}-adverbials, including the fact that indefinites in the syntactic scope of \textit{for}-adverbials tend not to covary with these adverbials (\textit{John found a flea on his dog for a month}, Zucchi & White 2001).

The operator-based perspective on stratified reference naturally led to postulating a formal connection between covert and overt distributivity. This made it possible in Chapter 9 to analyze distance-distributive items across languages as overt versions of distributivity operators, as suggested by Link (1991b) for the case of \textit{each}. The granularity parameter, along with the notion of an anaphoric cover from Schwarzschild 2006, made it possible to account for the crosslinguistic variation between those distance-distributive items that only exhibit atomic distributivity, such as adverbial and adnominal \textit{each} in English, and those that also distribute over salient nonatomic entities such as time intervals, such as adverbial and adnominal \textit{jeweils} in German. Essentially, these two items were treated as overt versions of the atomic and the nonatomic distributivity operator respectively. The typological correlation between atomic distributivity and ability to be used as a distributive determiner observed by Zimmermann (2002b) turned out to be expected once the operator-based perspective was extended to distributive determiners such as \textit{each} and \textit{every}. Because stratified reference always provides access to the sum event and not just to its parts, this extension immediately explained why these determiners can participate in nondistributive phenomena with items outside of their syntactic scope, such as cumulative readings and nondistributive adverbial modifiers (Schein 1993, Kratzer 2000, Champollion 2010a).

The property-based and the operator-based perspective on stratified reference, as well as both the dimension and the granularity parameter, all came into
play in Chapter 10, whose main focus is on explaining the behavior of *all* with respect to different collective predicates, such as *all the students gathered* versus *all the students were numerous* (Dowty 1987, Winter 2001). The impetus for this chapter came from the startling observation by Zweig (2009) that a noun phrase headed by *all*, such as *all the safari participants*, can lead to a cumulative reading when it combines with a verb phrase that contains an unbounded argument, such as the dependent plural in *saw zebras*, but not when the verb phrase contains a bounded argument, such as *saw thirty zebras*. The search for a formal property that sets these two predicates apart was facilitated by the property-based perspective. My guiding intuition was that *see zebras* is to *see thirty zebras* what *eat apples* is to *eat thirty apples*; however, the second pair captures the telic/atelic opposition while both expressions in the first pair are atelic. Stratified reference allows us to model this situation as a difference in settings of the dimension parameter. *Eat apples* but not *eat thirty apples* distributes down the time dimension; *see zebras* but not *see thirty zebras* distributes down the agent dimension. Stratified reference instantiated with *time* is atelicity; stratified reference instantiated with *agent* is distributivity. If *for*-adverbials test for atelicity, *all* tests for distributivity.

While a traditional view on distributivity might lead us to expect that *all* is synonymous with other distributive items such as *each*, the fact that different items set the granularity parameter to different values leads us to expect otherwise. The fact that *all* but not *each* is compatible with collective predicates that exhibit subgroup distributivity finds a natural explanation in the assumption that *all* is a coarser sieve than *each*, in line with the characterization of *gather*-type predicates as subgroup distributive (Dobrovie-Sorin 2014, Kuhn 2014). Stratified reference was also used to formulate meaning postulates that capture the fact that *gather*-type predicates give rise to distributive inferences to subgroups. Finally, the distributive operator from Chapter 8 helped account for cases in which *all* appears to take away the collective interpretation of a predicate that can normally be interpreted either distributively or collectively.

### 11.2 Future work

This section, adapted in part from Champollion 2015b,c, sketches some broader implications of strata theory and connections to other domains of linguistics.

Any theory of distributive constructions needs to specify the constraint that
these constructions impose on their constituents (the nature of the sieve) as well as the reason these constituents satisfy it (the nature of the grains that pass through the sieve). In the case of one-word predicates, I have used stratified reference to formulate meaning postulates that describe their grain size. As we have seen in Chapter 8, complex predicates can also be characterized with respect to whether or not they satisfy stratified reference. A full account of aspect and distributivity in these cases will need to be complemented by a theory of how a given complex predicate ends up having or not having stratified reference. Certain overt modifiers, such as adverbial each and together, can determine whether the predicate that they modify is understood distributively or collectively. The question of how complex predicates end up being collective or distributive is analogous to the question of how complex predicates end up being atelic or telic, a process also known as aspectual composition (e.g. Krifka 1998). Stratified reference allows us to think about the effect of each, together and distributivity operators and about aspectual composition as two sides of the same coin.

This also means that we can link problems that affect accounts of these processes. For example, Doetjes (2015) correctly notes that stratified reference does not rule out incremental-theme verbs whose themes are downward-entailing modified numerals, such as (3a). That modified numerals pose problems for algebraic accounts of aspectual composition has been noticed many times (Egg 1994, Eberle 1998, Naumann 1999). Stratified reference has this problem in common with the subinterval property, which it is meant to generalize. Cumulative reference does not fare any better because an analogous problem occurs with upward-entailing modified numerals (3b). Doetjes therefore proposes combining stratified reference with cumulative reference, following Landman & Rothstein (2012b). This will rule out both types of examples as desired, but unfortunately not (3c), discussed by Zucchi & White (2001). Likewise, the contrast in (3b), discussed by Mittwoch (1982), remains unexplained.

(3)  
   a. He drank at most thirty glasses of water for three hours.  
   b. He finished at least three books for three hours.  
   c. John drank { some / a quantity of } milk for an hour.  
   d. John {ate / #ate something } for an hour.

This kind of behavior is puzzling for most if not all algebraic theories of aspect, including strata theory. The noun phrases that cause the sentences in (3) to sound
odd seem to behave for the purposes of these theories as if they were quantized, at least along the relevant (temporal) dimension. An early feature-based theory of aspectual composition, Verkuyl 1972, grouped modified and unmodified numerals together by assigning both of them a [+Specified Quantity] feature, while bare plurals and mass nouns carried a [-Specified Quantity] feature. Algebraic notions like quantization, stratified reference, and the subinterval property are meant to make such features superfluous. But in noun phrases like the ones in (3), the effects of these two systems come apart (Verkuyl 2005, fn. 3). A similar issue is discussed by Schwarzschild (2015) in connection with the word line. Other problematic predicates include twig, rock, and sequence. A helpful but ultimately inconclusive discussion of possible ways to address this problem is found in Zucchi & White 2001. Similarly, as discussed in Chapter 10, a number of collective predicates that are incompatible with all but that are still subgroup distributive, such as be a group of less than five, would be expected to be compatible with all under the account I have discussed here (Kuhn 2014). Finally, the constraint against cumulative readings of all described in Chapter 10 also rules out a cumulative reading when the verb phrase contains a delimited but nonquantized object (All the linguistics majors dated several chemistry majors, Zweig 2009). If a solution to these problems emerges in one domain, we may well be able to adapt it to the other domain.

If this book is on the right track, distributivity is ubiquitous. We just need to recognize it when it presents itself in unusual ways. I have made the case for this idea using each, all, for-adverbials and pseudopartitives. Now that we know what we are looking for, it should be easy to find more distributive constructions. Here are some possible places to look:

German and Japanese split quantifier constructions, in which a quantifier appears in adverbial position apart from the noun phrase over which it quantifies, are similar to adverbial-each distributive constructions in that they are incompatible with collective interpretations, and they are similar to pseudopartitive constructions in that their measure functions are subject to the same monotonicity constraint (Nakanishi 2004).

As discussed in Ursini 2006, directional prepositional phrases can be modified by measure phrases when they are unbounded (three miles towards the beach), but not when they are bounded (*three miles to the beach). This points towards the possibility that this is a distributive construction. The measure
phrase in these examples might be a Key, and its directional prepositional phrase a Share.

*For*-adverbials are not the only examples of aspectually sensitive constructions. As noted in Karttunen 1974, Hitzeman 1991, 1997, *until* is also sensitive to the atelic-telic distinction. The same appears to be true for *since*, though the situation is more complicated here. In English, *since* requires the Perfect, which is often analyzed as introducing an Extended Now interval (Dowty 1979, von Stechow 2002a). This muddles the picture, but once we move to German, where the equivalent *seit* does not require the Perfect, we see the correlation emerge:

An Extended Now Perfect modified by *since* $\alpha$ may embed any aktionsart. German perfects modified by *seit* $\alpha$ may have these readings, though they are a bit marked. In contrast to English, *seit* $\alpha$ may combine with simple tenses as well, but then it behaves differently. The aktionsart modified must be a state or an activity. (von Stechow 2002a)

The theory of the behavior of indefinites in the scope of *for*-adverbials presented in Chapter 8 can be extended to other modifiers that do not or not easily induce covariation of indefinites in their scope. In particular, habitual or generic sentences show analogous scopal effects to *for*-adverbials (Carlson 1977, Kratzer 2007). This is illustrated in the examples in (4), taken from Krifka, Pelletier, Carlson, ter Meulen, Chierchia & Link 1995, 39f.

(4)  
   a. Mary smokes cigarettes / *a cigarette.
   b. Mary smokes cigarettes / a cigarette after dinner.

Just like in the case of *for*-adverbials, singular indefinites can covary with habitual operators when a salient level of granularity is provided (see also Rimell 2004).

(5)  
   a. Yesterday, Mary smoked cigarettes / *a cigarette for an hour.
   b. Last month, Mary smoked cigarettes / a cigarette after dinner for a week.

This fact suggests that the generic quantifier might carry a stratified reference presupposition, and that it might be appropriate to fold strata theory into a more
general theory of imperfective and generic/habitual sentences such as the one proposed in Deo 2009 for English and Gujarati and extended to for-adverbials in Deo & Piñango 2011. Similar effects to the ones in (5) hold in Hindi (Ashwini Deo, p.c.), which is close to Gujarati. For more discussion and for a synthesis of Deo & Piñango 2011 and the present account, see Champollion 2013.

Other potential applications can be found in morphosyntax. Strata theory may help explain how boundedness is marked by semantic case in Finnish (Krifka 1992, Kiparsky 1998), by perfective prefixes in Slavic (Filip 2000), and by accusative adverbials in Korean (Wechsler & Lee 1996). Throughout this book, I have assumed that singular count nouns are interpreted as involving reference to singular entities but not sums. This was necessary in order to explain the contrast between five pounds of books and *five pounds of book, and it is justified in English by the corresponding contrast in numeral phrases (five books vs. *five book). Other languages, like Hungarian and Turkish, require nouns to be morphologically singular when they combine with numerals, and also when they are used as substance nouns in pseudopartitives. From the point of view of the present theory, this leads to the view that singular nouns in these languages and constructions can be interpreted as involving reference to sums. Theories that adopt this view (Farkas & de Swart 2010, Bale, Gagnon & Khanjian 2011) are compatible with the view developed here. This may be seen as an advantage for them over theories that reject this assumption (Ionin & Matushansky 2006).

I have focused on pseudopartitives like three liters of water. As noted by Schwarzchild (2002, 2006), true partitives like three liters of the water and comparatives like more water are subject to the same constraint on measure functions as pseudopartitives. An extension of the present account to true partitives is straightforward if we assume that the constituent of the water has divisive reference, stratified reference, or whatever is the relevant property of the substance nominal of pseudopartitives. However, the assumption that the of-PP has divisive reference is not uncontroversial: Ladusaw (1982), and many accounts that follow him, adopts it but Matthewson (2001) argues against it.

While I have shown that the behavior of a large number of constructions can be reduced to one principle (namely, sensitivity to stratified reference), I have not addressed the question why this principle exists and why these constructions are sensitive to it. In formal semantics, this is not the kind of question that is typically answered, or perhaps even answerable. There is no agreement on
whether it even needs to be answered. On the one hand, for the purposes of comparing formal semantic theories to each other, formal semantics usually pays attention to something similar to Chomskyan explanatory adequacy: “If a number of highly complex and apparently unrelated facts are reducible to a few simple principles, then these principles explain these facts” (von Stechow 1984a). On the other hand, we need not confine ourselves in this way: “we can seek a level of explanation deeper than explanatory adequacy, asking not only what the properties of language are but also why they are that way” (Chomsky 2001).

I do not know why there should be any constructions in language, let alone so many of them, that are sensitive to stratified reference or to the various properties it captures. To answer this question, it may be worth looking for explanations in domains other than formal semantics, such as first-language acquisition. Stratified reference may conceivably help first-language learners distinguish the functions of different constructions. For example, learners must distinguish constructions that specify the quantity of a substance or event, such as pseudopartitives, from superficially similar constructions that specify non-quantity-related properties, such as attributive constructions (three-pound strawberries). Attributive constructions do not impose stratified reference and are therefore compatible with intensive measure functions, as illustrated by three-degree water (Schwarzschild 2006). Apart from sometimes misinterpreting the number word in pseudopartitives as referring to cardinality of a relevant set of objects, four-year-olds tend to correctly distinguish pseudopartitives from attributives (Syrett 2013). Similarly, various studies have suggested that children are sensitive to the atelic-telic opposition as early as three years old, raising the question of how much of it is innately specified (Crain 2011). If something like the boundedness-unboundedness opposition is among the building blocks of the language faculty, then we might expect that children access it early on, and possibly that a child will learn different constructions that involve this building block at the same age.

Another kind of explanation, as well as another avenue for further research, may be found in linguistic theories that study conceptual linguistic knowledge and the mental patterns and representations in which it is organized, such as cognitive semantics (Talmy 2011) and conceptual semantics (Jackendoff 1996). The metaphor I have used to explain stratified reference, namely that individuals, substances, and events occupy regions in an abstract space whose dimensions include thematic roles and measure functions as well as spatial and temporal
dimensions, is reminiscent of the theory of conceptual spaces in Gärdenfors 2007. The words that introduce stratified reference constraints, such as for, until, of, each and all, belong to closed-class categories such as prepositions and determiners. Cognitive semantics has found that closed-class categories are highly constrained in the range of conceptual categories they can express. The relevant conceptual category in this case would be boundedness. While cognitive semantics is sometimes seen as opposed to formal semantics, this does not have to be so (Krifka 1998, Zwarts & Verkuyl 1994). We can make use of formal semantic techniques such as the ones I have developed here, and assume that expressions are interpreted by elements of conceptual structures rather than entities in the real world. The present system may then be seen as a step towards a model-theoretic characterization of such frameworks.