

## **Telicity, Atomicity and the Vendler Classification of Verbs**

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### **Abstract**

This paper develops the idea that the telicity is derived from atomicity. An atomic predicate is a singular predicate denoting a set of individuals which count as one individual on some scale of measurement, i.e. must be formally of the form  $\lambda a.P(a) \wedge \text{MEAS}(a) = \langle 1, U \rangle$ . Atomic sets of this kind are derived via a maximalisation operation (Filip and Rothstein 2005, Rothstein 2007b). While in the nominal domain, there is a distinction between count predicates which denote sets of atoms and mass predicates which do not, the set of verbs contains only count predicates, i.e. basic verbal denotations at the V and VP level are of the form  $\lambda e.P(e) \wedge \text{MEAS}(e) = \langle 1, U \rangle$ . However, there is a division between those verbal predicates for which a value for U is specified and those for which it is not. The former are telic and the latter are not. We see that the different Vendler classes contribute to determining the telicity of the VPs they head in different ways, depending on their inherent properties. We show that only atomic (i.e. singular) predicates are telic, and thus plural (distributive) predicates are necessarily atelic.

### **1. Introduction**

The goal of this paper is twofold: (i) to develop an account of the telic/atelic distinction in terms of countability and (ii) to investigate the relationship between the Vendler class that a verb belongs to on the one hand and the telicity of the VP that it heads, on the other. The paper develops an idea proposed in Rothstein 2004 that telicity is an expression of atomicity, and develops that idea in the framework of a theory of countability and atomicity in the nominal domain set out in Rothstein 2007b.

The structure of this paper is as follows. I begin with a very brief overview of a Vendler-based classification of verb types, more or less following Rothstein 2004. I continue with a review of some issues concerning telicity, including the properties which characterise telic predicates. Both these sections will support a fundamental hypothesis, namely that Vendler properties are properties of verbs, while telicity (and atelicity) are, in English, properties of VPs. (The restriction to English is essential since, as Filip and Rothstein 2005 argue, a central difference between the Slavic and Germanic verbal systems is that formal telicity is a property of Vs in Slavic, but not in English.) I will then outline the theory of atomicity presented in Rothstein 2007b. In this theory we follow Chierchia 1998, who argues that the mass domain and the count domain are both atomic, since both mass and count nouns denote domains which have the structure of atomic Boolean semi-lattices. However, we distinguish the atoms of a domain, which are the minimal elements in the lattice which it denotes, from the M-ATOMs which are grammatically countable elements, whose measure is 1 according to a given scale of measurement. I will argue that telic predicates denote sets of M-

ATOMs where the scale of measurement is grammatically recoverable from the lexical content of the VP. We then explore the role of Vendler classes in determining telicity, and show that different Vendler classes make available a scale of measurement to different degrees and in different ways. The final section is a first step towards adding a theory of plurality to this account and provides an explanation of why accomplishments with bare plural or mass theme/direct object arguments do not head telic VPs.

## 2. Vendler classes, Vendler features and natural atomicity

Vendler 1957/1967 proposed that verb meanings could be classified into four basic classes, *states*, *activities*, *achievements* and *accomplishments*, depending on their interaction with aspectual and temporal modifiers. Dowty 1979 suggests that these classes are characterised by the different kinds of intervals at which events could be said to hold. States hold at instants and at dense convex sets of instants, achievements hold at two adjacent instants, activities hold at minimal extended intervals and, since they are inherently iterable, at convex sets of such intervals, while accomplishments hold at extended intervals but are not (usually) iterable. In Rothstein 2004, I suggest that Vendler properties are constraints on how we characterise events. That there are four basic verb classes with exactly these temporal features follows from the fact that verb meanings – or event properties – are necessarily characterised by two basic features, whether or not they are inherently temporally extended, and whether or not they express events of change. By "event of change" I mean an event which is defined in terms of bringing about a specific situation or state of affairs.

The two features characterise the four basic verb types in the following way:

Table 1:

	Minimal events are extended	Event of change
States	–	–
Activities	+	–
Achievements	–	+
Accomplishments	+	+

According to table 1, *states* are not inherently extended and do not entail a change. This means that they can hold at instants, although they can also hold at stretches of instants. *Activities* are inherently extended, and thus cannot hold at instants, but do not involve a change. *Achievements* are minimal non-extended verbs of change, changes from  $\alpha$  to  $\neg\alpha$ . They are non-extended since a change of this kind must be instantaneous, although for technical reasons it is easiest to see them at two adjacent instants, one the last at which  $\alpha$  holds and the second the first at which  $\neg\alpha$  holds. (However, see Kamp 1979a,b for an account of event ontology at which achievements hold at a single instant.) *Accomplishments* are extended verbs of change, and can therefore best be characterised as changed from  $\beta$  to  $\alpha$  allowing for a middle period at which both  $\neg\beta$  and  $\neg\alpha$  hold. Verbs are assigned features according to their linguistic behaviour: whether or not a verb denotes an inherently extended event correlates with whether or not it occurs naturally in the progressive (activities and accomplishments do, while states and achievements do not), and whether or not it denotes an event of change correlates with whether or not it occurs with a telic

modifier, and whether or not it induces the imperfective paradox. We will come back to this later.

The prediction of this account is that event types other than these four would result from the interaction of other grammatical features with these types, and that these features should explain linguistic behaviour.

A test case for the theory is *semelfactives*, as discussed in Rothstein 2007a. Semelfactives are verbs such as *kick, jump, wink, blink, hop, and skip* and they are ‘single occurrence’ events, which are homonymous with activity predicates denoting events which involved iterations of the single event. However, while all semelfactives are homonymous with activities, not all activities have a semelfactive homonym. Thus, in addition to predicates with activity properties such as *kick, jump, wink, blink, hop* and *skip*, there are also activity predicates such as *run, swim, walk, and sing*. As shown by Dowty 1979, activities are singular events which are constructed out of iterations of minimal extended events. Dowty 1979 analyses the activity *walk* in this way, and shows that although it is unclear how big a minimal event of walking is, an extended event of walking can be seen as an iteration of minimal events. Dowty shows that the notion of the minimal activity event explains why activity predicates may introduce the imperfective paradox: if John is at the very beginning of a minimal event of walking which is not preceded by another such event, then you may want to say “John is walking” without committing yourself to the entailment “John has walked”. The entailment from the progressive to the perfect or the simple past holds only when the event verifying the progressive is big enough to include a minimal event.

What process or operation forms activities out of minimal events? In Rothstein (2004, 2007a), I suggest that there is an S-summing (or singular summing) operation which sums activity events in P with no temporal gap between them, and forms a new singular event out of this sum, which is also in P. S-summing is a general mechanism which can sum entities and turn the result into a singular object. Thus the sum of John and Mary can be turned into a singular object, a couple, while a sum of events can form a singular event such as a marriage ceremony and so on. But here, what we have in mind is a linguistic operation in the verbal domain, S-sum<sub>V</sub> or S-summing on V, where S-sum is an operation on V, with both the input and the output in the denotation of V. It takes events in the denotation of a verbal predicate, such as *run* which temporally overlap and sums them into a single more extended event also in the denotation of the same verb *run*:

(1) S-sum<sub>V</sub> (= the S-sum operation in the verbal domain):

$\forall e, e' : P(e) \wedge P(e') \wedge R(e, e') : S\text{-sum}(e, e') \rightarrow P(S(e \sqcup e'))$

"For any two events *e* and *e'* in the denotation P which stand in the R relation, S-sum<sub>V</sub> applied to *e* and *e'* yields a singular event formed out of the sum of *e* and *e'* and which is also in the denotation of P.

S-sum applies to two events in the denotation of a verbal predicate P which stand in the appropriate relation, sums them and turns them into a single event also in the denotation of the predicate P. The ‘appropriate relation’ in this case is that *e* and *e'* are temporally overlapping, i.e. that  $\tau(e)$  and  $\tau(e')$  overlap, where  $\tau$  is the temporal trace function from events to their running times. Thus two events in the domain of *run* which overlap temporally, say an event of John running from 9.00 am till 10.00 am and an event of his running from 10.00 am till 11.00 am can be S-summed into a

single event of running (from 9.00 am till 11.00 am). A predicate which is non-trivially closed under S-summing is said to be **s-cumulative**. P is s-cumulative if:

- (2)  $\exists e \exists e' [X(e) \wedge X(e') \wedge \neg e \sqsubseteq e' \wedge \forall e \forall e' [X(e) \wedge X(e') \wedge R(e, e') \rightarrow X({}^S(e \sqcup e'))]]$   
 "P is S-cumulative if S-summing applies non-trivially to events in its denotation which meet the conditions above, and the output is also in P."

S-cumulativity is clearly related to Krifka's (1989, 1992, 1998) definition of cumulativity (see (12) below), but where cumulativity is based on the simple notion of summing, which forms a plurality, S-summing crucially specifies that the output of the operation is a singular event.

Using this notion of S-summing, and following Dowty's intuition that activities are iterations of minimal activity events which hold at minimal intervals, and which have no temporal gaps between them, we use S-summing to form extended activity events recursively out of minimal ones. Events in the denotation of the activity predicates *skip* and *walk* are formed by S-summing from minimal events of skipping and walking. These predicates denote, respectively, the set of skipping and walking events closed under S-summing. The difference between them is that minimal events of skipping are naturally individuatable or **naturally atomic**, while minimal events of walking are not. This means that if an extended skipping or jumping activity event is going on, it is possible to identify the minimal events out of which the activity is made up and even count how many there are, but this is not the case for an event in *walk*. So, if a child skips for ten minutes, it is also possible to count how many minimal skips took place during that ten minutes, but if a walking event lasted for ten minutes, it makes no sense to ask how many minimal events it consisted of.

When the minimal events in the denotation of an activity predicate P are naturally atomic, or naturally individuatable, then they are lexically accessible. This means that there is a natural language predicate which denotes the set of naturally atomic events in P. In English, a predicate such as *skip* is ambiguous between the semelfactive use, under which it denotes the set of minimal skipping events, as well as an activity use under which it denotes this set closed under S-summing, i.e. the set of (possibly) extended skipping events, but this homonymy is not necessary. In Russian, the semelfactive predicate is derived from the activity predicate by *-nu* suffixation. In general, the set of activity predicates with a semelfactive use are precisely those predicates where the minimal events are naturally atomic, such as *skip*, *jump*, *flap*, *knock* and *blink*. Minimal events in *walk* are not naturally atomic and thus not lexically accessible. As a result, the predicate does not have a semelfactive use.

An important feature of this account of semelfactives is that it makes crucial use of the concept of natural atomicity, which will be central to the discussion below. A predicate P is naturally atomic if what counts as **one** instance of P is given as part of the meaning of P and is thus not context dependent. In Rothstein 2007b, I discuss natural atomicity in the nominal domain, and show that a naturally atomic predicate is not necessarily a count predicate. The predicate *boy* is naturally atomic, since if we know what *boy* means, we also know what one boy is, and thus in any given situation, we know how to count how many boys are contained in that situation.<sup>1</sup> In contrast, a count noun like *fence* is not naturally atomic. Given a square, fenced-in field, we might want to say that the situation contains four fences or one fence depending on whether we think of the field as surrounded by a fence (= one fence) or as having a fence on each of its sides (=four fences). In the verbal domain, a predicate like *jump* or *skip* is naturally atomic, since the minimal events have a clearly defined beginning

and endpoint, and thus define a natural trajectory. A single jump or minimal jumping event might be defined as starting at the point when you prepare for your feet to leave the ground and ending when they come in contact with the ground again. A similar definition for a single minimal walking event is not possible.

Semelfactives, then, fit into the table 1 naturally. Activities are inherently extended events which do not involve change, closed under S-summing. Semelfactives are a proper subset of this class, the set of minimal events which have the features [+extended, -change]. They do not show up as a separate class in the table because the table does not distinguish between minimal and non minimal (i.e. S-summed) events. Why then do only activity predicates show an ambiguity between the semelfactive and 'iterative' use? Or put differently, does S-summing apply only to activities? We assume that S-summing applies to states too, since they are naturally 'stretchable' and extend indefinitely. However, since minimal states hold at instants and we consider time to be dense, there is no way of accessing the minimal events, and thus states are not naturally atomic.

However, S-summing does not (normally) apply to accomplishments and achievements, because they are events of change, and they thus cannot stand in the temporal overlap relation. If P is a predicate of change then two events in P with the same participants cannot immediately follow each other since an event of changing from  $\alpha$  to  $\neg\alpha$  cannot immediately be followed by another event of the same kind without there first being a change back from  $\neg\alpha$  to  $\alpha$  (Kamp 1979a, b). So events of change cannot normally be S-summed.<sup>2</sup>

We have introduced several important concepts in this section: (i) the S-sum operation which applies to activities and states and which accounts for the fact that they are naturally extendable and have no defined stopping point; (ii) the [ $\pm$ change] feature, which distinguishes between accomplishments and achievements on the one hand and states and activities on the other, and has explanatory value because it explains which verb classes are closed non-trivially under S-summing and which are not; (iii) the concept of natural atomicity, which explains why some activities have a semelfactive use and others don't. These will all be central to the discussion of telicity which follows.

### 3. Telicity

While the question of what telicity is is still open, it is generally agreed that telic predicates are characterised by two pieces of linguistic behaviour: cooccurrence with expressions giving information about how long an event took till it was over, in particular *in  $\alpha$  time*, and a progressive use which gives rise to the imperfective paradox. Atelicity is characterised by cooccurrence with predicates such as *for  $\alpha$  time*, and the progressive does not give rise to the imperfective paradox (except in those cases of minimal activity events discussed above). Thus we get minimal contrasts such as those in (3) (Note that we are restricting our attention to singular predicates at the moment.)

- (3) a. John believed in the devil for several years/\*in several years. (*state*)  
b. Mary ran for half an hour/\*in half an hour. (*activity*)  
c. John arrived in half an hour/\*for half an hour. (*achievement*)  
d. Mary dug a ditch in a week/\*for a week. (*accomplishment*)
- (4) a. John is/was digging a ditch DOES NOT ENTAIL John dug a ditch.

- b. Mary is/was running ENTAILS Mary ran (on the assumption that she ran for at least a minimal interval.)
- c. Mary was arriving at the station (when she fell) DOES NOT ENTAIL Mary arrived at the station.

On these tests, unmodified states and activities head atelic VPs, and achievements and accomplishments with singular theme arguments come out as telic. Note also, that although there are restrictions on which achievements can occur as progressives and what they mean when they do so, they pattern with accomplishments in inducing the imperfective paradox.

On these same tests, semelfactives come out as telic. They can be modified by *in  $\alpha$  time*, while modification by *for  $\alpha$  time* forces an activity reading, and they induce the imperfective paradox, as (6) shows:

- (5) a. John jumped in 15 seconds.
- b. #Mary skipped for 10 seconds (except on activity reading).
  
- (6) a. John was knocking hard when he saw me, so he turned it into a tap instead.
- b. Bill was kicking him when he saw the referee watching him, so he stopped midway and didn't kick him.
- c. The bird was just flapping its wings for the first time when it fell of the branch, so it didn't flap them even once.

The data in (5) and (6) means that telicity cannot be characterised as an event inducing change, or as a predicate which cannot be S-summed, since semelfactives can be S-summed and do not denote changes. Since semelfactives and activities have exactly the same feature characterisation in terms of the properties in table 1, the telic/atelic distinction cannot be characterised in terms of the feature chart in table 1. Since the only difference between semelfactives and activities is that the former but not the latter denote a set of naturally atomic entities, it is plausible to look for an explanation of telicity which is connected to (natural) atomicity in some way.

Before doing this, we stress another important point. Characterising telicity in terms of the verb class or feature characterisation of the head is not possible, since various pieces of data show clearly that the head does not fully determine the telic/atelic status of the VP. The data in (3) and (4) indicate that unmodified activities and states are atelic, while intransitive achievements are telic, as are accomplishments with singular direct objects. However, activities can head telic VPs when modified by certain directional phrases or (possibly elliptical) measure phrases:

- (7) John ran a mile/his usual route/to the store in half an hour.

Accomplishments can head atelic VPs when their direct objects are either bare plurals or mass nouns:

- (8) a. John wrote a book in a month/\*for a month.
- b. John wrote books/propaganda for a month.

Some variation is possible with states and achievements as well. In particular a bare plural subject can induce atelicity in achievement verbs, as in (9).

(9) Guests arrived for hours.

This indicates that though activities and states may characteristically head atelic VPs while achievements and accomplishments characteristically head telic VPs, they need not do so. We take this to indicate that telicity is a property of VPs rather than of Vs (setting aside for the moment the fact that atelicity in (9) seems to be induced by the subject). However, the Vendler classification of the verbal head is not irrelevant, but indicates what contribution the head makes to determining the telicity of the VP, and what other factors are relevant too. A contrast between accomplishments and activities is that transitive accomplishments head atelic VPs if their direct object is a bare plural or mass noun, and telic VPs otherwise, while activities are not sensitive to this distinction. This is reflected in the contrast between the data in (8), where the head is an accomplishment, and (9) where it is an activity:

- (10) a. John pushed the cart for an hour/\*in an hour.  
 b. John pushed carts for an hour/\*in an hour.

We will assume then, that while Vendler properties are properties of verbal heads and the Vendler classification classifies verbal heads, telicity or atelicity is a property of VPs. The Vendler properties of the head will determine an unmarked [ $\pm$  telic] feature, which will show up in the intransitive singular case if it exists, and determines how other material contained in the VP will affect the telicity of the complete VP.

One account of telicity which takes the Vendler classification to apply to verbal heads, and analyses telicity as a property of VPs is that of Krifka 1989, 1992, 1998. Following the general intuition that telic predicates are predicates which have a specified end-point, he argues that telic predicates are quantized, and atelic predicates are cumulative, where quantization and cumulativity are defined as in (11) and (12):

(11) A predicate X is **quantized** iff:

$$\forall x \forall y [X(x) \wedge X(y) \rightarrow [x \sqsubseteq y \rightarrow x=y]]$$

"A predicate P is quantized if, whenever x is in P, no proper part of x is also in P."

If x is in the set denoted by *an apple* then no proper part of x is also in the denotation of *an apple*, while an entity in the denotation of *apples* may well have a proper part also in the denotation of *apples*. This carries over to the verbal predicates too. If e is an event in the set denoted by *eat an apple*, and e' is a proper part of e, then e' cannot also be an event of eating an apple. However, if e is in the set denoted by *eat apples* then there will be proper parts of e which are also in that set. So the predicate which is quantized is also telic and the predicate which is non-quantized is atelic, where the quantized/non-quantized status of the VP is determined by the quantized/non-quantized status of the direct object. Cumulativity works in exactly the same way:

(12) A predicate X is **cumulative** iff:

$$\exists e \exists e' [X(e) \wedge X(e') \wedge \neg e \sqsubseteq e' \wedge \forall e'' \forall e''' [X(e'') \wedge X(e''') \wedge R(e'', e''') \rightarrow X(e \sqcup e''')]]$$

"P is cumulative if, whenever e and e' are in X and e is not part of e', the sum of e and e' is also in P"

A predicate X is cumulative if whenever x and y are in X the sum of x and y are also in X. If x and y are in the denotation of *apples* then the sum of x and y is also in the

denotation of *apples*. If  $e$  and  $e'$  are in the set denoted by *run* or *eat apples*, then the sum of  $e$  and  $e'$  will also be in these sets. If  $e$  and  $e'$  are both in the set denoted by *eat an apple*, then the sum of these predicates cannot be in that set. So the predicate which is cumulative is atelic and the predicate which is non-cumulative is telic. Note that quantization and cumulativity are properties which applies to both nominal and verbal predicates, and that Krifka's theory makes crucial use of this.

Krifka argues that with accomplishment verbs, the direct object determines the telicity of the VP; when the direct object (or theme) is quantized, then the VP is quantized, and when it is not quantized, then the VP is not quantized. This is because of the properties of the thematic relation between an accomplishment and its theme, which Krifka calls “gradual”, which means that the event denoted by the V applies to the theme argument in a part-by-part way. Quantized direct objects lead to telic VPs since the event can be said to be over when the whole of the object (or sum of objects) specified by the nominal can be said to be 'used up' by the verb, and thus the endpoint of the event has been reached. If an apple is 'used up' gradually in an event of eating an apple, then the event cannot be over until the apple has been eaten, and it must be over when the apple has been eaten. In an event of *eating apples* there is no given endpoint. Since *apples* is cumulative there is no limit to the sum of entities which can be the theme of the event, and the event can be extended in an unlimited way. Formally, there is homomorphism from the extent of the theme to the extent of the running time of the event which allows the endpoint of the event to be calculated just in case the theme argument is quantized. Details of this are given in the papers by Krifka cited above.

Krifka's account relies crucially on the fact that only accomplishments assign gradual thematic roles. Assigning such a thematic relation is the crucial property which distinguishes accomplishments such as *write* from activities such as *push* and *run*. So Krifka succeeds in giving a characterisation of telicity as a property of VPs which allows for a Vendler classification of verbs and which shows why accomplishments and activities contribute to the telicity of VPs in different ways.

However, a closer look shows that the characterisation of telicity in terms of quantization does not work. None of the direct objects in (13), nor the VPs they are part of are quantized, but the VPs are telic by the tests discussed above:

- (13) a. John wrote a sequence of numbers in a minute.  
b. Mary ate at least three apples in five minutes.  
c. Mary ate at most three apples in five minutes.  
d. Mary ate a few apples/a lot of apples in five minutes.

Similarly, the progressive forms of these verbs do not entail the simple past. Zucchi and White (2001) make several suggestions for how to save the account of telicity in terms of quantization (see Rothstein 2004 for detailed criticism of their account), but such an approach misses the basic generalisation: a VP headed by an accomplishment is telic when the direct object (or theme) expresses some expression of quantity, and is atelic when the direct object is a mass noun or bare plural. Thus the examples in (14) contrast with the telic predicates in (13):

- (14) a. Mary ate apples for five minutes/\*in five minutes.  
b. Mary ate fruit for five minutes/\*in five minutes.

An account of what telicity is needs then to explain: (i) why the expression of measure in the theme argument of accomplishments leads to a telic VP, (ii) why modifying activities with directional or measure phrases as in (7) leads to a telic VP and, (iii) why semelfactives are telic when activities are not. We have already seen that the difference between semelfactives and activities lies in the fact that the former denotes sets of natural atoms while the latter do not, and thus it is plausible that this distinction will be relevant. So before discussing telicity any further, we will discuss the issue of atoms.

#### 4. Atoms

In Link's seminal paper of 1983, he argued that the relationship between different kinds of noun denotations could be modelled using Boolean semi-lattices. A singular count noun denotes a set of singular elements. These constitute the atoms of Boolean algebra. A plural count noun denotes the Boolean semi-lattice formed by the closure of the set of atoms under meet and join. Mass nouns denote atomless Boolean algebra, and mass and count nouns thus have denotations in different domains. This approach seems to explain adequately why count nouns are indeed countable: their denotation makes salient a set of atoms which can be counted, while a mass noun does not do so. Focusing on predicates such as *boy* or *dog*, vs. *mud* or *water*, this approach seems satisfactory. The atoms of a predicate *boy* or *dog* are straightforwardly identified as the singular individuals in the denotations of these predicates. The atoms of a Boolean algebra are the minimal elements in the algebra, those which have no proper parts other than the zero element. Since proper parts of boys and dogs are not themselves boys or dogs, it makes sense to think of the denotation of *boy* and similar nouns as denoting a set of Boolean atoms. Since parts of mud also count as mud, it makes sense to see the predicate *mud* as denoting an atomless Boolean algebra. However, as I argue in Rothstein 2007b, closer examination of the data makes it clear that this approach is inadequate to explain the grammar of counting.

First, as I argued in Rothstein 1999, 2004, not all entities which can be directly counted, are inherently individuable objects. Krifka 1992 points out that there are count nouns like *sequence* and *twig* which are not quantized, and thus in some sense not minimal elements in the denotation of the nominal predicate. Mittwoch 1988 makes the same point for nouns such as *line* and *plane*, and Rothstein 1999, 2004 show that the phenomenon is much more general and includes whole classes of count nouns such as *fence*, *wall* and *hedge*, *bouquet*, *bunch* and *piece*, which do not come in inherently individuable units, and where what counts as one N may be context dependent. For example, if I and my neighbour build adjoining walls in front of our houses, we may announce either "Together we built a wall in front of both our houses" or " We each built a wall in front of our houses" (depending on whether there is a price which has to be paid to the city council for a permit to build a wall, or whether the council gives out tax deductions to people who build such a wall). Similarly, if I have a bunch of flowers and I divide it into two and give a part of each to my daughter and her best friend, then either each has a bunch of flowers or each has half a bunch of flowers, depending on which way you look at it. Even nouns such as *table* have context dependent countable elements in their denotation: a restaurateur with twelve small tables may put them together to make three big tables or four big tables, or one big table and eight small ones and so on. Link's account of the count

domain relies on the intuition that the atomic elements in the count domain are in some sense inherently given, and that it is these elements which are countable. The examples given above show that this is not the case.

The second point follows from experimental work reported in Barner and Snedeker 2005. They examined quantity judgements, in the form of responses to "Who has more X?" They showed that normally, when X is a mass term such as *mud* or *water*, quantity judgements are made computing the overall volume of stuff. So one big heap of mud is considered to be 'more' than three small heaps. However, when they presented people with a picture of one large piece of furniture compared to three small pieces of furniture and asked "Who has more furniture", judgements were consistently that the three smaller pieces constitute 'more furniture' even if the overall space taken up by the one big piece is greater. In other words, when a mass term like *furniture* has salient inherent individuals in its denotation, people make quantity comparisons between two quantities by comparing the number of individuals in each quantity rather than their overall mass. Barner and Snedeker further show that when a noun is flexible such as *stone*, responses are driven by the syntax: When presented with a picture of one large stone and three small stones, and asked "Who has more stone?" subjects invariably choose the large stone, but when asked in the same context "Who has more stones", they choose the case with three small stones. Barner and Snedeker conclude that mass nouns such as *furniture* and *cutlery* have individual entities in their denotation and that these individuals are salient for making quantity judgments, even though they cannot be directly counted in language. This means that there are mass nouns whose denotation makes available a set of indivisible entities, although these entities are not grammatically countable.

The conclusion is that countable elements are not necessarily inherently given by the world, (although some are). Assume, following the discussion of semelfactives above, that entities whose unit structure is inherently given are, in some sense 'naturally atomic'. Suppose that the (weakest possible) definition of 'count noun' is that the entities in the denotation of a count noun are **grammatically countable**, then the discussion here shows that natural atomicity is neither a necessary nor sufficient condition of being the denotation of a count noun and thus grammatically countable. Of course, it has often been remarked that what I am calling natural atomicity is not a sufficient condition for being in the denotation of a count noun. But what is new here is the argument that it is not a necessary condition either. What we count are **atomic constructs**, which in some cases, such as *boy*, correlate with natural real-world inherent individuals, and in other cases, such as *fence*, *sequence* and so on, do not.

In Rothstein 2007b, I adopt Chierchia's 1998 proposal that mass nouns, like count nouns, have their denotations in the atomic domain. Chierchia suggests that mass nouns are lexical plurals, that is, despite their singular morphology, they denote a set of minimal elements closed under the sum operation. The set of minimal elements in *furniture* is usually the set of single pieces of furniture, and the denotation of the mass noun *furniture* is the set of pieces of furniture closed under sum. *Furniture* and *pieces of furniture* have the same denotation. *Mud* also denotes the set of minimal elements of mud closed under sum: the only difference between the two is that in the case of *furniture* the minimal elements are perceptually salient and in the case of *mud* they are not. I propose in that paper that all root nouns are lexical plurals, and that mass nouns just are root nouns. Singular count nouns are derived from root nouns by an operation which picks out a set of M-ATOMS (or measured atoms), which are elements in the denotation of the root noun which count as 1 by some explicit criterion of measurement.<sup>3</sup> When the root noun is naturally atomic, then the M-ATOM operation

will pick out the set of minimal elements in the denotation of the root noun. The M-ATOM operation applied to  $BOY_{ROOT}$  will give the set of individual boys as the denotation of  $BOY_{COUNT}$ . In other words, the M-ATOM operation uses our context-independent knowledge of what counts as one unit of boy to determine the denotation of  $BOY_{COUNT}$ .

When the root noun is not naturally atomic, as is the case with *fence*, the M-ATOM operation picks out a set of non-overlapping elements which count as one N by a context dependent measure of what counts as one. This set does not necessarily correlate with the set of minimal elements or atoms in the denotation of the root noun. The plural of the noun will denote the closure of that particular set closed under sum. Thus two adjacent stretches of fencing may count as one fence or two depending, for example, on whether the unit measure is spatial continuity ('one fence' is one continuous piece of fencing) or ownership ('one fence' is defined by the person who owns it and is responsible for its upkeep).

Formally, we make use of the measure function, MEAS which is a function from (singular and plural) individuals into ordered pairs of where the first element is a natural number and the second element is a unit of measurement U. We assume that MEAS is additive, that is if  $MEAS(x) = \langle n, U \rangle$  and  $MEAS(y) = \langle m, U \rangle$  then  $MEAS(x \sqcup y) = \langle m+n, U \rangle$  (Krifka 1998).

Using this we define M-ATOM. M-ATOM is a function of type  $\langle \langle e, t \rangle \langle e, t \rangle \rangle$  from sets into sets which maps a set onto a subset of entities which count as one by a specified criterion. We assume that the output of the function is constrained to be a set of elements which are non-overlapping. For more details of how this operation works see Rothstein 2007b.

$$(15) \text{ M-ATOM}(N) = \lambda x. N(x) \wedge MEAS(x) = \langle 1, U \rangle \\ \text{if } MEAS(x) = MEAS(y) = \langle 1, U \rangle \text{ and } \neg x=y, \text{ then } x \sqcap y = 0.$$

The elements of  $M\text{-ATOM}(N)$  are the largest elements which count as one N-entity in the context. It follows from the no overlap condition that iff an element x is in the output of the M-ATOM operation applied to N, then no proper part of it can also be in the set. We will see below that, following Filip and Rothstein 2005, the M-ATOM operation can best be seen as a maximalisation operation, giving the set of maximal non-overlapping elements which count as 1 entity by a specified unit of measure.

The difference between mass nouns and count nouns can then be represented as follows:

$$(16) \text{ Mass noun: } \lambda x. P(x) \\ \text{Count noun: } \lambda x. P(x) \wedge MEAS(x) = \langle 1, U \rangle$$

When a noun is naturally atomic, the value of U is determined by the meaning of the predicate itself, and M-ATOM is the identity function on the set of naturally atomic individuals. When the predicate is not naturally atomic, then value of U is contextually determined.

$$(17) \text{ a. } BOY_{COUNT} \rightarrow \lambda x. BOY(x) \wedge MEAS(x) = \langle 1, BOY \rangle \\ \text{b. } FENCE_{COUNT} \rightarrow \lambda x. FENCE(x) \wedge MEAS(x) = \langle 1, U \rangle$$

## 5. Atomicity in the verbal domain

It is not new to suggest that countability is connected to the atelic/telic distinction. Bach 1986 argued that the atelic/telic contrast is just the mass/count distinction expressed in the verbal domain, and many others have adopted his position since then. I have argued against this elsewhere, (Rothstein 1999) proposing that all verbs have inherently count denotation. What I want to argue in this paper is that while all verbs have a count denotation in the sense described in section 4, there is a contrast between those verbal predicates where a value for U can be constructed on the basis of the meaning of the verbal predicate, and those where it cannot be. This contrast is the semantic basis of the telic/atelic contrast: telic predicates are those for which a value for U is lexically provided, while atelic predicates are those where such a value cannot be constructed.

I begin by reviewing briefly the arguments that verb meanings are inherently count. In Rothstein 1999, I argued that the distinction between mass and count in the domain of events is expressed in the distinction between adjectives and verbs. Adjectives (or APs) denote uninstantiated states, while Vs and VPs denotes sets of events, where events are countable instantiations of states. The evidence supporting the claim that all VPs denote countable individuals comes from a series of contrasts between bare AP small clauses and minimally contrasting VP clauses:

i. bare APs cannot be counted. Bare VPs can be directly counted. In (18a), the modifier *three times* can only modify the matrix V, while in (18b) it can modify either the matrix V or the embedded predicate *be ill*:

- (18) a. The witch made John ill three times/twice.  
 b. The witch made John be ill three times/twice.

ii. Bare AP predicates cannot be temporally located. Bare VP predicates can be temporally located. (19a) is infelicitous and can only be interpreted (if at all) as a contradiction, where as (19b) is perfectly felicitous:

- (19) a. #Last night the witch made John ill on Monday.  
 b. Last night the witch made John be ill on Monday.

iii. Bare APs cannot be distributed over, bare VPs can be.

- (20) a. #The witch made John and Mary each ill.  
 b. The witch made John and Mary each be ill.

Thus, unlike nominal expressions, **all** verbs can be directly modified by individuating modifiers, and entities in the denotations of Vs and VPs can be directly counted without the mediation of classifier expressions, can be distributed over and etc. This is in direct contrast to nominals like *furniture*, where, even if the denotation contains individuable entities, these entities are not lexically accessible. Nominal mass expressions cannot be modified or distributed over without the mediation or classifiers, and thus the ungrammatical *\*two furnitures*, *\*each furniture*, contrast with *two pieces of furniture*, *each piece of furniture*. This is despite the fact, as Barner and Snedeker show, that the individuals in the denotation of *furniture* are perceptually salient and relevant for the making of quantity judgements. Grammatical support for the claim that verbs are inherently count comes from the fact that there are apparently

no verbal classifiers, indicating that the set of individuals in the denotation of all verbal expressions must be lexically accessible.<sup>4</sup>

If verbs are inherently count expressions, then on the theory of grammatical countability developed in section 4, it follows that all verbs denote expressions of the form given in (21).

$$(21) V \rightarrow \lambda e. P(e) \wedge \text{MEAS}(e) = \langle 1, U \rangle$$

All verbal expressions can thus function structurally as count expressions without modifiers, as illustrated in the examples in (18-20). There is no structural distinction between mass and count verbs which parallels the structural distinction between mass and count nouns. All verbs denote sets of M-ATOMs.

However, operations in the verbal domain are sensitive to a different distinction, and this is the distinction as to whether or not the content of U is recoverable. In the nominal domain, there is no grammatical operation which is sensitive to the distinction between naturally atomic nominals such as *boy* and nominals which are not naturally atomic, such as *fence*. *Boy* denotes a set of M-ATOMs, which can be enumerated or individuated on the basis of non-context dependent information, namely what are boys in the domain of discourse. *Fence* is of the type to denote a set of M-ATOMs, but until a context-dependent value for U has been specified, the extension of the set cannot be given. Nonetheless, a sentence such (22) is perfectly acceptable 'out of the blue'.

(22) John built a fence today.

This is because use of *fence* apparently presupposes that a contextually dependent value for U is available, i.e. as soon as the context is specified, a denotation for *fence* can be given. We assume that the presupposition arises because (a) most concrete nouns are naturally atomic and (b) there is a good pretheoretic notion of what an individual is.

In contrast to the nominal domain, operations in the verbal domain are sensitive to whether the value for U is explicitly specified. There is no presupposition that this U can be supplied contextually, presumably because there is no good pretheoretic notion of what counts as one event. This derived from the fact, discussed in Parsons 1990 and Landman 2000, that events can only be individuated under descriptions. As we will see, if a grammatical operation requires a value to be specified for U, then the absence of such a value makes the sentence infelicitous. The distinction between verbal predicates for which U is grammatically specified and those where it is not is precisely the distinction between telic and atelic predicates. Thus a typical telic predicate such as *John ate an apple*, provides information as to what counts as one eating event, namely an event of eating one apple, and so (23a) is felicitous. In contrast, in *John slept*, we are not given the information about what counts as one sleeping event. Modifiers such as *in a time* are precisely sensitive as to whether criteria for what counts as one event are specified, thus, (23b) is infelicitous (except on a derived inchoative reading):

- (23) a. John ate an apple in 10 minutes.  
b. John slept in an hour.

**I propose treating telic predicates as sets of M-ATOMs which have a fully specified value for U, and thus denote sets of single events which count as 1 entity by the measure value specified.** Filip and Rothstein 2005 proposed that telicity involved a maximalisation operation  $MAX_E$  which applies to a set of events  $\Sigma$  such that  $MAX_E(\Sigma) \subseteq \Sigma$ , and yields the set of events which are maximal according to an ordering criterion. These two approaches to telicity come together in the following way. As I suggested above, the M-ATOM operation in the nominal domain, is a maximalisation operation which applies to an inherently plural set (a set closed under sum) and picks out a set of maximal non-overlapping entities which count as 1 by the criterion specified. In the verbal domain, M-ATOM is split into a formal semantically underspecified structure, and a **distinct** maximalisation level which applies at the VP level and gives a set of maximal non-overlapping entities in V iff and only if it can recover compositionally a value for U.

Formally we assume that verbal predicates automatically undergo the M-ATOM operation and are born with the structure in (21), repeated here. :

$$(21) V \rightarrow \lambda e. P(e) \wedge MEAS(e) = \langle 1, U \rangle$$

These expressions are semantically underspecified since U is not given, and there is no presupposition that it can be accommodated from context.

We assume a maximalisation operation TELIC which applies to VP expressions, and which yields the maximal set of entities in VP which count as 1 by U, if and only if it can recover a value for U. If a value for U is supplied then the operation marks the predicate as such, while if the U value cannot be supplied, then the TELIC operation is the identity operation.

$$(24) \text{TELIC}(VP) = \left. \begin{array}{l} \lambda x. P(e) \wedge MEAS(e) = \langle 1, U \rangle \wedge MAX_U(e) \text{ if } U \text{ is specified} \\ \lambda x. P(e) \wedge MEAS(e) = \langle 1, U \rangle \text{ otherwise} \end{array} \right\}$$

While a verbal predicate is always of the type denoting a set of M-ATOMS, since it includes the conjunct  $MEAS(e) = \langle 1, U \rangle$ , there are operations which can only apply to the predicate if the predicate is marked as denoting sets of maximal events. The most obvious operation which is sensitive to this is modification by *in  $\alpha$  time*. Predicates of the form *in  $\alpha$  time* are modifiers from denotations of telic predicates, i.e. sets of events whose unit measure is specified, to sets of telic predicates whose events have a maximal running time. These modifiers are thus constrained to apply only to predicates which are marked as maximal. We will see how this works below.

An important fact about the TELIC operation is that it applies in English at the VP level. Therefore the whole content of the VP is used to recover a value for U. We thus get the contrast in (25): while *run* is not telic and therefore *in half an hour* cannot modify it, the predicate *ran to the store* is telic since the combination of a verb and a modifier does allow a value for U to be recovered. What counts as one running event is an event of running to the store, and the denotation of *run to the store* is the set of maximal unit events of running to the store.

- (25) a. #John ran in half an hour.  
 b. John ran to the store in half an hour.

If the VP does not contain lexical material from which U can be recovered but the context is rich enough to do so, then TELIC can apply. Thus the sentence in (26) is felicitous:

- (26) John runs around the park every morning, and he always times himself.  
This morning he ran in half an hour.

That telicity is derived compositionality is a crucial property of English. In English there are only two kinds of naturally atomic verbal predicates, semelfactives and achievements like *arrive*. Thus these are the only two kinds of verbs for which a value for U can be calculated on the basis of the lexical content of the verbal head alone. In all other cases, telicity is compositionally derived. In the next section, we examine the Vendler classes one by one and show how each allows the units in P to be determined in a different way.

## 6. Vendler classes, atomicity and telicity

If telicity is compositional in this way, then the obvious question is how units of measurement for measuring atoms of V are constructed or recovered from lexical and contextual information. In this section, I show that the way in which the measurement unit can be constructed is determined by the lexical properties of the verbal head. The Vendler class of the head will determine how the measurement unit is constructed, since the method of measuring single events will depend on the properties of the event type.

An important fact about the construction of the unit of measurement is that lexical information provided by the verb cannot be ignored. Thus the lexical properties of the head constrain how the content of U is constructed. If a verb is naturally atomic, then the unit measurement U will be determined by the content of the verb. This is the case for semelfactives and achievements. If the verb is an accomplishment, then the U will be calculated on the basis of the interaction of V and theme (where this is possible). If a verb is an activity then U will be calculated on the basis of the interaction of verb meaning and modifier expressions. If, as we saw in (26), the VP contains no basis on which to recover a value for U, but the discourse context does provide a value, then this value can be used. Information about measurement cannot be ignored and the calculation of telicity is fully compositional, working from the verbal head upwards.

We will now look at each verb class in turn, showing how the Vendler properties of the head determine the process by which a U value is calculated. In this section, the discussion is restricted to events as singular predicates. We will look at plurality and telicity in the final section of the paper. We will ignore states, since they are too complicated to discuss in the scope of this paper.

(i) **Semelfactives.** We begin with semelfactives, the semantics of which were introduced above. Semelfactives are naturally atomic, since they denote sets of minimal events with defined beginning and endpoint, and thus the unit measure U is fully determined by the meaning of the verb. The lexical entry for a semelfactive such as *jump* will be (27a), and thus TELIC will maximalise relative to our knowledge of what a single event of jumping is. In general, TELIC(JUMP), on the semelfactive reading of jump, illustrated in (27b), will denote the same set of events as VP. VPs

headed by semelfactives show the properties of telic VPs, as the examples in (28), repeated from section 3, show:

- (27) a.  $\lambda e.JUMP(e) \wedge MEAS(e) = \langle 1, \lambda e.JUMP(e) \rangle$  .  
 b.  $\lambda e.JUMP(e) \wedge MEAS(e) = \langle 1, \lambda e.JUMP(e) \rangle \wedge MAX_{\lambda e.JUMP(e)}(e)$ .
- (28) a. John jumped in 15 seconds.  
 b. Mary was knocking loudly on the door when I arrived, so she turned it into a tap instead.

(ii) **Achievements.** Achievements are also naturally atomic since they are non-extended changes. They are near instantaneous changes from  $\neg\alpha$  to  $\alpha$ , and they are temporally constituted of pairs of adjacent instants  $\langle i_1, i_2 \rangle$ , where  $\neg\alpha$  holds at  $i_1$  and  $\alpha$  holds at  $i_2$ . So, an event in the denotation of *arrive* consists by definition of the last moment before the participant was ‘there’ and the first moment at which the participant was ‘there’. Clearly, a minimal achievement event has a definitive beginning and endpoint defined by the nature of the change, thus as we saw above, achievements are quantized and are not S-cumulative. As a consequence, what counts as a single achievement event is determined by the lexical meaning of the verb itself which dictates the properties of the change (i.e. the content of  $\alpha$ .) The full lexical entry of a verb such as *arrive* will be as in (29), with the unit of measurement supplied by the content of the verb itself. Again, TELIC(VP) will have a denotation identical to VP.

- (29) a.  $\lambda e.ARRIVE(e) \wedge MEAS(e) = \langle 1, \lambda e.ARRIVE(e) \rangle$   
 b.  $\lambda e.ARRIVE(e) \wedge MEAS(e) = \langle 1, \lambda e.ARRIVE(e) \rangle \wedge MAX_{\lambda e.ARRIVE(e)}(e)$

A consequence of the fact that the unit of measure is determined by the V alone is that the V is telic independent of the properties of its arguments. Thus while bare plural theme arguments lead to atelic VPs with accomplishment verbs (as we will discuss below), this is not the case with achievements. The following are all telic:

- (30) a. Guests/help arrived in a few minutes.  
 b. I noticed thieves in an instant.  
 c. Instantly, I understood many things I had never understood before.  
 d. Immediately, I noticed blood on the wall.  
 e. We began to search, and discovered intruders in the building in five minutes.  
 f. It took English tourists decades to discover the pleasures of walks in the area.

The explanation is as follows. Landman 1996 argues that singular events by definition take singular arguments. Naturally atomic events, which are singular, require a singular argument and force a collective reading on a bare plural argument. Similarly in (30c) an implicit quantity reading is imposed in the bare plural.

Atelic readings can also occur with achievements when either subject or object is a bare plural (noted in Verkuyl 1972, Dowty 1979 and others), as illustrated in (31):

- (31) a. Guests arrived for hours.  
 b. Tourists discovered that village for months during the summer.

c. John discovered unknown villages in the Alps all summer.

In these cases the verb is interpreted denoting a plurality and the bare plurals are interpreted as plural entities and not as collective entities. We will discuss why this gives an atelic reading in section 7.<sup>5</sup>

(iii) **Activities.** Activity predicates denote sets of dynamic events which hold at intervals, closed under S-summing. It follows from the definition of S-summing that these predicates cannot be naturally atomic. S-summing gives us a set of overlapping since the singular events are themselves composed of iterations of other singular events. The lexical entry for a predicate like *run* is thus (32). If TELIC applies to the expression in (32), it cannot find information about what is the criterion for being one running event, and maximalisation does not apply:

$$(32) \text{ RUN} \rightarrow \lambda e. \text{RUN}(e) \wedge \text{MEAS}(e) = \langle 1, U \rangle$$

However, since TELIC applies at the VP level, if the verbal predicate contains a measure phrase or modifier, as in (32), TELIC can apply successfully. In (32a), what counts as one running event is an event of running one mile, and in (32b) one running event is a complete event of running to the store.

- (33) a. John ran a mile.  
b. John ran to the store.

Interpretations for TELIC(*run a mile*) and TELIC (*run to the store*) are given in (34):

- (34) a. TELIC(RUN A MILE) =  
 $\lambda e. \text{RUN}(e) \wedge \text{MEAS}(\text{PATH}(e)) = 1 \text{ MILE}$   
 $\wedge \text{MEAS}(e) = \langle 1, \lambda e. \text{RUN}(e) \wedge \text{MEAS}(\text{PATH}(e)) = 1 \text{ MILE} \rangle$   
 $\wedge \text{MAX}_{\lambda e. \text{RUN}(e) \wedge \text{MEAS}(\text{PATH}(e)) = 1 \text{ MILE}}(e)$ .
- b. TELIC(RUN TO THE STORE) =  
 $\lambda e. \text{RUN}(e) \wedge \text{END}(\text{PATH}(e)) = \text{AT THE STORE}(e)$   
 $\wedge \text{MEAS}(e) = \langle 1, \lambda e. \text{RUN}(e) \wedge \text{END}(\text{PATH}(e)) = \text{AT THE STORE}(e) \rangle \wedge$   
 $\wedge \text{MAX}_{\lambda e. \text{RUN}(e) \wedge \text{END}(\text{PATH}(e)) = \text{AT THE STORE}(e)}(e)$

If context allows the construction of an explicit measure as in (26) above, TELIC can apply. But if no available measure can be constructed, then TELIC is the identity function on the lexical predicate, and operations which are sensitive to telicity cannot apply to it.

(iv) **Accomplishments.** This is the most complicated case. Accomplishments, like activities, hold for extended periods of time, but, unlike activities are not S-cumulative since they denote the coming about of changes of state. Like achievements, it is natural to assume that the structure of the change determines what counts as one event. In Rothstein 2004, I argue that accomplishments are best analysed as complex events consisting of an activity event  $e_1$  and a gradual process event  $e_2$ , or process of change which the incremental theme argument undergoes. I argued that the change of state or process of change is a contextually defined process whose trajectory (and therefore run time) defines the limits of the event. Thus *eat NP*

is associated with a contextually defined process (in part determined by the content of the theme NP) which defines what one event is; one event is defined as one instantiation of the change of state.

However, since the extent of a process is determined in part by what the process applies to, the possibility of identifying one instantiation of the change of state depends on identifying an atomic entity to which the change of state occurs. Thus we have the contrasts in (35). Where the direct object is atomic, it allows a measure for a single event to be determined (a single event is an event of a complete process of eating applying to one sandwich), and where the direct object is not atomic, as in (35b) it does not allow us to determine a measure for what counts as an atomic event.

- (35) a. John ate a sandwich in an hour.  
b. #John ate bread in an hour.

## 7. Atomicity, telic modifiers, and plurality

The discussion in the previous section has concerned only singular events. We have seen that some events, namely achievements and semelfactives are naturally atomic. The maximalisation operation can recover a value for U from the meaning of the predicate and thus the operation can apply to the predicate. Activities are not naturally atomic, so maximalisation does not apply, and accomplishments allow a value for U to be recovered only when they apply to countable arguments, in which case maximalisation can apply. Modifiers which modify only telic VPs are sensitive to whether maximalisation has applied.

This account of telicity, as long as it is restricted to singular events, is not very different from Krifka's account. Krifka argues that telicity of the VP follows from the quantization property, while I have argued that it follows from the atomicity of the predicate. Since atoms are by definition quantized (relative to a specific value for U), the same non-plural VPs are predicted to be telic by both accounts. The difference between the two accounts shows up when we turn our attention to the two most vexed questions about telicity. The first is why bare plural direct objects make accomplishment headed VPs atelic, as indicated in (36):

- (36) a. #John ate apples in five minutes.  
b. John ate three apples in five minutes.

The second is why bare plural objects or subjects allow achievement headed VPs to have an atelic reading, as illustrated in the examples in (31) above, repeated here:

- (31) a. Guests arrived for hours.  
b. Tourists discovered that village for months during the summer.  
c. John discovered unknown villages in the Alps all summer.

These questions force us to face the issue of plurality and telicity explicitly. We will begin with the problem in (36).

Krifka's account of the atelicity of *eat apples* illustrated in (36) is that the VP predicate is not quantized, since the direct object *apples* is not quantized, and thus the predicate is atelic. However, this cannot be an adequate explanation, since a large number of technically non-quantized predicates are also telic, as illustrated in (37):

- (37) a. I ate at least three apples in five minutes.  
 b. I ate at most three apples in five minutes.  
 c. #I ate apples in five minutes.

(37a/b) are telic VPs since they are felicitous with *in five minutes*, and only (37c) is infelicitous. But, neither *eat at least three apples* nor *eat at most three apples* is quantized. An event *e* of eating at least three apples can have a proper part *e'* which is also an event of eating at least three apples (and if *x* is in *at least three apples*, then *x* can also have a proper part in the denotation of the same predicate). An event of eating at most three apples can have a proper part which is in the same set and so on. As mentioned above, Zucchi and White 2001 make several suggestions for how to save the account of telicity in terms of quantization, and I have argued elsewhere (Rothstein 2004) that the solutions do not work for technical reasons. I shan't rehearse these arguments here, but instead concentrate on one point. An attempt to explain the contrast in (37) in terms of quantization misses this central generalisation: **any** expression of quantity in the direct object of an accomplishment verb, no matter how imprecise, is sufficient to make a VP telic. The examples in (38) are also telic:

- (38) a. John ate a lot of apples in five minutes.  
 b. Mary crossed an infinite number of points in 10 seconds.  
 c. John answered an unspecified but large number of telephone calls in three hours this morning.  
 d. The doctor examined an enormous number of patients in three hours this morning.  
 e. It took John a long time to drink a virtually unnoticeable quantity of beer.

None of these examples can be felicitously modified by *for  $\alpha$  time*. Only bare plurals and mass terms make these VPs atelic. It seems that any expression of quantity, rather than a precise expression of quantity itself, is sufficient for a predicate to count as telic. This makes it implausible that a VP is telic if and only if there is a homomorphism from the extent of the theme to the extent of the running time of the event, since there are many cases where telic VPs have themes whose number or extent is not fully specified. This suggests that quantization is not the basis of telicity.

We therefore turn our attention to another property of sets of M-ATOMS, singularity. M-ATOMS are singular, by definition. If telic modifiers apply only to sets of M-ATOMS, they are applying only to sets of singular events.

This makes a strong prediction. Whenever telic modifiers occur, the predicate modified must be singular. So, in (36b) *John ate three apples in five minutes*, the predicate *ate three apples* must be interpreted as denoting a set of M-ATOMS, i.e. a set of singular events which count as 1 according to a specified unit of measurement. On the assumption (which we discuss below) that singular events are relations between singular individuals, the direct object *three apples* must be interpreted as a singular collection of apples which is the theme of the singular event. If we think about what modification by a telic modifier means, this is very plausible. Telic expressions such as *V in  $\alpha$  time* or *x took  $\alpha$  time to VP* indicate the single temporal location of the endpoint of the event.<sup>6</sup> They presuppose a single event with a single endpoint which can be located. In (39), the predicate is naturally interpreted as denoting a set of singular events with collections of three houses as the theme and asserting that the three-house-building event ended within a month:

(39) John built three houses in a month.

The measure adverbial measures the length of the single event which has three houses as its theme. Note that if we add a counting adverbial as in *John built three houses in a month twice*, this asserts that in two periods of less than an month, an event of building three houses took place. In order to interpret (39) as an assertion that there were three events of building a house, each of which took less than a month, we have to add a distributive operator as in (40), which allows the adverbial to modify the atomic events of building one house;

(40) John built three houses in a month each.

If telic VPs are atomic VPs, then the questions we formulated above can be reformulated as follows: (i) why is it that *three apples* in (36b) can be treated as a singular theme of a singular verb and that the VP is thus telic, while *apples* in (36a) cannot be treated in this way?

(36) a. #I ate apples in five minutes.  
b. I ate the/three apples in five minutes.

(ii) why are bare plural objects interpretable as singular arguments in examples like (30a), where the predicate is telic, but as plural arguments in (31a), where the VP is presumable atelic:

(30) a. Guests/help arrived in a few minutes.  
(31) a. Guests arrived for hours.

In order to answer this, we need an explicit theory of plurality. We will adopt the theory of Landman 1996, which we have already made informal use of above.

Landman 1996 treats verbs as ambiguous between a singular reading where they denote a set of minimal events, and a plural reading where they denote the set of minimal events closed under sum, and argues that distributivity should be analysed as semantic plurality. The crucial assumption that he makes concerns thematic roles. He distinguishes two kinds of structural 'thematic' roles: singular roles, which are genuinely thematic, and plural roles which are only indirectly thematic. Singular thematic roles are assigned by a singular verb to a DP and determine that the denotation of the DP is thematically related to the singular event denoted by the verb. Plural roles are assigned to plural DPs by plural verbs denoting pluralities of events, but these plural roles do not determine that the denotation of the DP is thematically related to the event. This is because a genuine thematic relation between an individual *d* and an event *e* reflects the fact that *d* is a participant in *e*. Singular events have individual participants to which they are thematically related, but only the atomic parts of a sum of events have participants and not the sum itself. Similarly, while plural DPs denote plural entities which are sums of individuals, the plural entities are not direct participants **as plural individuals** in any event in the denotation of the verb. The arguments of a sum of events are related thematically to that plurality only indirectly, since there is a direct thematic relation only between the atomic parts of the sum of events and the atomic part of the sum of individuals. The thematic

relation distributes down to the minimal parts of the plural elements. This is illustrated in (41-42):

(41) a. John visited Mary.

b.  $\exists e[\text{VISIT}(e) \wedge \text{Ag}(e) = \text{JOHN} \wedge \text{Th}(e) = \text{MARY}]$

(42) a. John and Mary visited Bill and Jane.

b.  $\exists e[*\text{VISIT}(e) \wedge *\text{Ag}(e) = \text{JOHN} \sqcup \text{MARY} \wedge *\text{Th}(e) = \text{BILL} \sqcup \text{JANE}]$

In (41), John and Mary are the thematic participants in the visiting event which is said to have taken place. (42) however, asserts that a plurality of visiting events took place with a plural agent and a plural theme. The thematic relations hold between the atomic parts of the sums denoted by the subject and object respectively and the atomic parts of the plural event denoted by the verb. So (43) holds:

(43) If  $e$  is in the denotation of plural  $V$  and  $x$  is the value of a plural thematic role  $R$ , then each minimal part of  $x$  stands in the  $R$  relation to some minimal part of  $e$  and each part of  $e$  stands in the  $R$  relation to some minimal part of  $x$ .

The minimal parts of  $e$  and  $x$  are the atomic elements of which the plural is a sum. Note that (43) leaves open exactly which atomic part of the subject visited exactly which atomic part of the object, and this is exactly as it should be.

Having made this distinction between singular and plural roles, Landman argues that collective readings are singular readings. On its collective reading, (41) asserts that a single visiting event took place, with a singular collective formed out of the sum of John and Mary as thematic agent and the singular collective formed out of the sum of Bill and Jane as theme. He postulates an operation which allows a sum denoting a noun phrase such as *the boys* to shift its interpretation from a plural interpretation  $\sigma(*\text{BOY})$ , the sum of all individual boys, to group interpretation  $\uparrow \sigma(*\text{BOY})$ , the boys as a group. The group forming operation  $\uparrow$  maps sums onto groups, which are atomic individuals in their own right.<sup>7</sup> This is essentially an updated version of the group formation operation proposed in Landman 1989. The collective reading of (41) is given in (44):

(44)  $\exists e[\text{VISIT}(e) \wedge \text{Ag}(e) = \uparrow(\text{JOHN} \sqcup \text{MARY}) \wedge \text{Th}(e) = \uparrow(\text{BILL} \sqcup \text{JANE})]$

The singular individual formed from the sum of John and Mary was the agent of a (singular) visiting event which has as its theme the singular individual formed from the sum of Bill and Jane. Landman 1996 shows that when collectivisation or group formation has taken place, the new group individual shows the same kind of thematic properties as any singular individual.

Now let us see how this is relevant for us.

I have argued that a telic predicate is M-ATOMic. It is thus necessarily singular, and must thus have a singular thematic argument. The sentence in (36b) *John ate three apples* is ambiguous between a reading where *three apples* is plural, and so forces a plural reading on the VP, and one in which *three apples* has is a collective and allows a singular reading of the VP. On the singular reading, the VP denotes a set of M-ATOMs, on the plural reading, it denotes this set closed under sum.

*In  $\alpha$  time* applies only to telic predicates, i.e. only to sets of M-ATOMS marked as maximal. The most natural reading of *John ate three apples in five minutes* is the one

in which the temporal modifier modifies the VP directly. This means that the VP must be M-ATOMIC, and the DP must be interpreted as a collective: "There was a three-apple-eating event with John as agent which took less than five minutes."

There is a second reading in which the modifier *in five minutes* distributes over a plural VP predicate and modifies its atomic parts, i.e. the M-ATOMIC events of which the plural sums are constructed. On this reading, the sentence asserts that there were three events of eating an apple and no single event took longer than five minutes. This reading is less natural and must usually be indicated explicitly by the use of the distributive modifier *each*.

(45) John ate three apples in five minutes each.

We interpret *in  $\alpha$  time* as in (46), and give the interpretations for (36b) in (47):

(46) *in five minutes*  $\rightarrow \lambda P \lambda e. P(e) \wedge \tau(e) \subseteq \text{FIVE MINUTES}$   
Condition: P is maximal

(47) a. **collective reading:** John ate three apples in five minutes  
 $\exists x \exists e [EAT(e) \wedge Ag(e) = JOHN \wedge Th(e) = x \wedge x = \uparrow y : y \varepsilon *APPLES \wedge |y| \geq 3 \wedge$   
 $MEAS(e) = \langle 1, \lambda x \lambda e. EAT(e) \wedge Th(e) = x \wedge x = \uparrow y : y \varepsilon *APPLES \wedge |y| \geq 3 \rangle$   
 $\wedge MAX(e) \wedge \tau(e) \subseteq \text{FIVE MINUTES}]$

b. **distributive reading:** John ate three apples in five minutes (each).  
 $\exists x \exists e [*EAT(e) \wedge *Ag(e) = JOHN \wedge *Th(e) = x : x \varepsilon *APPLES \wedge |x| \geq 3$   
 $\wedge \forall e' : EAT(e') \wedge e' \sqsubseteq e : \exists y : y \sqsubseteq x \wedge y \varepsilon APPLE \wedge MEAS(e') =$   
 $\langle 1, \lambda x \lambda e. EAT(e) \wedge Th(e) = x \wedge x \varepsilon APPLE \rangle \wedge MAX(e') \wedge$   
 $\tau(e') \subseteq \text{FIVE MINUTES}]$

Now we come back to the infelicity of (36a): what is wrong with *John ate apples in five minutes*? Note, first of all that on the distributive reading, (36a) with the bare plural direct object is not infelicitous. There is an acceptable reading where the temporal modifier modifies the atomic events of eating a single apple. This becomes clearer if we look at the examples in (48) where the distributive reading of the bare plural direct object is more prominent for pragmatic reasons:

(48) a. John can eat apples in 10 seconds.  
b. John built houses in three weeks for years before new regulations about government inspections slowed the whole process down.

In (48a), the predicate *in 10 seconds* distributes over the atomic parts of the VP to give the reading which can be paraphrased as "John has the ability to eat an apple in 10 seconds". In (48b), *in three weeks* distributes over the plural VP to its atomic parts and the sentence asserts that there was a plural event of building with a plurality of houses as its theme, and that each atomic part of the plurality, i.e. each atomic building of an atomic house, took no more than three weeks. But only this distributive reading is available. It is impossible to interpret the bare plural as a collective. There is no plausible reading asserting that there was an event of building a single group of multiple houses in no more than three weeks.

The conclusion is that, since there is an acceptable distributive reading, the problem with the collective reading must be that *houses* cannot denote a collective predicate, in other words that collectivisation cannot apply.

Our theory of M-ATOMs provides a plausible explanation why this is. I argued in section 4 above that count nouns denoted sets of entities which counted as 1 by a criterion of measurement, i.e. a set of M-ATOMs. Landman's collectivisation operation applies to sums and yields atoms. We modify this and assume that it maps a sum onto an M-ATOMIC entity, an entity which counts as 1 by some criterion of measurement:

(49) collectivisation:

For all  $x \in *P$ :  $MEAS(\uparrow(x)) = \langle 1, U \rangle$ .

This means that the output of collectivisation is an entity which is singular and counts as 1 by some scale of measurement. The contrast between *build three houses in three weeks* and *#build houses in three weeks* follows from the fact that the  $\uparrow$  operation can form an M-ATOM from *three houses* but not from *houses*, although the singular parts of both nominals are equally able to count as M-ATOMs.

I suggest that the  $\uparrow$  operation can apply to *three houses* because the adjective *three* forms a measure criterion for what counts as one collective-atomic entity, namely a collective that has at least three non-accessible singular parts. Collectivisation cannot apply to *houses* because it contains no such measure criterion, and no information is given as to what counts as an atomic-collection-of-houses. Assume (following Landman 1996) an operation  $\downarrow$  which is the inverse of  $\uparrow$ , and gives you back a sum from a collective entity, so that  $\downarrow\uparrow x = x$ . We can define

(50) for any  $x \in \text{THREE } *P$ :  $MEAS(\uparrow x) = \langle 1, \lambda x. |\downarrow\uparrow x| \geq 3 \rangle$

"For any plural  $x$  in the denotation of the predicate *three N*, the application of the atomic group formation operation to  $x$  gives you the atomic entity which counts as 1, where the measure criterion is that the sum out which the collective has been formed has at least three atomic parts. "

It is easy to see that no such measure criterion is recoverable from the bare plural *houses* which denotes the set denoted by HOUSE closed under sum, since the only possible measure criterion  $|\downarrow\uparrow x| \geq 1$  would be trivial since it would let everything in. If *houses* cannot denote an M-ATOMIC set of collective entities, then the VP cannot denote a set of M-ATOMS, and it cannot be modified by *in  $\alpha$  time*. However, if there is a contextually relevant way of collectivising the denotation of a bare plural, the telic reading is available:

(51) He rushed in, gulped down sandwiches and coffee in five minutes and rushed out again.

Note that the  $\uparrow$  operation, unlike the M-ATOM operation in the count domain, requires an explicit measure criterion. One might wonder if the  $\uparrow$  operation can be reduced to the operation deriving count nouns from mass/root nouns, so that  $\uparrow$ *three churches* can be interpreted as a predicate denoting a set of M-ATOMS. But there is a crucial difference. The operation forming count nouns requires that the set of entities in the denotation of the count noun are non-overlapping. But in (52), there is a reading in which *three churches* is interpreted as a collective noun, but in which the

predicate *visit three churches in a year* distributes over the subject. In this reading, *three churches* denotes a different collective entity for each atomic part of the subject, but different entities can overlap:

(52) John and Mary (each) visited three churches in a year.

If John and Mary each visited three churches in a year, it does not follow that six churches were visited, only that six church-visits were made.

We can now be more precise about why bare plurals are acceptable in telic readings of achievements as in (30):

- (30) a. Guests/help arrived in a few minutes.  
b. I noticed thieves in an instant.

I have argued that collectivisation is a construction of an M-ATOM out of a sum or plurality, and that it takes place with plural nominal denotations when there is a criterion of measurement for what counts as one collective element. Achievements are naturally atomic and denote sets of M-ATOMs with a unit of measurement recoverable from the meaning of V itself, so maximalisation will apply. Since the set of M-ATOMs is fully specified, and since singular events must have singular entities as their participants, being a participant in, or theme of, an achievement event is itself a criterion of individuation or measurement. Thus collectivisation can apply. This contrasts with accomplishments, where the content of the argument determines the value for U and not the other way around.

Note that this predicts that all naturally atomic predicates can get telic readings with bare plural arguments and in particular that this should be possible with semelfactives. On this surface this appears not to be the case, as we see in (53):

- (53) a. Boys kicked in an hour.  
b. John kicked doors.

The reason is as follows. The meaning of semelfactives is such that they naturally have 'naturally' single entities as their arguments rather than collectives. We naturally hit or knock on one surface at a time, rather than a collective **in a single event** and thus it is harder to get the singular reading with a bare plural argument, especially since an activity reading is so easily available. In contexts in which singular semelfactives can naturally have collectives as their arguments, the VP is telic:

(54) There was a loud bang. In an instant, bells rang and children screamed

Note one other instant where bare plurals are interpreted as denoting atomic elements without being collectives. This is where they are interpreted as kind terms. We thus have the contrast in (55) pointed out to me by Fred Landman, where *hobbits* in (55a) denotes the kind, and in (55b) it has a normal bare plural interpretation.

- (55) a. Tolkien invented hobbits in half an hour.  
b. Tolkien invented hobbits for three hours this morning.

(55a) asserts that Tolkien invented the kind in half an hour (whether or not he invented any particular instantiations of the kind) whereas (55b) can only mean that Tolkien invented a plurality of individual hobbits for three hours.

## 8. Atelic modifiers

The second question we asked is why bare plural subjects can induce atelicity in achievements, while numerical plural subjects cannot. (56a/b) show that bare plural subjects of achievements, when they are given a plural, distributive interpretation, are the subjects of atelic predicates.

- (56) a. Guests arrived for an hour.  
 b. Tourists discovered this village all summer.  
 c. #Three guests arrived for hours.

We assume that these VPs are atelic since they contain the modifier *for  $\alpha$  time*. The question is twofold: first, why can the subject argument apparently induce atelicity in achievement-headed VPs, when we assume that (a)telicity is apparently calculated at the VP level. Note that in (56a) we might try and argue that it is because *arrive* is an unaccusative, and therefore the subject argument is moved from the VP. However, this cannot be the explanation, because in (56b) the subject is clearly generated in subject position. The second part of the question is why bare plural subjects can induce atelicity, where numerical subjects cannot. This second question can be asked about the direct object position in accomplishment headed VPs, as the example in (57a/b) show. Bare plural and mass direct object arguments allow modification by *for  $\alpha$  time*, while numerical arguments do not. Bare plural direct objects of achievements also allow modification by *for  $\alpha$  time*.

- (57) a. John ate apples/fruit for an hour.  
 b. # John ate three apples for an hour.  
 c. John noticed holes in the walls/dirt on the walls for days.

In both (56) and (57), this modifier is understood as directly modifying the plural predicate and **not** distributing down to the individual events making it up. (57a) means that the plural event of eating apples lasted for an hour; (56b) means that the plural event of tourists discovering the village lasted all summer. Note that, with accomplishments, **only** the direct object/theme allows this kind of modification. In contrast with (56a/b), (58) is infelicitous (except on the reading where *drink a glass of wine* is interpreted as an activity and the glass of wine lasts a long, long time.):

- (58) #Guests drank a glass of wine for hours.

In order to understand the distribution of *for an hour*, we need to begin by looking at what it means. (59) is basically Dowty's (1979) analysis translated into an event framework:

- (59)  $\lambda P. \exists e [\tau(e) = 1 \text{ HOUR} \wedge P(e) \wedge \forall i \sqsubseteq \tau(e) \exists e' [P(e') \wedge e' \sqsubseteq e \wedge \tau(e') = i]]$   
 "For an hour applies to a predicate P to yield a set of events in P whose running time was an hour, such that at all subintervals of the running times of these

events, an event in the denotation of P was going on."

(We assume a pragmatic restriction to all sufficiently large subintervals of e.) Given (59), *John ran for an hour* has the interpretation in (60): it asserts that there was an event lasting for an hour such that at every subinterval of that hour there was an event of John's running:

- (60)  $\exists e [\tau(e) = 1 \text{ HOUR} \wedge \text{RUN}(e') \wedge \text{Ag}(e') = \text{JOHN}$   
 $\wedge \forall i \sqsubseteq \tau(e) \exists e' [\text{RUN}(e') \wedge \text{Ag}(e') = \text{JOHN} \wedge e' \sqsubseteq e \wedge \tau(e') = i]]$   
"There was a running event e with John as agent which lasted for an hour and at every subinterval of e, an event of John running was going on."

*For  $\alpha$  time* applies to atelic predicates like *run*, because running events are homogeneous and thus (60) meets the condition that every part of the specified interval contains a P event. It follows from the subinterval condition that telic predicates cannot be modified by *for  $\alpha$  time*. A telic predicate is an atomic predicate, therefore an event in the denotation of P cannot have proper parts which are also in the denotation of P. Applying *for  $\alpha$  time* to an achievement such as *arrive* can only give us the empty set since events in its denotation do not have parts that are also in *arrive*. Similarly, when *run* is modified by a modifier which determines a value for U, the VP becomes telic and modification by *for  $\alpha$  time* is no longer possible as in \**John ran a mile/to the corner for half an hour*.

Since homogeneity down to the appropriate minimal intervals is naturally a property of sets of events closed under S-summing, *for  $\alpha$  time* naturally modifies activities and state predicates, and does not modify telic predicates. So why does it modify achievement headed predicates in (56a/b) and the achievement and accomplishment headed predicates in (57)? Clearly the homogeneity must be derived in some way from the bare plural argument. We will look first at the examples in (57): (For reasons of space we will discuss only bare plurals, and assume that the extension to mass nouns is straightforward.)

As argued above, bare plurals cannot be interpreted as collectives in the complements of accomplishments. They need not be interpreted as collectives in the complements of achievements. Plural arguments require plural verb meanings, and are interpreted distributively. Thus *eat apples* denotes a set of plural events with a set of plural apples as theme, such that each atomic event part of the plural event has an atomic apple as its theme. Such a plural event e can be seen as homogeneous if the individual apple-eating events which make up e are spread out homogeneously throughout the running time of e. *Eat apples for an hour* denotes the set of sums of eating-apples events that lasted for an hour such that all subintervals of the event are also intervals at which sums of apple-eating events occurred. Since  $a \sqcup a = a$ , i.e. an entity e is considered to be its own sum, and a plural set includes the atomic elements in its denotation, *John ate apples for an hour* is true if there is a plural eating-apples event which lasted an hour such that all relevant subintervals of that hour included an apple-eating event by John. Similarly *John noticed holes in the walls for days* will be true if there is a plural event which went on for days such that all relevant temporal parts of it include a hole-noticing event.

Note that this requires a slightly different interpretation of homogeneity than the one made use of in (59). (59) made *for an hour* hold of an event e in P only if all subintervals (including overlapping subintervals) of the running time of e were also intervals at which a P event was going on. This notion of homogeneity is too strong to account for homogeneity of plurals. Achievements are punctual events, thus no subinterval of a duration bigger than an instant (or two adjacent instants) will be the running time of a singular achievement. Similarly, since accomplishments are extended events there will be

many subintervals at which a singular accomplishment does not hold. Instead of (59) we need (61a), with (61b/c) showing how it is used in an interpretation:

(61) a. *for an hour*:

$\lambda P. \exists e [\tau(e) = 1 \text{ HOUR} \wedge P(e) \wedge \forall i_{CL} \sqsubseteq \tau(e): \exists e' [P(e') \wedge e' \sqsubseteq e \wedge \tau(e') \sqsubseteq i]]$   
 "The set of predicates P such that there was an event e in P which lasted an hour and all contextually large enough subintervals of the running time of e contain an event which is a part of e and which is in P."

b. *John ate apples for an hour*.

$\exists e \exists e' [\tau(e) = 1 \text{ HOUR} \wedge *EAT(e') \wedge *Th(e) = x: x \in *APPLES \wedge Ag(e) = JOHN \wedge \forall i_{CL} \sqsubseteq \tau(e) \exists e' [*EAT(e') \wedge *Th(e) = x: x \in *APPLES \wedge Ag(e) = JOHN \wedge e' \sqsubseteq e \wedge \tau(e') \sqsubseteq i]]$   
 "There was an event e of John eating apples, which lasted an hour and all contextually large enough subintervals of the running time of e contain a plural event e' which is a sum of eating events which is part of e and which has a sum of apples as its plural theme and John as its agent."

c. *Guests arrived for an hour*.

$\exists e \exists e' [\tau(e) = 1 \text{ HOUR} \wedge *ARRIVE(e') \wedge *Th(e) = x: x \in *GUESTS \wedge \forall i_{CL} \sqsubseteq \tau(e) \exists e' [*ARRIVE(e') \wedge *Th(e) = x: x \in *GUESTS \wedge e' \sqsubseteq e \wedge \tau(e') \sqsubseteq i]]$   
 "There was an event e of guests arriving which lasted an hour and all contextually large enough subintervals of the running time of e contain a plural event e' which is a sum of arriving events which is part of e and which has a sum of guests as its plural theme."

(61b) asserts that every significant part of an hour contained an event of John eating apples and (61c) asserts that every significant part of an hour contained an event of guests arriving. This gives us the correct truth conditions, since (61c), for example, is normally true in a situation in which a steady stream of guests arrived with each arrival located at points spaced fairly evenly over the hour. Crucially, only bare plurals and not numerical plurals induce homogeneity in this way. *Eat three apples* is not homogeneous. On the collective reading, it denotes an atomic event and is telic. On the distributive reading, it is neither telic (obviously) nor homogeneous, since it is not the sum of events each of which is in *eat three apples*. *Three guests arrived for an hour* is infelicitous since, whether the subject is interpreted as a singular collective DP or as a plural DP, the event type is not homogeneous. If the subject is interpreted as a collective, then the VP is telic and clearly not homogeneous. But if the DP is interpreted as plural DP denoting a sum of individuals whose cardinality is at least three, the predicate is not homogeneous either since a subpart of a plural event of three guests arriving cannot itself be an event of three guests arriving. Thus we see that not all atelic predicates are homogeneous, and that *for a time* is an appropriate modifier only for homogeneous atelic predicates.<sup>8</sup>

We are still left with the question of apparent subject object asymmetry. In principle we expect only material inside the VP to affect telicity, so why is the plural subject able to induce homogeneous atelicity with achievement verbs. And if the subject can influence (a)telicity in this way, why is it possible with achievement headed VPs, but not with accomplishments headed VPs? As noted above, in (61c), one might argue that *arrive* is an unaccusative, but with examples like (56b) *Tourists discovered this village all summer* that argument cannot be made. And there is a clear contrast between these examples and (58) above: *Guests drank a glass of wine for hours*, does not make the assertion that there was

an unspecified number of single events of drinking a glass of wine, scattered homogeneously throughout a period of some hours.<sup>9</sup>

I suggest that the basis for this contrast is the inherent atomicity (i.e. telicity) of achievement verbs. Achievement headed predicates such as *arrive*, *discover that village*, *notice three new pictures* are naturally atomic, and thus inherently telic. This means that *for  $\alpha$  time* cannot modify them as is. This mismatch triggers a shift to the plural interpretation of the predicate. If *discover this village* is shifted to a plural reading, then it is potentially homogeneous, depending on what the subject argument is, and if the subject is a bare plural, homogeneity is maintained and modification by *for an hour* is acceptable. It is the modifier which triggers the shift to the plural reading: without the modifier, the shift will not be triggered, and out of the blue *Tourists discovered this village* will have a singular, telic interpretation.

With accomplishments the modifier does not trigger shift to a plural interpretation. This seems to be because there is another potential solution to the mismatch, namely to shift the accomplishment predicate to an activity reading.<sup>10</sup> Thus, as we saw *for an hour* triggers a shift to the homogeneous activity reading of *drink a glass of wine*. To the degree to which a particular accomplishment allows an activity interpretation, the output is felicitous. Thus (58) is very marginal on the activity reading, but (62) is much better:

(62) People read *The Women's room* for years, before it went out of fashion..

Our analysis predicts that other inherently telic predicates, specifically semelfactives, should also be modifiable by *for  $\alpha$  time* when the subject is a bare plural. This seems to be the case. (63a) has a plausible semelfactive reading in which lots of bells chimed a single time at fairly evenly and closely spaced points in time over an hour, while (63b) only has the activity reading where the three bells chimed continuously for an hour:

- (63) a. Bells chimed for an hour.  
b. Three bells chimed for an hour.

There is much more to say about *for  $\alpha$  time* and its meaning. It is clear that (61a) does not capture all that needs to be said about its meaning, since it predicts that downward entailing predicates such as *eat at most three apples* also ought to be acceptable with *for an hour*, and they clearly are not, since *John ate at most three apples for an hour* is not felicitous. However, an in-depth discussion of the semantics of this adverbial deserves a paper to itself, and I will not discuss these issues here.

## 9. Conclusion

I have made several claims in this paper. The first is that all verbal predicates are formally countable, and that telic predicates are a proper subset of countable predicates. They denote sets of M-ATOMs which count as one entity by a criterion of measurement U recoverable from the content of the predicate or from a rich discourse context. To these predicates maximalisation applies. Secondly, I have shown that the semantics of verbal heads, i.e. what kind of event they denote, determines how values for U may be specified. The semantic property which is relevant for determining how these values may be specified is what Vendler class the verb belongs to. Put differently, Vendler classes at the verbal level constrain event types and, as a consequence, they determine possible measures for what counts as one event for each type. Telicity

is a precondition for certain semantic operations, in particular modification by the family of temporal adverbials represented by *in  $\alpha$  time*. Telicity is crucially a property of VPs.

Finally, I argued that *in  $\alpha$  time* and *for  $\alpha$  time* do not modify complementary sets, although they do modify non-overlapping sets. *In  $\alpha$  time* modifies telic predicates, while *for  $\alpha$  time* modifies a subset of atelic predicates, those which are both atelic and homogeneous. There are thus three classes of VPs: (i) telic VPs modifiable by *in  $\alpha$  time*; (ii) atelic homogeneous VPs which can be modified by *for  $\alpha$  time*; (iii) atelic non-homogeneous VPs which can be modified by neither, such as *build three houses* on the plural, distributive reading.

The general moral that I want to draw from this is the relevance of the theory of counting and plurality for the semantics of VPs, for the semantics of temporal modification and measurement of events. This paper has tried to show that there is a close connection between telicity/atelicity and the semantics of plurality, and suggests that investigating this connection further would be fruitful.

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## Notes

<sup>1</sup> In fact, I argue that natural atomicity is a gradable property, rather than a feature which has a positive or negative value. For details see Rothstein 2007b

<sup>2</sup> (Note that Rothstein 2007a argues that the one exception is degree achievements such as *cool*. Here extended changes of degree can be seen as S-summissions of minimal changes since these are changes in values on a scale of degrees and not changes from  $\alpha$  to  $-\alpha$ , and thus the R condition in (1) can be met.)

<sup>3</sup> The idea that being an atom is having the value "1" and thus being countable, and that there is an operation in the mass domain which picks out things which count as "1", originates in Landman's 2006

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manuscript on mass nouns. The formulation of the M-ATOM operation in this paper (and in Rothstein 2007b) uses an operation to pick out atoms which applies in the **count** domain, and requires the operation picking out M-ATOMs to map entities onto a pair  $\langle 1, U \rangle$ , rather than a just a number. Previous attempts to formulate how an atom in the count domain was picked out occur in Rothstein 1999, 2001.

<sup>4</sup> In Rothstein 1999 I argue that the copula BE is essentially a classifier. It denotes a function which applies to adjectival denotations (which are mass) and gives as an output a set of countable events denoted by BE(AP).

<sup>5</sup> It should follow from this that a semelfactive also heads a telic VP independent of the properties of the arguments. Initially, it seems that this predication is not borne out, since examples like (i) seem clearly worse than (ii). We give an explanation of this in section 7.

- i. #She hit boys in an instant.
- ii. She hit a boy in an instant.

<sup>6</sup> The second test is that telic predicates induce the imperfective paradox. But the progressive anyway does not naturally apply to predicates with plural numerical themes, as we see in (i):

- i. # John was eating three apples/reading three books.

Note that there is evidence that the progressive applies to singular predicates anyway: examples like (i) improve if the event can be interpreted as a single event with a collective theme:

- ii. John was drinking his two cups of tea.
- iii. John was building three houses when he went bankrupt, and so none of them got built.

Note that adding *in half an hour*, which forces a singular reading of the VP, improves (i):

- iv. John was reading three books in half an hour. It was a school project that he had to finish.

See also the discussion in Mehlig (this volume).

<sup>7</sup> Note that group formation makes atomic groups out of already existent sums, where as S-summing sums sets of atoms and then turns that sum into an atom in one operation.

<sup>8</sup> The obvious question is why *Three guests arrived for an hour* is infelicitous, rather than being felicitous but false, (where it is false because it is not homogeneous). The answer is that since because of its structure it has no hope of being true, and this makes using the modifier inappropriate. The intuition behind this is that sentences divide situations non-trivially into those that support the assertion and those that don't. If no situation can make the sentence true because of formal properties of the assertion,, then presuppositions of non-triviality are violated and the sentence is infelicitous.

<sup>9</sup> Note that atelic accomplishments with bare plural subjects are felicitous on a habitual reading. (i) has an acceptable explicit habitual paraphrase, and it can also occur with a present tense verb:

- i. Children ate an ice-cream here on the way home from school for years.
  - ii. Children used to eat an ice-cream here on the way home from school for years.
  - iii. Children eat an ice-cream here on the way home from school for years.

Applying these tests to (58) we can see that it does not have a plausible habitual reading.

<sup>10</sup> For some discussion of the shift from accomplishment to activity readings, see Rothstein 2004 chapter 5, also Hans Robert Mehlig's paper in this book.