

INCREMENTAL HOMOGENEITY IN THE SEMANTICS OF ASPECTUAL *FOR*-PHRASES

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1. TWO PROBLEMS

This paper discusses two related questions:

(i) *What is the proper notion of homogeneity to use in the semantics of **for**-phrases?*

Received wisdom is that *for*- phrases modify homogeneous predicates, in particular states and activities as in (1):

- (1) a. *John was happy* for some weeks. (stative)
b. *Mary ran* for two hours. (activity)
c. *Bill pushed three cars* for two hours (activity)

This means that the italicized sentences in (1) are required to be homogeneously true at subintervals of an interval of the type specified by the *for*-phrase. The examples in (1) already make an appropriate definition of the notion of homogeneity non-trivial, since states are argued to be homogeneous down to instants, while activities are homogeneous down to larger intervals whose precise size is dependent on the nature of the VP-predicate (see the discussion in Dowty 1979). We will discuss in this paper a number of other cases for which even the latter notion of homogeneity isn't good enough, including cases of achievements with bare plural subjects and of iterations.

We shall argue that in all these cases, the notion of **incremental homogeneity** defined in Landman 2008 will be adequate to account for the distribution of *for*-phrases.

(ii) *Why do you get modification by **for**-phrases with accomplishment predicates which have bare plural or mass objects and with no other DP object.*

Look at (2):

- (2) a. John ate *apples* for an hour.
b. John ate *bread* for an hour.
c. #John ate *three apples* for an hour.

We shall argue that (2a/b) are acceptable because, even though the interpretation of the VP is episodic, the semantics makes reference to a **kind**, and the predicate involved is incrementally homogeneous.

2. PREVIOUS ACCOUNTS

The intuition underlying all accounts of the meaning of *for an hour* is that it means that the predicate they modify goes on at all parts of the hour. This has been formulated in various ways, both in interval semantics and in event semantics.

To start the discussion let us formulate a semantics for *for*-phrases which makes the homogeneity requirement a presupposition (as in Krifka 1998), and is as yet unspecified as to the notion of homogeneity involved.

When defined:

α for an hour is true iff $α$ holds at an interval i of length 1 hour

Defining condition:

α for an hour is only defined for interval i if $α$ is homogeneous in i .

Bennett and Partee 1972 and Dowty 1979 take **$α$ is homogeneous at i** to mean: $α$ is true at every subinterval of i (including every point in i). So *John was happy for a week* is true if there was a week during all subintervals of which John was happy. Since Bennett and Partee and Dowty take accomplishments and achievements to be non-homogeneous in this sense, this explains why *for* phrases do not modify them (as in 2c). However, this requirement is obviously too strong. While the notion applies naturally to states (and hence accounts for the felicity of (1a), activities can also be modified by *for*-phrases and, as Dowty himself argues, they are not homogeneous in this sense: if John is running at i , then he only counts as running at sufficiently large subintervals: at smaller intervals he may be taking a step or lifting his foot, but these are not big enough to host a running. This suggests that minimally we should replace the above definition by: **$α$ is homogeneous at i** if $α$ is true at every 'sufficiently' large subinterval of i .

However, Landman 1992, 2008 shows that even this modification is inadequate to deal with activities. This is because activities allow for pause stages. So if *John ran for three hours* is true, there may still be subintervals of that three hour interval at which he is not running (waiting for the lights to change at a long traffic lights, stopping to take his breath for a minute or two and so on), and these subintervals may well be 'sufficiently large' (to fit running in).

Krifka (1989 1992, 1998) approaches the problem from another direction. He assumes a semantics for *for*-phrases much similar to a 'every sufficiently large subinterval-definition': for a running event in i , a running event is required to go on at every subinterval of i that is big enough for running to have a measure value. While maintaining such a downward notion of homogeneity in the semantics of the *for*-phrase (with all its problems), Krifka argues that the class of predicates that are felicitous with *for*-phrases coincides with the predicates that satisfy an **upward** notion of homogeneity: cumulativity:

Let P be a predicate of eventualities. Then (ignoring irrelevancies here):

Predicate P is **cumulative** iff if $e, e' \in P$ then $e \sqcup e' \in P$.

(where $e \sqcup e'$ is the sum of e and e')

Krifka defines a notion of **telic** predicates and shows that the class of cumulative predicates (by and large) coincides with that of **atelic** predicates (under his definition of the latter). This is good, one would think, because the data concerning felicity under *for*-phrases has always been the main diagnostic for atelicity. And indeed, *for*-phrases apply felicitously to activities, since these are cumulative, although they are not divisive down to instants.

Krifka argues that cumulativity explains the contrast between (2a,b) and (2c). He argues that with accomplishment predicates (i.e. those with incremental theme arguments) the cumulativity/non-cumulativity of the theme percolates up to the VP.

Since *apples + apples = apples*, the theme argument in (2a) is cumulative and the predicate *eat apples* is cumulative too (the same for *eat bread* in 2b) and modification by *for*-phrases is possible. When the theme is quantized (as it is in 2c), the predicate is not cumulative: *eat 3 apples + eat 3 apples ≠ eat 3 apples* (but = *eat 6 apples*). However, Rothstein 2004 argues a large number of predicates, that are infelicitous when modified by *for*-phrases, come out as cumulative, hence atelic on Krifka's definition. While *eat (exactly) three apples* is not cumulative on Krifka's definition, *eat at least three apples*, *eat a lot of apples*, *eat many apples* and so on all come out as cumulative predicates, and yet none of them allow modification by *for* phrases, as seen in (3).

- (3) a. #John ate (at least) three apples for an hour.
 b. #John ate many apples for an hour.
 c. #John ate much bread for an hour.

White and Zucchi 2001 try to save Krifka's approach to the licensing of *for* phrases by claiming that the VPs in (3) are non-cumulative, since they assume that DPs are interpreted as maximal objects in particular discourse situations. The idea is that *eat at least three apples* denotes a set of maximal events of eating three apples and pairs of two such maximal events cannot be put together to make a single maximal event relative to the same discourse situation. Rothstein 2004 shows that this cannot work. She discusses examples like those in (4):

- (4) a. Lady A: Do you have a chauffeur nowadays?
 Lady B: My dear, I've had a *chauffeur* for twenty years. Always very competent ones.
 b. This bicycle *carried three children around Amsterdam* for twenty years.
 (Rothstein 2004)
 c. #I *caught a flea on my dog* for twenty years (c.f. Dowty 1979).

In these examples, a predicate with an indefinite object is in the scope of the *for*-phrase, and, importantly, the predicate itself is stative (4a) or an activity predicate (4b). Rothstein points out that on their natural reading, these sentences allow the objects satisfying the indefinite description to vary in the course of the twenty year interval. In this, the state/activity predicates in (4a,b) differ sharply from achievement predicates like (4c), where that interpretation is lacking, as shown by the oft remarked upon infelicity of (4c).

Thus, as Lady B. indicates in (4a), she has had a series of competent chauffeurs in the course of these twenty years, and the bicycle in (4b) is truly famous: for the first five years, it carried Jan, Ed and Ruud around Amsterdam, and then for the next five years it carried Ed, Ruud and Fred around Amsterdam, and then for another five years it carried Ruud, Fred and Truus around Amsterdam. And then (since it was an amazingly good bicycle like they don't make them any more) it was given to a neighbour and it carried her three children around Amsterdam for another five years. What Rothstein points out is that in this case, there is no maximal set of three children which make this sentence true, but a maximal set of eight children, subsets of which make it true at different times.

Coming back to the data in (1-3), it seems clear that what blocks the modification by the *for*-phrases is the presence of a determiner. Only bare plurals and mass noun themes allow *for* phrases to modify accomplishment-headed VPs. Now

bare plurals and mass nouns form a natural class of predicates, which Carlson 1977 argued are best analysed as names of kinds. Since proper names of individuals as themes of accomplishments do not result in VPs which allow modification by *for* phrases, it must be the kind term which leads to the atelicity in (2a/b). This is not merely a formal issue: it is not that the kind type as theme of an accomplishment results in an atelic VP. Rather it is the relation between the event and the theme, or **the way in which the kind participates in the event** which results in an atelic VP. This is clear from examples like (5), where the VP is atelic or telic depending on how the kind participates in the event denoted by V.

- (5) a. Tolkien invented hobbits in two hours.
 b. Tolkien invented hobbits for two hours.

(5a) asserts that Tolkien invented the kind HOBBITS within a certain period. It does not entail that he invented any particular hobbit, since he may have invented the kind by inventing a stereotype. The kind as a whole, independent of any particular instantiations, has the property of having been invented, and is directly affected, as a kind by the predicate *invented*. Since *invent* is an accomplishment, the VP is telic.

(5b) asserts that Tolkien invented instantiations of hobbits (the characters Peregrine Took, Frodo Baggins...) over a period of two hours, or that he invented sub-kinds such as Tooks and Bagginses. Here the kind HOBBIT is not directly affected, but is indirectly affected by what happens to its sub-kinds or particular instantiations.

With all this in mind, we go back to the question of what definition of homogeneity will identify those VPs which allow modification by *for*-phrases. As was noted in Rothstein 2004, the range of VPs which allows modification by *for* phrases is not confined to statives and activities. In the next section we review the range of constructions which allow this kind of durative modification.

3. PREDICATE TYPES WHICH ALLOW MODIFICATION BY ASPECTUAL FOR-PHRASES

The following VP predicates allow modification by *for* phrases:

- i. **Stative predicates:** *be happy (for a week)* as in (1a) above. The modified predicate is homogeneous down to instants.
- ii **Habituals** as in (6):

- (6) a. John took buses to school for ten years.
 b. Buses ran down this street for ten years.

We will analyse these, and other cases, as statives.

- iii. **Activities:** *run, push three carts (for an hour)* as in (1b/c) above. The predicate is homogeneous down to short intervals defined by minimal activities, as discussed in Dowty 1979, Rothstein 2004, and allows pauses (Landman 1992, 2008).

- iv. **Accomplishments with bare plural or mass direct objects:** *eat apples, eat bread (for an hour)*, as in (2a/b). These have generally be analysed as a sub-case of (iii). We shall argue that they are to be treated differently, arguing that the kind term plays a crucial role in allowing the predicates to be treated as homogeneous.

- v. **Kind readings with bare plural subjects** as in (7):

- (7) a. Dinosaurs inhabited the earth for 200 million years.
 b. Dogs barked outside my house for two hours this morning.

(7a) is a gnomic generic, which can presumably be argued to be a stative. (7b) contains a bare plural subject and an episodic predicate; our analysis will not distinguish (7b) from episodic cases with bare plural objects, like (2a.)

-vi **achievements with bare plural or mass direct objects or subjects:** (cf. Rothstein 2008)

- (8) a. English tourists discovered this village all summer.
 b. Guests/Help arrived for two hours.
 c. John noticed miserable looking people for several hours.

These are not obviously homogeneous at all: If (8b) is true, then there were a number of events of individual guests arriving spread out over a two hour period, but there will usually be long intervals during which no guests arrived. (8c) illustrates a similar problem: while *notice miserable looking people* is modified by a *for*-phrase, the sentence is true if a John has the property of being the subject of a series of disconnected events of noticing miserable people. Unlike the cases in (7a), these cases cannot be analysed as generic events, nor can they be analysed as habits. While (6a) has an appropriate explicitly habitual paraphrase, "For a period of 10 years, John under normal circumstances usually took a bus to school" there is no such plausible paraphrase involving *usually* for (8b). It means, simply, that over a period of two hours, a plurality of guests arrived gradually.

-vii. **Iterations of accomplishments.**

- (9) Susan drank half a glass of orange juice every twelve minutes for twenty five hours the Yom Kippur she was pregnant.

These cases are standardly analysed as iteration-complexes, but, of course, they raise the same question as the cases under (vi) in that they allow for long (11 minute) periods in which no drinking goes on, yet the *for*-phrase is felicitous.

4. OUR PROPOSAL

4.1. ASPECTUAL *FOR*-PHRASES IN EVENT SEMANTICS

We assume an event semantics based on a domain of eventualities, where eventualities are states or events. Eventualities have running times: the running time of eventuality e , $\tau(e)$, is the time interval at which e goes on. We interpret verbs, verb phrases, and sentences as **event types**, sets of events; the event type corresponding to a verb phrase like *eat an apple* is the set of apple eating events. With **verb phrase** *eat an apple* we also associate the event type EAT of the **verb it is based on**, we call the later the **verbal event type** corresponding to *eat an apple*. The interpretation schema for *for an hour* is given the following form in our event semantics:

Let α be a verb phrase with event type α and verbal event type V .

When defined:

α for an hour = $\lambda e. \alpha(e) \wedge \text{LENGTH}(\tau(e)) = \langle 1, \text{HOUR} \rangle$

(the set of events in α that last an hour)

Defining condition (preliminary):

α for an hour is only defined if α is homogeneous.

The crux will lie in the notion of homogeneity. We assume that the relevant notion is notion of incremental homogeneity introduced in Landman 2008. Thus the defining condition becomes:

Defining condition: α for an hour is only defined if α is **incrementally homogeneous with respect to α and V**.

Event type α is incrementally homogeneous with respect to α and V if **every event in α is incrementally homogeneous wrt. α and V**.

Thus we need to explain the notion of incremental homogeneity.

4.2. INCREMENTAL HOMOGENEITY

Incremental homogeneity, introduced in Landman 2008, is incremental preservation of cross-temporal identity of an event, and of its event type, between the running time of the onset of that event and the running time of that event itself. These notions are explained in the following subsections.

4.2.1. INCREMENTALITY

Incrementality is a temporal notion: interval j **incrementally extends** interval i if i is an **initial subinterval** of j : $i \subseteq_{\text{in}} j$ iff i is a subinterval of j that starts at the same time as j .

4.2.2. CROSS-TEMPORAL IDENTITY

As explained in Landman 2008, **cross-temporal identity** is a notion which the semantics cannot do without in a theory which assumes **both** that eventualities are **temporal particulars** (go on at one and only one running time) **and** that eventualities have aspectual substructure. The reason is that in such a theory we need to be able to express that if I am in Tokyo for a week, the state of me being in Tokyo on Tuesday and the state of me being in Tokyo on Thursday **count as the same state** as the state of me being in Tokyo that whole week (though they are three states, they don't count up to three: I've only been in Tokyo once). Similarly, if you and I dance the Emperor's waltz together, and no other dance, we waltz once: the waltzing at the beginning of the Emperor's waltz, and the waltzing towards the end do not count as separate waltzings.

This can be expressed by using an **equivalence relation of cross-temporal identity**:

e_1 is **cross-temporally identical to** e_2 , $e_1 \sim e_2$ iff e_1 and e_2 count as 'one and the same event', i.e. for counting purposes e_1 and e_2 count as **one** event.

This is not a definition: Landman 2008 treats cross-temporal identity as a primitive which is to be axiomatically constrained by the event theory (see Landman 2008 for some suggested properties).

4.2.3. EVENT ONSETS

Following Landman 2008, we introduce for event e of verbal event type V the notion **onset** of e :

Let e be an eventuality of **verb type** V .

The **onset** of e , relative to V , $O(e, V)$ is the smallest eventuality of type V such that: $O(e, V) \sim e$ and $\tau(O(e, V)) \subseteq_{in} e$.

As an example, if e is an event of waltzing, then $O(e, WALTZ)$ is the smallest initial event in $\tau(e)$ that is big enough to count **both** as waltzing **and** as cross-temporally identical to e . The onset is the first stage where the incremental sequence of events cross-temporally identical to e reaches a stage big enough to count as waltzing. (We **do** assume a full incremental sequence of cross-identical events inside the onset interval, just too small to be waltzing.) The notion of onset corresponds to Dowty 1979's notion of initial intervals minimally big enough to host an activity.

As another example, if e is an event of eating three apples, $O(e, EAT)$ is the smallest event which is big enough to count **both** as eating **and** as cross-temporally identical to e . It is, intuitively the most initial bit of the eating of those three apples. Importantly, the onset of the event of eating three apples is required to be an eating event, but not required to be itself an eating three apples event. Thus the onset of a telic event is the onset of the activity it is based on.

Technically we postulate for states (and some activities like *move*) a null-onset, at the beginning time or initial limit of that state. So we assume V -onsets for any eventuality of verb type V .

4.2.4. INCREMENTAL HOMOGENEITY

With this we define the notion of incremental homogeneity:

Let α be a VP with event type α and verbal event type V ,

Let $e \in V$ and $e \in \alpha$.

e is **incrementally homogeneous wrt.** α and V iff

for every interval i : if $\tau(O(e, V)) \subseteq_{in} i \subseteq_{in} \tau(e)$

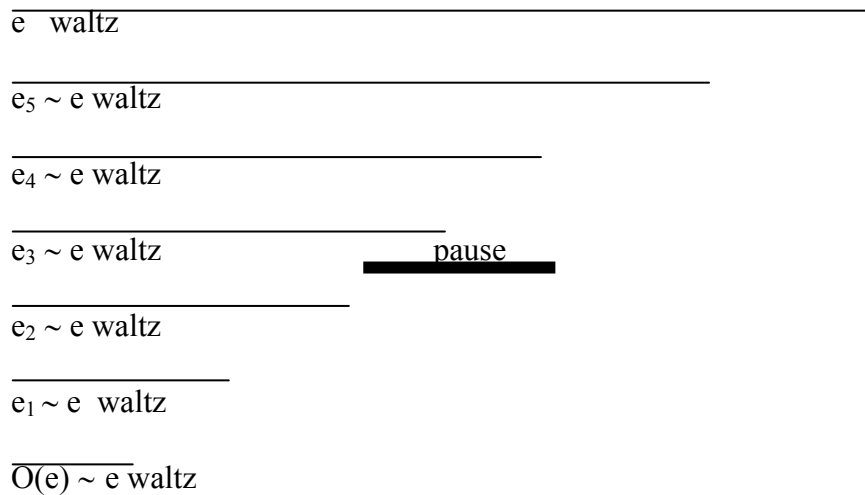
then there is an eventuality e' of event type α such that:

$e' \sim e$ and $\tau(e') = i$

We will see below that using a notion of incremental homogeneity dependent on event type and verbal event type allows us to distinguish between telic and atelic predicates. The notion of incremental homogeneity was developed in Landman 2008 (building on ideas in Landman 1992) to deal with the fact that activities (unlike states) naturally allow gaps and pauses (see Landman 2008 for discussion). The main idea of that paper was that activity events allow gaps if you look at them segmentally, **but not** if you look at them incrementally.

The lexical requirement on the verb *waltz* that the events in the verb type $WALTZ$ are incrementally homogeneous means intuitively that we impose upon the event e of us waltzing an **incremental-event-identity-and-event-type-clock**: the clock tells us that we find at each initial subinterval (bigger than the onset) a waltzing

event cross-temporally identical to e , which, so to say, represents **how far 'e' had gotten at that point**:



The notion of incremental homogeneity will allow waltzing events to have gaps and pauses (subintervals where no event cross-identical to e and of the type WALTZ goes on). In the first place, if e is incrementally homogeneous, there is no requirement that an event cross-temporally identical to e goes on at any interval properly inside the onset of e . More generally, any **very small** subinterval of $\tau(e)$ is going to be too small to be the running time of a waltzing event. Secondly, subintervals much bigger than that may not have any waltzing event in them: dancing a Vienna Waltz is physically exhausting, hence it includes regularly sections where the dancers stand still, catching their breath. Such segments are pause segments. The above picture shows that the existence of pause subintervals is quite compatible with incremental homogeneity.

What counts then for homogeneity is the incremental preservation of event identity and event type, i.e. along growing initial subintervals.
 -we allow for onsets in activities because we carry, incrementally, the event identity across them (i.e. inside the onset we do find incrementally events cross-temporally identical to the main event, but not yet of the verb type V .)
 -we allow for pauses in activities because we carry, incrementally, the event identity across them.

In both cases **contextual naturalness** plays a central role: if we stretch out the onset or the pauses for too long we may lose the **willingness** to regard what goes on as an event, as one event, as an event of type α , as one event of type α .

The notion of incremental homogeneity as defined here differs from the one in Landman 2008 in two important respects:

1. Our variables here range over eventualities, hence over events or states. Technically this means that states which are required by the semantics of stative verbs in Landman 2008 to satisfy a **stronger** constraint of **segmental homogeneity**, provably also satisfy the present notion of incremental homogeneity. This motivates the earlier statement that in the theory of Landman 2008 stative predicates and activity predicates satisfy incremental homogeneity.
2. It is not just the cross-temporal event identity which is preserved incrementally, but also the event type α . This was not important in Landman 2008, since that paper was only concerned with states and activities, and the progressive, but it is central here. The incremental preservation of the event type α is precisely what arguably accomplishments and achievements fail to do.

4.3. INTERPRETATION OF SENTENCES WITH BARE PLURALS

We have now made our proposal to deal with what we called problem One above, the proper definition of homogeneity, and in the next section we will show how this proposal accounts for the distribution of aspectual *for*-phrases. In this section we make some specific proposals concerning the semantics of *bare plurals* which will allow us to deal with problem Two above, why accomplishment verbs with bare plural are atelic.

We assume, with Carlson 1977, that bare plurals like *apples* can denote kinds, and we take this to mean that the sentences in (10a) and (11a) have event type interpretations as in (10b) and (11b):

(10) a. Cats purr.

b. $\lambda e.PURR(e) \wedge Ag(e) = k_{CAT}$

(11) a. John ate apples.

b. $\lambda e.EAT(e) \wedge Ag(e)=j \wedge Th(e) = k_{APPLE}$

We claim, then, with Carlson, that sentences with bare plurals involve derivationally event types with roles filled by kinds rather than individuals. We say, *derivationally*, because it is essential to our analysis that the event type with the kind is input for the aspectual *for*-phrases. It is important to stress that this signals an important difference with Carlson's approach. Carlson assumes that for **episodic predicates**, like the verbal predicate *ate* in (11a), the kind-interpretation is actually analysed away out of the derivation. This is because Carlson **defines** *eat kind k*, for episodic verb *eat*, as: *eat some instance of kind k*. We do **not** make that assumption.

We **will**, for clarity, assume with Carlson, a **gnomic-episodic ambiguity**. That is, we will assume that in the event type $\lambda e.EAT(e) \wedge Th(e) = k_{APPLE}$, EAT is unspecified for one of two values: EAT_{GN} , an event type of gnomic eating events, and EAT_{EPI} , an event type of episodic eating events. Thus we assume that in *eat kind k*, (i.e. 'be an eating event with k as theme') *eat* means **either gnomic-eat kind k** (i.e. 'be a gnomic eating event with k as theme') or **episodic-eat kind k** (i.e. 'be an episodic eating event with k as theme'). This means that the most plausible readings of (10a) and (11a) reduce to:

(10) a. Cats purr.

c. $\lambda e.PURR_{GN}(e) \wedge Ag(e) = k_{CAT}$

(11) a. John ate apples.

c. $\lambda e.EAT_{EPI}(e) \wedge Ag(e)=j \wedge Th(e) = k_{APPLE}$

So the interpretations in (10c) and (11c) are the ones we assume the grammar operates on.

Now, Carlson argues extensively against trying to **define** $PURR_{GN}$ in terms of purring events with **individual instances of the kind** as themes (i.e. defining away the kind). The reason is that such a definition – if possible at all – could only be a disjunction of the most uninspiring and uninformative kind. That is, what supports the truth of the generic, what we may call the **episodic event witnesses**, may vary wildly from context to context (although in all these cases the interpretation has a 'universal flavour'):

e is a *gnomic-purr* event with theme k_{CAT} :

Possible episodic event witnesses:

1. Sufficiently many individual purring events of individual cats took place over a sufficiently long period of time (inductive reading)
 2. Individual cats have individual dispositions to events as under 1.
 3. Cat-physiology includes a purring-reflex, related to events under 1.
 4. Purring often stands on the cat-activity menu.
- etc. etc. etc...

Carlson assumes that this multiplicity of interpretations is absent for the episodic cases: they have just existential interpretations lexically induced by the episodic meaning of the verb:

e is an *episodic-eat* event with theme k_{APPLE}

Necessary episodic event witnesses:

some episodic eating event with individual theme d , where d is an apple, a plurality of apples, a piece of apple, etc,...

We accept all of this from Carlson, with one exception: we assume that the existential interpretation of EAT_{EPI} is a **correspondence postulate** just as it is in the case of the gnomic interpretation: an episodic eating a kind event **will**, in context, correspond to episodic eatings of individuals, its episodic event witnesses. But (as in the case of the gnomic event), we assume that the grammar specifies this as a one-way inference from the event with kind theme to its episodic witnesses. The inverse inference, which introduces reference to a kind from assertions about individual events is not, on our view, a principle of sentence semantics (but is available in discourse, as in *There are three beavers in my garden. They are destructive little beasts.*)

Two things are important for us:

1. The episodic sentence with the kind theme in (11a) directly involves the kind k_{APPLE} . The semantics of the aspectual *for*-phrase will make use of this.
2. Episodic sentences without kind terms, like the accomplishments in (2c) do not in the **semantic derivation** make reference to the kind k_{APPLE} . Hence, the semantics of the aspectual *for*-phrase will not be able to access that kind in these cases.

To summarize, we assume the following semantics:

(10) a. Cats purr.

c. $\lambda e.\text{PURR}_{\text{GN}}(e) \wedge \text{Ag}(e) = k_{\text{CAT}}$

Episodic event witnesses: if e is of this type and $\tau(e)=i$ then e has gnomic properties in i

(11) a. John ate apples.

c. $\lambda e.\text{EAT}_{\text{EPI}}(e) \wedge \text{Ag}(e)=j \wedge \text{Th}(e) = k_{\text{APPLE}}$

Episodic event witnesses: if e is of this type and $\tau(e)=i$ then some episodic eating of individual apple must take place corresponding to this inside i .

5. ACCOUNTING FOR THE FACTS ABOUT ASPECTUAL *FOR*-PHRASES

5.1. STATES/ACTIVITIES AND ACCOMPLISHMENTS/ACHIEVEMENTS

We assume, with Bennett and Partee 1972, Dowty 1979, and most authors since, that **stative predicates** are lexically constrained as being homogeneous down to instants in the sense of Bennett and Partee: formulated in our event-theory, the event type α of a stative predicate consists of states s such that **every sub-interval** of $\tau(s)$ is the running time of a state of type α which is cross-temporally identical to s (including at singleton intervals, i.e. points). Obviously, if a predicate is homogeneous in this strict sense, it is also incrementally homogeneous.

Secondly, we assume with Landman 2008 that **activity predicates** are lexically constrained as being incrementally homogeneous (as discussed for *waltz* above). With this, we predict that aspectual *for*-phrases are compatible with stative predicates and activity predicates:

- (12) a. I lived in Amsterdam for three years.
b. I waltzed for two hours.
c. I pushed a cart for two hours.

The situation is different for accomplishments and achievements. We make the argument for accomplishments, but the case is analogous for achievements. Let us consider (13): Let APPLE be the set of singular apples.

- (13) a. John ate an apple.
b. $\lambda e.EAT(e) \wedge Ag(e)=j \wedge Th(e) \in APPLE$

The event type in (13b) is **not** incrementally homogeneous. This is easy to see: take an event e in event type (13b), say: $Th(e) = d$ where $d \in APPLE$. Already the **onset** of e , $O(e,EAT)$ is **not itself** an event in event type (13b), and no event of type (13b) goes on at $\tau(O(e,EAT))$. This violates the definition of incremental homogeneity which would require an event of type (13b) to go on at event incremental interval from the time of the onset to $\tau(e)$. Consequently, we predict, correctly, that (14) is not felicitous:

- (14) #John ate an apple for an hour.

Note that you can replace in (14) *an apple* by *three apples*, *at least three apples*, *a lot of apples*, *the apples*, *every apple*, *most apples*... and the argument stays exactly the same: all of these constructions involve event types that are not incrementally homogeneous. This, then, also accounts for the infelicity of the examples in (3), repeated here:

- (3) a. #John ate (at least) three apples for an hour.
b. #John ate many apples for an hour.
c. #John ate much bread for an hour.

Downward entailing cases are somewhat subtle here. On any standard analysis of plurality, (15a) comes out as equivalent to (15b), which is not

incrementally homogeneous for the same reasons as above, and hence (15c) is predicted to be infelicitous, correctly, we think:

- (15) a. John ate at most three apples.
b. John ate 0 apples or John ate 1 apple or John ate 2 apples or John ate 3 apples.
c. #John ate at most three apples for an hour.

However, you may wonder whether the equivalence between (15a) and (15b) isn't too strong (is (15a) false if John ate a little chunk of one apple?) We will not argue this case here, but only note that Landman 2000 argues that the event type involved in the semantics for (15a) is not simply the event type:

$$\lambda e. \text{EAT}(e) \wedge \text{Ag}(e)=j \wedge \text{Th}(e) \in \text{APPLES} \wedge |\text{Th}(e)| \leq 3$$

but a more complex event type that involves maximalization. The latter event type is distinctly not incrementally homogeneous.

All in all then, we see that all of the event types corresponding to sentences of the form:

John ate DET apple(s)

are of the accomplishment type, and are predicted (correctly, we think) to be incompatible with aspectual *for*-phrases. (Note that, as argued in Rothstein 2004, included here are cases with determiners and mass nouns like (16):

- (16) #John ate a lot of/a little apple for an hour.

The argument that shows these mass cases infelicitous is essentially the same as the argument in the count cases above.)

5.2. CASES THAT ARE ANALYSED AS STATIVES

We assume that stative predicates are homogeneous down to instants, hence *a fortiori* incrementally homogeneous, and hence compatible with aspectual *for*-phrases. In the semantic literature, a good case has been made, for various **complex** constructions, that the constructions in question are stative (see, for instance, the discussion in Landman 2008). Examples involve:

- (17) **Progressives:**

a. *I have been driving* for an hour.

Habituals:

b. *I smoked* for twenty years.

Modals:

c. Our teacher doesn't allow eating in class, but she's not there this week, and the replacement teacher is softer, so for a whole week *we may eat an apple in class*. [on the interpretation where the **modal** is in the scope of the *for*-phrase]

We are not analysing these constructions in this paper, but assume that homogeneity down to instants is a **defining characteristic** of all stative predicates. This means that we assume that the semantics for the constructions in (17) must make these predicates homogeneous down to instants. For instance, the semantics of the habitual operator

involved in (17b) must be made to guarantee that in the twenty years interval in (17b) the **smoking habit** holds at every sub-interval (this doesn't necessarily mean much about how **actual** smoking is distributed over the interval: that depends on the correspondence between the habit and its event witnesses, which, of course, highly depends on lexical and contextual information).

With that, our semantics for the aspectual *for*-phrases predicts that the sentences in (17) are felicitous. We assume that cases like example (4), discussed above, also fall under this heading, since they are habitual:

(4) This bicycle carried three children around Amsterdam for twenty years.

(4) involves the habit of carrying three kids around Amsterdam. The habit may be instantiated by witness events involving different children at different times, but the habit is realized at each instant of the twenty year interval.

5.3 GNOMIC READINGS OF PREDICATES WITH BARE PLURALS

(18) a. *Dinosaurs ruled the world* for 200 million years.

b. $\lambda e. \text{RULE-THE-WORLD}_{\text{GN}}(e) \wedge \text{Ag}(e) = k_{\text{DINOSAUR}}$

It is straightforward to require event types of the sort (18b) to be homogeneous, even homogeneous down to instants, just like habituals. We do not think, however, that this should be imposed as a general across-the-board principle. Rather, in (18b) we must think about **what it means** for an event to be a gnomic event of ruling the world with kind dinosaurs as agent.

For (18a) this means that, say, in enough relevant situations, instances of the kind dinosaur come out on top in relevant fighting battles, or they have a disposition to do so. If, in this case, we let the gnomic events be witnessed by a habit or a disposition, then we can take it to be the stativity of the habitual or dispositional predicate which accounts for the incremental homogeneity, and hence for the felicity of (18a). Obviously this requires more details of a theory of generics.

But these are not the only cases. Gnomic predicates are not necessarily interpreted habitually, and whether or not you should expect event types of the form in (18b) to be homogeneous depends strongly on the verb involved, the kind involved, and the context. For instance, look at the cases in (19):

(19) a. #Tolkien invented Hobbits for a week.

b. #Rats/the rat reached Australia for a century.

As discussed above, (19a) has a **felicitous** reading, where we interpret $\text{invent}_{\text{GN}}(e) \wedge \text{Th}(e) = k_{\text{HOBBIT}}$ as *invent characters instantiating the kind HOBBIT*, i.e. Frodo, Sam, ... This reading is much like that of (18a). But (19) has a more prominent reading, on which *for a week* is infelicitous: the reading where the relation of *inventing* is directly to the kind: *bring the kind HOBBIT into existence*. On this reading, the gnomic interpretation affects the kind itself, rather than the instances of the kind, and the gnomic event type is an accomplishment event type, and not incrementally homogeneous. Hence, on this reading, *for a week* is infelicitous, but, as argued for (5a) above, *in two hours* is felicitous.

Case (19b) is similar. Whether or not (19b) is felicitous depends on the interpretation of the gnomic-predicate/kind complex: as a statement about instances of the kind it is similar to (18a), but as a statement expressing *where-The-Rat-boldly-went-where-no-rat-had-gone-before*, it is interpreted as a non-homogeneous predicate.

5.4 EPISODIC READINGS OF PREDICATES WITH BARE PLURALS

We are now concerned with (20):

- (20) a. John ate apples
 b. $\lambda e.EAT_{EPI}(e) \wedge Ag(e)=j \wedge Th(e)=k_{APPLE}$
 c. John ate apples for an hour.

We make two assumptions about the event types involving an episodic predicate and a kind theme like (20b). The first is that we assume that this event type is indeed incrementally homogeneous. This means that we assume that when (20a) is true at an interval of time i , this means that there is an event e such that $EAT_{EPI}(e)$ and $Ag(e)=j$ and $Th(e)=k_{APPLE}$ and $\tau(e)=i$ and there is for each incremental sub-interval i' of i , bigger than the time of the onset of e , an event e' such that $EAT_{EPI}(e')$ and $Ag(e')=j$ and $Th(e')=k_{APPLE}$ and $\tau(e')=j$ and $e' \sim e$.

The second assumption is the witness assumption of this sort of predicate that if event e in event type (20b) is realized at interval i , this realization **entails** the realization of **some** event witness $e'' \in EAT$ with $Ag(e)=j$ and $Th(e) \in APPLE \cup APPLE_{mass}$ and $\tau(e'') \subseteq \tau(e)$. Thus the episodic kind reading is witnessed by events of eating specific apples or apple-parts.

Now note the following. By incremental homogeneity, we have kind-eating events (cross-temporally identical to e) relating John to the kind k_{APPLE} incrementally within the interval $\tau(e)$. This means that **each** such kind-eating event at an incremental sub-interval must satisfy the witness requirement at that interval, i.e. must be witnessed by some actual apple-eating. But, and this is the crux of the analysis, since these intervals are **incremental**, for two such events e_1 and e_2 either $\tau(e_1) \subseteq_{inc} \tau(e_2)$ or $\tau(e_2) \subseteq_{inc} \tau(e_1)$, and this means that these events may well use **the same** bit of actual apple eating as their witnessing individual event. This means that if $\tau(e_1)$ is a proper initial sub-interval of $\tau(e_2)$, then $\tau(e_2)$ need not necessarily contain more apple eating than $\tau(e_1)$.

This has the following consequence. We predict that (20c) is felicitous and that if (20c) is true, **some** apple-eating must take place during that hour. This much is required by the semantics. Next let us ask: yes, but **how much** apple eating must take place during the hour, or rather, how soon and how often must there be apple eating? And the answer of our analysis is: that depends on our intuitions concerning the notion of event identity in this case.

First: how big is the onset of an episodic kind event of apple eating? Answer: how long are you prepared to wait till the first apple eating is required to take place for you to call it apple eating. That's how big you will allow the onset to be. Secondly, suppose the event starts with a little bit of apple eating. How long till the next bit of apple eating must take place? Answer: how long are you prepared to wait without apple eating and still call it **the same event** of apple eating.

For a predicate like *apple eating* and an interval of an hour, probably you will be variably strict: the first bit of apple should come fairly soon, and then next bits should come with some regularity, or else we run the risk that you call the process off, i.e. decide that the process of apple eating, the episodic-eat events with kind object connected by event identity, stops before the hour is over.

In other words: we predict **semantically** that some apple eating must take place, and contextually, in relation to the notion of event identity, that there must be some spread of apple eating through the interval. This seems to be just what we want.

How much instantiation is required is, once again, highly variable. For instance look at (21):

(21) I woke up in the middle of the night. Something was going on, dogs howled for an hour.

How much howling does this require? Well, if the sentence is said by my light-sleeping elderly neighbour of the complaining type, it would be enough to have a bit of howling to start off the hour, a bit of yelping after half an hour and one more bark later on. This may be stretching things, but it is compatible with our analysis. Note that incrementality plays a central role here. In theories that use a notion of homogeneity in the spirit of Bennett and Partee, or Dowty, there should be an event of the episodic howling type with kind agent at **every** sufficiently large sub-interval of the hour. Each such event would, by the episodic witness connection, be required to correspond to some individual dog-howling. But that means that the interval is **semantically** required to be homogeneously packed with dog-howling, and it is hard to see how there could be any serious gaps in the howling.

On the incremental theory gaps are not only possible but **natural** in these cases: the episodic howling events with kind subjects can be thought of precisely as **stages in an abstract process connecting different instances of dog-howling through event identity**. As long as the gaps are naturally bridged by process-identity they are indeed natural. On this idea the process is carried forward by producing incrementally more instances, but it is completely natural in that to assume that what you have gathered so far can be used **as credit** to continue to assert that the process continues, even if for some time no instances follow.

There is a clear analogy between these chains of witness-events and the chain witness events which justify the use of a progressive such as *John has been writing a book for twenty years* (see Landman 1992, 2008 for discussion of the progressive cases).

We have presented here our proposal for episodic event types with bare plural kind-denoting themes. Though we do not give an analysis here, we assume that the ideas presented here carry over to episodic event types with mass noun themes, like (2b). Treating mass nouns as kind-denoting expressions, as in Krifka 1995, Chierchia 1998, suggests how such an extension may take place.

5.5. A NOTE ON *EATING FOR THREE HOURS*

Why is (22a) felicitous?

- (22) a. John ate for three hours.
b. John ate.
c. $\lambda e.EAT(e) \wedge Ag(e)=j \wedge \exists x[Th(e)=x]$
- (23) a. John ate something.
b. #John ate something for three hours.

Anita Mittwoch argued many years ago, in Mittwoch 1982 that if (22b) is analysed with the event type in (22c), then (22b) is given the same interpretation as (23a). But (23a) is an accomplishment, as shown by the infelicity of (23b). So this analysis of (22b) wouldn't predict that (22a) is felicitous. Mittwoch concluded that (22b) must be distinguished semantically from (23a). This can be done either by assuming an **intransitive** verb *eat* with a verbal **activity** event type for which the theme role is not defined (as in 22b):

- (22) b. John ate.
d. $\lambda e.EAT_{ACT}(e) \wedge Ag(e)=j$

More attractive possibly is to assume that (22b) allows an analysis with a null object with a **kind interpretation**, as in (24):

- (24) a. John ate *e*.
b. $\lambda e.EAT_{EPI}(e) \wedge Ag(e)=j \wedge Th(e) = \mathbf{k}$

By our analysis, this is predicted to be semantically existential (i.e. existentially witnessed), but compatible with *for an hour*, just like episodic event types with bare plural objects.

5.6. ACHIEVEMENTS

The achievement cases in (8) are interesting in that they have been a stumbling block for most analyses of atelicity.

- (8) a. *English tourists discovered this village* all summer.
b. *Guests arrived* for two hours.
c. *John noticed miserable looking people* for several hours.

(8a), from Verkuyl 1972, has, of course, played a noble history in arguing against theories that allow aspectual notions only to be defined at the V or at the V/VP level. (There is no such problem in our analysis, since we associate event types with V, VP, and IP.) Independent of that problem, these cases have been difficult to analyse semantically, because of the achievement predicates involved. In cases like (21) – with a bare plural subject and an activity predicate – once could, in principle try to attribute the compatibility with *for an hour* to the interpretation of the activity predicate *howl* and not to the presence of the bare plural subject *dogs*. We think that

both strategies (*via* activity predicate or *via* bare plural subject) are available, and the activity predicate strategy is what accounts for the felicity of (25):

(25) Three dogs/the dogs howled for an hour yesterday night.

However, because achievement predicates are interpreted as sets of **punctual** events, the predicate strategy is unavailable, and we are forced to attribute the felicity of the cases in (8) to a kind interpretation of the bare plural subject, as evidenced by the fact that (26) is infelicitous:

(26) #Three guests/the guests arrived for two hours.

The central fact about the interpretation of achievement cases like (8b) is that on anyone's intuition about its truth conditions, there will be intervals between the guest-arrival events within the relevant interval at which no guests arrivals take place. This is because arrivals are punctual. It is easy to see that for sets of punctual events a requirement of *homogeneity up to 'sufficiently' large sub-intervals*, as Dowty and Krifka have it, **coincides** with *homogeneity up to instants*. This means that Dowty and Krifka's requirement, as applied to cases like (8b) would predict that (8b) is felicitous only on an interpretation where at every point of time during the relevant two hours individual guests arrived; similarly, the truth of (8a) would require a continuous sequence of tourists standing waiting in line for their turn to discover the village throughout last summer. This is, of course, ridiculous. Hence, even with a kind subject, standard notions of homogeneity are untenable. An appeal to gnomonic properties to explain the spread seems out of the question, since the achievement cases in (8) seem to be distinctly episodic. Taking all this together this points at episodic predicates, kind subjects, and incremental homogeneity.

And indeed, our analysis deals with these cases readily and smoothly. Since the cases in (8) are all cases with bare plurals, we can assume for each of the cases in (8) an interpretation with an episodic event type with a role specified as a kind (i.e. $k_{\text{ENGLISH TOURISTS}}$ in 8a). With that, the analysis of these cases is exactly the same as the analysis of the accomplishment cases with bare plurals in section 5.4. And the discussion of how the howling of *dogs* is spread over the relevant interval in example (21) carries over straightforwardly to the spread of individual guests arriving within the two hour interval in (8b).

The point of our analysis of (8b) should be familiar by now: (8b) doesn't express **at all** semantically that punctual arrival events of individual guests were **spread** over the two hour interval. What it expresses is that these punctual arrival events are presented as if they are part of an incremental process of more and more instances of kind GUEST arriving. The spread – how many guests are required to arrive when – is part of the cross-temporal identity conditions of that process: just as many guests are required to arrive at different times in this interval as **you** need in order to think of this as **one** coherent process. In this particular case, it is natural that this requires the interval to be punctuated with arrival events with some frequency, but nothing requires the interval to be densely packed with arrival events. And this is as should be.

5.7. ITERATIONS

The felicity of (8a), *Guests arrived for two hours*, raises the question of why accomplishments with kind subjects are not compatible with aspectual *for*-phrases, as in (26), with the interpretation that complete glass-of-juice-drinking events were spread over the two hour interval?

(26) #Girls drank a glass of juice for two hours.

Our answer is that such incrementally homogeneous predicates with accomplishments **do** occur, but only when the VP is in the scope of a iteration-creating quantificational operation, as in (27a). However, in this case the felicity of the aspectual *for*-phrase depends purely on the presence of the iteration operation, and is independent of the bare plural subject, as shown by the felicity of (27b):

- (27) a. Girls drank a glass of juice *every twenty minutes* for two hours.
b. Susan drank half a glass of orange juice *every twelve minutes* for twenty five hours the Yom Kippur she was pregnant.
c. The jogger arrived at a kilometre pole *every ten minutes* for an hour.

The cases in (27) show the same spreading effect as the achievements discussed in the previous subsection, but in the present cases, there is no felicity without the explicit iteration-phrase. Note that in the scope of an iteration phrase, also individual subject-**achievements** are compatible with aspectual *for*-phrases, as in (27c). All this leads to two questions: Why are the cases in (27) felicitous? and: Why is (26) infelicitous?

We do not give a worked-out analysis of the cases in (27) here, but we will sketch one. We propose to take the oft-given description of these cases as involving iteration completely literally: we think that the predicates in (27) denotes sets of **iterations**.

What is an iteration? We propose that an iteration is a **singular, abstract, event** *e*, which corresponds to a temporally ordered plurality of events: the latter events can be seen as the temporally ordered **witnesses** of *e*.

Thus, we assume that the semantics of (27b) involves an iteration *e* which (27b) claims lasts twenty five hours, and which is a singular sequence of drinking-orange-juice events at 12 minute temporal intervals. Now *e* is an abstract event, like the episodic kind *eat* events with kind-theme k_{APPLE} , and we assume that iterations are constrained analogously. What this means is that we assume that there is a grammatically accessible operation ITERATE which forms (sets of) iterations out of (sets of) pluralities. We assume that the operation ITERATE is constrained in such a way that, for felicitous input α , ITERATE(α) is incrementally homogeneous.

The intuition underlying this constraint is that the iteration event *e* can be regarded as an (abstract) incremental process of producing more and more witnesses for the iteration. In this case, one would think that the requirements on cross-temporal event identity would be very minimal: *being an initial sub-sequence of this iteration*. Since that is easy to satisfy, there need not be more requirements on the spread of witnessing events than just the spread that the **formation** of the iteration entails: an event of drinking half a glass of orange juice every 12 minutes.

Importantly, we assume that the incremental homogeneity of the iteration process requires, for the singular abstract iteration event, an onset to be set which is

not determined by the verb, as in the cases we have discussed so far, but by the size of the iteration-chunks: in (27b) the onset of the iteration is the first 12 minute chunk.

With this we come to the final comparison:

-In (8b), the achievement case, since achievement events are punctual, the onset will naturally contain a complete arrival event, and the event type will be preserved incrementally: (8b) is incrementally homogeneous and felicitous.

-In (26), the accomplishment with the individual theme, as in all other cases of accomplishments, the onset is too small to be of the event type, and the event type is not preserved incrementally: (26) is not incrementally homogeneous and thus infelicitous.

-(In (27b), with the onset reset by the iteration operation, the onset event **is** big enough to be of the iteration event type: the event type is preserved incrementally, and (27b) is incrementally homogeneous and felicitous.

Of course, the analysis of iteration needs to be worked out and neatly and compositionally implemented in a grammar, but we think that this can be done, and we think that, once done, the ideas concerning incremental homogeneity apply to such iterative cases in a completely natural way.

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REFERENCES

- Bennett, Michael and Barbara Partee, 1972, 'Towards the logic of tense and aspect in English,'. Report for the System Development Corporation, Santa Monica, CA. Reprinted in: Partee, Barbara, 2004, *Compositionality in Formal Semantics*, Blackwell, Oxford, pp. 59-109.
- Carlson, Gregory, 1977, *Reference to Kinds in English*, Ph.D. Dissertation, UMass, Amherst. Published, 1980, Garland, New York.
- Chierchia, Gennaro, 1998, 'Reference to kinds across languages,' in: *Natural Language Semantics* 6, pp. 339-405.
- Dowty, David, 1979, *Word Meaning and Montague Grammar*, Kluwer, Dordrecht.
- Krifka, Manfred, 1989, 'Nominal reference, temporal constitution and quantification in event semantics,' in: R. Bartsch, J. van Benthem and P. van Emde Boas (eds.), *Semantics and Contextual Expression*, Foris, Dordrecht, pp. 75-115.
- Krifka, Manfred, 1992, 'Thematic relations as links between nominal reference and temporal constitution,' in: I. Sag and A. Szabolsci (eds.), *Lexical Matters*, CSLI, Stanford, pp. 29-53.
- Krifka, Manfred, 1995, 'Common nouns: a contrastive analysis of Chinese and English,' in: G. Carlson and F. J. Pelletier (eds.), *The Generic Book*, Chicago University Press, Chicago, pp. 398-411.
- Krifka, Manfred, 1998, 'The origins of telicity,' in: S. Rothstein (ed.), *Events and Grammar*, Kluwer, Dordrecht, pp. 197-235.
- Landman, Fred, 1992, 'The progressive,' in: *Natural Language Semantics* 1,1, pp. 1-30.
- Landman, Fred, 2000, *Events and Plurality*, Kluwer, Dordrecht.
- Landman, Fred, 2008, '1066. On the differences between the tense-perspective-aspect systems of English and Dutch,' in: S. Rothstein (ed.), *Theoretical and Cross-linguistic Approaches to the Semantics of Aspect*, Benjamins, Amsterdam.
- Mittwoch, Anita, 1982, 'On the difference between *eating* and *eating something*: activities versus accomplishments,' in *Linguistic Inquiry* 13, pp. 113-122.
- Rothstein, Susan, 2004, *Structuring Events*, Blackwell, Oxford.
- Rothstein, Susan, 2008, 'Telicity, atomicity and the Vendler classification of verbs,' in: S. Rothstein (ed.), *Theoretical and Cross-linguistic Approaches to the Semantics of Aspect*, Benjamins, Amsterdam.
- Verkuyl, H. J., 1972, *On the Compositional Nature of the Aspects*, Reidel, Dordrecht.
- Zucchi, Sandro and Michael White, 2001, 'Twigs, sequences and the temporal constitution of predicates,' in: *Linguistics and Philosophy* 24, p. 187-222.

Landman, Fred and Susan Rothstein, to appear, 'Incremental homogeneity in the semantics of aspectual *for*-phrases,' in: Rapaport Hovav, Malka, Ivi Sichel and Edit Doron (eds.), *Syntax, Lexical Semantics and Event Structure*, John Benjamins, Amsterdam.