

Group Events as Means for Representing Collectivity*

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1. Introduction

In this paper I argue in favor of the introduction of “group” events into a framework of event semantics; these mirror the “group” individuals introduced by Landman (1989), and give the domain of events a structure similar to that of the domain of individuals. Group events are used in order to capture collectivity effects that cannot be represented through the domain of individuals, as in the case of predicate conjunction. An attempt to extend the notion of group events and to use them for counting with adverbials such as *three times* proves at the very least troublesome.

2. Framework

The framework for discussion is a theory of event semantics, adapted to deal with plural individuals and events along the lines of Landman (1995). In this theory every model includes a domain of individuals D , consisting of entities of type d , and a domain of events E , with entities of type e . We also allow for the construction of functional types such as $\langle d,t \rangle$, the type of functions from individuals into truth values. Although the theory is one of functional types, I will in addition use set-theoretic notation for clarity, and will shift freely between functions and their characterizing sets. Common nouns denote sets of individuals (type $\langle d,t \rangle$): *BOY* is the set of all individuals who are boys. Verbal predicates refer to sets of events; for instance, *WALK* is the set of walking events (type $\langle e,t \rangle$):

$$(1) \quad \text{BOY} = \{x \in D \mid \text{BOY}(x)\}$$

$$(2) \quad \text{WALK} = \{e \in E \mid \text{WALK}(e)\}$$

Participants are related to events through thematic roles, which are (partial) functions from events to individuals. The abstract sentence *John walk* is

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the set of walking events whose agent is John, an event-type of type $\langle e,t \rangle$; the verb *walk* itself is a function from individuals to event-types (type $\langle d, \langle e,t \rangle \rangle$), with an open slot for the agent:

- (3) $John\ walk \Rightarrow \{e \in E \mid e \in WALK \wedge Ag(e)=j\}$
 (4) $walk \Rightarrow \lambda x \{e \in E \mid e \in WALK \wedge Ag(e)=x\}$

A sentence is considered true if its event-type is realized by at least one event. Therefore, assertion of a sentence introduces an existential quantifier on the event type. The sentence *John walks* will thus receive the following translation:

- (5) $John\ walks \Rightarrow \exists e \in E [e \in WALK \wedge Ag(e)=j]$
 “There exists a walking event whose agent is John.”

Treatment of plurals in our models is based on the theory proposed by Landman (1995). Plural items are created by closing the domains D and E under sum formation, forming a lattice structure (see Link 1983, Bach 1986): the domain D is taken to include not only the atomic individuals, but also all the possible sets of atomic individuals. For example, if j and b are the individuals John and Bill, then the domain of individuals D also includes the plural individual $j \cup b$, which is the set $\{j, b\}$. In a similar way the domain of events includes all the possible plural events, which are sets of atomic events. We will also define a function AT , which takes a set of individuals or events and returns those members of the set that are truly atomic.

The plurality operator (the star operator of Link 1983) transforms a one-place predicate P into the set of all sums of atoms in P . For instance, if *BOY* denotes the set of all individuals who are boys, then **BOY* denotes the set of all the pluralities of boys, i.e. all the sets of boys. Similarly, if *WALK* denotes the set of all atomic walking events, then **WALK* denotes the set of all the plural walking events, i.e. all the sets of walking events.

Plural events do not have thematic roles; rather, their roles break down into the roles of their atomic parts. Landman defines the plural role **R* of a plural event as the union (set) of the roles R of all its atomic subparts, if the role R is defined for all of them. For example, the plural agent of a plural event e will be the set of agents of all the atomic subparts of e , provided that each atomic subpart has an agent. By default, sentences are given a plural interpretation, so the sentence *John walks* will receive the plural interpretation in (6), which is logically equivalent to (5):

- (6) $\exists e \in E [e \in *WALK \wedge *Ag(e)=j]$
 “There exists a set of walking events, the agents of which are all John.”

In addition to forming pluralities, or sets, individuals can also form “groups” through the group operator (Landman 1989). A group is an atomic individual that corresponds to a certain set. For example, the group $\uparrow(j \cup b)$ is an atomic

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individual corresponding to the set of John and Bill. Since groups are atomic individuals, they may serve as thematic roles of certain events. Landman (1995) uses the distinction between sets and groups to argue for **the collectivity criterion**, which states that collective predication is thematic and individual, whereas plural predication is non-thematic. Plural NPs can shift freely between a set and a group interpretation: when they are interpreted as sets we get plural readings, and when they are interpreted as groups we get collective readings.

In Landman's theory a sentence such as (7) below can receive a whole range of interpretations:

(7) Two boys invited three girls.

Each of the NPs can be interpreted either as a group or as a plurality, yielding readings ranging from the double collective reading, in which two boys as a group invite three girls as a group, to the cumulative reading, where individual boys invite individual girls such that altogether two boys do the inviting and three girls get invited. In addition Landman uses a quantifying-in mechanism to get various distributive readings, for example when two boys each invite three girls. All of those readings comply with the collectivity criterion, in that whenever a NP is interpreted collectively it receives a thematic role from some event, while when a NP is interpreted as a plurality it is the individual parts of the plurality that receive thematic roles.

Landman uses groups only in the domain of individuals. However, the distinction between collective and plural interpretation is not limited to NPs. The existence of collectivity effects in predicates suggests that we devise a similar mechanism on the domain of events. In the following section we will look at collective predicates and introduce "group events" to account for them. Later on we will investigate other uses that we may find for these group events.

3. Collective events

Carlson (1987: 539) draws attention to the distinction between collective and distributive coordination of predicates. He notes that normally conjunction can lead either to a collective or to a distributive interpretation. Sentence (8) is thus ambiguous between a reading in which John did one thing, and a reading in which John did two separate things:

(8) John went to the store and bought ice cream.

In certain cases, however, only one interpretation is available. Extraction of a wh-phrase from the coordinate structure is possible only under the collective reading, as in (9), while in (10) it is the word *different* that forces a distributive interpretation:

(9) What did John go to the store and buy?

(10) Different women went to the store and bought ice cream.

Carlson demonstrates that these are indeed two distinct readings by showing that extraction from a coordinate structure and sentence-internal *different* are incompatible with each other, thus the unacceptability of (11):

(11) * What did different women go to the store and buy?

If we want to adhere to Landman's collectivity criterion we have to represent the predication in (9) as thematic, individual predication. We thus need a single (atomic) event that will be able to give John a thematic role of agent. Modeling our domain of events on the domain of individuals, a good candidate for such an atomic event could be a group event, corresponding to the sum of going-to-the-store and buying-ice-cream events.

The following pair of sentences gives further support for the claim that in the case of collective conjunction we have a single atomic event involved:

(12) John and Mary went to the store and bought ice cream.

(13) What did John and Mary go to the store and buy?

Sentence (12) has a variety of readings associated with it, among them a cumulative reading, where it is John who goes to the store and Mary who buys ice cream (or the other way around). Sentence (13) crucially lacks the cumulative reading: either John and Mary, together, performed both actions, or both actions were performed by each of them separately. The subject in sentence (13) may receive a plural, distributive reading, but the predicate may not. It seems as if the predicate in (13) has only one slot, in which it can accommodate only a single subject. Here again we see the validity of the collectivity criterion, which states that collective predication is individual predication.

We can begin defining group events in a similar fashion to group individuals: given a plural event e , the group event \hat{e} will be an atomic event corresponding to e . We must also include in our definition some relation between the roles of corresponding group and plural events. The roles of group events must be thematic roles, hence they must be atomic individuals. As sentence (13) shows, the conjunction can be interpreted collectively only in the case when the same entity is the agent of both going to the store and buying ice cream; there is no collective interpretation available with more than a single (individual or group) agent.

It thus seems reasonable to define the thematic role of a group event as the plural role of the corresponding plural event, if that particular role happens to be an atomic individual; if the plural role is a set consisting of more than one individual then no thematic role can be assigned to the corresponding group event:

(14) $R(\hat{e}) =_{\text{df}} *R(e)$ iff $*R(e) \in AT(D)$, undefined otherwise.

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From the above definition it follows that a group event will have a thematic role R defined only if the same individual occupies the role R of all the parts that compose the corresponding plural event. If all the events that together form the plural event e have the same individual as their role R , then that individual will be the sole member in the set which is plural role $*R$ of e , and will thus be able to get “lifted” into being the role R of the group event $\hat{\uparrow}e$. If however the events that are part of e have different individuals as their R roles then the plural role $*R$ of e will be a set of more than one element, and no role R will be defined for the group event $\hat{\uparrow}e$.

Let us see how this definition works. We will derive the meaning of sentence (15), with conjunction interpreted collectively (such a reading is available, as demonstrated by the extraction test in (16)). The reason we use transitive verbs is in order to have two thematic roles: our collective event should have a thematic role of agent, realized as John, but no theme role.

(15) John picked up the phone and dialed Mary’s number.

(16) Whose number did John pick up the phone and dial?

First we must give a definition for collective *and*: it is a function which takes two predicates and returns a third one. Recall that predicates are functions of type $\langle d, \langle e, t \rangle \rangle$; in the following formula, then, P and Q are variables for predicates. Collective *and* takes two such predicates and returns a new one, a function from individuals to event-types. These event-types are sets of collective (group) events, which correspond to plural conjunction of P and Q events (for our purpose it is sufficient to interpret predicate conjunction simply as forming sets of appropriate events; see Lasnik (1992) for a different treatment).

(17) $and \Rightarrow \lambda P \lambda Q. \lambda x \{ e \in E \mid \exists e_1, e_2 \in E [e = \hat{\uparrow}(e_1 \cup e_2) \wedge P(x)(e_1) \wedge Q(x)(e_2)] \}$

The meanings of the VPs *pick up the phone* and *dial Mary’s number* are given in (18) and (19) below (p stands for the meaning of the NP *the phone* and n for *Mary’s number*); joined together with collective *and* we get the meaning in (20):

(18) $pick\ up\ the\ phone \Rightarrow \lambda x \{ e \in E \mid e \in *PICK \wedge *Ag(e)=x \wedge *Th(e)=p \}$

(19) $dial\ Mary's\ number \Rightarrow \lambda x \{ e \in E \mid e \in *DIAL \wedge *Ag(e)=x \wedge *Th(e)=n \}$

(20) $pick\ up\ the\ phone\ and\ dial\ Mary's\ number \Rightarrow$
 $\lambda x \{ e \in E \mid \exists e_1, e_2 \in E [e = \hat{\uparrow}(e_1 \cup e_2) \wedge e_1 \in *PICK \wedge *Ag(e_1)=x \wedge *Th(e_1)=p$
 $\wedge e_2 \in *DIAL \wedge *Ag(e_2)=x \wedge *Th(e_2)=n] \}$

Combining the meaning of the VP with its subject, *John*, gives us the meaning of the entire sentence (after existential closure):

(21) $John\ picked\ up\ the\ phone\ and\ dialed\ Mary's\ number \Rightarrow$
 $\exists e \in E: \exists e_1, e_2 \in E [e = \hat{\uparrow}(e_1 \cup e_2) \wedge e_1 \in *PICK \wedge *Ag(e_1)=j \wedge *Th(e_1)=p \wedge$
 $e_2 \in *DIAL \wedge *Ag(e_2)=j \wedge *Th(e_2)=n]$

Now this is where our definition of group events shows its effect. Looking at sentence (21) we see that the plural event $e_1 \cup e_2$ has as its plural agent the atomic individual j , while its plural theme is the plural individual $p \cup n$. The corresponding group event will have j as agent, but no theme defined. We can therefore rewrite (21) as follows:

$$(22) \quad \text{John picked up the phone and dialed Mary's number} \Rightarrow \\ \exists e \in E: *Ag(e)=j \wedge \exists e_1, e_2 \in E [e = \uparrow(e_1 \cup e_2) \wedge e_1 \in *PICK \wedge *Th(e_1)=p \wedge \\ e_2 \in *DIAL \wedge *Th(e_2)=n]$$

The representations in (21) and (22) are logically equivalent, given the definition in (14). In (22) however we see clearly where collectivity comes in: John is not only the agent of picking up the phone and of dialing Mary's number, he also stands in a thematic relation to the combination of the two acts.

Turning back to sentences (12) and (13) above, our analysis correctly predicts that a cumulative reading is impossible when the conjunction is interpreted collectively. In the cumulative reading of (12) the agent must be a plurality, so that its individual elements may distribute freely over the two predicates. Our definition of roles for group events does not allow pluralities as thematic roles of group events, thus blocking a cumulative reading with a collective predicate.

4. Cardinality adverbials

We now turn to find further uses for group events. One place where such a notation may turn out useful is with adverbs of cardinality such as *twice* or *three times*. Theories of event semantics (such as Parsons 1990) assume that adverbials enter the semantic representation as modifiers of the event argument. Thus, adding the adverbial *three times* to sentence (23) will give sentence (24), with the semantic representation (24'). In this formula GO is the semantic representation of the unanalyzed predicate *go to the beach*, and the expression $|e|=3$ signifies that e is a (plural) event of cardinality 3, i.e. a set of three atomic events.

(23) John went to the beach.

$$(23') \quad \exists e \in E [e \in *GO \wedge *Ag(e)=j]$$

(24) John went to the beach three times.

$$(24') \quad \exists e \in E [e \in *GO \wedge *Ag(e)=j \wedge |e|=3]$$

The adverbial *three times* itself will be, like any other adverbial, a function from predicates (type $\langle d, \langle e, t \rangle \rangle$) to predicates, which attaches a restriction onto the event argument. The restriction in this case will be on the cardinality of the event argument:

$$(25) \quad \text{three times} \Rightarrow \lambda P. \lambda x \{e \in E | P(x)(e) \wedge |e|=3\}$$

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This formulation allows us to capture the various readings we get when the sentence has a plural subject, as in (26):

(26) John and Bill went to the beach three times.

Using the mechanisms introduced by Landman (1995) we predict three readings for sentence (26). A collective reading, in which John and Bill go to the beach three times together, is achieved by giving the NP *John and Bill* a group interpretation. When the same NP receives a plural interpretation we get the cumulative reading, where John and Bill go to the beach altogether three times. Finally, invoking Landman's quantifying-in mechanism gives us the distributive subject reading, where each of John and Bill goes to the beach three times. So far we see that Landman's framework produces satisfactory results, without a need to define new entities such as group events.

We may now continue to check how cardinality adverbials interact with predicate conjunction. Consider the following sentence:

(27) Three times John picked up the phone and dialed Mary's number.

Does the predicate in this sentence have a collective interpretation or a distributive one? Both interpretations are possible, as demonstrated by Carlson's wh-extraction and *different* tests, which both yield grammatical sentences:

(28) Whose number did John three times pick up the phone and dial?

(29) Three times different people picked up the phone and dialed Mary's number.

We will first deal with the collective interpretation of (27). Recall the representation we have derived for the collective predicate *pick up the phone and dial Mary's number*, repeated below:

(20) *pick up the phone and dial Mary's number* \Rightarrow
 $\lambda x \{e \in E \mid \exists e_1, e_2 \in E [e = \uparrow(e_1 \cup e_2) \wedge e_1 \in *PICK \wedge *Ag(e_1) = x \wedge$
 $*Th(e_1) = p \wedge e_2 \in *DIAL \wedge *Ag(e_2) = x \wedge *Th(e_2) = n]\}$

The event-type in (20) is a set of group events, i.e. a set of atomic events. When we want to combine it with the meaning of the adverbial *three times* in (25) we encounter a problem: the adverbial takes a set of (plural) events of arbitrary cardinality, and returns only those events in that set that are of cardinality three. Since all the events in (20) are of cardinality one, the resulting event-type will always be the empty set, regardless of the situation in the world.

This is obviously not the desired outcome. To reach the desired semantic representation we need to perform an additional process of pluralization. We have noted above that sentences receive a plural interpretation by default. Our definition of collective *and* has accidentally produced a set of atomic events, so we must now take the set of events in (20) and turn it into a set of plural events.

The following rule performs the required pluralization by attaching the star operator to the set of events inside a predicate (P is of type $\langle d, \langle e, t \rangle \rangle$):

$$(30) \quad P \rightarrow \lambda x. * [P(x)]$$

In the above formula, $*[P(x)]$ is a set of plural events. I will show this explicitly by rewriting this set as $\{e' \in E \mid e' \in *[P(x)]\}$. (31) is our new notational variant to rule (30):

$$(31) \quad P \rightarrow \lambda x \{e' \in E \mid e' \in *[P(x)]\}$$

By performing the operation in (31) on the representation in (20) we get the plural interpretation of the predicate:

$$(32) \quad \textit{pick up the phone and dial Mary's number} \Rightarrow \\ \lambda x \{e' \in E \mid e' \in * \{e \in E \mid \exists e_1, e_2 \in E [e = \uparrow(e_1 \cup e_2) \wedge e_1 \in * \textit{PICK} \wedge * \textit{Ag}(e_1) = x \wedge \\ * \textit{Th}(e_1) = p \wedge * \textit{Ag}(e_2) = x \wedge e_2 \in * \textit{DIAL} \wedge * \textit{Th}(e_2) = n]\}\}$$

Note that if we were to use this plural representation in the derivation of sentence (15) above we would get a result logically equivalent to the result we derived earlier; this is because after existential closure, a single event that satisfies the event-type is sufficient to make both the singular formulation and the plural one true (we have already pointed out the equivalence of examples (5) and (6) in the second section). Now we need the plural representation so that we can apply the meaning of *three times* to it, and after adding the agent and the top existential quantifier we get the desired meaning of (27):

$$(33) \quad \textit{Three times John picked up the phone and dialed Mary's number} \Rightarrow \\ \exists e' \in E: e' \in * \{e \in E \mid * \textit{Ag}(e) = j \wedge \exists e_1, e_2 \in E [e = \uparrow(e_1 \cup e_2) \wedge e_1 \in * \textit{PICK} \wedge \\ * \textit{Th}(e_1) = p \wedge e_2 \in * \textit{DIAL} \wedge * \textit{Th}(e_2) = n]\} \wedge |e'| = 3$$

To sum up what we have done so far: our definition of collective conjunction yielded a set of singular, atomic events. This did not turn out to be a problem, because we have in our theory a standard process of pluralization, and sentences are given a default plural interpretation anyway. Also, in order to count instances of picking and dialing we make crucial use of the fact that the conjoined pick-and-dial events are considered atomic, because the cardinality of a set of events is defined as the number of its atomic elements. We seem to have found a new use for group events — they do not only signify collectivity, but may also serve as a basis for determining cardinality.

Counting does constitute a problem when we turn to the distributive interpretation of (27). I have not given a semantic representation for distributive *and* and will not attempt to develop one in this paper, but we can look at some of the difficulties that may arise. Consider sentence (29), repeated below:

$$(29) \quad \textit{Three times different people picked up the phone and dialed Mary's number.}$$

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This sentence is true if, for example, on one instance John picks up the phone and Bill dials Mary's number, on another instance Chris picks up the phone and Andy dials, and the third time it is Andy who picks up the phone but John who dials the number. We would like the adverbial *three times* to combine with a predicate that can include a plural event, which is composed of these three event pairs. But what are these pairs of events? Can they be considered group events? Clearly these conjoined events have no thematic roles associated with them. In what sense then can they be considered collective?

In order to make the pairs countable we would like to form an atomic event out of each pair of events in the situation described above. This means that group events will signify a more general notion of "collectivity", which includes events that somehow fit together even without any thematic predication. In the next section we will see additional examples that may favor such an interpretation of group events.

5. Counting with group events

A serious problem of counting occurs when we have in a sentence an adverbial of cardinality together with a NP specified for number. Take for instance the following sentence:

(34) Three times John ate five apples.

The predicate *eat five apples* will standardly receive the following meaning:

(35) $eat\ five\ apples \Rightarrow$
 $\lambda x \{e \in E \mid e \in *EAT \wedge *Ag(e)=x \wedge \exists y [y \in *APPLE \wedge *Th(e)=y \wedge |y|=5]\}$

If we try to directly combine the meaning in (35) with that of *three times* we run into an immediate problem. The result would restrict the event-type in (35) to plural events of cardinality three, yielding a meaning roughly corresponding to "John ate five apples at three distinct times." This is some kind of cumulative interpretation, where the eating takes place three times and altogether five apples get eaten. Though this sort of interpretation is possible with a prepositional adverbial (*on/at three times*), it is not a possible interpretation of sentence (34).

Where did things go wrong? By the time we have derived a meaning for *eat five apples*, the event argument has already been "used up" by the number five in *five apples*: the event-type in (35) includes any set of events in which altogether five apples get eaten. To get the multiplicative effect of the adverbial *three times* we need to form pluralities of five-apple-eating events and apply *three times* to the set of those pluralities.

Above we mentioned that in Landman's theory NPs may freely shift their meaning between a plural (set) and a collective (group) interpretation. In section 3 we had collective events "built in" as part of the meaning of a lexical item (collective *and*), but the process may be more general. We will now allow predicates to undergo a free shift from sets of plural events to sets of group

events. The group-forming operation in (36) turns the set of plural events inside a predicate into the corresponding set of group events. Performing this operation gives us a new meaning for *eat five apples* in (37).

$$(36) \quad P \rightarrow \lambda x \{ \uparrow e \in E \mid e \in P(x) \}$$

$$(37) \quad \textit{eat five apples} \Rightarrow \\ \lambda x \{ \uparrow e \in E \mid e \in *EAT \wedge *Ag(e)=x \wedge \exists y [y \in *APPLE \wedge *Th(e)=y \wedge |y|=5] \}$$

The event-type in (37) is a set of atomic events. Like example (20) in the previous section, this set has to be pluralized before it can combine with the adverbial *three times*. Pluralization works just like in the previous section, and then we can proceed adding the adverbial *three times* and the subject *John*, to get the following meaning:

$$(38) \quad \textit{Three times John ate five apples} \Rightarrow \\ \exists e' \in E: e' \in * \{ \uparrow e \in E \mid e \in *EAT \wedge *Ag(e)=j \wedge \exists y [y \in *APPLE \wedge *Th(e)=y \wedge |y|=5] \} \wedge |e'|=3$$

This representation has the desired multiplicative effect, since it requires three distinct events, in each of which five apples get eaten. It is indeed important that the apple-eating take place in three chunks of five, because not every case of eating fifteen apples can be appropriately described by (34). But at what cost do we get our numbers right? Our group events no longer signify collectivity, but rather some more general notion of cohesiveness, of events “belonging together” in some vague way.

The effect of the grouping operation in (37) is to “close off” a set of events in order to allow an adverbial to deal with it as a single unit — in a sense, to take scope over it. This does not have to be done through a collectivizing operation. Shoham (1996) gives independent evidence that some adverbs need to take scope over entire predicates, and proposes a different and much more elaborate mechanism for closing predicates and creating scope dependencies between adverbials. Her formulation (following Landman) does not involve group events, but rather defines states which stand for the closed predicates. It may be that these states can also serve as a basis for counting, leaving our group events for the representation of true collectivity.

There still remains an open question: why are the grouping and pluralization operations obligatory? That is, why is it impossible to give sentence (34) an interpretation where altogether five apples get eaten, at three distinct instances? It seems that the adverbial *three times* wants some closure to take place before it applies. Note the difference between the following sentences:

(39) Two boys invited Mary three times.

(40) Mary invited two boys three times.

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Sentence (39) has among its readings a cumulative one, where Mary gets invited three times altogether (say once by John and twice by Chris). Sentence (40) lacks such a reading: either Mary invites two boys three times together, or she invites each of them three times. Either way the event argument must somehow be closed off before the adverbial applies, preventing the free distribution of boys over invitations. This is in contrast with sentence (39) where such distribution can occur freely.

The formalism developed in this paper provides a way to give sentence (40) the desired meaning, where *three times* takes scope over *invite two boys*, treating it as a unit. However it does not give any reason for excluding a cumulative reading. At this point I do not have an explanation for the contrast between sentences (39) and (40), for the difference between NPs specified for number in subject and object positions.

6. Conclusion

In this paper I proposed the introduction of “group events” into a framework of event semantics. These add some structure to the domain of events, a structure already present in the domain of individuals. Group events prove successful in dealing with collectivity, and allow us to account for collective predicates which were not treated in the previous framework. It seems that the use of group events is limited to collectivity effects: though they can serve as a basis for counting in a special case — counting conjoined predicates — a thorough treatment of cardinality adverbials and counting problems seems to require different tools.

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