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ENGLISH ASPECTUAL VERBS AS GENERALIZED QUANTIFIERS

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1.Introduction

Linguistic intuitions support a fundamental three-fold distinction of the aspectual verbs into

- 1) the verbs of initiation: *start ,begin , commence , initiate , resume*
- 2) the verbs of cessation: *stop ,finish , complete , terminate , halt , cease, end*
- 3) the verbs of continuation: *continue , keep , go on.*

A second traditional division of aspectual verbs between causative and non-causative verbs concerns, as I will explain later, their control-structure. The non-causative verbs require a bound subject-argument internal to the event in the scope of the aspectual verb, for causatives this argument remains free.

Thirdly, there is the syntactic observation that English aspectual verbs either take only gerunds (e.g. *resume, stop, keep*) or they take both gerunds and infinitival clauses (e.g. *start, begin, cease, continue*).

Taking these three basic divisions as my starting-point, I will argue that the aspectual verbs are essentially quantificational in nature, and provide a uniform analysis of their syntax and semantics which will account for a number of interesting inferences and the projection of their presuppositions. From this viewpoint the three divisions can be seen as different aspects of a coherent and integrated theory of quantificational structure in natural language.

As for their syntactic structure I assume a universal base-generated structure as in (1) with a VP-internal subject-position in Spec, espousing Heim's dynamic theory of quantification and reference as background semantic framework (i.e. VP = nuclear scope).

1) IP[NP_I [V_{aspect} TENSE vp[Spec V']]]

My approach here is semantically motivated, though it has important consequences for syntax too. I utilize principles and results of the theory of generalized quantifiers to explain the properties characteristic of the different classes of aspectual verbs. The aspectual verbs are semantically represented as relations, called *aspectual constraints*, between an antecedently determined reference-time *t* as restrictive term and the event-type *E* described by the complement in nuclear scope, as in (2).¹

2) V_{aspect} (*t* , *E*)

This relational approach opens up the powerful tool-kit of GQ-theory, which proves a very fruitful and comprehensive theory of semantic structure, if applied to aspectual quantification. The presuppositions and entailments of aspectual verbs are my central explananda, but in the background there is a more general concern with dynamic interpretation and context-dependence which I cannot spell out in any detail here. In addition this analysis of aspectual verbs embodies a theory of events which clarifies significantly how events are identified and individuated. Just like an individual can have many different properties, in my theory an event can simultaneously be of many different event-types. The theory provides a systematic distinction between aspectual verbs which concern the internal structure of an event, quantifying over stages of one and the same event, and aspectual verbs which govern the external temporal relations between events, quantifying over distinct occurrences of the same type of event. I will discuss how thematic structure mediates between syntactic argument structure and the structure of events, arguing that thematic role assignment should occur prior to anaphoric linking. Furthermore, this analysis of aspectual quantification can be related very naturally to the account of the aspectual classes of states, activities, accomplishments and achievements developed in ter Meulen (forthcoming Bradford Books, MIT Press).

2. Events and event-types

It has already often been argued that the semantic interpretation of complements of aspectual verbs are dependent events, supported by their lack of full clausal complements as in (3), VP-ellipsis in (4), and anaphora in (5).²

3) * John started that he read a novel

4) a. John read a novel and Mary read too, but not a novel.

b. John started/ finished a novel and Mary started/ finished too,
*but not a novel.

5) a. *John kept reading [a novel]_i and Mary finished it_i

b. *John kept [reading a novel]_i and Mary finished it_i

c. John kept baking [a cake/cakes/two cakes]_i and Mary finished it/them

¹ Löbner (1987) suggests a similar quantificational account of aspectual verbs in the context of a relational theory of temporal adverbials, treating them as relations between propositions and moments of time. E.g. *stop* (p, t) is true iff. t is the last point of the period during which p is true. A basic difference with my account is that he relies on interval semantics and propositions, where my analysis is essentially more dynamic, based on events and contextually determined reference-times. The present paper provides a much more detailed and comprehensive theory of aspectual quantification.

² Note that verbs of creation seem to allow anaphoric dependencies, e.g. *John started baking a cake and Mary finished it* is much better than 5 in both cases.

d. ?John kept [baking a cake]_i and Mary finished it_i

Some aspectual quantifiers like *keep* create a dependency of the event-type in the complement on the reference-time *t* in the restrictive term, just like the subordination in quantificational NPs. Due to this subordination, the complement event-type constitutes an inaccessible domain for nominal or temporal anaphora in the main event-structure as in (5). As we see in (5c) and (5d), verbs of creation typically do allow NP anaphora to the indefinite internal argument in nuclear scope with an iterative interpretation, but they don't allow event anaphora quite so easily.³ The tense-inflection of aspectual verbs will normally depend on the contextually determined reference-time, which explains why aspectual verbs can be used to describe the internal structure of an event otherwise represented as atomic or indivisible (accomplishments or achievements). An event anaphor complementing a second aspectual verb with a subject coreferential to the first subject is unproblematic, as in (6).

6) John kept [reading a novel]_i, but left before he finished it_i

If the pronoun occurs at the same level of subordination as its antecedent event, it can corefer, if thematic role assignments agree, as is satisfied in (6) but not in (5). These facts concerning the subordination of the complement event hold only for gerundive complements, as the infinitival complements seem to admit this binding more freely.

7) a. John continued to bake [a cake]_i, but Mary eventually finished it_ib. John continued [to bake a cake]_i, but Mary eventually finished it_i

This suggests a fundamental distinction between located event-types, as interpretations of gerunds, as unlocated event-types, interpreting infinitives. The basic distinction between an event-type, which has at least one free argument-indeterminate, and an event, which is a saturated event-type, is fundamental to Situation Semantics and in the theory of events in ter Meulen (forthcoming), which allows an event to be of or to 'realize' different event-types simultaneously.⁴ The observations in (7) show that infinitival complements of aspectual verbs can quantify over distinct events or occurrences of the same event-type, allowing temporal gaps. The gerundive complements, however, are quantifying over stages of one and the same event, no gaps allowed and continuity of location is assumed. The anaphoric reference to the event-type in (7b) forces uniqueness of the cake-baking event. But otherwise the infinitival complements can get an interpretation which is temporally divided or 'iterative'. E.g. (8a) describes a situation in which Mary's singing is not interrupted by noise, whereas for (8b) she may stop singing, listen and then continue.

8) a. Mary kept singing, when she heard the noise

b. Mary continued to sing, when she heard the noise

The aspectual verbs *stop*, *resume*, *keep*, *end*, which presuppose that some of the complement event has already been going on, i.e. there are already some stages of it realized, take only gerundive complements. Most other aspectual verbs take either gerundive or infinitival complements, and if they carry a presupposition, like *finish* and *continue* do, it is that there are prior realizations of the same type of event, which do not necessarily belong to the same event.

³ Making the argument definite seems to help, for obvious reasons.

⁴ This is an important difference with a theory of events developed by Link and Krifka, where each predicate defines a distinct event, and locations of events have to account for their coincidence. In my 1989 paper I have argued against such a fine-grained conception of events.

3. Aspectual verbs as generalized quantifiers

The lack of presuppositions in verbs of initiation account for the fact that they occur in English with expletive subjects (*it*, *there*), whereas the other two classes of aspectual verbs do not.

- 9) a. There started a reading of a novel
 b. * There continued / finished a reading of a novel
 10) a. There began a story
 b. * There went on / stopped/resumed a story

There appears to be quite some cross-linguistic variation in the acceptability of expletive subjects. In Dutch the expletive *er* with aspectual verbs occurs liberally, as shown in (11).

- 11) a. Er begonnen twee films te draaien
 There started two films to play (litt. turn)
 b. Er bleven twee films draaien
 There remained two films play
 c. Er gingen twee films door met draaien
 There went two films on with play
 d. Er eindigden twee films om tien uur
 There finished two films at ten o'clock

The French data, partly from Lamiroy (1987, p. 280), indicate the opposite judgements, where only real arguments (including weather-arguments) rather than expletives are acceptable with aspectual verbs.

- 12) a. Il cesse de pleuvoir
 It stops raining
 b. Il commence de avoir besoin d'une drogue
 He begins to need a drug
 c. *Il continue à falloir partir
 It continues to be necessary to leave
 d. *Il commence à s'agir de travailler
 It begins to stir him to work

An explanation of this cross-linguistic variation is beyond the scope of the present paper, but the cross-linguistic variation is not really surprising, since definiteness effects are exhibited in all languages, but in a wide variety of forms (see Reuland & ter Meulen (eds.), 1987).

The English data in (9) and (10) justify the hypothesis that *start* and *begin* are indefinite 'existential' aspectual verbs. There is another 'existential' verb *resume*, which asserts that there is a new positive stage of the event, but presupposes that there is already a prior positive and negative stage of the same event in the representation. You can't resume anything unless you have started and stopped it first. So *resume* describes an event-internal change, represented by a new positive stage of an event of which an earlier stage is already realized and a negative stage was going on. Hence *resume* takes only gerundive complements, as in (13).

- 13) a. Mary started singing/to sing, when John entered
 b. Mary resumed singing/*to sing, when John entered

Generalized quantifier theory provides a neat formalization of such presuppositions, discussed in section 5, as computational procedures corresponding to GQs.

Let's continue on this path and wonder which aspectual verb may correspond to the universal quantifier. The universal quantifier in a first order logic is definable as the external negation of the internal negation of the existential quantifier. This will

prove a good heuristic: if it is not the case that a negative event-type (with polarity 0) starts, then it must mean that the positive event-type continues. So *continue* is the dual of *start*. . The facts on anaphoric subordination in (5) support this too, as the existential aspectual verbs do allow such binding into arguments of the event-type in nuclear scope.

Just like *start* and *resume*, the presuppositional universal aspectual verb which describes event-internal continuation is *keep*, taking only gerundive complements.

14) a. Jane kept coughing/*to cough during the concert

b. Jane continued coughing/to cough during the concert

From (14a) we infer that during the concert Jane was coughing, and due to the fact that *cough* is an achievement verb, we know its not one prolonged cough but rather repetitive coughing. But from (14b) we infer that Jane may have been coughing before the concert already. Although you cannot continue to do something, if you have not already done some of it, the part already done does not necessarily belong to the same event. The presupposition of *continue* requires that there are distinct realizations of the same event-type, which are not necessarily located as stages of the one and the same event, as *keep* requires. This is an important difference between presuppositions regarding the event-external structure and presuppositions which concern event-internal structure.

Now look at the verbs of cessation : *stop*, *finish*, *complete*, *terminate*, *halt*, *cease*, and *end*. They indicate that the polarity of the event-type is negative; they mark the transition from a positive stage to a negative stage. We see that *finish*, *cease* and *complete* are the internal negation of *start* and the external negation of *continue*. The others *stop*, *terminate*, *halt*, and *end* are event-internal, and take gerundive complements only. If they do occur with infinitival clauses as in (15), these are purpose clauses - the analysis of which is beyond my present concern.⁵

15) Jane stopped to eat

The verb *stop* is importantly different from the other cessation-verbs, because it entails the event may be resumed. Often we use it to indicate that there is only a temporary event-internal interruption, rather than a complete break or last stage reached. In fact, polarity reversal in the complement of *stop* gives us exactly the complement of *resume*, see (16) : to stop not reading is to resume reading.

16) $\langle\langle stop, t, \langle\langle read, x, y \rangle 0 \rangle 1 \rangle \langle \Rightarrow \rangle$

$\langle\langle resume, t, \langle\langle read, x, y \rangle 1 \rangle 1 \rangle$

The other presuppositional cessation verbs, *terminate*, *halt*, and *end* indicate that a final stage is reached; hence any later realizations of the same event-type are considered parts of other events of the same event-type.

Now I have established the correspondence of the three aspectual classes to the existential, the universal and the internal negation of the existential (or equivalently the external negation of the universal). The traditional square of oppositions has a fourth corner, the external negation of the existential which is equivalent to the internal negation of the universal. In English NPs this is lexicalized by the determiner *no*, but English does not seem to lexicalize the corresponding aspectual verb, having only the complex *not start*, or *continue not to V*.⁶ In the logical quantifier square the internally negated existential is not lexicalized in English, although the corresponding aspectual verb *finish* exists. It is remarkable that both

⁵ I advocate an analysis of purpose clauses as VP-adjuncts, cf. Chierchia (1989).

⁶ It has been suggested to me that *refuse* or *refrain from* may lexicalize this position, but I hesitate to include these verbs among the aspectual ones.

squares have one, but a different position which is not lexicalized in English. This deserves a further explanation, but I don't yet have one to offer.

Much of the older literature on aspectual verbs, especially in the syntactic tradition, has focussed on the fact that some aspectual verbs seem to behave like 'raising'-verbs, but others like 'control'-verbs. A controversy revolved around the question whether one is more basic than the other, and hence a transformational derivation accounts for their difference or whether a lexically governed coindexing strategy can explain it all.⁷ As I indicated already I assume a universal base-generated structure where lexically induced thematic constraints of a semantic nature put the requirement onto the non-causative verbs that the agent be the same as the agent of the complement event - this I call the constraint on thematic role transparency. The generalized quantifier perspective here proves to pay off again: the causatives *stop*, *start* and *keep* make up a square of oppositions together with the non-lexicalized *non-start*. The non-causatives *finish*, *resume*, *end*, *cease*, *terminate*, *halt*, and *continue* constitute another such square. Since the event-internal gerundive-only verbs *stop*, *resume*, *end/terminate/halt* and *keep* are also related by external and internal negations, time is ripe to draw some diagrams of these squares.

4. Squares of aspectual quantifiers

The square of opposition of NPs as generalized quantifiers is as in figure 1. where the four corners are related by internal negation and external negation and two quantifiers are each others duals when they are related by composition of internal and external negation.⁸

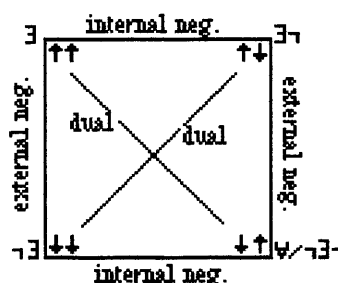


Fig. 1. Square of logical quantifiers

The arrows indicate the monotonicity direction in respectively the interpretation of the CN in the subject NP and the interpretation of the VP, which are the left and right argument of the determiner regarded as a relation D between sets A and B. Internal negation reverses the direction of monotonicity in the right argument, external negation reverses it in the left argument. The concepts and tests are illustrated in (17).

⁷ See Lamiroy (1987) for a lucid account of the arguments on the three alternatives.

⁸ According to van Eijck (1984, p. 5) the Aristotelian square of oppositions looks slightly different. It has external negations exchanged with duals of my fig. 1. I don't think any of the semantic properties are affected by this permutation. See also Löbner (1986, p. 54-56) for diagrams resembling mine more closely.

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- 17) a. existential - *a, some* - left and right increasing
 a beautiful woman sings => a woman sings
 a woman sings an aria => a woman sings
- b. universal - *every, all* - left decreasing, right increasing
 every woman sings => every beautiful woman sings
 every woman sings an aria => every woman sings
- c. internally negated existential - left increasing, right decreasing
 a beautiful woman is not singing => a woman is not singing
 a woman is not singing => a woman is not singing an aria
- d. externally negated existential - *no* - left and right decreasing
 no woman is singing => no beautiful woman is singing
 no woman is singing => no woman is singing an aria

Applying this basic square to the event-external aspectual verbs, we get fig. 2.

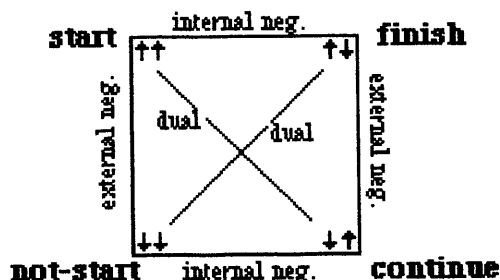


Figure 2. Square of event-external aspectual verbs

Let's check some facts now ($e0/1$ means e with positive polarity 1 or e with negative polarity 0 respectively):

- 18) a. $start(t, e0/1)$ $\Leftrightarrow finish(t, e1/0)$
- b. $not\ start(t, e0/1)$ $\Leftrightarrow continue(t, e1/0)$
- c. $continue(t, e1/0)$ $\Leftrightarrow not\ finish(t, e1/0)$
- d. $start(t, e0/1)$ $\Leftrightarrow not\ not\ start(t, e0/1)$

The monotonicity properties for the aspectual verbs as GQs $V_A(t, E)$ are interpreted as follows. First, the Conservativity of NP-quantifiers is reformulated as requiring that only realizations of the event-type which temporally overlap with the reference-time are to be considered, i.e.

$$\text{CONSERVATIVITY : } V(t, E) = V(t, (t \circ E))$$

The reference-times which constitute the left argument constitute a set partially ordered by the temporal precedence relation \leq , and the realizations of the event-type which constitute the right argument are partially ordered by a 'part-of' relation restricted to realizations of the same event-type, i.e. having the same relation, arguments and polarity. (e' and t' are implicitly universally quantified). If at t an event e is started, then at any later t' that event has been started (note how the shift in reference time affects the change of simple past to present perfect): *start* is left increasing. If at t an event e is started, and we take a larger realization of the same event-type e' which covers e , then at t' e' is started too: *start* is right-increasing. This means that larger parts of the same event cannot ever get located before t , i.e. t is the starting-point of the event, i.e. e can only 'grow' into the future of reference time (19a). Similarly, if you assume that an event is finished at t , and take a later time t' , then the event certainly has been finished at t' too: *finish* is left-increasing. And with the same assumption taking a smaller part of the event, that part is finished at t too: *finish* is right-decreasing. In other words, an event which is finished cannot grow into the future of reference time (19b). And again, for

continue, the event was continued before the reference time, and a larger part continued at the reference time, i.e. you're 'amidst' of the event.

- 19) a. *start* - left and right increasing
 $start(t, e), t \leq t' \Rightarrow start(t', e)$
 $start(t, e), e \text{ is part of } e' \Rightarrow start(t, e')$
 b. *finish* - left increasing, right decreasing
 $finish(t, e), t \leq t' \Rightarrow finish(t', e)$
 $finish(t, e), e' \text{ is part of } e \Rightarrow finish(t, e')$
 c. *continue* - left decreasing, right increasing
 $continue(t, e), t' \leq t \Rightarrow continue(t', e)$
 $continue(t, e), e \text{ is part of } e' \Rightarrow continue(t, e')$

The right-decreasing character of *stop* and *cease* is further attested in their triggering negative polarity NPs like *anything*.⁹

(20) John stopped/ceased/*continued/*started doing anything else
 Monotonicity properties can be used to characterize a larger class of verbs (incl. aspectual verbs) as indefinite (e.g. *appear*, *exist*) and definite (e.g. *disappear*, *discontinue*). Parallel to the extraposition with indefinite NPs in (21), indefiniteness of VPs explain the new extraposition data in (22).

- (21) Only NPs with indefinite (weak) dets allow extraposition
 a. many/most reviews about this book appeared
 b. many reviews appeared about this book
 c. *most reviews appeared about this book
 (22) Only VPs with indefinite main verbs allow extraposition
 a. *many reviews disappeared about this book.
 b. a lecture just started/?continued/?*ended/*discontinued

These event-external aspectual verbs appear to be restricted as to their object NP, taking preferably singular event-denoting ones. We see in (23) that they do not, at least not easily, take a predicative bare mass term or plural.

- (23) a. John started/finished/continued the concert/the conversation/his affair
 b. John started/finished/continued his book
 c. ? John started/finished/continued poetry/books

In fact, (23c) is often interpreted generically, as if John started some kind of action, rather than doing something with any particular amount of poetry or set of books. There is an interesting connection here to the fact that these verbs take either an infinitival or a gerundive complement (with the exception of *finish*). Infinitives, as I argued, are event-types where the aspectual verb quantifies over distinct realizations of the same unlocated event-type not necessarily packaged into the same event, but gerunds denote events where the aspectual verb quantifies over internal stages of one and the same event requiring continuity of location. The reason why *finish* does not take infinitives is that the verb means there are no future realizations of the event-type to be part of the same event, which is equivalent to saying that the representation contains the last stage of that event. Hence the meaning of the verb rules out that further realizations that belong to same event can still be forthcoming, as one would expect if *finish* took an infinitival complement.

⁹ I owe this supporting observation to Jack Hoeksema. The explanation of why *finish* does not take such negative polarity complements needs to appeal to the fact that *finish* takes only count-term arguments, and *anything* is a mass term.

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Let's look at the event-internal aspectual verbs in a diagram, fig. 3. Note that all four positions are lexically realized, if *end* is taken in the sense of *not resuming*. Of course, *resume* means *begin again*, and *begin* could be in the same position, if we drop the presupposition of the prior realization of a negative stage of the same event-type.

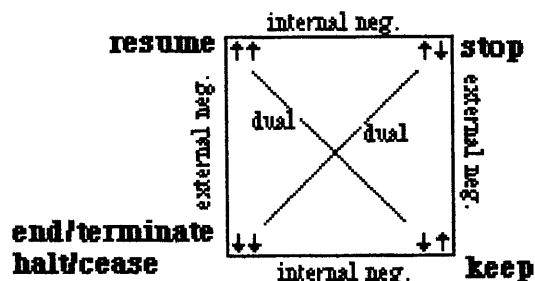


Figure 3. Square of event-internal aspectual verbs

Exactly the same tests can be applied to this square for equivalences and entailments, as I have specified in (24) and (25).

- 24) a. *resume* (t, e0/1) \Leftrightarrow *stop* (t, e1/0)
 b. *not resume* (t, e0/1) \Leftrightarrow *keep* (t, e1/0)
 c. *keep* (t, e1/0) \Leftrightarrow *not stop* (t, e1/0)
 d. *resume* (t, e0/1) \Leftrightarrow *not end* (t, e0/1)
- 25) a. *resume* - left and right increasing
 $resume(t, e), t \leq t' \Rightarrow resume(t', e)$
 $resume(t, e), e \text{ is part of } e' \Rightarrow resume(t, e')$
 b. *stop* - left increasing, right decreasing
 $stop(t, e), t \leq t' \Rightarrow stop(t', e)$
 $stop(t, e), e' \text{ is part of } e \Rightarrow stop(t, e')$
 c. *keep* - left decreasing, right increasing
 $keep(t, e), t' \leq t \Rightarrow keep(t', e)$
 $keep(t, e), e \text{ is part of } e' \Rightarrow keep(t, e')$
 d. *end/cease/terminate/halt* - left decreasing, right decreasing (achievement)
 $end(t, e), t' \leq t \Rightarrow end(t', e)$
 $end(t, e), e' \text{ is part of } e \Rightarrow end(t, e')$

Note again that the event-internal aspectual verbs take only gerundive complements, and if they occur with infinitival clauses they must be purpose clauses in Adjunct position to VP.

Another noteworthy feature of these verbs is that they cannot take ordinary count NPs, unless they are commonly understood as temporally extended, changing over time and hence divisible objects. A concert is such a temporally extended object, though it is a real count noun, but a book or an apple is not temporally extended in this sense. There are lots of nouns which may be taken in either way, e.g. a program is either a static description of a set of actions or a procedure a computer can execute. The two senses are clearly related in a way that could be spelled out along the lines developed here. Strangely, the universal *keep* seems to be an exception to this. It takes any count NP in object position of the main verb, but it is also the only event-internal aspectual verb which has an obligatory gerundive. This must be indicative of a meaningful relation between these two exceptional properties of *keep*, but I have not been able to formulate an insightful explanation yet. Bare

predicative plurals and mass terms are also acceptable object NPs for the event-internal aspectual verbs, being divisible, as illustrated in (26).

- (26) a. John resumed pot/the concert/*the apple
 b. John kept drinking milk/ a glass of milk/playing the sonata
 c. John stopped (with) poetry/ * a poem
 d. John ended/terminated/halted the affair/*the apple/the music

Now we have two squares, one for the event-external aspectual verbs, one for the event-internal ones. How can they be related?

We have already seen that *stop* is the internal negation of *start*, just as *finish*, but that *stop* presupposes that the event is started and an immediately preceding positive stage exists. *Finish* only presupposes that there is at least one distinct earlier realization of the same event-type. You can finish something even though you have not done it for a while, but you cannot stop doing something unless you are right there doing it. So *finish* admits gapping over time, *stop* does not. If *stop* is the internal negation of *start* with the additional presupposition that the event is started, we can relate the two squares in a three-dimensional diagram by flipping the event-internal diagram along its vertical axis, as in figure 4.

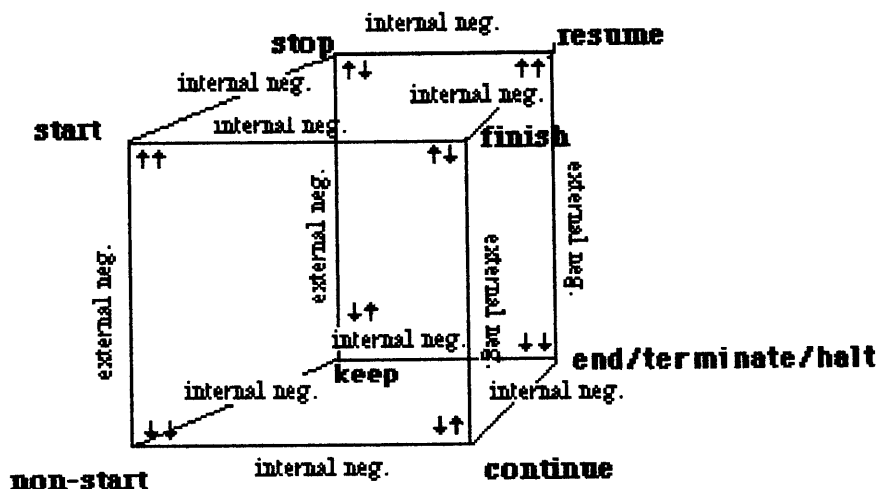


Figure 4. Three-dimensional square of aspectual quantifiers

It is now easy to check that the other internal negations work as polarity reversal.

- (27) a. *stop* (t, e1/0) \Leftrightarrow *start* (t, e0/1)
 b. *resume* (t, e1/0) \Leftrightarrow *finish* (t, e0/1)
 c. *not resume* (t, e1/0) \Leftrightarrow *continue* (t, e0/1)
 d. *keep* (t, e1/0) \Leftrightarrow *not start* (t, e0/1)

Furthermore a diagonal across the top from *start* to *resume* or *begin again* is equivalent to going from *start* to *stop* to *resume*, and if it did not go through *stop*, it would simply be *start* entailing *begin*. Similarly *continue* entails *keep* - the entailments across the diagonal over the top and the bottom are from the front event-external quantification to the back event-internal quantification.

It is immediate now that to resume a positive event presupposes you start it and stop it first. Similarly, to finish an event presupposes to start it and perhaps stop and resume it first. Or you end an event, by first starting it, then non-starting the negative counterpart, which is equivalent to keeping the positive event going on, and then you end it. Any transition through the diagram represents a valid

inference, if we make sure to enter in *start* and switch polarity of the embedded event when passing an internal negation and exit in *finish* or *end*.

To appreciate the full explanatory power of this diagram observe that the left side, consisting of *start*, *stop*, *keep* (and *non-start*), is the square of exactly the causative aspectual verbs with free agent arguments in the event-type. The right side, consisting of *finish*, *resume*, *end/terminate/halt*, *continue* is the square of just the non-causative ones which require that the agent of the embedded event-type be referentially dependent upon the agent of the aspectual verb. Such constraints on thematic role assignments are needed prior to determining anaphoric linking.

A last remark on these squares. Note that in the case of an achievement verb, like *knock*, *jump*, *arrive*, intuitively denoting atomic, i.e. indivisible events within the given perspective, the entire structure collapses into a topological point just like proper names do in the case of NPs as generalized quantifiers, i.e. they are both self-dual quantifiers. This accounts naturally for the fact that achievement-verbs are either blocked from complementing aspectual verbs or force an iterative or accomplishment-interpretation as in (28).

- (28) a. *John/ ?the Pope began to arrive
 b. People began to arrive
 c. John finished jumping

5. Semantic automata for aspectual quantifiers

The semantic automata designed by Johan van Benthem for NPs (see van Benthem 1986) as GQs can be applied to the aspectual verbs. It shows how the internal-external duality of the figure 4 can be represented by corresponding finite state automata. The main result here is that the presuppositions of the event-internal aspectual verbs are compositionally obtained from the simple machines for the external ones, accounting neatly for the projections of presuppositions of aspectual verbs.

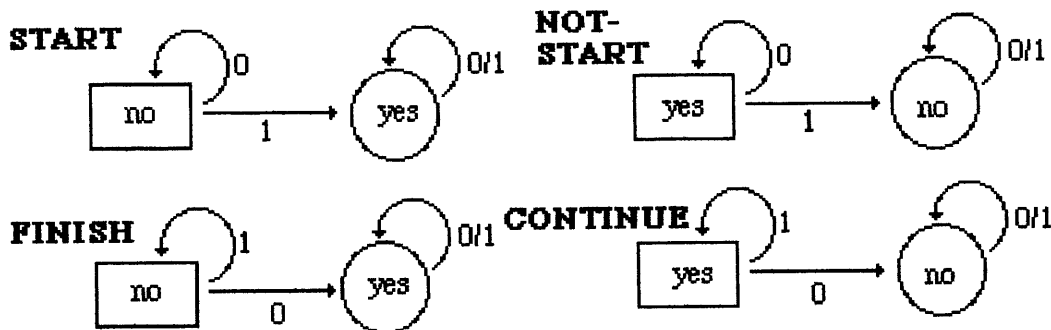


Figure 5. Automata for event-external aspectual verbs

In fig. 5 the starting-state for all machines is the square on the left, and the halting state the circle on the right. 'Yes' indicates the accepting state and 'No' the rejecting state. For the *START*-automaton you scan the event with negative polarity, rejecting until you find the first instance of the event with a positive polarity and you go into the accepting halting state. It is easy to see that if we scan individuals

rather than polarities of events, the same machine would work, for what matters to an existential quantifier is that you find at least one positive instance of the predicate you are testing for. The other automata for event-external aspectual verbs are easy to construct once you know that internal negation switches the 0 and 1 on the arrows, and external negation switches accepting and rejecting state. So the automaton for *finish* starts with checking positive instances and keeps rejecting until you get a negative instance, which means the event has come to an end. The presupposition of *finish*, i.e. that there is at least one earlier stage of the same event-type in the representation, is indirectly captured by the fact that the from its starting state you reject as long as the event polarity remains positive. It is not necessary to require that there must be at least one realization of the event with positive polarity, because we do use *finish* sometimes in contexts where the event is clearly not started. For instance, I ask my three-year old son whether he has finished his breakfast, even when it is clear to both of us that he has not touched it, but has had ample opportunity to do so. The semantic characteristic of *finish* (and internally negated existentials) is that *if* there are positive instances the verb or quantifier is rejected (falsified), but as soon as there is a negative instance, the verb (or quantifier) is accepted. Note that the automaton for *continue* does require at least one positive instance of the event, since it does not accept or reject until you've passed the 1-loop once. In that precise sense *continue* has a stronger presupposition than *finish*.

Creating an automaton for an event-internal aspectual verb is by constructing the automata for each node you pass from *start* until you reach the intended node in the backwall of the three-dimensional square. The automata for prior nodes then get 'pushed down' into a stack of sub-machines. For example, we can get the automaton for *stop* by embedding the *start* - machine into the starting-state of the machine for *finish* as in fig. 6 (*finish* and *stop* have the same monotonicity properties, fig. 4.).

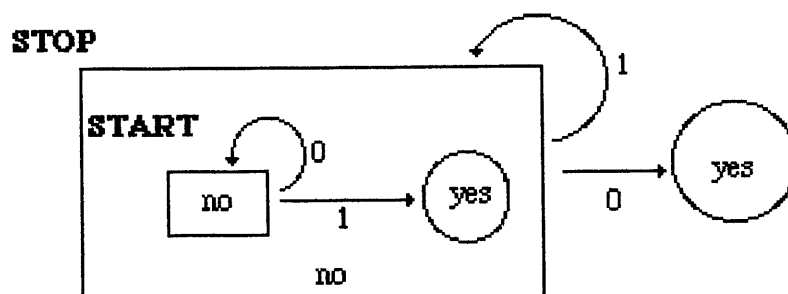


Figure 6. Automaton for event-internal *stop*

The same embedding of presupposed automata by compiling the four simple ones is carried out in figure 7 for the event-internal *resume* as $resume(t, e) = start(finish(start(t, e)))$. Hence the procedure for designing automata for all aspectual verbs is algorithmic, once we have established the three-dimensional square and the four elementary machines.

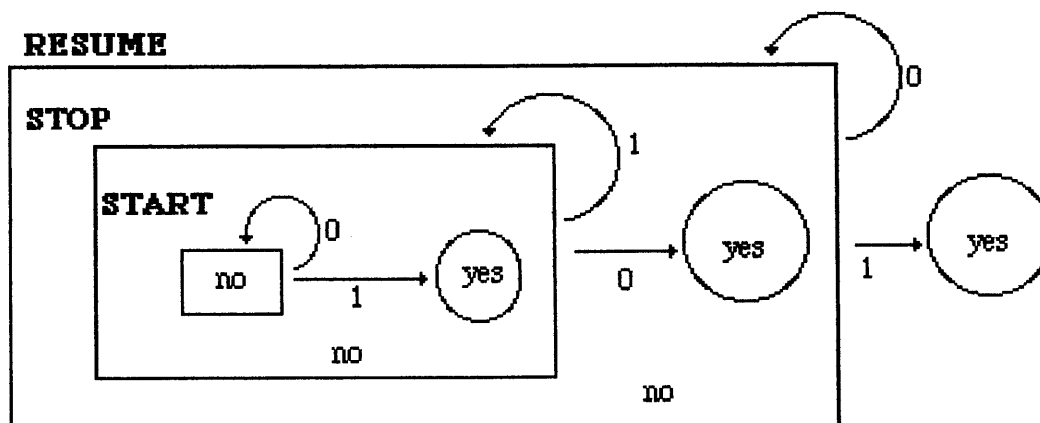


Figure 7. Automaton for event-internal *resume*

More speculatively I may conclude here suggesting that this study of aspectual verbs throws some new light on NPs as generalized quantifiers, on the relations between individuals and the quantities of stuff that constitutes them, and hence on the deep questions of identity and individuation. For more the mathematically minded this analysis may provide an interesting view of the interaction between continuous domains and discrete ones, and further a measure of complexity of quantificational structures, determined by the degree of embedding of submachines.

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