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A Motor- and Image-Schematic Analysis of Aspectual Composition

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Abstract

This work addresses the complexities involved in aspectual composition by presenting a cognitively motivated analysis that makes use of active event representations. Verbs, arguments and temporal modifiers are characterized in terms of the conceptual features they impose or contribute to this framework, which employs representations of both motor-schematic and image-schematic change. By accommodating the inherently dynamic nature of temporal events and resource usage, this framework can not only make standard aspectual distinctions (e.g. between states and processes, or between perfective and imperfective processes) but also provide simple analyses of usually difficult aspectual phenomena. The representation also illuminates the interaction between event structure and nominals, which can instantiate pieces of the image-schematic representation or otherwise constrain possible interpretations. Cognitive explanations of event structure distinctions are made more concrete by illustration in the context of the Neural Theory of Language modeling project at the International Computer Science Institute (Feldman *et al.* 1996).

1 The problem

Aspect is a sentence-level phenomenon, not a verb-level one: as has long been observed, not only do different verbs yield different aspectual interpretations, but the same verb combined with different arguments or modifiers will vary in acceptability, as the sentences in (1) demonstrate:[1]

(1) a. She ran for an hour.
*She ran in an hour.

b. #She ran to the park for an hour. *[forced iterative reading]*
She ran to the park in an hour.

c. #She ran a mile for an hour. *[forced iterative reading]*
She ran a mile in an hour.

d. #She ran from here to there for an hour. *[forced iterative reading]*
She ran from here to there in an hour.

e. She ran laps for an hour.
*She ran laps in an hour.

The task of determining when a verb can appear with temporal modifying phrases like *for an hour* and *in an hour* is complicated by the presence of complements; *run* can appear in the past tense with *for an hour* but not *in an hour*, in neither case requiring any special interpretation. But in examples (1b-d), *in an hour* can combine naturally with each verb phrase, while *for an hour* can be accepted only under a special iterative reading. Not all complements affect interpretation in this manner, however, as shown in (1e).

The complexity is not limited to simple acceptability under natural and special interpretations: temporal modifiers need something to modify, giving rise to issues of attachment:

(2) a. She loved him for five years. *[modifies period of loving]*

b. She ran for five minutes. *[modifies period of running]*

c. #She sneezed for a few minutes. *[modifies period of repeated sneezing]*

d. She read the book for an hour. *[modifies period of reading, book unfinished]*
She read the book in an hour. *[modifies period of reading, book finished]*

e. She left the room for an hour. *[modifies period after having left, before returning]*
@She left the room in an hour. *[modifies period up to and including leaving]*

f. *She won the race for a few minutes. *[cannot modify period of winning or (?) period after having won]*
She won the race in a few minutes. *[modifies period up to and including winning]*

It may seem uncontroversial to conclude from (2a) and (2b) that phrases of the form ***V**-ed for **time*** make assertions about the duration of the specified activity of ***V**-ing*, even if it happens to be a repeated activity, as in (2c). The other examples in (2) show otherwise: despite identical syntactic structure, (2d) and (2e) display a striking inconsistency between both the period modified and the inferences licensed. We cannot describe the period modified in (2d) as "the period after having read," nor even "the period after having read the book," but just such a statement is necessary to capture the modified period of (2e). The effect of temporal modifiers on high-level inferences like whether the book has been finished or whether the person returned after leaving pose equally challenging puzzles. Judgments become even more muddled upon taking into account examples like (2f), which behaves like (2e) with *in a few minutes* but inhibits a natural reading with *for a few minutes*.[2]

Lest we infer that issues of aspectual composition crop up only at the level of the verb phrase, it has also been observed that judgments as basic as whether verbs can appear in present tense (examples in (3a)) or

[1] Throughout this paper the standard asterisk (*) notation for linguistic unacceptability will be used. In addition to a loose use of ? for questionable or variable acceptability, several other symbols will indicate acceptability conditional on a particular interpretation: # denotes an *iterative* reading, % denotes a *habitual* reading and @ denotes an *inceptive* reading; these readings will be further discussed in Section 2.1.

[2] As with most acceptability judgments, a somewhat strained interpretation might be available with enough extra context (e.g. a photo-finish judgment eventually stripping the erstwhile winner of her title). Some constraints still appear inviolable, however; the *for a few minutes* cannot modify the period before winning the race, and if applied in a context-laden manner to the period after winning, some kind of reversal of the state is required.

progressive form (examples in (3b)) show susceptibility to the nature of the subject:[3]

(3) a. %She runs from here to there. *[forced habitual reading]*
The road runs from here to there.

b. She is running from here to there.
*The road is running from here to there.

Again, otherwise identical sentences produce differing readings and acceptability, suggesting that semantic features of the subject argument wield at least some influence on aspectual interpretation.

Although such linguistic phenomena have been widely noted in the literature, previous attempts at handling aspect have fallen short of providing a unified, compositional account that is not only descriptively adequate but also cognitively motivated. After a brief overview of the basic issues and distinctions established by major previous work in the field, I propose a framework for analyzing aspectual mechanisms in terms of basic cognitive processes. Verbs, arguments and temporal modifiers are all characterized in terms of the conceptual features they impose on or contribute to this framework. This approach owes much to foundational work by Langacker (1991), but it draws on observations from the logical tradition to make some additional specific claims about the nature of event structure and compositionality. Where possible, cognitive explanations are made more concrete by illustration in the context of the L_0 language acquisition project (Feldman *et al.* 1996), thus addressing at a level of detail amenable to computational modeling the issue of precisely how aspectual composition takes place.[4]

2 Background: linguistic phenomena

2.1 Some aspectual distinctions

Any discussion of aspect requires a clear understanding of the range of semantic distinctions it encompasses. Broadly construed, *aspect* refers to the internal shape of an event, or how it is distributed over time.[5] Attempts to provide a precise characterization of these event differences have demonstrated the difficulty of the task: different works have used different terminology, or, worse, the same terminology with different definitions. Perhaps the two aspectual oppositions that have borne the brunt of this terminology overload are the following:

- A **perfective** event usually denotes one that is seen as bounded, complete and not internally analyzed or analyzable; it is viewed from an external perspective. An **imperfective** event is seen as still in progress (like *progressives*, discussed below) with no specific boundary, viewed from an internal, incomplete perspective. *She ran a mile* is thus perfective, while *She ran (for an hour)* is imperfective.

- A **telic** event is usually goal-oriented, with a well-defined endpoint or result; an **atelic** event lacks a specific goal or endpoint.[6] In the telic *She ran to the park*, the park is the clear goal, and being in the park is the goal state, both of which are lacked by the atelic *She ran in the park*. Note that an event can be described as being telic regardless of whether the goal is ever reached.

The imperfective/perfective and telic/atelic distinctions are often conflated, but they are by no means redundant categorizations; an event could be both telic and imperfective, as in *She was running to the park*.

A few other useful aspectual distinctions are noted here:

[3] This paper will not consider other conditions allowing verbs to appear in present tense, most notably performatives (*I pronounce you man and wife*) and other verbs that describe events that are temporally coincident with the utterance. This condition is relaxed under certain conditions, including play-by-play accounts (e.g. *He shoots! He scores!*) and historical or future present tense; see Dowty (1979) for further discussion.

[4] By no means does this paper purport to present an exhaustive examination of the large body of work in logical approaches to aspect. Rather, it focuses on the contributions of a few major works and their relevance to the development of a cognitively motivated understanding of aspectual composition. Future work should certainly include a comprehensive comparison of recent logical work and the approach discussed here.

[5] It is distinct from tense, although the two exercise significant mutual influence.

[6] Though presence of a goal is distinct from presence of an endpoint or result, both have appeared in discussions of telicity in the literature.

- The **punctual/durative** opposition is based on perceived duration; punctual events take place at a particular point in time (e.g. *She left, He sneezed (at once, at that point)*), while durative events require some period of time (e.g. *She ran for an hour, He built a house*).

- An **iterative** reading is based on perceived repetition within the event; iterative events have internal cyclic activity, while non-iterative events can be seen as single and non-cyclic. Thus *John sneezed* describes a single event with no repetition, but *John sneezed for an hour* implies that he repeatedly sneezed during that time. Some verbs are inherently iterative, such as *scrub* in *John scrubbed the dishes.*

- A **habitual** reading profiles the regular recurrence of an event over an interval and can be considered an extension from an external point of view (as opposed to the progressive marking, below). In English, present habitual aspect can be conveyed by the present tense (*She runs (every morning)*), whereas past habitual aspect is best captured with *used to*, as in *She used to run (every morning).*

- An **inceptive** reading involves the beginning of an activity, as in constructions like *start* ***V****-ing.* With an inceptive reading, *She left in 10 minutes* can be interpreted as roughly synonymous with *It took her 10 minutes to leave.*

- A **progressive** reading predicates the ongoing, continuous nature of an event, which is extended from an internal point of view. (Note that in English a progressive reading is a phenomenon of both tense and aspect.) A progressive marking can entail at least three other aspects:

  (4) a. Mary is running from here to there. *[imperfective]*
  b. Mary is bumping her head. *[iterative]*
  c. Mary is living in Texas. *[transient/non-permanent]*

  One of the tasks of aspectual theory is to account for differing interpretations like those in (4); these will be discussed later.

2.2 Aspectual classes

This section provides a brief overview of some of the major work in aspect and the difficulties faced by aspectual accounts. Most approaches have attempted to capture the distinctions just described by assigning each verb an aspectual class; regularities across semantic interpretations in particular contexts can then be stated over these classes. Although the study of aspect stretches back at least as far back as Aristotle, modern approaches began with Vendler (1967), whose classification of verbs and verb phrases into four aspectual classes have stubbornly resisted being supplanted by the refinements proposed in subsequent work, despite no shortage of criticism. The Vendler classes and some representative examples are given below:

state true of any instant (in given interval), e.g. *love, know, resemble*

activity true of any interval (in given interval), e.g. *run, walk, swim*

accomplishment true of a specific interval, e.g. *draw a circle, paint a picture, build a house*

achievement true of a specific instant, e.g. *win a race, reach the summit, die*

Vendler's classification is based largely on the two dimensions of duration and specificity: activities and accomplishments are predicated of intervals, while states and achievements are predicated of instants; states and activities are predicated of any time (instant or interval) in a given interval, and accomplishments and achievements are predicated of specific times. Additional criteria include combinatorial properties with temporal adverbial modifiers (the *for* ***time*** and *in* ***time*** phrases mentioned already), logical entailments (such as whether having ***V****-ed for* ***time*** implies having ***V****-ed*, or whether ***V****-ing* implies having ***V****-ed* for any time) and appearance in particular linguistic constructions. For instance, states appear to resist both progressive form and constructions imputing agency or voluntary control (like *stop/start* ***V****-ing.*

(5) a. *I am knowing the answer.
*She is liking him.
b. *Stop knowing the answer.
*Stop being eight feet long.

Yet even these apparently robust generalizations display sensitivity to a variety of contextual factors, as discussed by Verkuyl (1993) and others. In particular, temporary or non-persistent readings (examples in (6a)) and states that are perceived as requiring effort or voluntary control (examples in (6b)) receive perfectly natural interpretations:

(6) a. I am living in Amherst.
She is standing by the Nile.
He is liking his teacher more and more.
b. Stop being a fool.
Stop being a workaholic.

Despite these and other inconsistencies to which such generalizations fall prey, accounts since Vendler (Comrie (1976), Dowty (1979), Mourelatos (1981) and Moens & Steedman (1988), to name just a few) have been nearly unanimous in adopting Vendler's *state* and *activity* classes, though the latter is usually termed *process*. The more complex event types, however, have given rise to a proliferation of class names, representations and semantic distinctions, many of which attempt to characterize qualitative aspectual distinctions of the sort described in Section 2.1.

But classes that are, like Vendler's, based on truth values of predicates at particular time periods face a significant stumbling block: aspectual phenomena have to do not with *temporal* structure but with *event* structure. This point is underscored by the difficulty many such theories face in explaining Dowty's Imperfective Paradox:

(7) a. John was walking. *[⇒ John walked]*
b. John was walking to the park. *[↛ John walked to the park]*

The same description of a state in the world may be described by a large number of sentences, each with a different aspectual flavor; (7a) and (7b) can describe the same walking event, but they behave differently with respect to the logical entailment test of whether ***V-ing*** implies having ***V-ed***.

Challenges along similar lines arise in determining the effect of nominals on aspectual behavior, as noted in Section 1; Verkuyl (1993) and Krifka (1992) have addressed these challenges in terms of the homogeneity of the object and how thematic relations depend on interaction with the temporal structure of the verb. Some examples like those raised by Verkuyl are given here:

(8) a. #She ate {a sandwich/three sandwiches} for an hour. *[count noun: forced iterative reading]*
She ate {a sandwich/three sandwiches} in an hour.
b. She ate {sandwiches/cheese/from the cheese} for an hour. *[mass noun]*
?@She ate {sandwiches/cheese/from the cheese} in an hour.
c. #She ate {some sandwiches/more than one sandwich/ *[quantified nouns: forced iterative reading]*
a pound of cheese} for an hour.
She ate {some sandwiches/more than one sandwich/
a pound of cheese} in an hour.
d. #She ate the cheese for an hour. *[specified mass noun: modifies period of eating, cheese unfinished]*
She ate the cheese in an hour. *[specified mass noun: modifies period of eating, cheese finished]*

Combination of the verb *eat* with count nouns like *a sandwich* and *three sandwiches* in (8a) produces perfective, telic readings, as opposed to the imperfective, atelic readings produced by the bare plural *sandwiches* and mass noun *cheese* in (8b). But the examples in (8c) and (8d) show that phrases like *some sandwiches* and *more than one sandwich*, though inexact in their quantification, nevertheless behave aspectually like count nouns, as does a mass noun like *cheese* when it is quantified or has a definite article.

2.3 Some observations

It seems clear that an adequate account of aspectual behavior minimally requires a notion of **event structure** that captures both the temporal ordering of its subevents and the causal or intentional relationships among them. Such a notion of internal event structure and *contingency* appears in, for instance, Moens & Steedman (1988): Vendler's accomplishments are analyzed as including a *preparatory process*, a *culmination* point and a *consequent state*; Vendler's achievements are similar but contain no preparatory process. This analysis provides a more motivated basis for understanding the behavior of temporal modifiers, which can focus attention on a particular subevent or effect a kind of lexical or aspectual *coercion* on the event overall. A punctual verb like *sneeze*, for instance, can be coerced into an atelic process by the imposition of an iterative reading, and thus provide appropriate input for modification by a *for* ***time*** phrase.

Event structure alone will not, however, suffice. A quick review of the example sentences presented so far yields a number of other critical factors that can constrain aspectual interpretation and the coercion of special readings. Among these are: presence of intention, effort or control in the subject; time scale (typical duration of an event); permanence or transience of an event or agent; boundedness (mass/count nature) of a nominal; and, of course, telicity. Although most theories of aspect have attempted to characterize some of these factors (notably telicity and noun quantity features), it is unclear whether any of them provides a unified framework for addressing all of them without having to resort to *ad hoc* features or rules that are otherwise unmotivated. The remainder of this paper attempts to provide such a unified and motivated framework, using principles from Langacker's (1991) Cognitive Grammar as a starting point.

3 A cognitively motivated approach

Cognitive approaches to grammar make a number of assumptions about the nature of language that depart in crucial ways from traditional approaches. These assumptions are described in great detail in Langacker (1991); for current purposes it will suffice to provide a broad overview of these grounding principles so that their consequences for aspectual phenomena can then be examined.

3.1 Insights from Cognitive Grammar

Cognitive Grammar takes seriously the hypothesis that the ability to use and understand language is intimately connected with the nature of cognitive processing. That is, meaning must be characterized relative to how humans conceive of the world: how we structure our knowledge of entities and events into categories (as in Lakoff's (1987) *radial categories*, with members that diverge in principled ways from central prototypes); how we structure situational knowledge into particular cognitive domains (akin to the *mental spaces* of Fauconnier (1985)); and how we impose a particular **construal** on a situation that is only partially constrained by its "objective" properties. The investigation of these claims has given rise to the postulation of a number of specific cognitive mechanisms and distinctions:

- Objects and events in the world do not fall neatly into strictly defined categories and types, and neither do linguistic elements; rather, they provide specific interrelated senses over which generalizations can be made. **Schemas** are abstract representations of these generalizations, which may be further **elaborated** or instantiated.

- **Principles of construal** include: the ability to distinguish between **trajector** and **landmark** (similar to a figure/ground distinction); the ability to **profile** some part of a whole (as necessary to define, for instance, *hypotenuse* with respect to a right triangle); sensitivity to **scope of predication**, **specificity** and **perspective**; and the ability to employ either **summary** or **sequential** scanning of a situation (discussed in Section 3.2.1).

- Linguistic expressions are either **nominal** or **relational** predications. Nominal predications profile some entity, which can be seen as either a **bounded** or **unbounded** region in some domain, and can be internally **homogeneous** or **heterogeneous**.

Relational predications profile the interconnections between a set of entities and can be either **atemporal** or **temporal**. Temporal relations (**processes**) are made up of a series of atemporal relations; like nominals, processes can be seen as either bounded or unbounded, and internally homogeneous or heterogeneous.

These mechanisms prove quite useful for characterizing the nature of events and motivating some aspectual phenomena. In particular, Langacker describes verbs as profiling some relation over time, providing a natural basis for the ubiquitous state/process distinction: stative events are simply the extension of a particular relation over time, while processes involve a relation that changes over time. This change can be either homogeneous or heterogeneous; Langacker defines homogeneous as "effectively" identical, which I will characterize more precisely in Section 4.2.1. This division controls the classification of processes as either *imperfective* or *perfective*, analogous to a basic distinction proposed in most other theories (e.g. telic/atelic, or Vendler's activities/accomplishments) but motivated by the larger Cognitive Grammar framework.

Note that the change over time can also be described in terms of trajectories and goal states: although all processes involve change or a trajectory of some kind in the time domain, only perfective processes have a second trajectory along some other primary domain to a specific final, goal state. Determining perfectivity, therefore, as well as acceptability of temporal modification, is largely a matter of identifying a valid second trajectory and goal state, based on the nature of both the process and its participants. In other words, the task of accounting for aspectual composition can be recast as specifying how each component contributes to and constrains the overall schema (or **image schema**[7]) and potential trajectories.

While Langacker does not address all the issues and phenomena involved in aspectual composition (particularly with respect to temporal modification), his analysis lends itself well to such a specification. Adopting Langacker's formulation, I cast verbs as describing change (or lack thereof) over time; the lexically specified nature of this change will be discussed in Section 3.4. At a schematic level, however, the notion of final state of this change is sufficient for describing the effect of composition with nominals and temporal modifiers. Section 3.2 describes how nominal arguments constrain interpretation: subjects (usually trajectors[8]) help determine the way events change over time, while objects (usually landmarks of some kind) help determine the way events change over some other dimension, or move along a trajectory toward a well-defined goal state. It is the presence and nature of such a goal state that determines when and how temporal modifiers (as well as progressive form) can legitimately apply, as described in Section 3.3.

3.2 The role of arguments

3.2.1 Subjects and the state/process distinction

> SUBJECTS instantiate the trajector in the image schema representing an event; depending on the relation depicted and the type of scanning employed, features of the subject (such as animacy) can help determine the presence of change over time. They are therefore most influential in distinguishing states and processes and consequently constraining the appearance of a verb in progressive tense.

Casting the state/process distinction in terms of change over time sheds considerable light on the role of subjects, since the nature of the subject/trajector may determine whether the entire conceptualization of the event changes over time:

(9) a. %Sally goes from Phoenix to Tuscon. *[forced habitual reading]*
Sally is going from Phoenix to Tuscon. *[process]*

b. The road goes from Phoenix to Tuscon. *[state]*
*The road is going from Phoenix to Tuscon. *[*process]*

[7] Langacker uses the term *schema* to refer to representations of both nominal and relational predications; I will use the term *image schema* (as in Lakoff (1987) and elsewhere) to refer specifically to relational predications, especially in the context of the representation of an event.

[8] Subjects usually but not always correspond to trajectors; Langacker analyzes the passive voice as effecting a reversal of trajector and landmark. For this paper we will assume that subject corresponds to trajector. Object often corresponds to landmark, but not always, as will be discussed in Section 3.2.2.

In (9a), disregarding the special habitual reading, we conceive of the subject moving from one place to another in a sequence of relations that must change over time. In (9b), however, the same physical path is reified as a trajector whose location is specified; here the relation is stable over time, and indeed cannot be interpreted as changing over time. The same verb *go* thus allows either a stative or a processual reading, depending on how the entities involved constrain possible construals.

In addition, Langacker postulates two kinds of cognitive processing: in sequential scanning, a situation is viewed as it progresses (or stays the same, as the case may be) from one time step to another; in summary scanning, the situation is viewed in a cumulative fashion. These different processing modes can account for the related senses of *surround* in (10), in particular the acceptability of both examples in (10b):

(10) a.	The moat surrounds the castle.	*[state]*
	*The moat is surrounding the castle.	*[*process]*
b.	Soldiers surround the castle.	*[state; summary scanning]*
	Soldiers are surrounding the castle.	*[process; sequential scanning]*

The soldiers can be viewed as either actively surrounding the castle or, having already surrounded it, together comprising a trajector in a relation that can be seen as stable over time.[9]

3.2.2 Objects and image schema instantiation

> OBJECTS can instantiate or otherwise provide elements of the image schema other than the trajector, including the goal and background; depending on the nature of the process depicted, features of the object (such as boundedness, homogeneity and specificity) can help determine the presence of change over a non-temporal primary dimension. They are therefore most influential in distinguishing imperfective and perfective processes and consequently constraining the appearance and interpretation of temporal modifiers.

Objects in Cognitive Grammar are usually seen as corresponding to landmarks in image schemas, in opposition to active, profiled trajectors. The term *landmark*, however, should be clarified, since it conflates two possible senses with quite different implications for the determination of trajectories. In the broader context of Langacker's discussion of transitivity and grammatical relations, the notion of an *action chain* captures the transfer of energy from an energy source, (potentially) through agents of energy transfer and on into an energy sink. Subjects sit at the heads (source) of the action chain, while (direct) objects tend to occupy a "downstream" position in the chain. In this usage, then, *landmark* applies to the recipient of force.

For the purposes of identifying a trajectory and final state, however, it is not energy transfer but movement toward a goal that is important. I will thus use *goal* to refer to a particular kind of landmark, one toward which the trajector is moving in some domain. Note that both direct objects and prepositional objects can provide this goal, though in different ways: the prepositional object in *walk to the park* itself provides the goal, while the direct object in *walk a mile* provides both a background for the motion and an abstract, implicit goal, the end of the mile. The object in *read a book* performs a similar function in a rather more abstract domain.

This kind of goal, also called an incremental theme, cannot be satisfied by all nominals. In general, only bounded (count) nominals can instantiate the goal, but as noted earlier in (8), quantification and specification (with a definite article) seem to make a difference. Thus even a mass noun like *cheese* can acquire a boundary, and the resulting nominal (e.g. *a pound of cheese*), though still internally homogeneous, is rendered bounded enough to provide a clear end point as the goal. When no such (bounded) goal is available, the object (either direct or prepositional) often merely provides an unbounded background, homogeneous mass that instantiates the background setting for the event without a distinct trajectory or goal, as in both *eat cheese* and *eat from the cheese*.

[9] Note that while the soldiers cannot be seen as identical over time, since they most likely do not remain in absolutely the same place at every moment, the (image-schematic) relation depicted by *surround* can persist over time. Note also that while the processual interpretation is the most salient reading for the progressive form, fictive motion may account for readings in which the progressive form describes a stable situation.

Note that an object may provide neither landmark nor background for movement. The classic example in Vendler (1967) is that of *push the cart*, whose object is both bounded (heterogeneous) and specified, yet behaves like other atelic activities:

(11) a. He pushed the cart for an hour.
b. ?@He pushed the cart in an hour. *[forced inceptive reading]*

The framework adopted here affords a simple explanation for this phenomenon: because the trajector (and energy source) represented by the subject in (11) is applying continuous force to the cart, the two participants are moving together over time. That is, there is no movement of the trajector *with respect to* the cart, which therefore cannot function as a goal in the sense of endpoint (even though it is a landmark in Langacker's sense for the application of force).

3.3 Requirements of temporal modifiers

Once the notion of perfectivity is defined in terms of boundedness and goals, characterizing the requirements and behavior of temporal modifiers becomes quite simple. This section provides a simple specification; compositional issues that arise when these modifiers are placed in particular contexts will be considered in detail in Section 4.

3.3.1 Span modifiers

> SPAN MODIFIERS of the form *in **time*** modify a relation by bounding it in a specified amount of time; this relation must be (construed as) a perfective process, i.e. one that is bounded in a non-temporal primary domain with a distinct goal.

Note that combination with verbs that lack a perfective process to modify usually results in either unacceptability or a (marked) inceptive reading, as in (10b) or (12):

(12) ?@Bill walked in an hour. *[forced inceptive reading: It took Bill an hour to walk.]*

This reading can be seen as a recasting of an imperfective process (walking) into a slightly different perfective event (starting to walk). That is, since a span modifier requires a perfective process, the absence of any such a process will lead to an alternative, perhaps less salient construal of the event that does satisfy the perfectivity requirement.

3.3.2 Durative modifiers

> DURATIVE MODIFIERS of the form *for **time*** modify a relation by bounding it within a specified amount of time, implicating that the relation ceases to hold at the end of the given time period. They thus also inhibit boundedness in the non-temporal primary domain and may implicate that the goal state is not reached.

The cessation of the relation may be viewed as either the *negation* of a state or the *halting* of a process:

(13) a. Bill loved Mary for years. *[⇒Bill no longer loved Mary after those years]*
b. Bill walked for five minutes. *[⇒Bill stopped walking after five minutes]*

The two forms of cessation can be treated uniformly if a notion of *process control*, to be discussed in the next section, is taken into account. Note that not all states can be negated; see discussion in Section 4.1.

3.4 Inherent verb semantics: What's in a verb?

Now that we have considered the semantic contributions of both nominals and temporal modifiers, we can can consider how to explicitly characterize the meanings of verbs beyond merely expressing change (or lack

thereof) over time. Specifically, inherent verb semantics must elaborate more precisely the type of this change, including at least three kinds:

- A basic definition for many verbs must rest on some specification of **motor control**: how the body *executes* a given action in terms of motor synergies and force dynamics (e.g. as discussed by Talmy (1988) and Bailey (1997)).
- Other verbs leave the actual execution unelaborated, instead placing constraints on **image schemas**, particularly by specifying image schemas that must apply before and after the profiled event. This provides a natural way to characterize the goal state. The verb *leave*, for instance, might entail that an image schema like that for *in* holds before some event, and that an image schema like that for *out* holds after the event. (Distinctions like this are present (in logical form) in Asher & Sablayrolles (1996).)
- Some verbs are specified relative to a notion of **process control** that captures their dynamic unfolding over time: processes can be started and stopped, or they can be in progress. A number of verbs are explicitly aspectual, like *stop*, *start* and *resume*; others must be specified in the context of some other verb (such as *stumble*, which is construed in terms of interruption of a walking process (Narayanan 1997)).

Any account of inherent verb meaning must somehow encompass all of these seemingly disparate varieties of change, and the specific context of aspectual composition is no exception. Indeed, the need to represent motor control, image schemas and process control has been implicit in a number of discussions already, including the determination of perfectivity, acceptability of progressive form and effect of durative modifiers. To accomplish this task in a unified manner using the cognitively motivated framework described so far, I draw on the computational approach to modeling aspect proposed by Narayanan (1997), which provides precisely the notion of process control needed, blended with a representation of motor control like that described in Bailey (1997).

Narayanan's computational approach to modeling aspect departs radically from previous theories in its active representation of verbal semantics: An *aspect processing net* (APN) captures both potential event structure and its interaction with resources (e.g. intentionality and energy) and time scale of reasoning. Successive *markings* (states) of the APN correspond to progress through an event, providing a natural basis for inference using the simulated course of events as recorded in the APN history and current state. Besides accounting for most lexicalized aspect (e.g. *start/stop* ***V-ing***, *used to* ***V***, etc.) and inferences involved in a number of other readings (including iterative, imperfective, progressive and perfective), the focus on the dynamic nature of verbal semantics demands and produces a model rich enough to capture a wide range of contextual effects. Thus far, however, it has dealt with only verb-level aspectual phenomena, not the sentence-level compositional issues that have been described here, and has concentrated on the process class of verbal semantics.

The models provided in the next section are intended to augment the APN with insights from cognitive theories to address the compositional issues described. To that end, they integrate the notions of *type of change* (motor- or image-schematic) and process control with the already discussed notions of *domain of change* (temporal or non-temporal) in the following manner: verbs can be classed according to whether they assert **no change** (*state*), **continuous motor-schematic change** (*process*) or **discrete image-schematic change** (*transition*). The presence of a trajectory can be associated with motor-schematic change (conditional on the presence of a well-defined goal) and the presence of a goal state with image-schematic change. But since the two kinds of change are not mutually exclusive, their co-occurrence produces semantic distinctions that correspond to additional classes, both involving continuous change followed by a discrete change, either profiling both (*perfective process*) or just the discrete change (Vendler's achievements, here called *process-transitions*). This coarse division should not, however, be taken as yet another incarnation of Vendlerian labels; each "class" will be given a precise specification in terms of variations on APNs, illustrating the relationship between different event types and motivating the inferences they sanction. This representation will demonstrate not only how the various compositional specifications described can be realized in a cognitively plausible way but also how the distinction between motor and image schemas can illuminate the larger issue of the relationship between action and perception.

4 Aspectual composition with cognitively motivated classes

This section describes in detail how each of the cognitively motivated aspectual classes interacts with arguments and temporal modifiers to account for the aspectual phenomena described so far.

The models used here mix variants of Narayanan's APN notation with a representation for image schemas. APNs are made up of *x-schemas*, an extension of the Petri Net formalism (Murata 1989). In this formalism, *places* (represented as circles) usually correspond to states, conditions or resources, and *transitions* (represented as rectangles) usually correspond to actions. I will dispense with their formal properties here, relying instead on informal discussions to clarify notation as it arises; see Narayanan (1997) for a more extensive description. Note that the APNs given here show only a subset of the standard APN, omitting for simplicity some elements not directly relevant to the current discussion. In some cases I have changed the labels of the APN as used by Narayanan to describe more intuitively the relevant state or action, but these don't affect its formal characteristics.

Correspondence between image schemas (usually in rounded boxes) and x-schemas will be depicted with double-headed unfilled arrows; these correspondences should not be taken as strong claims about the interaction of image schemas with x-schema notation, which is a subject of continuing research (as discussed in Section 5). As usual, tr and lm stand for trajector and landmark, respectively. (Landmark is used instead of goal to cover cases in which the goal role is unfulfilled.) Heavy lines indicate profiling, and dotted lines represent the lack of instantiation or binding.

4.1 States

> STATES are relations with no change of any kind over time. They persist over time but can be bounded by durative modification.
>
> Examples: *like, be, know, seem*; also positional relations *lie, sit*, etc.

Figure 1 shows some typical states in Cognitive Grammar-style representations; (a) is an abstract representation of the profiled relation between two entities in *John loves Mary*, while (b) depicts the more image-schematic situation in *The moat surrounds the castle.*

Figure 1: Image schemas for states: (a) *John loves Mary* and (b) *The moat surrounds the castle*

Such static relations can be easily represented in x-schema notation as a single place corresponding to a condition that holds, as in Figure 2(a). Alternatively, we can choose to see the holds condition as enabling a situation to PERSIST over time, as in Figure 2(b). Here the arrows represent passing of activation (in the form of *tokens*), and their cyclic configuration corresponds to the intuition that states can persist indefinitely. The advantage of this shift is that it facilitates the representation of states that do *not* persist indefinitely (as with durative modification) and states that require some resource as input (as with progressive marking).

Temporal modification of states

- **Span modifiers** can apply only if a marked inceptive reading can be found, in which case the state becomes more like a perfective process (described below). Thus *?He liked the class in three days* is most easily interpreted as *He began to like the class in three days.*
- **Durative modifiers** cause the relation to no longer be asserted after the specified time period, and possibly imply that the relation does not hold, as discussed in Section 3.3.2. The x-schema represen-

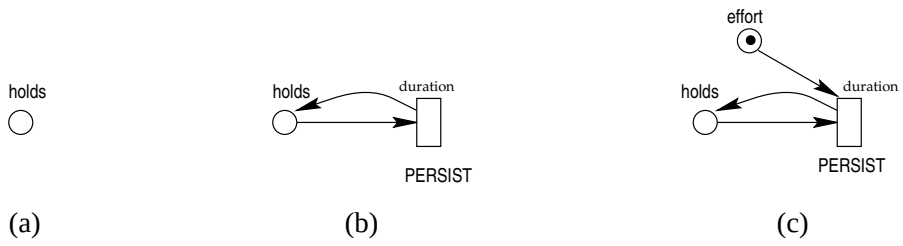

Figure 2: X-schema representations for STATE

tation in Figure 2(b) allows a **duration** of activation to attach to the PERSIST transition, as in *John loved Mary for five years.*

Progressive form of states

In general, states disallow progressive form. But verbs that normally depict stative events can allow progressive form in a number of circumstances, as mentioned earlier:

(14) a. Soliders are surrounding the castle. *[sequential scanning]*
b. He is liking his new teacher more and more. *[explicit change over time]*
c. John is being silly. *[effort/control/intention required]*
d. John is lying on the beach. *[non-persistence]*
e. The lamp is standing by the table. *[non-persistence]*

Note that these construals differ as to whether change over time is being asserted: (14a) and (14b) can be seen as changing over time (in degree of surrounding, or degree of liking, respectively) and thus are most simply handled under PROCESSES below. The other examples, however, involve more static situations, although both (14c) and (14d) involve at least minimal variation over time (e.g. in silliness or precise position on the beach). All three situations can be seen as non-persistent, either because something can cause the state to no longer hold (e.g. moving the lamp), or because some minimal effort needed to maintain the state is no longer available.

We can represent these cases with the addition of an input arc from an **effort** resource, as in Figure 1(c). This resource stands for a more general notion of required input conditions (e.g. intention, energy, control) necessary for the continued persistence of a state. We hypothesize that for states, progressive marking profiles (by way of an x-schema marking) the PERSIST transition (similar to the profiling of the PROCESS transition of the standard APN in Narayanan (1997)); to appear in progressive form, a state must be at least potentially temporary. That is, the requirement of effort, control or intention for the persistence of the state carries with it the implication that these resources can be depleted (e.g. energy) or ceased (e.g. intention) and thus cause the state to terminate.

This view of progressive form accounts for the restriction against sentences like **He was being tall* and the acceptance of *He was being funny*: in the former the **effort** arc is not a valid resource for the state to hold, but in the latter it is. It may also provide (in addition to the lack of a processual construal based on sequential scanning) an account for the restriction against inanimate subjects in progressive form, as in **The moat is surrounding the castle*, since the situation cannot normally be construed as temporary, and no effort is involved.

4.2 Processes

PROCESSES are sequences of relations with continuous motor schema changes over time. IMPERFECTIVE PROCESSES are homogeneous, with no distinct goal state, but a trajectory and goal state may be specified to produce a PERFECTIVE PROCESS.

Examples: *walk, swim, run, read*

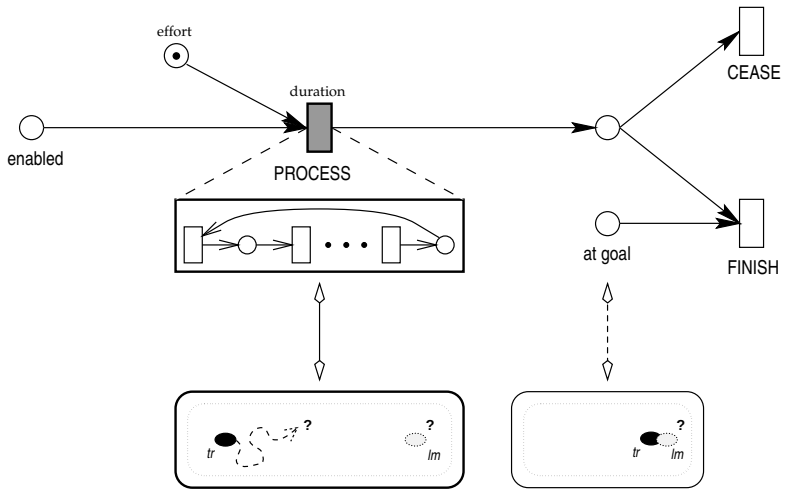

Figure 3: X-schema representation for PROCESS (imperfective)

4.2.1 Imperfective processes

(Imperfective) processes are represented in Figure 3 as profiling the subnet x-schema specified by the PROCESS transition of the APN, which always requires **effort** as a resource. The (effective) homogeneity of the motor activity itself is captured by the cyclic nature of the subnet; although the actual state of the subnet may change from one time step to another, the fact that it can continue indefinitely (as long as the PROCESS node is asserted to be activated) guarantees that the process is expansible in the same way mass nouns are.

If an image schema is activated, it is only partially instantiated; the trajector has no specified path or landmark, and certainly no goal state. The motor process entails that the trajector is moving, but we can distinguish change of **position** with respect to some background, which may be specified by an object, from change of **location** with respect to a goal. This potential background is here represented by the dotted boundary on the inside edge of the image schema. Prepositional phrases often specify a background:

(15) John ran around the field. *[field = background]*
John walked in the park. *[park = background]*

Mass nouns can specify background in a very similar fashion (*eat the cheese*, *eat from the cheese*). Note the case of *push the cart* mentioned in Section 3.2.2, where an object may furnish neither the goal nor the background but instead some secondary trajector.

Temporal modification of (imperfective) processes

- **Span modification** can take place only if the FINISH node can fire at the end of the specified duration. For imperfective processes, the node cannot fire, since no goal state is available or activated. (As with states, span modifiers may apply if a marked inceptive reading can be found, in which case the process becomes more like a perfective process.)
- **Durative modification** is straightforwardly represented by the **duration** on the PROCESS node; after that time, activity (and effort) ceases.

Progressive form of processes

In line with the hypothesis that progressive form requires the activation of an energy-consuming subnet (which can then be halted), processes all allow progressive form.

4.2.2 Perfective processes

PERFECTIVE PROCESSES are sequences of relations with continuous motor schema changes over time that define a trajectory toward a unique goal.

Examples: *walk to the park, read a book*

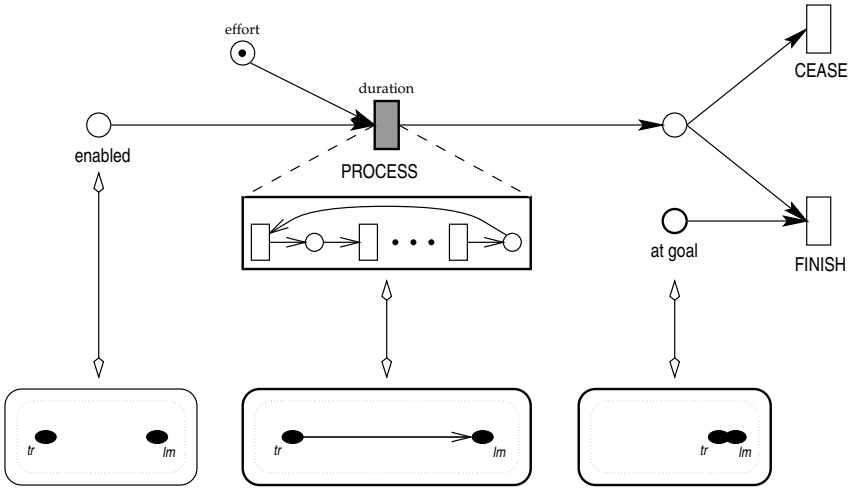

Figure 4: X-schema representation for PROCESS (perfective)

Perfective processes are simply processes whose image schemas also fulfill the requirements for a trajectory and goal, which are profiled, as shown in Figure 4. The instantiation of a goal at the end of a path (or extent) provides a final state in an image schema transformation, which takes place concurrently with the continuation of motor schema processing. Note that the initial image schema may be part of the enabling conditions for the process schema. In addition, the goal state is bound to or activates the at goal condition for firing the FINISH transition.

(16) John ran (is running) to the store. *[store = goal]*
John ran (is running) a mile. *[mile = extent/goal]*

The landmark/goal can be instantiated by a bounded object. Recall from Section 2.2, however, that either quantification or specification can render a mass noun into an acceptable goal state. Some relation thus seems to hold between being bound (instantiated) and being bounded (quantified/specified): both are necessary for a goal to exist.

Temporal modification of perfective processes

- **Span modifiers** apply naturally to perfective processes: the entire event, including final state, takes the specified amount of time.
- As with imperfective processes, **durative modifiers** activate the PROCESS subnet of a perfective process for the specified length of time; if the goal state has been attained when the activity ceases, the FINISH transition (in addition to the CEASE transition) is also enabled.

  Since perfective processes profile both a process and a final state, some attachment ambiguity might in theory apply to durative modification. In fact, however, durative modification of the final state does not seem to be allowed: in *Bill read the book for an hour*, the durative can modify only the (haltable) period of reading, not the state of having reached the end of the book. An explanation for this observation may lie in the fact that the durative can straightforwardly apply to the PROCESS

node (i.e. the reading process). On the other hand, it is not clear how to terminate the resulting state (e.g. of having read the book), which can't be reversed or negated in any sense. It is for this reason that neither the FINISH transition nor the CEASE transition automatically results in any distinctive new state.

Special case: verbs of creation

The fact that verbs of creation result in the existence of the object provides an explanation for the difference in judgments between (17a) and (17b), despite the seeming similarity of events:

(17) a. I read the book for an hour. *[reading ends, book unfinished]*
b. ?I wrote the book for an hour. *[verb of creation]*
c. I wrote poetry for an hour. *[verb of creation, mass noun]*

(18) a. I baked the cake for an hour. *[baking ends, cake unfinished]*
b. *I baked you the cake for an hour. *[verb of creation]*

The landmark in verbs of creation doesn't exist until the goal state of the perfective process is attained; further, durative modification profiles the PROCESS transition without asserting attainment of the goal. The product therefore does not yet exist and cannot take part in the relation asserted as having duration.[10] With the unbounded nominal in (17c), any amount of poetry can be construed as a relatively legitimate example of poetry, so the durative modification doesn't cause any conflicts.

A similar phenomenon in (18) demonstrates interaction with issues of argument structure: the dative construction in (18c) requires a recipient as well as the product of creation being received. Again, durative modification interrupts the creation of the product.

4.3 Transitions

TRANSITIONS are sequences of relations with discrete image schema changes over time involving change of location with respect to a landmark.

Examples: *leave (the office), enter (the room)*

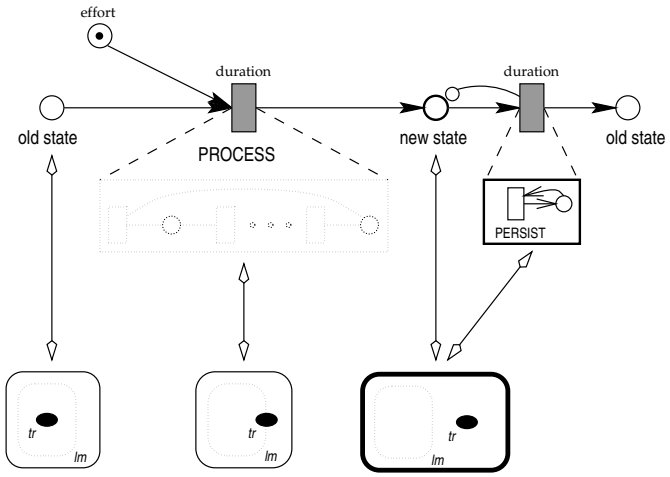

Figure 5: X-schema representation for TRANSITION

[10] Judgments seem to vary, however; some people find both readings acceptable, possibly because of some metonymic process that allows the unfinished product to stand for the finished product.

Transitions profile the new state that is produced by an unspecified process (as depicted by the lack of instantiation of the PROCESS node above in Figure 5). Image schemas are bound most strongly with the states before and after the unspecified process, and no particular trajectory is associated with the process itself (although note that one can be: *leave through the garden*). Instead, as the example of *leave* above suggests, some discrete intermediate state(s) (in this case, an essential boundary crossing condition) must bind to some stage of the unspecified process. Notice also that unlike perfective processes, whose goal must be instantiated, landmarks for transitions may be left implicit or uninstantiated.

Note that unlike the other classes described so far, transitions themselves have neither CEASE nor FINISH nodes (although the unspecified process subnets do). Instead, the completion of the action produces a new state, which can then itself persist and be modified much like a normal state.[11]

Temporal modification of transitions

- **Span modification** is slightly marked: *He left in five minutes* is acceptable only when seen as a process that took that long to execute or when seen as a period ended by his leaving; in either case, a perfective process may be inferred.
- **Durative modification** illustrates the "collapsed" nature of the unspecified process in its inability to modify the period before the goal state:

(19) a. She walked to the store for an hour. *[process: modifies period of walking, store unreached]*
b. She went to the store for an hour. *[transition: modifies period at store]*

The difference between processes and transitions, as exemplified by (19), is what durative modifiers terminate: the process (of walking or going), or the state (of being at the store). Durative modification requires a CEASE transition inhibiting the effort required to maintain a process and thus cannot describe the period before arriving at the store; at the level of the verb *go*, there is nothing to cease nor any access to the possible CEASE transition in the PROCESS subnet. Instead, the profiling of the newly created state provides a natural choice for the durative. Here, in line with the discussion of durative modification of states, the ending of the modified period must inhibit the state, which is most easily effected by a reversal of the transition and return to the previous state.

The salience or profiling of a transition may also be affected by a preposition:

(20) Bill passed through town for a few weeks. *[⇒no longer in town]*

Here the effect of *through* is strong enough to cause durative modification to modify an in intermediate state.

Progressive form of transitions

Progressive form is allowed, attaching to the unspecified (effortful) process; *I am leaving* refers most naturally to the process that results in leaving and cannot refer to the period resulting from leaving, nor can it license the inference that the speaker left.

Special case: Process-Transitions

> PROCESS-TRANSITIONS are sequences of relations with discrete image schema changes over time involving change of location with respect to a landmark (transition), preceded by a less salient sequence of relations with continuous motor schema changes over time that define a trajectory toward a unique goal (process).
>
> Examples: *win (the race), reach (the top)*

[11] For convenience the new state is shown here directly following the transition, but in a more elegant formulation (like in Narayanan (1997)) the transition APN would interact directly with a representation of world context.

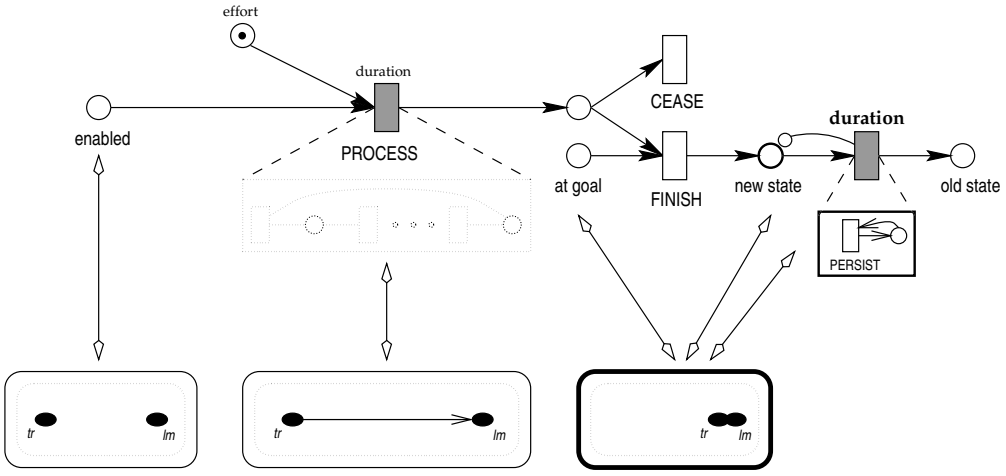

Figure 6: X-schema representation for PROCESS-TRANSITION

The most complicated lexically specified type of verb, shown in Figure 6, appears to be one that profiles a transition that takes place at the end of a larger process; it refers only to the moment of transition, but the preceding process, though uninstantiated, is salient enough to affect behavior under modification. In particular, this class differs from a usual transition in that the unspecified process corresponds to a trajectory, indicating the presence of some kind of continuous, telic activity. The process-transition thus combines elements of all the other classes: an effortful process corresponding to a trajectory, a unique goal state that happens also to be a significant new state with its own state APN (and is profiled). It may be the superimposition of a transition and a perfective process, e.g. *climb the mountain* and *reach the top*, which share *at the top* as a goal state.

- **Span modification** seems to be allowed with no problem, possibly because of the presence of a perfective process ending at the same time and thus the facilitation of the normal span requirements.
- **Durative modification**: process-transitions generally don't combine easily with durative modifiers; the durative profiles the process, while the process-transition profiles the point of completion, thus precluding attachment to the period before the transition:

  (21) *Bill won the race for three minutes (before losing/winning).

  It is in principle possible to modify the period after the transition, since like other transitions this state is profiled. But because the state produced is similar to that produced by a perfective process, its reversibility may be less salient. Context implying a clearly non-persistent reading often assists such cases:

  (22) a. ??Bill reached the top for five minutes. *[modifies period at top, before descending]*
  b. ?Bill reached the peak of fitness for three years. *[modifies period at peak, before descending]*
  c. We put up the tent for the week. *[modifies period of tent being up, before being taken down]*

- **Progressive form** seems acceptable if both the process subnet is activated (with effort) and the goal state seems to be satisfied. For instance, *Mary is winning the race* modifies a period before the winning event, but not the entire process subnet; it is limited to modifying some subperiod that is restricted not by time (*Mary was winning for a few minutes at the beginning of the race*) but by resemblance to the goal state! The goal state can't, however, be said to actually obtain until the processing has stopped; that is, the winning state has to be true at the end of the race as well.

5 Conclusions

This paper has made a number of proposals about the nature of aspectual composition that are cast in a framework like that of Cognitive Grammar but produce the broad generalizations that have long been observed in the wider linguistics literature. A few conclusions cannot be missed: aspectual phenomena involve rather subtle interactions at a level much finer than that of individual events. Even assuming events come neatly segmented into objectively independent situations — which they clearly do not — within each event, structured subevents interact with each other in semi-predictable ways, and the potential for both commonality and variation across these subevents are the likely source of the overlapping and ambiguous distinctions throughout the aspect literature. More importantly, however, aspect is largely a matter of construal: how humans perceive the presence of paths and goals, the persistence and reversibility of states, the use of effort and intention, the homogeneity of actions — all of these conspire to determine the most likely interpretation of even the simplest sentence. The complexity of the phenomenon thus requires a rich, active representation that acknowledges and accommodates the essentially dynamic nature of both events and the environment, as well as the various cognitive factors that produce interpretations.

Some general claims of this account:

- Inherent verb semantics are claimed to provide a skeletal event specifying some combination of motor- or image-schema change; this event representation is then fleshed out by arguments and modifiers, which can either instantiate pieces of the image-schematic representation according to mutual constraints and requirements, or affect the flow of control through the graph and help constrain possible interpretations.
- Finding a workable interpretation for a temporal modifier or the progressive tense involves a constrained search throughout the representation for an appropriate referent. This search may be constrained by profiling, which may determine scope for bounding/modification.
- A storehouse of general cognitive abilities appears necessary for understanding aspect: the ability to detect change, both over time and over some other dimension; the ability to detect a path or trajectory in some domain with respect to a landmark; binding of mental representations to individuals in the world; the consumption of resources (like effort and intention); the ability to distinguish count (bounded) and mass (unbounded) nouns, as well as naturally unbounded nouns that have had a boundary imposed on them; understanding of force dynamics involved in motor verb meanings; understanding of spatial prepositions and other image-schematic relations. These requirements, while complicating the picture, support the position that language is a bodily and conceptually grounded phenomenon.

The proposed models of aspectual composition also make a few specific claims about the mechanisms enforcing aspectual composition. First, progressive form is hypothesized to be allowed only when active processing takes place in a subnet requiring **effort** as a resource and thus implying the ability to stop the relation by halting the expenditure of effort. Durative modification, in contrast, generally inhibits the relation itself. The modeling of the difference between the two elucidates the alternate paths to achieving the non-persistence of a state or process. In addition, the importance of both instantiation and boundaries seem surprisingly related: the identification of an object as a valid goal seems to require it to be both bound and bounded.

Finally, some speculation about the nature of the binding between image-schematic transformations and motor control representations of event structure is in order. One hypothesis is that the binding is not purely bi-directional. Clearly, some parts of the motor schema rely on perceptual input that should match an image schema to some degree; for instance, the x-schema for *leave* can't be activated unless something like an image schema for *in* applies to the situation. Other parts of the image schema — movement along the trajectory, for instance — seem to be driven by execution (or simulated execution) of the PROCESS subnet's x-schema. It may be, then, that binding between the image schema and motor schema *places* indicate perceptual input feeding the motor schema, while binding between the image schema and motor schema *transitions* (or subnets) indicate image-schematic transformations controlled by the x-schema. In any case, it is clear that image- and motor-schematic representations of event structure must cooperate to model action and perception, and the attempt to integrate them in the study of aspect represents but a first step toward understanding the nature of that interaction.

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