Tense, aspect and coercion in a cross-linguistic perspective

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Abstract

Aspectual operators like the progressive in English change the aspectual nature of the eventuality. The meaning shift is grammaticalized by means of a morphological marker or a syntactic construction. But sometimes aspectual shift is hidden. These are cases where an eventuality description is coerced in order to repair the mismatch between the aspectual nature of the eventuality and the aspectual input requirements of an aspectual operator like the progressive, or a tense operator (like the English Simple Present). Coercion leads to special meaning effects (iteration, habituality, inchoative readings). In this paper we analyze some examples of coercion in English, French and Dutch in the framework developed by de Swart (1998) and de Swart and Molendijk (1999). This framework uses the general set-up of Discourse Representation theory as developed by Kamp and Reyle (1993) to formulate an event-based semantics of tense and aspect, with an ontology of states, processes and events. The examples involve the Progressive, the Perfect and the Simple Present in English, and some comparisons with their counterparts in Dutch and French. The examples will show that there is cross-linguistic variation in what is encoded in aspectual operators, and what is left to coercion. Moreover, we will see that not all possibilities of hidden shift are available in all languages. Thus the general network of aspectual transitions is like a tool box, and languages have a certain amount of freedom to grammaticalize certain transitions in aspectual operators, allow some aspectual transitions as hidden shift, and block others entirely.

1 The aspectual framework

1.1 Aspectual class and grammatical aspect

I assume that aspectual class is determined at the level of predicate-argument structure, which I identify as the level of the 'eventuality description'. According to Comrie (1976, 3), "tense relates the time of the situation referred to some other time, whereas aspects are different ways of viewing the internal temporal constituency of a situation". Accordingly, I assume that grammatical aspect applies to eventuality descriptions to provide a perspective on the situation. Tense operates after all the aspectual operators have done their work. Under these assumptions, the syntactic structure of the sentence is as follows:

(1) [Tense [Aspect* [eventuality description]]]

The Kleene star indicates zero, one or more operations. Eventuality descriptions denote sets of eventualities, where the term 'eventuality' generalizes over different types of situations (cf. Bach 1986). Following Mourelatos (1978), Bach (1986), Piñón (1995) and others, I assume an ontology of states, processes and events. Aspectual operators are interpreted as eventuality modifiers, so they map sets of eventualities (of a certain type) onto sets of eventualities (of some possibly other type). Tense operators introduce existential closure over this set of eventualities, and map the event onto the time axis via its location time in relation to the speech time. An important claim made in this paper is that aspectual information plays a role at all three levels.

Following Bach (1986), Krifka (1989), Piñón (1995) and others, I adopt a lattice-theoretic structure of the domain of eventualities $\mathcal{E}$. I assume that every eventuality—whether atomic or non-atomic—is a state, a process or an event, so $\mathcal{E}$ is the union of the set S of states, the set P of processes, and the set E of events: $\mathcal{E} = S \cup P \cup E$. Processes and events are both non-stative, and form the supercategory of dynamic eventualities. States and processes pattern together in having homogeneous, non-quantized reference, just like bare plurals and mass nouns. They have divisive reference (parts of being sick qualify as being sick), and cumulative reference (writing plus writing is writing). Events have non-homogeneous, quantized reference, just like count nouns. The classification of eventualities is summarized in figure 1 (compare also Verkuyl 1993, Piñón 1995):

figure 1

<table>
<tr><td colspan="2">HOMOGENEOUS</td><td>QUANTIZED</td></tr>
<tr><td>state</td><td>process</td><td>event</td></tr>
<tr><td>STATIVE</td><td colspan="2">DYNAMIC</td></tr>
</table>

The position of processes in this classification represents such eventualities as sharing certain properties with states, and others with events. In the version of Discourse Representation Theory I adopt here, the ontological nature of the discourse referent is reflected in the use of designated variables: s for states, p for processes and e for events. I use h to refer to members of the super-category of non-quantized, homogeneous eventualities (members of $S \cup P$), and d to refer to dynamic eventualities (in $P \cup E$). There is a straightforward correlation between the aspectual class of an atomic eventuality description and the type of eventuality it denotes: stative sentences introduce states, process sentences refer to processes, and event sentences describe events.

1.2 Grammatical aspect in a DRT-style representation

Following Bach (1986), I interpret grammatical aspect as a mapping relation from one domain of eventualities to another in ways similar to the mapping relations that have been defined between the mass and the count domain by Link (1983), Pelletier (1979), Bach (1986), etc, and that account for the 'mass' use of count nouns and the 'count' use of mass nouns. The observation that states can be presented as events, and vice versa suggests that the metaphor of the Universal Grinder and the Universal Packager extends to the temporal domain, where it can be used to account for aspect shift. Along similar lines, Moens (1987) and Moens and Steedman (1988) argue that aspectual operators take us through an aspectual network.

In a language like English, aspectual operators are optional. There are no aspectual operators in (2):

(2) Mary is sick.
[PRES [Mary be sick]]

The aspectual class of the eventuality description determines that (2) introduces a state into the Discourse Representation Structure (DRS). Application of the tense operator completes the grammatical structure:

figure 2
Mary is sick

$$\boxed{\begin{array}{c} \text{n s t x} \\ \\ \text{n} \subseteq \text{t} \\ \text{Mary(x)} \\ \text{s} =_t \text{t} \\ \text{s: } \boxed{\text{x be sick}} \end{array}}$$

The tense operator PRES requires the speech time n (for 'now') to be included in the location time t of the state s. The location time is the projection of the eventuality onto the time axis.

I take it that we want a unified interpretation of tense operators in sentences with and without aspectual operators. The optionality of aspectual operators suggests an interpretation in terms of eventuality description modifiers: they map sets of eventualities onto sets of eventualities. This interpretation guarantees that the input to the tense operator is always a set of eventualities. It also opens the way to the iteration of aspectual operators.

Sentences in the Perfect are taken to involve an aspectual operator. The syntactic structure of a sentence like (3a) is given in (3b):

(3) a. Mary has met the president

b. [PRES [PERF [Mary meet the president]]]

Sentences in the Perfect are stative, so the Perfect maps an eventuality onto a state. The Perfect introduces the consequent state which starts when the eventuality ends. For the Present Perfect, this result state still holds at the speech time, so that the sentence describes an 'extended now', or an event the consequences of which have 'current relevance' (cf. McCawley 1971).

figure 3
Mary has met the president

$$\boxed{\begin{array}{c} \mathrm{n\quad e\quad s\quad t\quad x\quad y} \\ \\ \mathrm{n} \subseteq \mathrm{t} \\ \mathrm{Mary(x)} \\ \mathrm{President(y)} \\ \mathrm{s} =_t \mathrm{t} \\ \mathrm{e} \supset\subset \mathrm{s} \\ \mathrm{e:}\ \boxed{\mathrm{x\ meet\ y}} \end{array}}$$

The condition $e \supset\subset s$ (e 'abuts' s) means that the result state starts right at the end of the event. The Perfect is an extensional operator, which asserts the existence of both the event e, and its consequent state s. It is the result state which provides the variable for the tense to operate on, because that state corresponds to the output of the Perfect operator. The state has a temporal location t (s $=_t$ t), which, according to the tense operator, includes the time of speech n (n $\subseteq$ t), so s holds now. If the result state s holds now, we know that the event e took place in the past of the speech time, and the consequent state has current relevance.

Certain aspectual operators come with special input conditions. Sentences in the Progressive are always stative, whether the underlying sentence is characterized as a process (4a) or as an event (4b). But the input to the Progressive cannot be a state, that is, the Progressive does not normally combine with stative eventuality descriptions (4c):

(4) a. Susan was writing letters.
b. Susan was writing a letter.
c. # Susan was being in the garden.

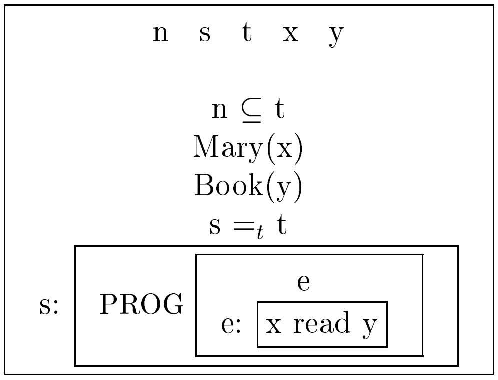
The examples in (4) illustrate that the Progressive maps dynamic eventuality descriptions, denoting either processes or events onto the state of that process or event being in progress. So the Progressive denotes a function PROG: $P \cup E \rightarrow S$. As pointed out by Dowty (1979), the Progressive requires an intensional semantics, which I will not go into here.

The introduction of the operator PROG gives (5a) the grammatical structure (5b), and the DRS representation in figure 4:

(5) a. Mary is reading a book.

b. [PRES [PROG [Mary read a book]]]

figure 4
Mary is reading a book



The intensional nature of the Progressive means that there is no guarantee that Mary will finish the book she is reading. Accordingly, there is no claim that the event variable corresponding to the description ‘Mary read a book’ exists in the main box of the DRS in figure 4. At the top level, only the state of the event in progress is asserted to exist. The tense operator locates this state in the present.

The three examples of the Simple Present, the Perfect and the Progressive provide basic illustrations of the aspectual framework. The examples discussed so far all meet the requirements on the tense operator and/or the aspectual operator. But in other cases, we have a clash between the aspectual nature of the eventuality and the aspectual input requirements of the operator. This is where we find coercion, a hidden form of aspect shift.

2 Coercion in the aspectual domain

Coercion is the general terms for contextual reinterpretation (cf. Pustejovsky 1995). In this paper, we will reserve the term for cases of aspectual reinterpretation. Moens (1987) and Moens and Steedman (1988) talk about free transitions in the aspectual network. The most clearcut examples of aspectual reinterpretation arise when an eventuality description does not meet the input requirements of an aspectual operator, and we get an adjustment, a coerced interpretation of the input, which repairs the mismatch. Examples of aspectual operators that can trigger coercion are the English Progressive (section 2.1) and the Perfect (section 2.3). Examples of aspectually sensitive tense operators that can trigger coercion are the French past tenses (the Passé Simple and the Imparfait, cf. de Swart 1998) and the Present tense in English and other languages (section 2.2).

2.1 The Progressive

It is generally acknowledged that the Progressive only applies to dynamic descriptions, not to stative ones. However, there are well-known exceptions to this rule:

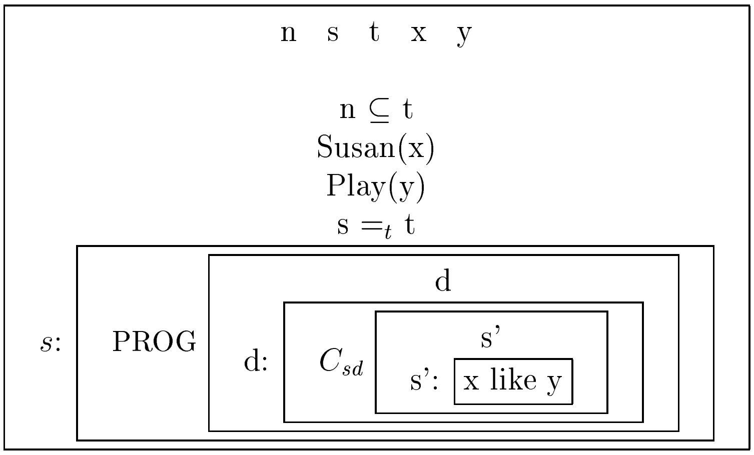
(6) a. Susan is liking this play a great deal.
b. Peter is believing in ghosts these days.
c. Charles is being silly.

Smith (1991: 20) argues that the sentences in (6) present states as dynamic situations. In the present framework, we assume that the state has been coerced into a dynamic eventuality.

I treat coercion as a hidden operator of the same type as grammaticalized aspectual operators like the Perfect or the Progressive. This means that coercion operators C are eventuality description modifiers, which map a set of eventualities onto another set of eventualities. The input and output type are represented as indices on the operator, e.g. C_{sd}, C_{he}, C_{eh}. For the Progressive we need to assume a mapping C_{sd}, from stative onto dynamic eventualities. If this operator is inserted before the Progressive applies, the input conditions on the aspectual operator are satisfied, and we can build a well-formed DRS. The grammatical structure of (6a) in (7) leads to the DRS in figure 5:

(7) Susan is liking this play.
[PRES [PROG [C_{sd} [Susan like this play]]]]

figure 5
Susan is liking this play



The dynamic variable d, obtained by coercion, is the right kind of input for the Progressive operator. The output of the Progressive is again a state, but the state of an event or process being in progress is a lot more 'dynamic' than the underlying lexical state. The more complex internal structure accounts for the vivid color of the description.

The example illustrates some general properties of our treatment of coercion. First of all, coercion operators are only inserted when they are triggered by a mismatch. In the absence of a mismatch (cf. figure 4 above), no coercion operators appear. This is also reflected in the construction rules, which introduce coercion operators as part of the rules for aspectual or tense operators only when there is an aspectual conflict (see appendix for formal details). Second, the use of designated variables for states, processes and events makes it easy to formulate construction rules that check the input conditions for aspectual operators, and that introduce a coercion operator if the aspectual constraints are not met. Thus, mismatches can be defined in the 'box' language of DRT. Finally, the coercion operators show up in the same position as an aspectual operator, but their semantics is left to the embedding conditions (compare our treatment of the progressive). Thanks to this approach we need not introduce specific aspectual operators ITER, ADD-CUL or BOUND into the DRS. This is good, because we want to preserve the insight that the interpretation in terms of coercion is fully compositional, but the value of the hidden operator is dependent on linguistic context and world knowledge. If the linguistic and extra-linguistic context do not support any aspectual transition which satisfies the aspectual restrictions on the operator, there is no proper embedding of the DRS into the model, which means that it cannot be verified. Thus the well-formedness of the DRS can be saved by the introduction of coercion operators, but its verification is dependent on the felicity of specific aspectual transitions in the context.

2.2 The Simple Present in English and other languages

The Simple Present is an example of an aspectually sensitive tense in English. Most tenses are transparent, by which I mean that they combine with eventualities of all aspectual classes, and they present the state/process/event as something which happened in the past or the future. The Simple Present however, if not used as a historical present or a reporter's present, is only applicable to states. The aspectual constraint on the application of the present tense operator is fulfilled in examples (2), (3) and (5) above, so no particular meaning effects are observed. If the aspectual requirement of the Simple Present is not satisfied by the eventuality description, we need to insert a coercion operator C_{ds} in order to resolve the aspectual conflict. As before, the embedding function requires the meaning effects of at least one of the possible mappings to be supported by the context. Consider the examples in (8):

(8) a. Eve reads poetry.

b. Peter plants tulips.

c. Sue runs three miles.

It is generally acknowledged (Verkuyl 1993 and many others) that these sentences have a well-formed iterative or habitual interpretation, but cannot describe a single event. In English, iteration or habituality is not expressed by an explicit grammatical marker, but it is one of the possible transitions in the aspectual network which allows a process (8a,b) or event (8c) to be presented as a state. Observations like these point towards a hidden aspectual transition triggered by the mismatch between the nature of the eventuality description and the aspectual requirements on the tense operator. The introduction of the coercion operator C_{ds} resolves the mismatch as in (9), and allows us to derive a well-formed DRS, as in figure 6:

(9) a. Sue runs three miles.

b. [PRES [C_{ds} [Sue run three miles]]]

figure 6
Sue runs three miles

n s t x

$n \subseteq t$
Sue(x)
$s =_t t$

s: C_{ds} [e ; e: $\boxed{\text{x run three miles}}$]

The event of running three miles is represented as a state in order to satisfy the input conditions on the Simple Present. An iterative or habitual interpretation is one way of stativizing an event description.

The Simple Present opens the possibility to study cross-linguistic variation in the operators that are grammaticalized and those that are only available by means of hidden aspect shift. If we translate the sentences (9) into Dutch, we observe that we have more interpretive possibilities. The sentences can get an iterative or habitual reading, but a progressive interpretation is also available:

(10) a. Eva leest poëzie. [Dutch]

b. Peter plant tulpen.

c. Susan rent drie kilometer.

We should realize that Dutch does not have a Progressive operator similar to the English progressive. There is an aspectual construction 'aan het V zijn', where V can be any dynamic verb (either process or event), but this construction is not grammaticalized in the same way as the English progressive. Thus the contrast between (10) and (8) illustrates that the aspectual transitions which are available by coercion are limited to those which are not grammaticalized by the language. Thus, the sentences in (10) have the exact same grammatical structure as those in (8) (cf. 9b). However, the progressive interpretation is a free aspectual transition in Dutch, which can be triggered by an aspectual mismatch, but it is not in English, where it is constrained to the progressive operator PROG (cf. also Moens 1987).

The lack of a grammaticalized progressive in Dutch means that certain meaning effects which combine the progressive and coercion, and which were illustrated in (6) above, are unavailable in Dutch. This is the consequence of our position that coercion must be triggered by a grammatical operator. The result of this claim is that coercion operators cannot be iterated. In English, the presence of the progressive triggers a hidden shift from states to dynamic eventualities and encodes an explicit shift back to states. Because there is no explicit progressive operator in Dutch, the only way to derive this interpretation would be to stack coercion operators C_{sd} and C_{ds}. The observation that sentences like (11) only have an interpretation as regular states supports our claim that this iteration of coercion operators is not allowed by the language:

(11) a. Susan houdt van dit toneelstuk.
Susan likes this play

b. Peter gelooft in geesten.
Peter believes in ghosts

c. Charles is stom.
   Charles is silly

Of course this does not exclude the possibility that the language finds other ways to express the meanings intended. E.g. the meaning of (7c) can be rendered by an active verb as in (12):

(12) Charles doet stom.
     Charles acts silly
     'Charles is acting in a silly way'

In sum, the differences in the way transitions in the network are distributed among explicit grammatical operators and hidden operations triggered by coercion explains not only the presence of certain meaning effects in certain languages, but also their absence in other languages.

2.3 The Present Perfect in English and other languages

So far, we did not mention any aspectual constraints on the Perfect. However, it is quite clear from the interpretation we gave that the Perfect maps a quantized event on its consequent state. Without a final boundary on the event, there would not be a consequent state, so the Perfect must presuppose a non-homogeneous eventuality (cf. Moens 1987, Moens and Steedman 1988). Not surprisingly therefore, special meaning effects arise when the Perfect is combined with non-quantized eventualities, i.e. states or processes:

(13) a. Mary has read poetry.

     b. Mary has lived in Amsterdam.

     c. [PRES [C_{he} [state/process]]]

For both the process in (13a) and the state in (13b), it is easy to come up with a bounded portion of the process/state which provides the quantized eventuality. The perfect then focusses on the consequent state, which makes the existential reading of the perfect the most likely interpretation of the sentence: 'there has been an activity of reading poetry by Mary in the past, and it has ended some time before now'. This interpretation is captured by the schematic grammatical structure in (13c).

But it is well known that the English Present Perfect also allows a universal reading, in particular if the sentence contains a measurement phrase such as *for three years*, and an explicit or implicit *now*. Consider (14):

(14) Mary has lived in Amsterdam for three years (now).

Without the *now* an existential reading is prominent: there was a time in the past at which Mary lived in Amsterdam, and that period of time lasted (at least) three years, and she does not live there anymore. The explicit or implicit presence of *now* triggers the universal reading of the Present Perfect: Mary moved to Amsterdam three years ago, and she still lives there. In order to understand the semantic structure of the existential and universal readings of the Present Perfect, we need to give an interpretation of measurement phrases such as *for three years*. In de Swart (1998) these expressions are analyzed as eventuality description modifiers that map homogeneous eventualities (states or processes) onto quantized (bounded) events. If we take *for three years* in (14) to modify the state of Mary living in Amsterdam, we satisfy the input conditions on the measurement phrase. The output is a quantized event, which is the right input for the Perfect operator. That is, if we assign (14) the grammatical structure in (15), we obtain the existential reading as reflected in the DRS of figure 7:

(15) Mary has lived in Amsterdam for three years
[PRES [PERF [for three years [Mary live in Amsterdam]]]]

figure 7
Mary has lived in Amsterdam for three years (existential reading)

$$\boxed{\begin{array}{c} \text{n e s s' t x y mt} \\ \\ \text{n} \subseteq \text{t} \\ \text{Mary(x)} \\ \text{Amsterdam(y)} \\ \text{s} =_t \text{t} \\ \text{e} \supset\subset \text{s} \\ \text{e = BOUND(s')} \\ \text{three years(mt)} \\ \text{dur(s')} \geq \text{mt} \\ \text{s'}: \boxed{\text{x live in y}} \end{array}}$$

The measurement phrase introduces a certain amount of time (mt), and the duration of s' is at least equal to that amount of time (in this case: three years). The eventuality e is defined as BOUND(s), that is, as the state plus its beginning point and endpoint. Because of the addition of boundaries, this qualifies as a quantized eventuality, which is what the Perfect operates on. We obtain an existential interpretation in which the stay in Amsterdam lasted for at least three years, and we are now in the consequent state of that bounded state of affairs.

Note that in the existential reading, *for three years* specifies the length of the state s' of living in Amsterdam, and not of the consequent state s. In order to obtain the universal interpretation, we need to attach the measurement phrase not to the state of living in Amsterdam, but to the consequent state of the event of moving to Amsterdam (cf. Kamp and Reyle 1993, 586-587). In the framework set up here, this implies that the transition from state to event, necessary to satisfy the input conditions on the perfect is not taken care of by the measurement phrase, but is performed by a hidden coercion operator. If we assign sentence (14) the structure in (16), we can derive the universal reading as in the DRS of figure 8:

(16) Mary has lived in Amsterdam for three years (now)
[PRES [for three years [PERF [C_{he} Mary live in Amsterdam]]]]

figure 8
Mary has lived in Amsterdam for three years (universal reading)

n e s t x y mt

$n \subseteq t$
Mary(x)
Amsterdam(y)
$s =_t t$
three years(mt)
$dur(s) \geq mt$
$e \supset\subset s$

e: C_{he} s'
s': $\boxed{\text{x live in y}}$

C_{he} allows the option of an inchoative reading, which gets us the interpretation in which Mary started living in Amsterdam at some point in time, and the consequent state of that event lasts at least three years up till now. Note that this derivation is less economical than the one reflected in figure 7, because the universal reading requires a coercion operator whereas the existential one does not. This might very well be the explanation why the universal reading is rather restricted across languages. Note also that we do not expect the universal reading of the perfect to be available for event descriptions: given that event descriptions satisfy the input conditions of the Perfect, no aspectual reinterpretation is triggered. In the absence of a coercion operator, an inchoative reading does not arise.

It is well known that the existential reading of the Perfect is available in other languages than English, e.g. Dutch and French. Although the universal reading is not exclusively found in English, it is not very widespread. Remember that even in English, it is restricted to stative sentences. In many other languages, including French and Dutch, we do not find the universal interpretation at all. Thus, sentences like (17a) and (b) only have the existential reading, which interprets the state as a bounded quantity of time:

(17) a. Marie heeft drie jaar in Amsterdam gewoond. [Dutch]

b. Marie a habité Amsterdam pendant trois ans. [French]

Both Dutch and French use constructions with the Present tense in order to convey the meaning expressed by the universal Present Perfect in English:

(18) a. Marie woont al drie jaar in Amsterdam. [Dutch]
Marie lives already three years in Amsterdam

b. Marie habite Amsterdam depuis trois ans. [French]
Marie lives in Amsterdam since three years.

The way the aspectual framework is set up, we expect languages to appeal to coercion operators only if we are forced to. Languages like French and Dutch seem to prefer a derivation without coercion operators if possible, and choose the simpler derivation in figure 7 over the more complex one in figure 8. On the other hand, all languages considered here use coercion operators to derive the bound readings in (13), so this may make it easier for a language like English to exploit this structure for the universal reading.

At this point, we might be tempted to conclude that the semantics of the Perfect is richer in English than it is in Dutch or French. However, the English Perfect is more constrained in other respects. E.g. the Present Perfect (although not the Past Perfect) is incompatible with time adverbials locating the event in time, but Dutch and English are not, cp:

(19) a. *Sara has left at six o'clock. [English]

b. Sara is om zes uur vertrokken. [Dutch]

c. Sara est partie à six heures. [French]

Michaelis (1994) blames the prohibition against locating time adverbials on a peculiarity of English. Following her approach, de Swart and Molendijk (2000) formulate a constraint for the English Perfect, which blocks any temporal relations between the underlying event and any time or event other than the reference time R or the speech time S. Dutch is subject to a weaker constraint that blocks any temporal relation between the underlying event and another event. This allows the time adverbial in (19c), but it blocks the use of a 'voltooid tegenwoordige tijd' (the Dutch equivalent of the present perfect) in temporal subordinate clauses introduced by *toen* ('when'):

(20) a. *When John has seen (PP) me, he has got (PP)/
got (SP) frightened. [English]

b. *Toen Jan me heeft gezien (VTT) is hij bang geworden (VTT)/
werd hij bang (OVT). [Dutch]

c. Quand Jean m'a vu (PC), il a eu peur (PC). [French]

The French Passé Composé is just a Perfect, which is not subject to any further constraints. Thus, it has the widest use of the three languages, as illustrated by the fact that it can even used in narrative contexts (cp. de Swart and Molendijk 2000 for discussion). In sum, the English Present Perfect is very constrained, but paradoxically it allows more hidden aspectual transitions than its counterpart in languages like Dutch and English. An explanation of this inverse correlation is beyond the scope of this paper, though.

3 Concluding remarks

In this paper, we have set up a system to interpret restrictions on aspectual operators in a principled and uniform way. The framework of DRT allows us to define aspectual mismatches in the 'box' language, and to solve them by the introduction of coercion operators. Coercion operators involve hidden aspectual transitions that are not explicitly encoded by grammatical operators in the language. They are only triggered when they are required to solve a mismatch, so they cannot be freely introduced or be iterated. This control mechanism helps to account for cross-linguistic variation in the availability of certain readings (e.g. the simple present tense in English versus Dutch). The discussion of the universal reading of the Perfect shows that languages may vary in their ability to attach aspectually sensitive expressions such as measurement phrases at a point in the tree that creates a mismatch at another point in the grammatical structure. In this particular case English proves to be more liberal than Dutch or French, but in other respects, the constraints on the Present Perfect in English are much stricter than those on its counterparts in Dutch and French. Further investigation of such constraints in relation to aspectual mismatches might help us to obtain a better understanding of these facts.

4 Appendix

Construction rules

- Introduction of discourse referents for progressive sentences of the form Prog(S):

  a. Introduce in U_K: a new state discourse referent s

  b. Introduce in Con_K: s: $\boxed{\text{PROG K}_1}$

  c. If γ, the eventuality description of S, is a dynamic description, introduce in U_{K_1}: a new discourse referent p or e.

  d. Introduce in Con_{K_1}: p: $\boxed{\gamma}$ or e: $\boxed{\gamma}$.

  e. If γ is not a dynamic description, so does not satisfy the input conditions on the Progressive, introduce in U_{K_1}: a new discourse referent d.

  f. Introduce in Con_{K_1}: d: $\boxed{C_{sd}\ \mathrm{K}_2}$

  g. Introduce in U_{K_2}: a new discourse referent s

  h. Introduce in Con_{K_2}: s: $\boxed{\gamma}$

- Duration adverbials

  (i) For sentences modified by a *for*-adverbial of the form (FOR x time(S)):

    a. Introduce in U_K: new discourse referents e and mt

    b. Introduce in Con_K: x-time(mt)

    c. If γ is a state or a process description, introduce in Con_K:
    $\mathrm{dur}(s) \geq mt$ or $\mathrm{dur}(p) \geq mt$ and $e = \mathrm{BOUND}(s)$ or $e = \mathrm{BOUND}(p)$

    d. If γ is an event description, introduce in Con_K:
    h: $\boxed{C_{eh}\ \mathrm{K}_1}$
    and introduce in Con_K: $\mathrm{dur}(h) \geq mt$ and $e = \mathrm{BOUND}(h)$

    e. Introduce in U_{K_1}: a new discourse referent e.

    f. Introduce in Con_{K_1}: e: $\boxed{\gamma}$

- Tense operators

  (i) Past tense (English/Dutch):

    a. If S is the first sentence of the discoure, introduce in U_K: a new discourse referent n which is identified with the speech time. If S is not the first sentence of the discourse, continue with b.

    b. Introduce in U_K: a new time discourse referent t
    where t is the location time of the eventuality.

c. Introduce in Con$_K$: $t \prec n$

d. If γ is a state or a process description, introduce in Con$_K$: $s =_t t$ or $p =_t t$.

e. If γ is an event description, introduce in Con$_K$: $e \subseteq t$

(ii) Present tense

a. If S is the first sentence of the discoure, introduce in U$_K$: a new discourse referent n which is identified with the speech time. If S is not the first sentence of the discourse, continue with b.

b. Introduce in U$_K$: a new time discourse referent t

c. Introduce in Con$_K$: $n \subseteq t$

d. If γ is a state description, introduce in Con$_K$: $s =_t t$

e. If γ is not a state, introduce in Con$_K$:

s: $\boxed{C_{ds}\ \mathrm{K}_1}$

and introduce in Con$_K$: $s =_t t$

f. Introduce in U$_{K_1}$: a new discourse referent e or p.

g. Introduce in Con$_{K_1}$: e: $\boxed{\gamma}$ or p: $\boxed{\gamma}$.

C. **The model**

The model M is a structure consisting of (among others):

- A set $\mathcal{E}_M$ of eventualities such that $\mathcal{E}_M = S_M \cup P_M \cup E_M$ where S_M is the set of states, P_M is the set of processes, and E_M is the set of events. $S_M \cup P_M$ constitutes the supercategory of homogeneous eventualities. $P_M \cup E_M$ constitutes the supercategory of dynamic eventualities. $\mathcal{E}_M$ is partially ordered by a part-whole relation $\sqsubseteq$;

- A function Pred$_M$ which maps predicates onto their denotation such that:

  (i) For each one-place predicate MT$_i$ over amounts of time, Pred$_M$(MT$_i$) is a subset of the set of all equivalence classes under $\equiv$;

  (ii) For each atomic state description P$_i$(s_i, $\alpha_1, \ldots, \alpha_n$), Pred$_M$(P$_i$) is a set of tuples $<\mathbf{s}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ where $\mathbf{s}_i \in S_M$ and $\mathbf{a}_1 \ldots \mathbf{a}_n \in \mathrm{U}_M$;

  (iii) For each atomic process description P$_i$(p_i, $\alpha_1, \ldots, \alpha_n$), Pred$_M$(P$_i$) is a set of tuples $<\mathbf{p}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ where $\mathbf{p}_i \in P_M$ and $\mathbf{a}_1 \ldots \mathbf{a}_n \in \mathrm{U}_M$;

  (iv) For each atomic event description P$_i$(e_i, $\alpha_1, \ldots, \alpha_n$), Pred$_M$(P$_i$) is a set of tuples $<\mathbf{e}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ where $\mathbf{e}_i \in E_M$ and $\mathbf{a}_1 \ldots \mathbf{a}_n \in \mathrm{U}_M$;

  (v) $<\mathbf{s}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to Pred$_M$(PROG(P$_i$)) for P$_i$ an event or a process description iff there is a state $\mathbf{s}_i \in S_M$ such that $<\mathbf{s}_i, \mathbf{a}_1 \ldots \mathbf{a}_n>$ belongs to (PROG(Pred$_M$(P$_i$)));

(vi) $<\mathbf{e}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to Pred_M(IN x time (P_i)) for P_i an event description iff there is an event $\mathbf{e}_i \in \mathrm{E}_M$ such that $<\mathbf{e}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to (IN x time ($\mathrm{Pred}_M(\mathrm{P}_i)$));

(vii) $<\mathbf{e}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to Pred_M(FOR x time (P_i)) for P_i a state description iff there is an event $\mathbf{e}_i \in E_M$ such that $<\mathbf{e}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to (FOR x time ($\mathrm{Pred}_M(\mathrm{P}_i)$));

(viii) The coercion operator C_{eh} is multiply ambiguous and has senses C_{eh_1} $\ldots C_{eh_n}$ for the n free aspectual transitions defined as possible mappings from events to states/processes in the language under consideration. $<\mathbf{h}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to $\mathrm{Pred}_M(C_{eh_1}(\mathrm{P}_i))$ for P_i an event description iff $\mathbf{h}_i \in S_M \cup P_M$ and $<\mathbf{h}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to ITER($\mathrm{Pred}_M(\mathrm{P}_i)$); $<\mathbf{h}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to $\mathrm{Pred}_M(C_{eh_2}(\mathrm{P}_i))$ for P_i an event description iff $\mathbf{h}_i \in S_M \cup P_M$ and $<\mathbf{h}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to PROC($\mathrm{Pred}_M(\mathrm{P}_i)$); $<\mathbf{h}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to $\mathrm{Pred}_M(C_{eh_3}(\mathrm{P}_i))$ for P_i an event description iff $\mathbf{h}_i \in S_M \cup P_M$ and $<\mathbf{h}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to HAB($\mathrm{Pred}_M(\mathrm{P}_i)$), etc;

(xi) The coercion operator C_{he} is multiply ambiguous and has senses C_{he_1} $\ldots C_{he_n}$ for the n free aspectual transitions defined as possible mappings from states/processes to events in the language under consideration. $<\mathbf{e}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to $C_{he_1}(\mathrm{Pred}_M(\mathrm{P}_i))$ for P_i a state/process description iff $\mathbf{e}_i \in E_M$ and $<\mathbf{e}_i, \mathbf{a}_i, \ldots, \mathbf{a}_n>$ belongs to ADD-CUL($\mathrm{Pred}_M(\mathrm{P}_i)$); $<\mathbf{e}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to $C_{he_2}(\mathrm{Pred}_M(\mathrm{P}_i))$ for P_i a state/process description iff $\mathbf{e}_i \in E_M$ and $<\mathbf{e}_i, \mathbf{a}_i, \ldots, \mathbf{a}_n>$ belongs to INCHO($\mathrm{Pred}_M(\mathrm{P}_i)$); $<\mathbf{e}_i, \mathbf{a}_1, \ldots, \mathbf{a}_n>$ belongs to $C_{he_3}(\mathrm{Pred}_M(\mathrm{P}_i))$ for P_i a state/process description iff $\mathbf{e}_i \in E_M$ and $<\mathbf{e}_i, \mathbf{a}_i, \ldots, \mathbf{a}_n>$ belongs to BOUND($\mathrm{Pred}_M(\mathrm{P}_i)$), etc.

- Semantic effect of aspectual transitions (informal)

  (i) PROG is a function from $E_M \cup P_M$ to S_M which maps dynamic eventuality descriptions onto state descriptions in such a way that the state describes the process or event as being in progress. For event predicates, the progressive sentence is interpreted as a development which would eventually lead to a culmination point (although that need not be reached in the real world).

  (ii) ITER is a function from $E_M \cup P_M \cup S_M$ to S_M which maps any eventuality description onto a state description in such a way that the state describes an unbounded number of eventualities of the type described by the predicate.

  (iii) HAB is a function from $E_M \cup P_M \cup S_M$ to S_M which maps eventuality descriptions onto state descriptions. HAB functions like an implicit adverb of quantification similar to *always*, and is interpreted as a default operator (universal quantification unless there is evidence to the contrary).

(iv) ADD-CUL is a function from P_M to E_M which maps process descriptions onto event descriptions by adding a culmination to the process.

(v) ADD-PREP is a function from $S_M \cup P_M$ to E_M which maps state/process descriptions onto event descriptions such that the event consists of the preparatory phase leading up to plus the onset of the state/process as a culminated process. This interpretation generates the entailment that the state/process holds after the culmination.

(vi) INCHO is a function from $S_M \cup P_M$ to E_M which maps state/process descriptions onto event descriptions in such a way that the event describes the onset of the state or process. This interpretation generates the entailment that the state/process holds after the inchoative event.

(vii) BOUND is a function from $S_M \cup P_M$ to E_M which maps state/process descriptions onto event descriptions in such a way that the event consists of a bounded, quantized portion of the state/process.

(ix) DYNAMIC is a function from S_M to $P_M \cup E_M$ which maps state descriptions onto dynamic descriptions in such a way that the state is presented as a process or event the agent is actively involved in.

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