Kamp & Reyle 1993, Ch. 5 (6)
DRS Construction with Aspectual Auxiliaries

Missing reference:

Although K&R do not acknowledge it, in Ch. 5.4 they draw heavily on Moens & Steedman 1988 (M&S) theory of event structure and aspect. Specifically, the tripartite structure with a preparatory process, culmination/event itself, and a consequent state, as well as the idea that aspectual operators crucially refer to that structure, is due to M&S.

Examples (1)–(7) below outline a simplified version of M&S analysis of perfect and progressive aspect in English. This analysis is formalized in K&R's DRT by the DRS construction rules given on the next two pages.

- ENGLISH PERFECT WITH EVENTS, STATES AND NEGATION

(1) John **has** *bought* a house. $t = n,\ s \circ t,\ s = \text{CON}(e),\ buy(e, x, y)$

(2) John **has** *owned* a house. $t = n,\ s \circ t,\ s = \text{CON}(s'),\ own(s', x, y)$

(3) John **has** not *bought* a house.

(4) John **has** not *owned* a house.

- ENGLISH PROGRESSIVE WITH EVENTS, STATES AND NEGATION

(5) John **is** *buying* a house. $t = n,\ s \circ t,\ s = \text{PRG}(e),\ buy(e, x, y)$

(6) # John **is** *owning* a house. …* $s = \text{PRG}(s')$ [PRG undefined for states]

(7) John **is** not *buying* a house.

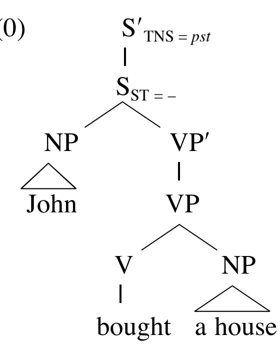
Syntactic assumptions about tense and aspect features:

The following DRS construction rules assume a simplified version of K&R's syntax — with the tensed aspectual auxiliary *have*-TNS or *be*-TNS in Aux under VP′, without any extra VP node. Following K&R, we assume three semantically relevant features:

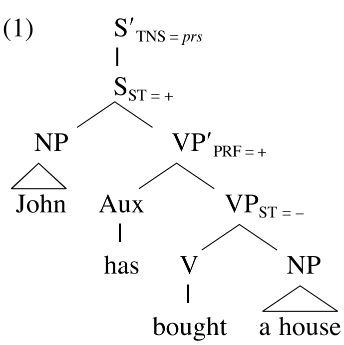
• Tense Feature:	TNS = *pst*, *prs* or *fut*	percolates from tensed Aux to S′
• Stativity Feature:	ST = + (stative) or – (eventive)	percolates as follows: (a) from stative Aux *have*- or *be*- to S (b) from the main V to VP (c) if no stative Aux, then go on from VP to S
• Perfectivity Feature:	PRF = + (done) or – (in progress)	percolates from Aux *have*- or *be*- to VP′ (no Perfectivity Feature if no *have*- or *be*-)

For example:

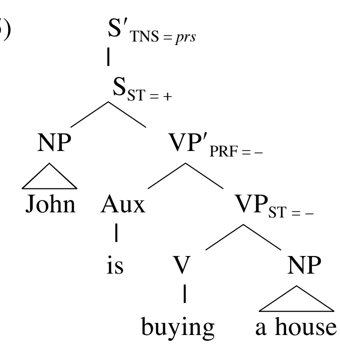
(0)



(1)



(5)



DRT conditions introduced by tense and aspect features:

In the following rules conditions introduced by Tense Features (TNS) relate *a temporal dref* to the utterance time. In contrast, conditions introduced by Aspect Features (ST or PRF) relate an *eventuality dref* either to a temporal dref (ST) or to another eventuality dref (PRF).

In DRT this formal contrast articulates the traditional idea that *tense* locates the eventuality of the verb in time relative to the utterance time, whereas *aspect* is concerned with the internal structure of that eventuality.

CR.TNS (for discourse initial sentences)

Triggering configurations $\gamma \in \mathbf{Con_K}$:

(i) $[\,S'_{TNS = \alpha}\ [\,S_{ST = \beta}\,]\,]$ (ii) $[\,S'_{TNS = \alpha}\ [\,S_{ST = \beta}\,]\ [\,\text{Adv}\,]\,]$ (S and Adv in any order)

Introduce in $\mathbf{U_K}$: new discourse referent **t** for a time

Introduce in $\mathbf{Con_K}$:

- new condition $\alpha(\mathbf{t}, n)$,
  where

$pst(\mathbf{t}, n)$	stands for	$\mathbf{t} < n$
$fut(\mathbf{t}, n)$	stands for	$n < \mathbf{t}$
$prs(\mathbf{t}, n)$	stands for	$\mathbf{t} = n$

- new condition $\text{Adv}(\mathbf{t})$, if γ = (i)

Replace γ **by**: $S_{ST = \beta}(\mathbf{t})_1$

where $S_{ST = \beta}$ (1) is obtained from $S_{ST = \beta}$ by changing the form of the main V to the infinitive and deleting any tensed Aux (*will*, *do*-TNS, *have*-TNS or *be*-TNS).

CR.NEG

Triggering configuration $\gamma \in \mathbf{Con_K}$:

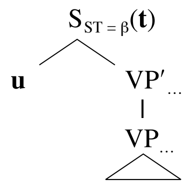
$[\,S_{ST = \beta}(\mathbf{t})\ \mathbf{u}\ [\,VP'_{\ldots}\ \text{not}\ [\,VP_{\ldots}\,]\,]\,]$

Replace γ **by**:

$\neg\ \boxed{[\,S_{ST = \beta}(\mathbf{t})\ \mathbf{u}\ [\,VP'_{\ldots}\ [\,VP_{\ldots}\,]\,]\,]}$

CR.ST (for discourse initial sentences)

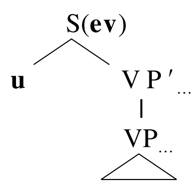
Triggering configuration
$\gamma \in$ **Con$_K$:**



Introduce in U$_K$: new discourse referent **ev** for an eventuality, where **ev** ranges over states if $\beta = +$, and over events otherwise

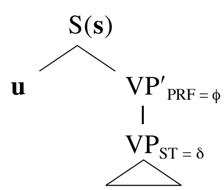
Introduce in Con$_K$:
- new condition $ST_\beta(\mathbf{ev}, \mathbf{t})$,
  where $ST_-(\mathbf{ev}, \mathbf{t})$ stands for $\mathbf{ev} \subseteq \mathbf{t}$
  $ST_+(\mathbf{ev}, \mathbf{t})$ stands for $\mathbf{ev} \circ \mathbf{t}$

Replace γ by:



CR.PRF

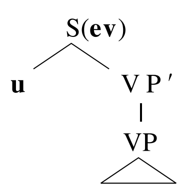
Triggering configuration
$\gamma \in$ **Con$_K$:**



Introduce in U$_K$: new discourse referent **ev** for an eventuality, where **ev** ranges over states if $\delta = +$, and over events otherwise

Introduce in Con$_K$:
- new condition $PRF_\phi(\mathbf{ev}, \mathbf{s})$,
  where $PRF_-(\mathbf{ev}, \mathbf{s})$ stands for $\mathbf{s} = PRG(\mathbf{ev})$, if **ev** is an event
  undefined, otherwise
  $PRF_+(\mathbf{ev}, \mathbf{s})$ stands for $\mathbf{s} = CON(\mathbf{ev})$

Replace γ by:



Kamp & Reyle 1993, Ch. 5 (7)
Extending DRT to Aspect and Temporal Anaphora

The following semantics formalizes, in a DRT style framework, ideas from Moens & Steedman 1988 about event structures and aspect, and from Webber 1988 about the relevance of such event structures for temporal anaphora.

DRT Syntax (cf. K&R df 5.6.4, p. 676)

(i) *Vocabulary*:

- Discourse referents (drefs)
  - (a) individual drefs: $x_0, x_1, \ldots$
  - (b) temporal drefs: $n, t_0, t_1, \ldots$
  - (c) event drefs: $e_0, e_1, \ldots$ — drefs under (c) and (d) are jointly referred to as
  - (d) state drefs: $s_0, s_1, \ldots$ — *eventuality drefs*
- Logical constants:
  - (a) tmp. and asp. functors: **loc**, **aft**, **cul**, **con**, **prg**
  - (b) identity and tmp. relations: $=, \subseteq, <, \bigcirc$
- Names: *John*, *Mary*, …
- Temporal functors: *today*, *last_Sunday*, …
- Predicates:
  - (a) 1-place nominal predicates: *man*, *dog*, …
    1-place temporal predicates: *Sunday*, *on_Sunday*, …
  - (b) 1-place event predicates: *arrive*, *die*, …
    1-place state predicates: *be_ill*, *stink*, …
  - (c) 2-place event predicates: *buy*, *write*, …
    2-place state predicates: *own*, *like*, …

(ii) *Terms*:

- Any dref is a term.
- For any eventuality term α,
  - (a) **cul**(α) is an event term
  - (b) **prg**(α) and **con**(α) are state terms
  - (c) **loc**(α) and **aft**(α) are temporal terms.

(iii) *DRS-conditions*:

(a) $\alpha = \beta$, where α and β are terms of the same type.
$\alpha \subseteq \beta$, $\alpha < \beta$, $\alpha \bigcirc \beta$, where α and β are temporal or eventuality terms.

(b) $\pi(\mathbf{x})$, where **x** is an individual dref and π is a name.
$\tau(\mathbf{t})$, where **t** is a temporal dref and τ is a temporal functor.

(c) $\eta(\mathbf{x})$, where **x** is an individual dref and η is a 1-place nominal predicate.
$\eta(\mathbf{t})$, where **t** is a temporal dref and η is a 1-place temporal predicate.

(d) $\zeta(\mathbf{e}, \mathbf{x})$, where **e** is an event dref, **x** an individual dref and ζ is a 1-place event predicate.
$\zeta(\mathbf{s}, \mathbf{x})$, where **s** is a state dref, **x** an individual dref and ζ is a 1-place state predicate.

(e) $\zeta(\mathbf{e}, \mathbf{x}, \mathbf{y})$, where **e** is an event dref, **x** and **y** are individual drefs and ζ, a 2-place event predicate.
$\zeta(\mathbf{s}, \mathbf{x}, \mathbf{y})$, where **s** is a state dref, **x** and **y** are individual drefs and ζ, a 2-place state predicate.

(f) $\neg$K, where K is a DRS.

(iv) DRSs:
A DRS is a pair $\langle$U, Con$\rangle$, consisting of a set U of drefs and a set Con of DRS-conditions.

DRT Models (cf. K&R pp. 664–678)

A *model* M *for a vocabulary* V is a tuple $\langle U_M, E_M, S_M, \mathbf{I}_M, \mathbf{T}_M, Loc_M, CE_M, CS_M, PS_M, Name_M, Fun_M, Pred_M \rangle$ consisting of:

(i) non-empty pairwise disjoint sets U_M (*individuals*), E_M (*events*), and S_M (*states*).

(ii) an *instant structure* $\mathbf{I}_M = \langle I_M, < \rangle$, where

- I_M is a non-empty set (of *instants*), pairwise disjoint from U_M, E_M and S_M.
- $<$ (*precedence*) is a strict linear order over I_M, i.e.
  (Ax_1) $i_1 < i_2 \rightarrow \neg\, i_2 < i_1$ [asymmetric]
  (Ax_2) $i_1 < i_2 \wedge i_2 < i_3 \rightarrow i_1 < i_3$ [transitive]
  (Ax_3) $i_1 \neq i_2 \rightarrow i_1 < i_2 \vee i_2 < i_1$ [connected]

(iii) the *interval structure* $\mathbf{T}_M = \langle T_M, <_T, s_T \rangle$ induced by the instant structure $\mathbf{I}_M = \langle I_M, < \rangle$ as follows:

- T_M (set of *intervals*) is the set of non-empty convex subsets of I_M, i.e.,
  $T_M := \{t: \varnothing \subset t \subseteq I_M \wedge \forall i, i', i''(i \in t \wedge i'' \in t \wedge i < i' < i'' \rightarrow i' \in t)\}$
- $t <_T t'$ iff $\forall i, i'(i \in t \wedge i' \in t' \rightarrow i < i')$ [T-*precedence*]
  $t \bigcirc_T t'$ iff $\exists i(i \in t \wedge i \in t')$ [T-*overlap*]

(iv) a function Loc_M which to each eventuality in $E_M \cup S_M$ assigns a time interval (*location time*) in T_M.

(v) a partial function CE_M, from E_M into $\{e \in E_M: |Loc_M(e)| = 1\}$ [maps events to instantaneous events], which assigns to each event $e \in Dom(CE_M)$ an instantaneous event e' (*culmination point*) such that:
- $Loc_M(e') \subseteq Loc_M(e)$ [culmination e' is temporally included in e]
- $\neg\exists i \in Loc_M(e): Loc_M(e') <_T \{i\}$ [culmination e' occupies the final instant of e]

(vi) a partial function CS_M, from $E_M \cup S_M$ into S_M [maps eventualities to states], which assigns to each eventuality $ev \in Dom(CS_M)$ a state s (*consequent state*) such that:
- $Loc_M(ev) <_T Loc_M(s)$ [consequent state temporally follows the eventuality]
- $Loc_M(ev) \cup Loc_M(s) \in T_M$ [immediately follows, without any temporal gap]

(vii) a partial function PS_M, from $\{e \in E_M: |Loc_M(e)| \neq 1\}$ into S_M [maps non-instantaneous events to states], which assigns to each event $e \in Dom(PS_M)$ a state s (*progressive state*) such that:
- if $e \in Dom(CE_M)$ then $Loc_M(s) = Loc_M(e) - Loc_M(CE_M(e))$ [telic events progress up to culmination]
- if $e \notin Dom(CE_M)$ then $Loc_M(s) = Loc_M(e)$. [atelic events progress throughout]

(viii) a function $Name_M$ which assigns
- an individual in U_M to each individual constant in $\{John, Mary, \ldots\} \subseteq V$.

(ix) a function Fun_M which assigns
- a function from instantaneous intervals in T_M to intervals in T_M to each temporal functor in $\{today, last\_Sunday, \ldots\} \subseteq V$.

(x) a function $Pred_M$ which assigns:
- a subset of U_M to each 1-place nominal predicate in $\{man, dog, \ldots\} \subseteq V$.
  a subset of T_M to each 1-place temporal predicate in $\{Sunday, on\_Sunday, \ldots\} \subseteq V$.
- a subset of $E_M \times U_M$ to each 1-place event predicate in $\{arrive, die, \ldots\} \subseteq V$.
  a subset of $S_M \times U_M$ to each 1-place state predicate in $\{be\_ill, stink, \ldots\} \subseteq V$.
- a subset of $E_M \times U_M \times U_M$ to each 2-place event predicate in $\{buy, write, \ldots\} \subseteq V$.
  a subset of $S_M \times U_M \times U_M$ to each 2-place state predicate in $\{own, like, \ldots\} \subseteq V$.

Anchored DRT models (cf. K&R pp. 247–248)

An *anchored model* for a vocabulary V is a pair $\langle M, \phi \rangle$ of a model $M = \langle U_M, E_M, S_M, \langle I_M, < \rangle, \mathbf{T}_M, Loc_M, CE_M, CS_M, PS_M, Name_M, Fun_M, Pred_M \rangle$ for V and an (*indexical*) M-*anchor* $\phi = \{\langle n, \{i\} \rangle\}$ where $i \in I_M$.

DRT Semantics (cf. K&R p. 678)

Let K = $\langle U_K, Con_K\rangle$ be a proper DRS confined to vocabulary V
M = $\langle U_M, E_M, S_M, \mathbf{I}_M, \mathbf{T}_M, Loc_M, CE_M, CS_M, PS_M, Name_M, Fun_M, Pred_M\rangle$, a model for V,
ϕ = $\{\langle n, \{i\}\rangle\}$, an M-anchor
f, a ϕ-extending embedding from drefs in V into M
(i.e. $\phi \subseteq$ f and, for any dref $\mathbf{u} \in$ Dom(f), we require f($\mathbf{u}$) $\in U_M$ if $\mathbf{u}$ is an individual dref, f($\mathbf{u}$) $\in E_M$ if $\mathbf{u}$ is an event dref, f($\mathbf{u}$) $\in S_M$ if $\mathbf{u}$ is a state dref, and f($\mathbf{u}$) $\in T_M$ if $\mathbf{u}$ is a temporal dref).

(0) We first define the *value* of a term β in M under f, denoted by $[\beta]_{M,\,f}$, and the *temporal value*, denoted by $^T[\beta]_{M,\,f}$:

- $[\beta]_{M,\,f}$ = f(β) if β is a dref.
- $[\beta]_{m,\,f}$ = $CE_M([\alpha]_{M,\,f})$ if β is of the form **cul**(α) and $[\alpha]_{M,\,f} \in Dom(CE_M)$
  = $PS_M([\alpha]_{M,\,f})$ if β is of the form **prg**(α) and $[\alpha]_{M,\,f} \in Dom(PS_M)$
  = $CS_M([\alpha]_{M,\,f})$ if β is of the form **con**(α) and $[\alpha]_{M,\,f} \in Dom(CS_M)$
  = $Loc_M([\alpha]_{M,\,f})$ if β is of the form **loc**(α)
  = $Loc_M(CS_M([\alpha]_{M,\,f}))$ if β is of the form **aft**(α) and $[\alpha]_{M,\,f} \in Dom(CS_M)$
- $^T[\beta]_{M,\,f}$ = $[\beta]_{M,\,f}$ if β is a temporal term
  = $Loc_M([\beta]_{M,\,f})$ if β is an eventuality term

(i) For any DRS condition $\gamma \in Con_K$, f *verifies* γ in $\langle M, \phi\rangle$ iff

(a) γ is of the form $\alpha = \beta$ and $[\alpha]_{M,\,f} = [\beta]_{M,\,f}$.
γ is of the form $\alpha \subseteq \beta$ and $^T[\alpha]_{M,\,f} \subseteq {}^T[\beta]_{M,\,f}$.
γ is of the form $\alpha < \beta$ and $^T[\alpha]_{M,\,f} <_T {}^T[\beta]_{M,\,f}$.
γ is of the form α s β and $^T[\alpha]_{M,\,f} \bigcirc_T {}^T[\beta]_{M,\,f}$.

(b) γ is of the form $\pi(\mathbf{x})$ and f($\mathbf{x}$) = $Name_M(\pi)$
γ is of the form $\tau(\mathbf{t})$ and f($\mathbf{t}$) $\subseteq Fun_M(\tau)(\phi(n))$

(c) γ is of the form $\eta(\mathbf{x})$ and f($\mathbf{x}$) $\in Pred_M(\eta)$.
γ is of the form $\eta(\mathbf{t})$ and f($\mathbf{t}$) $\in Pred_M(\eta)$.

(d) γ is of the form $\zeta(\mathbf{e}, \mathbf{x})$ and $\langle f(\mathbf{e}), f(\mathbf{x})\rangle \in Pred_M(\zeta)$.
γ is of the form $\zeta(\mathbf{s}, \mathbf{x})$ and $\langle f(\mathbf{s}), f(\mathbf{x})\rangle \in Pred_M(\zeta)$.

(e) γ is of the form $\zeta(\mathbf{e}, \mathbf{x}, \mathbf{y})$ and $\langle f(\mathbf{e}), f(\mathbf{x}), f(\mathbf{y})\rangle \in Pred_M(\zeta)$.
γ is of the form $\zeta(\mathbf{s}, \mathbf{x}, \mathbf{y})$ and $\langle f(\mathbf{s}), f(\mathbf{x}), f(\mathbf{y})\rangle \in Pred_M(\zeta)$.

(f) γ is of the form $\neg K'$ and there is no extension g of f such that
- Dom(g) = Dom(f) $\cup U_{K'}$
- g verifies K′ in $\langle M, \phi\rangle$

(ii) f *verifies* the DRS K in $\langle M, \phi\rangle$ iff f verifies each condition $\gamma \in Con_K$ in $\langle M, \phi\rangle$.

(iii) K is *true in* $\langle M, \phi\rangle$ iff there is a ϕ-extending embedding f from R into M such that Dom(f) = U_K and f verifies K in $\langle M, \phi\rangle$.

DRS Subordination (as in K&R Ch. 1)

Let K and K′ be DRSs.

(i) K is *immediately subordinate to* K′ iff $\neg K \in Con_{K'}$

(ii) K is *subordinate to* K′, K < K′, iff either (a) or (b):
(a) K is immediately subordinate to K′
(b) K is immediately subordinate to some K″ < K′.

(iii) K is *weakly subordinate to* K′, K ≤ K′, iff K = K′ or K < K′.

Dref Accessibility (as in K&R Ch. 1)

Let K be a DRS, $\mathbf{u}$ a dref, and γ a DRS-condition.
We say that $\mathbf{u}$ is *accessible from* γ in K iff, for some K″ ≤ K′ ≤ K, $\gamma \in Con_{K''}$ and $\mathbf{u} \in U_{K'}$.

Kamp & Reyle 1993, Ch. 5 (8)
Verification Conditions for the Perfect and Progressive

• PRESENT PERFECT OF EVENT VERB

(1) John has bought a house.

• *DRS* K_1 for (1):

```
n t x s e y

t = n
John(x)
s ○ t
s = con(e)
buy(e, x, y)
house(y)
```

• *Verification conditions* for K_1:

Consider any anchored DRT model $\langle M, \phi \rangle$, where

$M = \langle U_M, E_M, S_M, \mathbf{I}_M, \mathbf{T}_M, Loc_M, CE_M, CS_M, PS_M, Name_M, Fun_M, Pred_M \rangle$.

Then K_1 is *true* in $\langle M, \phi \rangle$ iff the following equivalent statements hold:

1. there is a ϕ-extending embedding f such that:
   - $f(t) = \phi(n)$ — sem (0), (i.a)
   - $f(x) = Name_M(John)$ — sem (i.b)
   - $Loc_M(f(s))\ s_T\ f(t)$ — sem (0), (i.a)
   - $f(s) = CS_M(f(e))$ — sem (0), (i.a)
   - $\langle f(e), f(x), f(y) \rangle \in Pred_M(buy)$ — sem (i.e)
   - $f(y) \in Pred_M(house)$ — sem (i.c)
2. there is a ϕ-extending embedding f such that: — [eliminating identities from 1.]
   - $Loc_M(CS_M(f(e))) \bigcirc_T \phi(n)$ — 1st •, 3rd •, 4th • above
   - $\langle f(e), Name_M(John), f(y) \rangle \in Pred_M(buy)$ — 2nd •, 5th • above
   - $f(y) \in Pred_M(house)$
3. there is an event $\varepsilon \in E_M$ and an individual $a \in U_M$ such that: — [df. embedding]
   - $Loc_M(CS_M(\varepsilon)) \bigcirc_T \phi(n)$ — 1st • above
   - $\langle \varepsilon, Name_M(John), a \rangle \in Pred_M(buy)$ — 2nd • above
   - $a \in Pred_M(house)$
4. there is an event $\varepsilon \in E_M$ and an individual $a \in U_M$ such that:
   - $\phi(n) \subseteq Loc_M(CS_M(\varepsilon))$ — df. s_T, $\phi(n) = \{i\}$ for some $i \in I_M$
   - $\langle \varepsilon, Name_M(John), a \rangle \in Pred_M(buy)$ — 2nd • above
   - $a \in Pred_M(house)$

[i.e., a is a house, ε is an event where the individual named John buys a, and the consequent state $CS_M(\varepsilon)$ of ε holds at the utterance time $\phi(n)$.]

• *Diagram*:

Note that by the def. of DRT model, the consequent state $CS_M(\varepsilon)$ must immediately follow ε (clause (vi)).

```
                                   φ(n)
___________________________________|||||______________
          |----ε----|======CS_M(ε)=====|
          ('buy')
```

- PRESENT PERFECT OF STATE VERB

(2) John has owned a house.

- *DRS* K_2 for (2):

n t x s s′ y
t = n John(x) s ○ t s = **con**(s′) own(s′, x, y) house(y)

- *Verification conditions* for K_2:

  Consider any anchored DRT model ⟨M, ϕ⟩, where

  $M = \langle U_M, E_M, S_M, \mathbf{I}_M, \mathbf{T}_M, Loc_M, CE_M, CS_M, PS_M, Name_M, Fun_M, Pred_M \rangle$.

  Then K_1 is *true* in ⟨M, ϕ⟩ iff the following equivalent statements hold:

  1. there is a ϕ-extending embedding f such that:
     - $f(t) = \phi(n)$ — sem (0), (i.a)
     - $f(x) = Name_M(John)$ — sem (i.b)
     - $Loc_M(f(s)) \bigcirc_T f(t)$ — sem (0), (i.a)
     - $f(s) = CS_M(f(s'))$ — sem (0), (i.a)
     - $\langle f(s'), f(x), f(y) \rangle \in Pred_M(own)$ — sem (i.e)
     - $f(y) \in Pred_M(house)$ — sem (i.c)
  2. there is a ϕ-extending embedding f such that: — [eliminating identities from 1.]
     - $Loc_M(CS_M(f(s'))) \bigcirc_T \phi(n)$ — 1st •, 3rd •, 4th • above
     - $\langle f(s'), Name_M(John), f(y) \rangle \in Pred_M(own)$ — 2nd •, 5th • above
     - $f(y) \in Pred_M(house)$
  3. there is a state $\sigma \in S_M$ and an individual $a \in U_M$ such that: — [df. embedding]
     - $Loc_M(CS_M(\sigma)) \bigcirc_T \phi(n)$ — 1st • above
     - $\langle \sigma, Name_M(John), a \rangle \in Pred_M(own)$ — 2nd • above
     - $a \in Pred_M(house)$
  4. there is a state $\sigma \in S_M$ and an individual $a \in U_M$ such that:
     - $\phi(n) \subseteq Loc_M(CS_M(\sigma))$ — df. s_T, $\phi(n) = \{i\}$ for some $i \in I_M$
     - $\langle \sigma, Name_M(John), a \rangle \in Pred_M(own)$ — 2nd • above
     - $a \in Pred_M(house)$

  [i.e., *a* is a house, σ is a state where the individual named John owns *a*, and the consequent state $CS_M(\sigma)$ of σ holds at the utterance time ϕ(n).]

- *Diagram*:

  Again, by the def. of DRT model, the consequent state $CS_M(\sigma)$ must immediately follow σ (clause (vi)).

```
                                      φ(n)
______________________________________|||||______________
          |===σ===|=======CS_M(σ)=====|
          ('own')
```

• PRESENT PROGRESSIVE OF EVENT VERB

(5) John is buying a house.

- *DRS* K_5 for (5):

n t x s e y
$t = n$
John(x)
$s \bigcirc t$
$s =$ **prg**(e)
buy(e, x, y)
house(y)

- *Verification conditions* for K_1:

Consider any anchored DRT model $\langle M, \phi \rangle$, where

$M = \langle U_M, E_M, S_M, \mathbf{I}_M, \mathbf{T}_M, Loc_M, CE_M, CS_M, PS_M, Name_M, Fun_M, Pred_M \rangle$.

Then K_1 is *true* in $\langle M, \phi \rangle$ iff the following equivalent statements hold:

1. there is a ϕ-extending embedding f such that:
   - $f(t) = \phi(n)$ — sem (0), (i.a)
   - $f(x) = Name_M(John)$ — sem (i.b)
   - $Loc_M(f(s)) \bigcirc_T f(t)$ — sem (0), (i.a)
   - $f(s) = PS_M(f(e))$ — sem (0), (i.a)
   - $\langle f(e), f(x), f(y) \rangle \in Pred_M(buy)$ — sem (i.e)
   - $f(y) \in Pred_M(house)$ — sem (i.c)
2. there is a ϕ-extending embedding f such that: [eliminating identities from 1.]
   - $Loc_M(PS_M(f(e))) \bigcirc_T \phi(n)$ — 1st •, 3rd •, 4th • above
   - $\langle f(e), Name_M(John), f(y) \rangle \in Pred_M(buy)$ — 2nd •, 5th • above
   - $f(y) \in Pred_M(house)$
3. there is an event $\varepsilon \in E_M$ and an individual $a \in U_M$ such that: [df. embedding]
   - $Loc_M(PS_M(\varepsilon)) \bigcirc_T \phi(n)$ — 1st • above
   - $\langle \varepsilon, Name_M(John), a \rangle \in Pred_M(buy)$ — 2nd • above
   - $a \in Pred_M(house)$
4. there is an event $\varepsilon \in E_M$ and an individual $a \in U_M$ such that:
   - $\phi(n) \subseteq Loc_M(PS_M(\varepsilon))$ — df. s_T, $\phi(n) = \{i\}$ for some $i \in I_M$
   - $\langle \varepsilon, Name_M(John), a \rangle \in Pred_M(buy)$ — 2nd • above
   - $a \in Pred_M(house)$

[i.e., a is a house, ε is an event where the individual named John buys a, and the progressive state $PS_M(\varepsilon)$ of ε — intuitively, the state during which ε is in progress — holds at the utterance time $\phi(n)$.]

- *Diagram*:

Since 'buy' is telic (full) buying events culminate, formally, $\langle \varepsilon, b, a \rangle \in Pred_M(buy)$ implies $\varepsilon \in Dom(CE_M)$. So by clause (vii) of the def. of DRT model, ε is in progress up to its culmination point at the final instant.

```
                                φ(n)
____________________________|||||_____________
                |======PS_M(ε)=====|              (ε in progress)
                |---------------ε--------------|
                         ('buy')
                                  |---|           (culmination point of ε)
                                 CE_M(ε)
```

- NEGATED PRESENT PERFECT OF EVENT VERB

(4) John has not bought a house.

- *DRS* K_4 for (4):

```
      n  t  x

      t = n
      John(x)
      ________________
      |  s  e   y     |
      |               |
      |  s ○ t        |
   ¬  |  s = con(e)   |
      |  buy(e, x, y) |
      |  house(y)     |
      |_______________|
```

- *Verification conditions* for K_4:

Consider any anchored DRT model $\langle M, \phi \rangle$, where

$M = \langle U_M, E_M, S_M, \mathbf{I}_M, \mathbf{T}_M, Loc_M, CE_M, CS_M, PS_M, Name_M, Fun_M, Pred_M \rangle$.

Then K_4 is *true* in $\langle M, \phi \rangle$ iff the following equivalent statements hold:

1. there is a ϕ-extending embedding f such that:	
• $f(t) = \phi(n)$	sem (0), (i.a)
• $f(x) = Name_M(John)$	sem (i.b)
• there is no f-extending embedding g such that:	sem (i.f)
• $Loc_M(g(s)) \bigcirc_T f(t)$	sem (0), (i.a), $f \subseteq g$
• $g(s) = CS_M(g(e))$	sem (0), (i.a)
• $\langle g(e), f(x), g(y) \rangle \in Pred_M(buy)$	sem (i.e), $f \subseteq g$
• $g(y) \in Pred_M(house)$	sem (i.c)
2. there is no ϕ-extending embedding g such that:	[eliminating identities from 1.]
• $Loc_M(CS_M(g(e))) \bigcirc_T \phi(n)$	1st •, 4rd •, 5th • above
• $\langle g(e), Name_M(John), g(y) \rangle \in Pred_M(buy)$	2nd •, 6th • above
• $g(y) \in Pred_M(house)$	
3. there is no event $\varepsilon \in E_M$ and no individual $a \in U_M$ such that:	[df. embedding]
• $Loc_M(CS_M(\varepsilon)) \bigcirc_T \phi(n)$	1st • above
• $\langle \varepsilon, Name_M(John), a \rangle \in Pred_M(buy)$	2nd • above
• $a \in Pred_M(house)$	
4. there is no event $\varepsilon \in E_M$ and no individual $a \in U_M$ such that:	
• $\phi(n) \subseteq Loc_M(CS_M(\varepsilon))$	df. s_T, $\phi(n) = \{i\}$ for some $i \in I_M$
• $\langle \varepsilon, Name_M(John), a \rangle \in Pred_M(buy)$	2nd • above
• $a \in Pred_M(house)$	

[i.e., there is no event ε and individual a such that a is a house, ε is an event where the individual named John buys a, and the consequent state $CS_M(\varepsilon)$ of ε holds at the utterance time $\phi(n)$.]

- *Diagram* for K_4 **not** true:

```
                                   φ(n)
_____________________________________|||||_______________
           |----ε----|======CS_M(ε)=====|
           ('buy')
```

Webber 1988 Revisited: Temporal Anaphora and Aspect

- SOME PLAUSIBLE RESULTS

(1)	(1) A man entered the White Hart.			$t_1 < n$,	$e_1 \subseteq t_1$		
	(2) He had (just) won a bet.	ELA(1)	$t_2 = \mathbf{loc}(e_1)$	$t_2 < n$,	$s_2 \bigcirc t_2$,	$e_1 \subseteq s_2$	$s_2 = \mathbf{con}(e_2)$
	(3) He was whistling an Irish jig.	ELA(1)	$t_3 = \mathbf{loc}(e_1)$,	$t_3 < n$,	$s_3 \bigcirc t_3$,	$e_1 \subseteq s_3$	$s_3 = \mathbf{prg}(e_3)$
	(4) Bill served him a beer.	CTD(1)	$t_4 = \mathbf{aft}(e_1)$,	$t_4 < n$,	$e_4 \subseteq t_4$	$e_1 < e_4$	
	(5) The man drank the beer.	CTD(4)	$t_5 = \mathbf{aft}(e_4)$,	$t_5 < n$,	$e_5 \subseteq t_5$	$e_4 < e_5$	
	(6) Some of it ran down his chin.	ELA(5)	$t_6 = \mathbf{loc}(e_5)$,	$t_6 < n$,	$e_6 \subseteq t_6$	$e_4 < e_6$	

```
                                  Loc(CS(ε1))                                  φ(n)
______________________||||||||||||||||||||||||||||||||______________________________||||||______________
                                        Loc(CS(ε4))
                                        ||||||||||||||||||||||||||||

                  |--ε2,enter--|    |---ε4,serve--|    |--ε5,drink--|

                                                          |--ε6,rn-|

     |-ε2,win--|===CS(ε2)===|

                 |===PS(ε3)===|
                 |-----ε3,whistle_jig----|
```

(2)	(1) John arrived at 10.			$t_1 < n$,	$e_1 \subseteq t_1$ at_10(e_1)		
	(2) He had got up at 5.	ELA(1)	$t_2 = \mathbf{loc}(e_1)$	$t_2 < n$,	$s_2 \bigcirc t_2$,	$e_1 \subseteq s_2$	$s_2 = \mathbf{con}(e_2)$ at_5(e_2)
	(3) He had showered quickly.	ELA(1) CTD(2)	$t_3 = \mathbf{loc}(e_1)$,	$t_3 < n$,	$s_3 \bigcirc t_3$,	$e_1 \subseteq s_3$	$s_3 = \mathbf{con}(e_3)$ $e_2 < e_3$
	(4) He had set off at 6.	ELA(1) CTD(3)	$t_4 = \mathbf{loc}(e_1)$,	$t_4 < n$,	$s_4 \bigcirc t_4$,	$e_1 \subseteq s_4$	$s_4 = \mathbf{con}(e_4)$ at_6(e_4), $e_3 < e_4$
	(5) Now he was tired.	ELA(1)	$t_5 = \mathbf{loc}(e_1)$,	$t_5 < n$,	$s_5 \bigcirc t_5$,	$e_1 \subseteq s_5$	

(3)	(1) John looked at Mary.			$t_1 < n$, $e_1 \subseteq t_1$
	(2) She didn't smile.	CTD	$t_2 = \mathbf{aft}(e_1)$	$t_2 < n$, $\neg\exists e_2(e_2 \subseteq t_2$, $e_1 < e_2, \ldots)$

(4)	(1) John looked at Mary.			$t_1 < n$, $e_1 \subseteq t_1$
	(2) She wasn't smiling.	ELA	$t_2 = \mathbf{loc}(e_1)$,	$t_2 < n$, $\neg\exists s_2(s_2 \bigcirc t_2$, $e_1 \subseteq s_2$, $s_2 = \mathbf{prg}(e_2), \ldots)$

(5)	(1) John was buying a house last month.		$t_1 < n$, $s_1 \bigcirc t_1$, last_mo(t_1) $s_1 = \mathbf{prg}(e_1)$
	(2) He's still buying it.	ELA	$t_2 = n$, $s_2 \bigcirc t_2$, $s_2 = s_1$, $e_2 = e_1$, $s_2 = \mathbf{prg}(e_2)$
			[NB: *prs* **not** anaphoric] [ana. by *still*]

(6)	(1) John is buying a house.		$t_1 = n$, $s_1 \bigcirc t_1$, $s_1 = \mathbf{prg}(e_1)$
	(2) He hasn't bought it yet.	ELA	$t_2 = n$, $\neg\exists s_2 e_2(s_2 \bigcirc t_2$, $e_2 = e_1$, $s_2 = \mathbf{con}(e_2), \ldots)$

• PROBLEMS WITH NEGATION AGAIN: IMPERFECTIVE PARADOX

(7) (1) John was buying a house
last month.

(2) But he didn't buy it (in the end).