ASPECT-BASED THEORY (3):
Formalizing I, D, R, L′ for atomic episodes (Bittner *in press*)

1 PREVIEW

I. Aspect-based (discourse) instants

A discourse referent for a time is:
• a (*discourse*) *instant*, if it is the time of an event referent
• a (*discourse*) *period*, otherwise

D. Aspect-based temporal defaults (v. 1)

Given a $^{\top}w$-real point-of-view $^{\top}a$, the default topic time is:
• the instant of $^{\top}a$-onset in $^{\top}w$, if $^{\top}a$ is a *state*
• the instant of $^{\top}a$ in $^{\top}w$, if $^{\top}a$ is an *event*

<u>Presupposed</u> background (with familiar Aani and Juuna): $\langle w_0, \langle\,\rangle, \langle A, J\rangle\rangle$

Start of speech-act e_0 in w_0 sets <u>default topics</u> (*start-up update*):

(^{0})	$[\mathbf{w}|\ \mathbf{w} = r]$;	$\langle w_0, \langle w_0\rangle, \langle A, J\rangle\rangle$
	$[\mathbf{e}|\ \mathbf{e}$: AGT $speak.up_{\mathbf{d}\omega}]$;	$\langle w_0, \langle e_0, w_0\rangle, \langle A, J\rangle\rangle$
	$[\mathbf{t}|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\mathbf{d}\varepsilon]$	$\langle w_0, \langle t_0, e_0, w_0\rangle, \langle A, J\rangle\rangle$

Model$_0$:

i-reality: $^{\top}w_i$	•	$^{\top}e_0$: e_0-agent speaks up
	|	$^{\top}t_0$: e_0-time (instant) in $^{\top}w_i$

"When I speak I presuppose that others know I am speaking…This fact, too, can be exploited in the conversation, as when Daniels says *I am bald*, taking it for granted that his audience can figure out who is being said to be bald. I mention this COMMONPLACE way [MB emph.] that assertions change the context in order to make it clear that the context on which assertion has its ESSENTIAL effect is not defined by what is presupposed before the speaker begins to speak, but will include any information which the speaker assumes his audience can infer from the performance of the speech act." (Stalnaker 1968:323)

R. Aspect-based reality presuppositions (v. 1)

In a $^{\top}w$-real speech event $^{\top}e$, the speaker may report:
• a *state* s as a fact, iff s-onset precedes the time of $^{\top}e$ in $^{\top}w$
• an *event* e as a fact, iff e precedes the time of $^{\top}e$ in $^{\top}w$

L′. Aspect-based location wrt topical instant (v. 1)

In the topical modality,
• a *state* is current at the topical instant,
• an *event* has a current result state at the topical instant

- *Events & states* wrt start-up instant:

(1K)	[1]*Aani*	***ani**-vu-q*.	[2]*Juuna*	***sinip**-pu-q*.		event-IND, state-IND
	Aani.sg$_{\top}$	go.out-IND.IV-3s	Juuna.sg$_{\top}$	be.asleep-IND.IV-3s		

(1E)	[1]*Ann*	***has***	*gone*	*out*.	[2]*John*	***is***	*asleep*.	state-PRS, state-PRS
	Ann$^{\top}$	have-PRS.3s	go-PRF	out	John$^{\top}$	be-PRS.3s	asleep	

(1K) Aani.sg$^{\top}$ $\langle w_0, \langle \mathrm{A}, t_0, e_0, w_0\rangle,$
$^{\mathrm{P}}[\mid d\alpha = aani]; [\mathbf{a}\mid \mathbf{a} = d\alpha];$ $\langle \mathrm{A}, \mathrm{J}\rangle\rangle$

go.out- (**event** v) $\langle w_0, \langle \mathrm{A}, t_0, e_0, w_0\rangle,$
$[e\ l\mid e\text{: AGT } exit_{\mathbf{d}\omega}\ l];$ $\langle e_1, l_1, \mathrm{A}, \mathrm{J}\rangle\rangle$

-IND.IV (**R-mood**) (**L′**) -3s
$^{\mathrm{P}}[\mid (d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon), (\mathrm{AGT}\ d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha)]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} \mathrm{RES}\ d\varepsilon]; {}^{\mathrm{P}}[\mid 3s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

Juuna.sg$^{\top}$ $\langle w_0, \langle \mathrm{J}, \mathrm{A}, t_0, e_0, w_0\rangle,$
$[\mid d\alpha_1 = juuna]; [\mathbf{a}\mid \mathbf{a} = d\alpha_1];$ $\langle e_1, l_1, \mathrm{A}, \mathrm{J}\rangle\rangle$

be.asleep- (**state**-v) $\langle w_0, \langle \mathrm{J}, \mathrm{A}, t_0, e_0, w_0\rangle,$
$[s\mid s\text{: EXP } asleep_{\mathbf{d}\omega}];$ $\langle s_2, e_1, l_1, \mathrm{A}, \mathrm{J}\rangle\rangle$

-IND.IV (**R-mood**) (**L′**) -3s
$^{\mathrm{P}}[\mid (\mathrm{BEG}\ d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon), (\mathrm{EXP}\ d\sigma =_{\mathbf{d}\omega} \mathbf{d}\alpha)]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma]; {}^{\mathrm{P}}[\mid 3s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

(1E) Ann$^{\top}$ $\langle w_0, \langle \mathrm{A}, t_0, e_0, w_0\rangle,$
$^{\mathrm{P}}[\mid d\alpha = ann]; [\mathbf{a}\mid \mathbf{a} = d\alpha];$ $\langle \mathrm{A}, \mathrm{J}\rangle\rangle$

have- (**state** v) $\langle w_0, \langle \mathrm{A}, t_0, e_0, w_0\rangle,$
$[s\mid \mathbf{d}\alpha =_{\mathbf{d}\omega} \mathrm{EXP}\ s];$ $\langle s_1, \mathrm{A}, \mathrm{J}\rangle\rangle$

-PRS (**tense**) (**L′**) .3s
$^{\mathrm{P}}[\mid \mathbf{d}\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma]; {}^{\mathrm{P}}[\mid 3s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

go- (**event** v) $\langle w_0, \langle \mathrm{A}, t_0, e_0, w_0\rangle,$
$[e\ l\mid (\mathrm{AGT}\ e =_{\mathbf{d}\omega} \mathrm{EXP\ RES}\ e), (e \subseteq_{\mathbf{d}\omega} l), \neg(\mathrm{RES}\ e \subseteq_{\mathbf{d}\omega} l)];$ $\langle e_1, l_1, s_1, \mathrm{A}, \mathrm{J}\rangle\rangle$

-PRF (**asp** v\V)
$[\mid (d\sigma =_{\mathbf{d}\omega} \mathrm{RES}\ d\varepsilon), (\mathrm{EXP}\ d\sigma =_{\mathbf{d}\omega} \mathrm{AGT}\ d\varepsilon)];$

out
$^{\mathrm{P}}[\mid d\varepsilon \subseteq_{\mathbf{d}\omega} d\pi]; [\mid outside_{\mathbf{d}\omega}\{\mathrm{RES}\ d\varepsilon, d\pi\}]$

John$^{\top}$ $\langle w_0, \langle \mathrm{J}, \mathrm{A}, t_0, e_0, w_0\rangle,$
$^{\mathrm{P}}[\mid d\alpha_1 = john]; [\mathbf{a}\mid \mathbf{a} = d\alpha_1];$ $\langle e_1, l_1, s_1, \mathrm{A}, \mathrm{J}\rangle\rangle$

be- (**state** v) $\langle w_0, \langle \mathrm{J}, \mathrm{A}, t_0, e_0, w_0\rangle,$
$[s\ k^{\alpha}\mid \mathbf{d}\alpha =_{\mathbf{d}\omega} k^{\alpha}\{s\}];$ $\langle s_2, k^{\alpha}{}_2, e_1, l_1, \ldots\rangle\rangle$

-PRS (**tense**) (**L′**) .3s
$^{\mathrm{P}}[\mid \mathbf{d}\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma]; {}^{\mathrm{P}}[\mid 3s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

asleep- $\langle w_0, \langle \mathrm{J}, \mathrm{A}, t_0, e_0, w_0\rangle,$
$[\mid asleep\ d\kappa^{\alpha}];$ $\langle s_2, k^{\alpha}{}_2, e_1, l_1, \ldots\rangle\rangle$

Model$_2$:
i-reality $^{\top}w_0$:

•	$^{\top}e_0$:° $speak.up_{w0}(e_0, \mathrm{AGT}_{w0}\ e_0)$
|	$^{\top}t_0 = \vartheta_{w0}\ e_0$
•(—)	e_1: $^{\top}$A exits $^{\perp}l_1$, (e_1-result state)
——	s_2: $^{\top}$J is asleep

2 LOGIC OF CENTERING (*LC*): MODELS INSTEAD OF AXIOMS

D1.1 (*LC* types & dref types)

- $t, \alpha, \beta, \pi, \tau, \omega, \varepsilon, \sigma, \varepsilon^{\bullet}, \zeta, s \in$ **Typ**
- $(\mathtt{ab}) \in$ **Typ** if $\mathtt{a}, \mathtt{b} \in$ **Typ**
- $t, \alpha, \beta, \pi, \tau, \omega, \varepsilon, \sigma, \varepsilon^{\bullet} \in$ **DTyp**
- $(\mathtt{ab}) \in$ **DTyp** if $\mathtt{a}, \mathtt{b} \in$ **DTyp**

D1.2 (Basic *LC*-terms)

- $\mathbf{Con}_{\alpha} = \{john, mary, \ldots\}$
  $\mathbf{Con}_{\beta} = \{John, Mary, \ldots\}$
  $\mathbf{Con}_{\pi} = \{paris, nyc, \ldots\}$
  $\mathbf{Con}_{\tau} = \{2006, \ldots\}$
  $\mathbf{Con}_{\omega\varepsilon\bullet\pi} = \{\Pi, \ldots\}$
  $\mathbf{Con}_{\omega\varepsilon\bullet\tau} = \{\vartheta, \ldots\}$
  $\mathbf{Con}_{\omega\varepsilon\bullet\alpha} = \{\text{EXP}, \ldots\}$
  $\mathbf{Con}_{\omega\varepsilon\alpha} = \{\text{AGT}, \ldots\}$
  $\mathbf{Con}_{\omega\varepsilon\sigma} = \{\text{RES}, \ldots\}$
  $\mathbf{Con}_{\omega\sigma\varepsilon} = \{\text{BEG}, \ldots\}$
  ⋮

  $\mathbf{Con}_{\tau\tau t} = \{<, \bullet<, \ldots\}$
  $\mathbf{Con}_{\pi\pi t} = \{\subseteq_{\pi}, \ldots\}$
  $\mathbf{Con}_{\omega\alpha\varepsilon t} = \{speak.up, \ldots\}$
  $\mathbf{Con}_{\omega\alpha\sigma t} = \{sleep, \ldots\}$
  $\mathbf{Con}_{\omega\pi\alpha\varepsilon t} = \{enter, exit, \ldots\}$
  $\mathbf{Con}_{\omega\tau\alpha t} = \{man, \ldots\}$
  $\mathbf{Con}_{\omega\tau\alpha\pi t} = \{home.of, \ldots\}$
  $\mathbf{Con}_{s\omega} = \{r, \ldots\}$
- $\forall \mathtt{a} \in$ **Typ**:
  $Var_{\mathtt{a}} = \{v_{0,\mathtt{a}}, v_{1,\mathtt{a}}, \ldots\}$
- $\forall \mathtt{a} \in$ **DTyp**:
  $\mathbf{Var}_{\mathtt{a}} = \{\mathbf{v}_{0,\mathtt{a}}, \mathbf{v}_{1,\mathtt{a}}, \ldots\}$
  $Dem_{s\mathtt{a}} = \{d\mathtt{a}_0, d\mathtt{a}_1 \ldots\} \subseteq \mathbf{Con}_{s\mathtt{a}}$
  $\mathbf{Dem}_{s\mathtt{a}} = \{\mathbf{da}_0, \mathbf{da}_1, \ldots\} \subseteq \mathbf{Con}_{s\mathtt{a}}$

D1.3 (*LC*-syntax)

- $\mathtt{A} \in \mathbf{Term}_{\mathtt{a}}$ if $\mathtt{A} \in \mathbf{Con}_{\mathtt{a}} \cup \mathbf{Var}_{\mathtt{a}} \cup Var_{\mathtt{a}} \cup \mathbf{Dem}_{\mathtt{a}} \cup Dem_{\mathtt{a}}$
- $\mathtt{AB} \in \mathbf{Term}_{\mathtt{a}}$ if $\mathtt{A} \in \mathbf{Term}_{(\mathtt{ba})}$ and $\mathtt{B} \in \mathbf{Term}_{\mathtt{b}}$
- $\lambda u[\mathtt{A}] \in \mathbf{Term}_{(\mathtt{ba})}$ if $u \in \mathbf{Var}_{\mathtt{b}} \cup Var_{\mathtt{b}}$ and $\mathtt{A} \in \mathbf{Term}_{\mathtt{a}}$
- $(\mathtt{A} = \mathtt{B}) \in \mathbf{Term}_t$ if $\mathtt{A} \in \mathbf{Term}_{\mathtt{a}}$ and $\mathtt{B} \in \mathbf{Term}_{\mathtt{a}}$
- $(\mathtt{A} \wedge \mathtt{B}) \in \mathbf{Term}_t$ if $\mathtt{A} \in \mathbf{Term}_t$ and $\mathtt{B} \in \mathbf{Term}_t$
- $\neg\mathtt{A} \in \mathbf{Term}_t$ if $\mathtt{A} \in \mathbf{Term}_t$
- $(u \cdot \mathtt{A}) \in \mathbf{Term}_s$ if $u \in \mathbf{Var}_{\mathtt{b}} \cup Var_{\mathtt{b}}$ and $\mathtt{A} \in \mathbf{Term}_s$

D2.1 (*LC*-frames)

- $D_t = \{\mathbf{T}, \mathbf{F}\}$
  $D_{\tau} = \{\mathtt{t} \mid \varnothing \subset \mathtt{t} \subseteq \{\ldots, -1, 0, 1, \ldots\}$
  $\& \; \forall \mathtt{i}, \mathtt{i}', \mathtt{i}'' \in \{\ldots, -1, 0, 1, \ldots\}: \mathtt{i} \in \mathtt{t} \;\&\; \mathtt{i}'' \in \mathtt{t} \;\&\; \mathtt{i} < \mathtt{i}' < \mathtt{i}'' \rightarrow \mathtt{i}' \in \mathtt{t}\}$
  $D_{\alpha}, D_{\beta}, D_{\pi}, D_{\varepsilon}, D_{\sigma}$, and D_{ω} are non-empty sets disjoint from each other and from D_t and D_{τ}
  $D_{\varepsilon\bullet} = D_{\varepsilon} \cup D_{\sigma}$
  $D_{\zeta} = \bigcup_{n \geq 0} (\bigcup_{\mathtt{a} \in \mathbf{DTyp}} D_{\mathtt{a}})^n$
  $D_s = D_{\omega} \times D_{\zeta} \times D_{\zeta}$
- $D_{(\mathtt{ab})} = \{f \mid \text{Dom } f \subseteq D_{\mathtt{a}} \;\&\; \text{Ran } f \subseteq D_{\mathtt{b}}\}$

D2.2 (*LC*-models and assignments)

- An *LC-model* is a structure $M = \langle D^M, \subseteq_\pi, [\![\cdot]\!]^M\rangle$ such that:
  - (i) $D^M = \{D_a{}^M: a \in \mathbf{Typ}\}$ is an *LC*-frame.
  - (ii) $[\![\cdot]\!]^M$ is a function that assigns to any $A \in \mathbf{Con}_a$ a denotation $[\![A]\!]^M \in D_a{}^M$.
  - (iii) For all $z \in D_\xi$:
    $^a z$ is the (possibly empty) subsequence of z consisting of the a-coordinates of z
    For all $\langle w, \top, \bot\rangle \in D_s$:
    $[\![r]\!]^M(\langle w, \top, \bot\rangle) = w$
    $[\![\mathbf{d}a_n]\!]^M(\langle w, \top, \bot\rangle) = {}^{n+1}({}^a\top)$, if defined (i.e. if $^a\top$ has an $(n + 1)$st coord.)
    $[\![da_n]\!]^M(\langle w, \top, \bot\rangle) = {}^{n+1}({}^a\bot)$, if defined (i.e. if $^a\bot$ has an $(n + 1)$st coord.)
  - (iv) $\forall t, t' \in D_\tau$:
    - $t <_\tau t'$ iff $\forall i \in t \forall i' \in t': i < i'$
    - $[\![<]\!]^M(t')(t) = \mathbf{T}$ iff $t <_\tau t'$
    - $t \bullet\!<_\tau t'$ iff $t <_\tau t'$ & $\neg\exists t'' \in D_\tau: t <_\tau t'' <_\tau t'$
    - $[\![\bullet\!<]\!]^M(t')(t) = \mathbf{T}$ iff $t \bullet\!<_\tau t'$
  - (v) $\forall l, l', l'' \in D_\pi$:
    - $l \subseteq_\pi l$
    - $l \subseteq_\pi l'$ & $l' \subseteq_\pi l'' \rightarrow l \subseteq_\pi l''$
    - $[\![\subseteq']\!]^M(l')(l) = \mathbf{T}$ iff $l \subseteq_\pi l'$
  - (vi) $\forall w \in D_\omega \forall e \in D_\varepsilon \forall s \in D_\sigma$:
    - $s = [\![\text{RES}]\!]^M(w)(e) \rightarrow [\![\vartheta]\!]^M(w)(e) \bullet\!<_\tau [\![\vartheta]\!]^M(w)(s)$
    - $e = [\![\text{BEG}]\!]^M(w)(s) \rightarrow [\![\text{EXP}]\!]^M(w)(e) = [\![\text{EXP}]\!]^M(w)(s)$
      & $\exists t \in D_\tau: [\![\vartheta]\!]^M(w)(e) \bullet\!<_\tau t$
      & $[\![\vartheta]\!]^M(w)(s) = ([\![\vartheta]\!]^M(w)(e) \cup t)$
  - (vii) $\forall w \in \text{Dom}\,[\![\text{AGT}]\!]^M$: $\text{Dom}\,[\![\text{AGT}]\!]^M(w) \subseteq (D_\varepsilon - \text{Ran}\,[\![\text{BEG}]\!]^M(w))$
- An *M-assignment* θ assigns to any variable $u \in \mathbf{Var}_a \cup Var_a$ a *value* $\theta(v) \in D_a{}^M$. If $d \in D_a{}^M$, then $\theta[u/d]$ is the *M*-assignment s.t. (i) $\theta[u/d](u) = d$, and (ii) $\theta[u/d](u') = \theta(u')$ if $u' \neq u$.

D2.3 (*LC*-semantics).

- $[\![A]\!]^{M,\theta}$ = $[\![A]\!]^M$ if $A \in \mathbf{Con}_a$
  = $\theta(A)$ if $A \in \mathbf{Var}_b \cup Var_b$
- $[\![AB]\!]^{M,\theta}$ = $[\![A]\!]^{M,\theta}([\![B]\!]^{M,\theta})$ if defined
- $[\![\lambda u[A]]\!]^{M,\theta}(d)$ = $[\![A]\!]^{M,\theta[u/d]}$ if defined
- $[\![(A = B)]\!]^{M,\theta}$ = $\mathbf{T}$, iff $[\![A]\!]^{M,\theta} = [\![B]\!]^{M,\theta}$
  $[\![(A = B)]\!]^{M,\theta}$ = $\mathbf{F}$, iff $[\![A]\!]^{M,\theta} \neq [\![B]\!]^{M,\theta}$
- $[\![(A \wedge B)]\!]^{M,\theta}$ = $\mathbf{T}$, iff $[\![A]\!]^{M,\theta} = \mathbf{T}$ & $[\![B]\!]^{M,\theta} = \mathbf{T}$
  $[\![(A \wedge B)]\!]^{M,\theta}$ = $\mathbf{F}$, iff $[\![A]\!]^{M,\theta} = \mathbf{F}$ or $[\![B]\!]^{M,\theta} = \mathbf{F}$
- $[\![\neg A]\!]^{M,\theta}$ = $\mathbf{T}$, iff $[\![\alpha]\!]^{M,\theta} = \mathbf{F}$
  $[\![\neg A]\!]^{M,\theta}$ = $\mathbf{F}$, iff $[\![\alpha]\!]^{M,\theta} = \mathbf{T}$
- $[\![u \cdot A]\!]^{M,\theta}$ = $\langle w, \langle\theta(u), d_1, \ldots d_n\rangle, \bot\rangle$, iff $u \in \mathbf{Var}_b$ & $[\![A]\!]^{M,\theta} = \langle w, \langle d_1, \ldots d_n\rangle, \bot\rangle$
  = $\langle w, \top, \langle\theta(u), d_1, \ldots d_n\rangle\rangle$, iff $u \in Var_b$ & $[\![A]\!]^{M,\theta} = \langle w, \top, \langle d_1, \ldots d_n\rangle\rangle$

A1 (some abbreviations). We write:

- $(\phi \to \psi)$ for $\neg(\phi \wedge \neg\psi)$
  $(\phi \vee \psi)$ for $\neg(\neg\phi \wedge \neg\psi)$
- $\forall u\phi$ for $(\lambda u[\phi] = \lambda u[u = u])$
  $\exists u\phi$ for $\neg\forall u\neg\phi$
- ${}^{n}\langle x_1, \ldots x_{n'}\rangle$ for x_n, for any $1 \leq n \leq n'$
- $a, a', \ldots, \mathbf{a}$ for $v_{\alpha,0}, v_{\alpha,1}, \ldots, \mathbf{v}_{\alpha,0}$
  $b, b', \ldots, \mathbf{b}$ for $v_{\beta,0}, v_{\beta,1}, \ldots, \mathbf{v}_{\beta,0}$
  $l, l', \ldots, \mathbf{l}$ for $v_{\pi,0}, v_{\pi,1}, \ldots, \mathbf{v}_{\pi,0}$
  $t, t', \ldots, \mathbf{t}$ for $v_{\tau,0}, v_{\tau,1}, \ldots, \mathbf{v}_{\tau,0}$
  $e, e', \ldots, \mathbf{e}$ for $v_{\varepsilon,0}, v_{\varepsilon,1}, \ldots, \mathbf{v}_{\varepsilon,0}$
  $s, s', \ldots, \mathbf{s}$ for $v_{\sigma,0}, v_{\sigma,1}, \ldots, \mathbf{v}_{\sigma,0}$
  $e^{\bullet}, e^{\bullet\prime}, \ldots, \mathbf{e}^{\bullet}$ for $v_{\varepsilon\bullet,0}, v_{\varepsilon\bullet,1}, \ldots, \mathbf{v}_{\varepsilon\bullet,0}$
  $w, w', \ldots, \mathbf{w}$ for $v_{\omega,0}, v_{\omega,1}, \ldots, \mathbf{v}_{\omega,0}$
  $z, z', \ldots$ for $v_{\zeta,0}, v_{\zeta,1}, \ldots$
  i, j, i', j' for $v_{s,0}, v_{s,1}, v_{s,2}, v_{s,2}$
- $\mathtt{R_W(X_1, \ldots X_n)}$ for $\mathtt{RWX_n \ldots X_1}$
  $\mathtt{R_{W,T}(X_1, \ldots X_n)}$ for $\mathtt{RWTX_n \ldots X_1}$
- $(t \subseteq t')$ for $\forall t''((t'' < t' \to t'' < t) \wedge (t' < t'' \to t < t''))$

A2.1. (DRT notation). We write

- $[u_1 \ldots u_n \mid \chi_1, \ldots \chi_m]$ for $\lambda ij\exists u_1 \ldots u_n(j = u_1 \cdot \ldots (u_n \cdot i) \wedge \chi_1 i \wedge \ldots \wedge \chi_m i)$
  $[\mid \chi_1, \ldots \chi_m]$ for $\lambda ij[i = j \wedge \chi_1 i \wedge \ldots \wedge \chi_m i]$
  $(J_{sst} \,;\, K_{sst})$ for $\lambda ij\exists k(J_{sst}ik \wedge K_{sst}kj)$
- $(\mathbf{w} = r)$ for $\lambda i(\mathbf{w} = ri)$
  $(\mathbf{t} =_{\mathbf{d}\omega} \vartheta\mathbf{d}\varepsilon)$ for $\lambda i(\mathbf{t} = \vartheta_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon_i)$
  $(\text{AGT } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha)$ for $\lambda i(\text{AGT}_{\mathbf{d}\omega i}\, d\varepsilon_i = \mathbf{d}\alpha_i)$
- $(1s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\, \mathbf{d}\alpha)$ for $\lambda i(\mathbf{d}\alpha_i = \text{AGT}_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon_i)$
  $(2s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\, \mathbf{d}\alpha)$ for $\lambda i(\mathbf{d}\alpha_i = \text{EXP}_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon_i)$
  $(3s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\, \mathbf{d}\alpha)$ for $\lambda i(\neg(\mathbf{d}\alpha_i = \text{AGT}_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon_i) \wedge \neg(\mathbf{d}\alpha_i = \text{EXP}_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon_i))$
- $(d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon)$ for $\lambda i(\vartheta_{\mathbf{d}\omega i}\, d\varepsilon_i < \vartheta_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon_i)$
  $(\text{BEG } d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon)$ for $\lambda i(\vartheta_{\mathbf{d}\omega i}\, \text{BEG}_{\mathbf{d}\omega i}\, d\sigma_i < \vartheta_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon_i)$
  $(d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau)$ for $\lambda i(\vartheta_{\mathbf{d}\omega i}\, d\varepsilon_i \subseteq \mathbf{d}\tau_i)$
  $(\mathbf{d}\tau \subseteq_{\mathbf{d}\omega} \text{RES } d\varepsilon)$ for $\lambda i(\mathbf{d}\tau_i \subseteq \vartheta_{\mathbf{d}\omega i}\, \text{RES}_{\mathbf{d}\omega i}\, d\varepsilon_i)$
  $(\mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma)$ for $\lambda i(\mathbf{d}\tau_i \subseteq \vartheta_{\mathbf{d}\omega i}\, d\sigma_i)$
- $(\mathbf{e}\text{: AGT } \mathit{speak.up}_{\mathbf{d}\omega})$ for $\lambda i\ \mathit{speak.up}_{\mathbf{d}\omega i}(\mathbf{e}, \text{AGT}_{\mathbf{d}\omega i}\, \mathbf{e})$
  $(e\text{: AGT } \mathit{exit}_{\mathbf{d}\omega}\, l)$ for $\lambda i\ \mathit{exit}_{\mathbf{d}\omega i}(e, \text{AGT}_{\mathbf{d}\omega i}\, e, l)$
  $(e\text{: AGT } \mathit{exit}_{\mathbf{d}\omega}\, d\pi)$ for $\lambda i\ \mathit{exit}_{\mathbf{d}\omega i}(e, \text{AGT}_{\mathbf{d}\omega i}\, e, d\pi_i)$
  $(s\text{: EXP } \mathit{asleep}_{\mathbf{d}\omega})$ for $\lambda i\ \mathit{asleep}_{\mathbf{d}\omega i}(s, \text{EXP}_{\mathbf{d}\omega i}\, s)$
- $\mathit{home.of}_{\mathbf{d}\omega, \mathbf{d}\tau}\{l, \text{AGT } d\varepsilon\}$ for $\lambda i.\ \mathit{home.of}_{\mathbf{d}\omega i, \mathbf{d}\tau i}(l, \text{AGT}_{\mathbf{d}\omega i}\, d\varepsilon_i)$

D3 (Truth and equivalence).

- A t-term ϕ is *true* in M, written $\models_M \phi$, iff $\forall\theta$: $\models_{M,\theta} \phi$
- An sst-term K is *true* in M, written $\models_M K$, iff $\models_M \exists ij\, Kij$ [Kamp 1981 def. of truth]
- $\mathtt{A}$ is *equivalent* to $\mathtt{B}$, written $\mathtt{A} \equiv \mathtt{B}$, iff $\forall M, \theta$: $[\![\mathtt{A}]\!]^{M,\theta} = [\![\mathtt{B}]\!]^{M,\theta}$

3 FROM DRT NOTATION TO (OFFICIAL) LC

(1K)	[1]*Aani*	*ani-vu-q.*	[2]*Juuna*	*sinip-pu-q.*
	Aani.sg$_{\top}$	go.out-IND.IV-3s	Juuna.sg$_{\top}$	be.asleep-IND.IV-3s

Presupposed background: $\langle w_0, \langle\ \rangle, \langle \mathrm{A}, \mathrm{J}\rangle\rangle$

Start-up update:

(^{0}) $[\mathbf{w} |\ \mathbf{w} = r]$;
$\equiv \lambda ij \exists \mathbf{w}(j = (\mathbf{w} \cdot i)$
$\wedge\ \mathbf{w} = r_i)$ — $\langle w_0, \langle w_0\rangle, \langle \mathrm{A}, \mathrm{J}\rangle\rangle$

$[\mathbf{e} |\ \mathbf{e}\text{: AGT } speak.up_{\mathbf{d}\omega}]$;
$\equiv \lambda ij \exists \mathbf{e}(j = (\mathbf{e} \cdot i)$ — $\langle w_0, \langle e_0, w_0\rangle, \langle \mathrm{A}, \mathrm{J}\rangle\rangle$
$\wedge\ speak.up_{\mathbf{d}\omega i}(\mathbf{e}, \mathrm{AGT}_{\mathbf{d}\omega i}\ \mathbf{e}))$ — $^\circ\ speak.up_{w0}(e_0, \mathrm{AGT}_{w0}\ e_0)$

$[\mathbf{t} |\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta \mathbf{d}\varepsilon]$
$\equiv \lambda ij \exists \mathbf{t}(j = (\mathbf{t} \cdot i)$ — $\langle w_0, \langle t_0, e_0, w_0\rangle, \langle \mathrm{A}, \mathrm{J}\rangle\rangle$
$\wedge\ \mathbf{t} = \vartheta_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i)$ — $^\circ\ t_0 = \vartheta_{w0}\ e_0$

i-reality $^{\top}w_0$: • $^{\top}e_0$: e_0-agt speaks up
| $^{\top}t_0 = \vartheta_{w0}\ e_0$

(^{1}) Aani.sg$^{\top}$
$^{\mathrm{P}}[|\ d\alpha = aani]$;
$\equiv\ \lambda ij(j = i$ — $^\circ\ {}^1({}^{\alpha}\langle \mathrm{A}, \mathrm{J}\rangle) = {}^1\langle \mathrm{A}, \mathrm{J}\rangle$
$\wedge\ d\alpha_i = aani)$ — $= \mathrm{A}$

$[\mathbf{a} |\ \mathbf{a} = d\alpha]$;
$\equiv\ \lambda ij \exists \mathbf{a}(j = (\mathbf{a} \cdot i)$ — $\langle w_0, \langle \mathrm{A}, t_0, e_0, w_0\rangle,$
$\wedge\ \mathbf{a} = d\alpha_i)$ — $\langle \mathrm{A}, \mathrm{J}\rangle\rangle$

go.out-
$[e\ l |\ e\text{: AGT } exit_{\mathbf{d}\omega}\ l]$; — $\langle w_0, \langle \mathrm{A}, t_0, e_0, w_0\rangle,$
$\equiv\ \lambda ij \exists e\ l(j = (e \cdot (l \cdot i))$ — $\langle e_1, l_1, \mathrm{A}, \mathrm{J}\rangle$
$\wedge\ exit_{\mathbf{d}\omega i}(e, \mathrm{AGT}_{\mathbf{d}\omega i}\ e, l))$ — $^\circ\ exit_{w0}(e_1, \mathrm{AGT}_{w0}\ e_1, l_1)$

-IND.IV
$^{\mathrm{P}}[|\ (d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon), (\mathrm{AGT}\ d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha)]$;
$\equiv\ \lambda ij(j = i$
$\wedge\ \vartheta_{\mathbf{d}\omega i}\ d\varepsilon_i < \vartheta_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i$ — $^\circ\ \vartheta_{w0}\ e_1 < \vartheta_{w0}\ e_0$
$\wedge\ \mathrm{AGT}_{\mathbf{d}\omega i}\ d\varepsilon_i = \mathbf{d}\alpha_i)$ — $^\circ\ \mathrm{AGT}_{w0}\ e_1 = \mathrm{A}$

$[|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} \mathrm{RES}\ d\varepsilon]$
$\equiv\ \lambda ij(j = i$
$\wedge\ \mathbf{d}\tau_i \subseteq \vartheta_{\mathbf{d}\omega i}\ \mathrm{RES}_{\mathbf{d}\omega i}\ d\varepsilon_i)$ — $^\circ\ t_0 \subseteq \vartheta_{w0}\ \mathrm{RES}_{w0}\ e_1$

-3s
$^{\mathrm{P}}[|\ 3s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$
$\equiv\ \lambda ij(j = i$ — $^\circ\ \neg(\mathrm{A} = \mathrm{AGT}_{w0}\ e_0)$
$\wedge\ \neg(\mathbf{d}\alpha_i = \mathrm{AGT}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i) \wedge \neg(\mathbf{d}\alpha_i = \mathrm{EXP}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i))$ — $\wedge\ \neg(\mathrm{A} = \mathrm{EXP}_{w0}\ e_0)$

i-reality $^{\top}w_0$:

•	$^{\top}e_0$: e_0-agt speaks up
∣	$^{\top}t_0 = \vartheta_{w0}\, e_0$
•(—)	e_1, (RES$_{w0}$ e_1) Ann $\notin$ {e_0-agt, e_0-exp} exits l_1

(2) Juuna.sg$^{\top}$

$^{P}[\mid d\alpha_1 = juuna]$; $\circ\ {}^{2}({}^{\alpha}\langle e_1, l_1, \text{A}, \text{J}\rangle) = {}^{2}\langle \text{A}, \text{J}\rangle$

$\equiv\ \lambda ij(j = i$ $= \text{J}$

$\wedge\ (d\alpha_1)_i = juuna)$

$[\mathbf{a}\mid \mathbf{a} = d\alpha_1]$;

$\equiv\ \lambda ij\ \exists \mathbf{a}(j = (\mathbf{a} \cdot i)$ $\langle w_0, \langle \text{J}, \text{A}, t_0, e_0, w_0\rangle,$

$\wedge\ \mathbf{a} = (d\alpha_1)_i)$ $\langle e_1, l_1, \text{A}, \text{J}\rangle\rangle$

be.asleep-

$[s\mid s\text{: EXP } asleep_{\mathbf{d}\omega}]$; $\langle w_0, \langle \text{J}, \text{A}, t_0, e_0, w_0\rangle,$

$\equiv\ \lambda ij\ \exists s(j = (s \cdot i)$ $\langle s_2, e_1, l_1, \text{A}, \text{J}\rangle\rangle$

$\wedge\ asleep_{\mathbf{d}\omega i}(s, \text{EXP}_{\mathbf{d}\omega i}\ s))$

-IND.IV

$^{P}[\mid (\text{BEG } d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon), (\text{EXP } d\sigma =_{\mathbf{d}\omega} \mathbf{d}\alpha)]$;

$\equiv\ \lambda ij(j = i$

$\wedge\ \vartheta_{\mathbf{d}\omega i}\, \text{BEG}_{\mathbf{d}\omega i}\ d\sigma_i < \vartheta_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i$ $\circ\ \vartheta_{w0}\, \text{BEG}_{w0}\, s_2 < \vartheta_{w0}\, e_0$

$\wedge\ \text{EXP}_{\mathbf{d}\omega i}\ d\sigma_i = \mathbf{d}\alpha_i)$ $\circ\ \text{EXP}_{w0}\, s_2 = \text{J}$

$[\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma]$

$\equiv\ \lambda ij(j = i$

$\wedge\ \mathbf{d}\tau_i \subseteq \vartheta_{\mathbf{d}\omega i}\ d\sigma_i)$ $\circ\ t_0 \subseteq \vartheta_{w0}\, s_2$

-3s

$^{P}[\mid 3s_{\mathbf{d}\omega,\, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

$\equiv\ \lambda ij(j = i$ $\circ\ \neg(\text{J} = \text{AGT}_{w0}\, e_0)$

$\wedge\ \neg(\mathbf{d}\alpha_i = \text{AGT}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i) \wedge \neg(\mathbf{d}\alpha_i = \text{EXP}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i))$ $\wedge\ \neg(\text{J} = \text{EXP}_{w0}\, e_0)$

i-reality $^{\top}w_0$:

•	$^{\top}e_0$: e_0-agt speaks up
∣	$^{\top}t_0 = \vartheta_{w0}\, e_0$
•(—)	e_1, (RES$_{w0}$ e_1): Ann $\notin$ {e_0-agt, e_0-exp} exits l_1
——	s_2: Juuna $\notin$ {e_0-agt, e_0-exp} is asleep

4 Comparative Overview of Basic Meanings

Kalaallisut:

Class	Item	Basic meaning	Example
LEXICAL			
1 ε-v	go.out-	$[e\ l \mid e\text{: AGT } exit_{\mathbf{d}\omega}\ l]$	(1K^{1})
σ-v	be asleep-	$[s \mid s\text{: EXP } asleep_{\mathbf{d}\omega}]$	(1K^{2})
1′ **asp**	-prf	$[s \mid (s =_{\mathbf{d}\omega} \text{RES } d\varepsilon), (\text{EXP } s =_{\mathbf{d}\omega} \text{EXP } d\varepsilon)]$	TOP 5
	-begin	$[e \mid e =_{\mathbf{d}\omega} \text{BEG } d\sigma]$	TOP 5
FUNCTIONAL			
2 **mood**	-IND (σ-base)	$^{P}[\mid \text{BEG } d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma]$	(1K^{2})
	(ε-base)	$^{P}[\mid d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; \quad [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} \text{RES } d\varepsilon]$	(1K^{1})
		$^{P}[\mid d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; \quad [\mid d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]$	TOP 5
	.IV (σ-base)	$^{P}[\mid \text{EXP } d\sigma =_{\mathbf{d}\omega} \mathbf{d}\alpha]$	(1K^{2})
	(ε-base)	$^{P}[\mid \text{AGT } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]$	(1K^{1})
	-FCT$_{\top}$	$^{P}[\mid d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon, \text{AGT } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]; [\mathbf{t} \mid \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES } d\varepsilon]$	TOP 5
	-FCT$_{\perp}$	$^{P}[\mid d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon, \text{AGT } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]; [\mathbf{t}\ a \mid \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES } d\varepsilon, a = \mathbf{d}\alpha]$	TOP 5
2′ **agr**	-1s$_{(\top)}$	$^{P}[\mid 1s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$	TOP 5
	-3s$_{(\top)}$	$^{P}[\mid 3s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$	(1K^{1,2})
	-3s$_{\perp}$	$^{P}[\mid 3s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ d\alpha]$	TOP 5

English:

Class	Item	Basic meaning	Example
LEXICAL			
1 ε-v	go-	$[e\ l \mid (\text{AGT } e =_{\mathbf{d}\omega} \text{EXP RES } e), (e \subseteq_{\mathbf{d}\omega} l), \neg(\text{RES } e \subseteq_{\mathbf{d}\omega} l)];$	(1E^{1})
σ-v	have-	$[s \mid \mathbf{d}\alpha =_{\mathbf{d}\omega} \text{EXP } s]$	(1E^{1})
	be-	$[s\ k^{\alpha} \mid \mathbf{d}\alpha =_{\mathbf{d}\omega} k^{\alpha}\{s\}]$	(1E^{2})
A	asleep	$[\mid asleep\ d\kappa^{\alpha}]$	(1E^{2})
1′ **asp**	-PRF (ε-base)	$[\mid (d\sigma =_{\mathbf{d}\omega} \text{RES } d\varepsilon), (\text{EXP } d\sigma =_{\mathbf{d}\omega} \text{AGT } d\varepsilon)]$	(1E^{1})
FUNCTIONAL			
2 **tns**	-PRS (σ-base)	$^{P}[\mid \mathbf{d}\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma]$	(1E^{1,2})
	-PST (σ-base)	$^{P}[\mid \mathbf{d}\tau <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma];$	TOP 5
	(ε-base)	$^{P}[\mid \mathbf{d}\tau <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [\mid d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [\mathbf{t} \mid \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES } d\varepsilon]$	TOP 5
3 **prn**	I (‘1s$^{\top}$’)	$[\mathbf{a} \mid 1s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ \mathbf{a}]$	TOP 5
	me (‘1s$_{\perp}$’)	$^{P}[\mid 1s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ d\alpha]$	
	he (‘3sm$^{\top}$’)	$^{P}[\mid 3s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha, male_{\mathbf{d}\omega}\ \mathbf{d}\alpha];$	
	him (‘3sm$^{\perp}$’)	$^{P}[\mid 3s_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ d\alpha, male_{\mathbf{d}\omega}\ d\alpha]$	

Recall p. 36 from ‘Aspectual universals of temporal anaphora’:

‘Aspect-based temporal anaphora does not depend on a grammatical tense system. A tense system is just one of the grammatical options, attested in English and typologically similar languages. It is a grammatical system that specializes in temporal anaphora, taking care of the entire complex of anaphoric phenomena covered by the above generalizations [**I**, **D**, **R**, **L**′, **L**, **L**″, **U**]. But each of these phenomena can also be dealt with by some other grammatical system, e.g. grammatical aspect, grammatical mood, and/or grammatical centering. So it is not surprising that there is a rich variety of tenseless languages, including but not limited to Kalaallisut, Yukatek, and Mohawk.’