Tense, Mood, and Centering*

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Abstract

I propose that tense and mood paradigms are grammatical centering systems. Specifically, English tenses form a *temporal centering system*, which monitors and updates topic times, whereas Kalaallisut moods form a *modal centering system*, which monitors and updates modal discourse referents. Nevertheless, English and Kalaallisut translation equivalents converge on the same truth conditions, due to the 'commonplace effect' of speech acts (see (Stalnaker, 1978)).

1 Introduction

Natural languages exhibit a great variety of grammatical paradigms. For example, in root clauses, English verbs are grammatically marked for tense, whereas in the tenseless Eskimo-Aleut language Kalaallisut they are marked for illocutionary mood. Although time is a universal dimension of the human experience and speaking is part of that experience, some languages encode reference to time without grammatical tense, or reference to speech acts without grammatical illocutionary mood.

Nevertheless, different grammatical systems are semantically parallel in certain respects. Specifically, I propose that English tenses form a *temporal centering system*, which monitors and updates topic times, whereas Kalaallisut moods form a *modal centering system*, which monitors and updates modal discourse referents. To formalize these centering parallels, I define a dynamic logic that keeps track not only of the current discourse referents but also of their current hierarchy (*Update with Centering*; compare (Grosz, Aravind, & Weinstein, 1995); (Bittner, 2001)). Different languages can be translated into this logic by universal directly compositional rules of *Categorial Grammar* (CG; the version to be used here is the Combinatory Categorial Grammar of (Steedman, 1996)).

The proposed centering theory of tense and illocutionary mood draws semantic parallels across different types of grammatical systems. The proposed centering generalizations span the extremes of the typological spectrum, so they are likely to be universal. In addition, the theory accounts for the translation equivalence of tense and illocutionary mood in a given utterance context. Following (Stalnaker, 1978), I assume that the very act of speaking up has a 'commonplace effect' on the context. It focuses attention on the speech act and thereby introduces default modal and temporal topics. These universal defaults complement language-specific grammars — for example, English tenses and Kalaallisut moods. In a given utterance context the universal discourse-initial defaults plus language-specific grammatical marking may add up to the same truth conditions. Thus, different linguistic forms may be intuitively equivalent.

* This is a theory-preserving revision of a manuscript that has been in circulation since 2009. I still believe that tense and mood are semantically parallel and contextually equivalent centering systems, but the analyses presented here are special cases of a more general and more nuanced theory (see (Bittner, 2014)). To facilitate theory comparison, while revising the 2009 manuscript, I have avoided making substantive changes, except for correcting errors. The revisions are mostly editorial, terminological, and notational. For helpful feedback on the original paper, I thank Hans Kamp, Sarah Murray, Craige Roberts, Katrin Schulz, Judith Tonhauser, Eric Wirkerman, and my audiences at the 2008 DGfS workshop on *Tense across Languages*, as well as the colloquia and discussion groups at Stuttgart IMS (2008), ILLC (2008), and the Ohio State University (2009).

The paper is organized as follows. Section 2 defines Update with Centering (UC). In particular, it defines a universal ontology of discourse referents and formally implements the universal 'commonplace effect' of (Stalnaker, 1978). The basic idea is that speaking up focuses attention on this speech act and thereby introduces default modal and temporal topics. Section 3 recasts the anaphoric theory of English tenses as top-level temporal discourse reference. Section 4 analyzes illocutionary mood in Kalaallisut as top-level modal discourse reference. Section 5 shows that, given the universal modal and temporal defaults, the mirror-image centering systems of English and Kalaallisut converge on equivalent truth conditions, up to a point. Section 6 concludes.

2 Update with Centering

According to (Stalnaker, 1978, p. 323), the very act of speaking up has a 'commonplace' effect on the context. In Stalnaker's own words: "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 emphasis] 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."

According to Stalnaker, the 'essential' effect of assertion is that the asserted proposition is added to the *common ground* (CG) — the set of worlds that are live candidates for the speech world according to the shared information of the discourse participants. After the 'commonplace' effect the CG consists of those worlds that are compatible with 'what is presupposed before the speaker begins to speak' plus the information about the speech act. For every proposition that is then asserted by the speaker, the input CG is updated to the subset consisting of those worlds that are compatible with the new proposition. In this way Stalnaker represents growth of the shared information.

This strategy works for discourse-initial sentences but it runs into problems with connected discourses, such as *A man came in. He sat down*. For in order to determine what proposition is expressed by the second sentence, *He sat down*, it is necessary to deal with the nominal anaphora by the pronoun, *he*, and the temporal anaphora by the past tense, *sat*. To address this problem, while preserving Stalnaker's insight, I define an update semantics that combines anaphora to currently salient discourse referents — along the lines of *Predicate Logic with Anaphora* (PLA, (Dekker, 1994)) — with many-sorted type theory. The resulting *Update with Centering* (UC) can be defined in a manner parallel to Dekker's definition of PLA, as follows.

Like PLA, UC keeps track of the current state of information (*info-state*) in discourse. An info-state is a set of lists of prominence-ranked semantic entities (*discourse referents* a.k.a. *drefs*) that can be referred to by discourse anaphors. Refining PLA, a UC list is structured into a *top sub-list*, of prominence-ranked dref entities in the center of attention, and a *bottom sub-list*, of prominence-ranked dref entities in the periphery.

Definition 1 (Structured lists, sub-lists, info-states). *Let $\mathcal{D}$ be a non-empty set of entities.*

- $\mathcal{D}^n \times \mathcal{D}^m$ *is the set of* structured lists *of n ranked entities in the center of attention and m ranked entities in the periphery.*
- *For any structured list* $\mathsf{i} = \langle \mathsf{i}_1, \mathsf{i}_2 \rangle \in \mathcal{D}^n \times \mathcal{D}^m$, i_1 *is the* top sub-list *and* i_2 *is the* bottom sub-list.
- *An n, m-*info-state *is any subset of* $\mathcal{D}^n \times \mathcal{D}^m$. *The null set,* $\varnothing$, *is the* absurd info-state.

A state of information about the current dref entities and the current dref hierarchy can be pictured as a two-dimensional matrix (e.g. (1)). Each row represents a possible structured list — i.e. a pair of a top sub-list and a bottom sub-list. Each column represents the set of dref entities at a particular prominence rank. For simplicity, suppose that matrix (1) consists of individuals. The top-ranked individual on the top sub-list is the current *topic* (⊤), while the top-ranked individual on the bottom sub-list is the current *background* (⊥). An info-state like (1) contains the information that the topical individual is a man just in case every individual in the ⊤-set (column) is a man. Furthermore, the state contains the information that the background individual is a donkey owned by the topical man just in case in every structured list (row) the ⊥-individual is a donkey owned by the ⊤-man.

(1) ⊤ ⊥

$$\langle\langle a_1,\ a_2, \ldots,\ a_n\rangle,\ \langle b_1,\ b_2, \ldots,\ b_m\rangle\rangle$$
$$\langle\langle a'_1,\ a'_2, \ldots,\ a'_n\rangle,\ \langle b'_1,\ b'_2, \ldots,\ b'_m\rangle\rangle$$
$$\langle\langle a''_1,\ a''_2, \ldots,\ a''_n\rangle,\ \langle b''_1,\ b''_2, \ldots,\ b''_m\rangle\rangle$$

A piece of discourse updates the input info-state to the output info-state. *Information update* eliminates structured lists that are incompatible with the new information. For instance, if (1) is updated with the information that the topical man beats the background donkey, then the structured lists that do not fit this constraint will be eliminated (see sample output in (2)):

(2) ⊤ ⊥

$$\langle\langle a_1,\ a_2, \ldots,\ a_n\rangle,\ \langle b_1,\ b_2, \ldots,\ b_m\rangle\rangle$$
$$\langle\langle a'_1,\ a'_2, \ldots,\ a'_n\rangle,\ \langle b'_1,\ b'_2, \ldots,\ b'_m\rangle\rangle$$

Attention update involves recentering — that is, extending the top and/or bottom sub-lists of the input structured lists with newly prominent dref entities. These can be new dref entities, freshly introduced into discourse; or familiar dref entities, reintroduced by definite descriptions or other recentering anaphors. For instance, if the next sentence begins with a definite subject, *The donkey* …, then the input background donkey is promoted to topical status. That is, in each structured list (row) the input ⊥-donkey (input background) is added to the top sub-list as the new ⊤-dref (output topic). Other dref entities on the top sub-list are thereby demoted one notch (see (3)).

(3) ⊤ ⊥

$$\langle\langle b_1,\ a_1,\ a_2, \ldots,\ a_n\rangle,\ \langle b_1,\ b_2, \ldots,\ b_m\rangle\rangle$$
$$\langle\langle b'_1,\ a'_1,\ a'_2, \ldots,\ a'_n\rangle,\ \langle b'_1,\ b'_2, \ldots,\ b'_m\rangle\rangle$$

To analyze nominal, temporal, and modal discourse reference, we sort basic dref entities into *individuals* (type δ), *events* (ε), *states* (σ), *discourse times* (τ), and *worlds* (ω). We also allow discourse reference to the corresponding sets. A structured list is formally a semantic object of the basic type s.

Definition 2 (UC types, dref types). *The set of UC* types Θ *is the smallest set such that*:

1. $\{t, \delta, \varepsilon, \sigma, \tau, \omega, s\} \subseteq \Theta$
2. $(ab) \in \Theta$ *if* $a, b \in \Theta$

The subset $\text{DR}(\Theta) = \{\delta, \varepsilon, \sigma, \tau, \omega, \delta t, \varepsilon t, \sigma t, \tau t, \omega t\}$ *is the set of* dref types.

Typed domains for UC are defined in the usual way, except for three non-standard features (see definition 3.1). First of all, while the time we live is intuitively continuous, in natural language discourses expressions such as *immediately after*, *next*, etc., presuppose *discourse times* consisting of minimal discourse-transparent parts (*discourse instants*; see e.g. (Kamp, 1979); (Bittner, 2008)). For simplicity, we model discourse times as non-empty sets of consecutive integers, i.e. non-empty convex sets. Secondly, the domain of structured lists, $\mathcal{D}_s$, is fully determined by the domains of entities of dref types. Specifically, it is the set of all the structured lists that can be built out of entities of dref types (i.e. out of individuals, events, states, discourse times, worlds, and sets thereof), including the *minimal structured list*, $\langle\langle\rangle, \langle\rangle\rangle$, without any dref entities. Thus, for any input structured list, the result of extending the top or bottom sub-list with any entity of any dref type is again a structured list. Finally, $\mathcal{D}_{ab}$ includes both total and partial functions from $\mathcal{D}_a$ to $\mathcal{D}_b$. This will be important, because anaphoric terms (type *sa*, for $a \in \mathrm{DR}(\Theta)$) may fail to denote.

Definition 3.1 (UC frame). *A UC* frame *is a set* $\mathcal{F} = \{\mathcal{D}_a | \, a \in \Theta\}$ *such that:*

1. $\mathcal{D}_t = \{1, 0\}$, $\mathcal{D}_\delta$, $\mathcal{D}_\varepsilon$, $\mathcal{D}_\sigma$, $\mathcal{D}_\tau$, *and* $\mathcal{D}_\omega$ *are non-empty pairwise disjoint sets.*
   $\mathcal{D}_\tau = \{\mathsf{t} | \; \mathsf{t}$ *is a non-empty convex set of integers*$\}$
   $\mathcal{D}_s = \cup_{n \geq 0, m \geq 0}\{\langle\langle \mathsf{d}_1, \ldots, \mathsf{d}_n\rangle, \langle \mathsf{d'}_1, \ldots, \mathsf{d'}_m\rangle\rangle: \mathsf{d}_i, \mathsf{d}_j \in \mathcal{D}_{dr}\}$, *where* $\mathcal{D}_{dr} = \cup\{\mathcal{D}_a: a \in \mathrm{DR}(\Theta)\}$
2. $\mathcal{D}_{ab} = \{f | \; \varnothing \subset \mathrm{Dom}\, f \subseteq \mathcal{D}_a \;\&\; \mathrm{Ran}\, f \subseteq \mathcal{D}_b\}$

Given a UC frame $\mathcal{F}$, we further define a *frame with a dref algebra*, $\mathcal{F}_f$, where dref entities are related by a network of relations and operations (see definition D3.2). Specifically, in every world, every eventuality (i.e. event or state) that is realized in that world is assigned a *run time* by the function ϑ. Some eventualities are also assigned a *place* (formally, an individual), by the function π. The run time of any event that has a consequent state ($^{\triangleright}\mathsf{e}$) is a *discourse instant* (unit set). The consequent state begins at the next instant. The run time of any state that has a beginning ($^{◣}\mathsf{s}$) is a *discourse period* (plural set), which begins and ends with the related changes of state ($^{◣}\mathsf{s}$, $^{◥}\mathsf{s}$). For any eventuality u, $\uparrow\mathsf{u}$ and $\downarrow\mathsf{u}$ are the *central individual* and the *background individual* of u, if defined. The central individual is preserved by all eventuality-valued operations ($^{\triangleright}$, $^{◣}$, and $^{◥}$).

Definition 3.2 (UC frame with dref algebra). *A UC* frame with a dref algebra, *based on a frame* $\mathcal{F}$, *is a structure* $\mathcal{F}_f = \langle \mathcal{F}, \mathcal{D}_\upsilon, \pi, \vartheta, ^{\triangleright}, ^{◣}, ^{◥}, \uparrow, \downarrow\rangle$ *such that*:

1. $\mathcal{D}_\upsilon = \mathcal{D}_\varepsilon \cup \mathcal{D}_\sigma$ (*eventualities*)
2. $\pi: \mathcal{D}_\omega \to [\mathcal{D}_\upsilon \to \mathcal{D}_\delta]$ (*place-of*)
   $\vartheta: \mathcal{D}_\omega \to [\mathcal{D}_\upsilon \to \mathcal{D}_\tau]$ (*run-time-of*)
   $\mathsf{t}_1 <_\tau \mathsf{t}_1 \;:\Leftrightarrow\; \mathsf{t}_1, \mathsf{t}_2 \in \mathcal{D}_\tau \;\&\; \forall n \in \mathsf{t}_1 \forall m \in \mathsf{t}_2: n < m$ (*strict precedence*)
3. $\mathsf{s} = {}^{\triangleright}\mathsf{e} \;\&\; \vartheta_\mathsf{w}\,\mathsf{e} = \mathsf{t} \Rightarrow \mathsf{e} \in \mathcal{D}_\varepsilon \;\&\; \mathsf{s} \in \mathcal{D}_\sigma \;\&\; \exists n: \mathsf{t} = \{n\} \;\&\; \vartheta_\mathsf{w}{}^{◣}\mathsf{s} = \{n+1\}$ (*point, consequent state*)
   $\mathsf{e} = {}^{◣}\mathsf{s} \;\&\; \vartheta_\mathsf{w}\,\mathsf{s} = \mathsf{t} \Rightarrow \mathsf{s} \in \mathcal{D}_\sigma \;\&\; \mathsf{e} \in \mathcal{D}_\varepsilon \;\&\; \vartheta_\mathsf{w}\,\mathsf{e} = \{\min \mathsf{t}\} <_\tau \vartheta_\mathsf{w}{}^{◥}\mathsf{s} = \{\max \mathsf{t}\}$ (*start/end point*)
4. $\mathsf{x} = \uparrow\mathsf{u} \Rightarrow \mathsf{u} \in \mathcal{D}_\upsilon \;\&\; \mathsf{x} \in \mathcal{D}_\delta$ (*central individual*)
   $\mathsf{x} = \downarrow\mathsf{u} \Rightarrow \mathsf{u} \in \mathcal{D}_\upsilon \;\&\; \mathsf{x}, \uparrow\mathsf{u} \in \mathcal{D}_\delta$ (*background individual*)
5. $\mathsf{x} = \uparrow\mathsf{u} \;\&\; f \in \{^{\triangleright}, ^{◣}, ^{◥}\} \Rightarrow \mathsf{x} = \uparrow(f(\mathsf{u}))$ (*center preservation*)

A model for UC consists of a frame with a dref algebra and an interpretation function for constants that respects the type constraints and three additional constraints (see definition 4). First of all, the eventuality argument of any constant of type $\omega\varepsilon\delta\ldots t$ (e.g. *leave* or *hit*) or $\omega\sigma\delta\ldots t$ (e.g. *sad* or *like*) is centered on the first individual argument. Secondly, events of speaking up, identified by a special constant ***spk*** $\in \mathcal{D}_{\omega\varepsilon\delta t}$, have consequences. Finally, for any dref type a, $\top a$ and $\bot a$ are top-level anaphors of type *sa*. They refer to the top-ranked dref entity of type a on the top sub-list (for $\top a$) or bottom sub-list (for $\bot a$), if there is such an entity, and fail to refer, otherwise. (For any sequence z, we write z_n or $(\mathsf{z})_n$ for the nth coordinate of z; and $(\mathsf{z})_a$, for the subsequence of z consisting of coordinates of type a. We also write '$X \doteq Y$' for 'X is Y if Y is defined; else, X is undefined'. Finally, for the sake of readability, we use characteristic functions and the sets they characterize interchangeably.)

Definition 4 (UC model). *A UC model is a structure* $\mathcal{M} = \langle \mathcal{F}_f, [\![\cdot]\!]\rangle$, *where* $\mathcal{F}_f$ *is a UC frame with a dref algebra and* $[\![\cdot]\!]$ *assigns a denotation* $[\![A]\!] \in \mathcal{D}_a$ *to each constant* $A \in Con_a$. *Moreover*:

1. $\forall a \in \{\varepsilon, \sigma\}, A \in Con_{\omega a\delta\ldots t}, \mathsf{w} \in \mathcal{D}_\omega, \mathsf{u} \in \mathcal{D}_a, \mathsf{x} \in \mathcal{D}_\delta: \langle \mathsf{u}, \mathsf{x}, \ldots\rangle \in [\![A]\!](\mathsf{w}) \Rightarrow \mathsf{x} = \uparrow\mathsf{u}$
2. $\forall \mathsf{w} \in \mathcal{D}_\omega, \mathsf{e} \in \mathcal{D}_\varepsilon: \langle \mathsf{e}, \uparrow\mathsf{e}\rangle \in [\![\boldsymbol{spk}]\!](\mathsf{w}) \Rightarrow \exists \mathsf{s}: \mathsf{s} = {}^{\triangleright}\mathsf{e}$
3. $\forall a \in \mathrm{DR}(\Theta), \mathsf{i} \in \mathcal{D}_s: [\![\top a]\!] \doteq ((\mathsf{i}_1)_a)_1, [\![\bot a]\!] \doteq ((\mathsf{i}_2)_a)_1$

The syntax of UC consists of six standard rules 1–6, a dref-relating rule 7, and two centering rules 8–9 (see definition 5). The dref-relating rule 7 introduces syntactic symbols for the assorted relations and operations that relate various types of dref entities: strict temporal precedence (<), strict temporal inclusion ($\sqsubset$), consequent state (${}^{\triangleright}$), start point (◣), end point (◥), central individual (↑), background individual (↓), world-dependent-place-of (π), and world-dependent-time-of (ϑ). Of the two centering rules, rule 8 extends the top or bottom sub-list of an input structured list with a dref entity, while rule 9 introduces two centering-sensitive sequencing operators: *topic-comment* ($A\ ^{\top}\!;\ B$) and *background-elaboration* ($A\ ^{\perp}\!;\ B$). The corresponding semantic rules are given in definition 6. The semantic centering rules 8 and 9 refer to the operation of *extension* and the related order defined below.

Definition 5 (UC syntax). *The set of terms of type a*, $Term_a$, *is the smallest set such that:*

1. $Con_a \cup Var_a \subseteq Term_a$
2. $(A = B) \in Term_t$ *if* $A, B \in Term_a$
3. $\neg A, (A \wedge B) \in Term_t$ *if* $A, B \in Term_t$
4. $\exists u_a B \in Term_t$ *if* $u_a \in Var_a$ *and* $B \in Term_t$
5. $\lambda u_a(B) \in Term_{ab}$ *if* $u_a \in Var_a$ *and* $B \in Term_b$
6. $BA \in Term_b$ *if* $B \in Term_{ab}$ *and* $A \in Term_a$
7. $(A < B), (A \sqsubset B) \in Term_t$ *if* $A, B \in Term_\tau$
   ${}^{\triangleright}A \in Term_\sigma$ *if* $A \in Term_\varepsilon$
   $\text{◣}A, \text{◥}A \in Term_\varepsilon$ *if* $A \in Term_\sigma$
   $\uparrow A, \downarrow A \in Term_\delta$ *if* $A \in Term_\varepsilon \cup Term_\sigma$
   $\pi(W, A) \in Term_\delta$ *if* $W \in Term_\omega$ *and* $A \in Term_\varepsilon \cup Term_\sigma$
   $\vartheta(W, A) \in Term_\tau$ *if* $W \in Term_\omega$ *and* $A \in Term_\varepsilon \cup Term_\sigma$
8. $(A\ ^{\top}\!\bullet B), (A\ ^{\perp}\!\bullet B) \in Term_s$ *if* $A \in Term_a$ $(a \in \text{DR}(\Theta))$ *and* $B \in Term_s$
9. $(A\ ^{\top}\!; B), (A\ ^{\perp}\!; B) \in Term_{(st)st}$ *if* $A, B \in Term_{(st)st}$

Notation (Extensions). *For any sequences* $\mathsf{z} \in \mathcal{D}^m$, $\mathsf{z}' \in \mathcal{D}^n$:

1. $(\mathsf{z}' \cdot \mathsf{z}) = \langle \mathsf{z}'_1, \ldots, \mathsf{z}'_n, \mathsf{z}_1, \ldots, \mathsf{z}_m \rangle$ *is the extension of* z *with* z′
2. z′ *extends* z, *written* $\mathsf{z} \prec \mathsf{z}'$, *iff* $\mathsf{z} \neq \mathsf{z}'$ & $\exists \mathsf{z}'': \mathsf{z}' = (\mathsf{z}'' \cdot \mathsf{z})$

Definition 6 (UC semantics). *For any* $\mathcal{M} = \langle \mathcal{F}_f, [\![\cdot]\!] \rangle$ *and assignment g, define* $[\![\cdot]\!]^g$ *as follows*:

1. $[\![A]\!]^g = [\![A]\!]$ *if* $A \in Con_a$
   $[\![A]\!]^g = g(A)$ *if* $A \in Var_a$
2. $[\![(A = B)]\!]^g = 1$ *if* $[\![A]\!]^g = [\![B]\!]^g$; *else*, 0
3. $[\![\neg A]\!]^g = 1$ *if* $[\![A]\!]^g = 0$; *else*, 1
   $[\![(A \wedge B)]\!]^g = 1$ *if* $[\![A]\!]^g = 1$ *and* $[\![B]\!]^g = 1$; *else*, 0
4. $[\![\exists u_a B]\!]^g = 1$ *if* $\{\mathsf{d} \in \mathcal{D}_a |\ [\![B]\!]^{g[u/\mathsf{d}]} = 1\} \neq \emptyset$; *else*, 0
5. $[\![\lambda u_a(B)]\!]^g(\mathsf{d}) \doteq [\![B]\!]^{g[u/\mathsf{d}]}$ *if* $\mathsf{d} \in \mathcal{D}_a$
6. $[\![BA]\!]^g \doteq [\![B]\!]^g([\![A]\!]^g)$
7. $[\![(A < B)]\!]^g = 1$ *if* $[\![A]\!]^g <_\tau [\![B]\!]^g$; *else*, 0
   $[\![(A \sqsubset B)]\!]^g = 1$ *if* $[\![A]\!]^g \subset [\![B]\!]^g$; *else*, 0
   $[\![fA]\!]^g \doteq f([\![A]\!]^g)$ *if* $f \in \{{}^{\triangleright}, \text{◣}, \text{◥}, \uparrow, \downarrow\}$
   $[\![f(W, A)]\!]^g \doteq f([\![W]\!]^g)([\![A]\!]^g)$ *if* $f \in \{\pi, \vartheta\}$
8. $[\![(A\ ^{\top}\!\bullet B)]\!]^g \doteq \langle ([\![A]\!]^g \cdot \mathsf{i}_1), \mathsf{i}_2 \rangle$ *if* $[\![B]\!]^g = \langle \mathsf{i}_1, \mathsf{i}_2 \rangle$
   $[\![(A\ ^{\perp}\!\bullet B)]\!]^g \doteq \langle \mathsf{i}_1, ([\![A]\!]^g \cdot \mathsf{i}_2) \rangle$
9. $\mathsf{c}[\![(A\ ^{\top}\!; B)]\!]^g = \{\mathsf{k} \in \mathsf{c}[\![A]\!]^g[\![B]\!]^g |\ \exists \mathsf{i} \in \mathsf{c} \exists \mathsf{j} \in \mathsf{c}[\![A]\!]^g \exists a \in \text{DR}(\Theta): (\mathsf{j}_1)_1 \in \mathcal{D}_a$ $\&\ \mathsf{i}_1 \prec \mathsf{j}_1\ \&\ (\mathsf{j}_1)_a = (\mathsf{k}_1)_a\ \&\ [\![B]\!]^g \neq [\![B[\top a/\perp a]]\!]^g\}$
   $\mathsf{c}[\![(A\ ^{\perp}\!; B)]\!]^g = \{\mathsf{k} \in \mathsf{c}[\![A]\!]^g[\![B]\!]^g |\ \exists \mathsf{i} \in \mathsf{c} \exists \mathsf{j} \in \mathsf{c}[\![A]\!]^g \exists a \in \text{DR}(\Theta): (\mathsf{j}_2)_1 \in \mathcal{D}_a$ $\&\ \mathsf{i}_2 \prec \mathsf{j}_2\ \&\ (\mathsf{j}_2)_a = (\mathsf{k}_2)_a\ \&\ [\![B]\!]^g \neq [\![B[\perp a/\top a]]\!]^g\}$

In the semantic definition 6, rules 1–6 are standard, like their syntactic counterparts. The dref-relating rule 7 interprets the temporal relation symbols, < and ⊏, as strict temporal precedence, $<_\tau$ (e.g. $\{1, 2\} <_\tau \{5, 6, 7\}$), and strict inclusion, ⊂ (e.g. $\{1\} \subset \{1, 2\}$). Dref operator symbols are interpreted as the corresponding operations (e.g. $^{\triangleright}$ as $^{\triangleright}$). The centering rule 8 builds an extended structured list by adding the dref entity $[\![A]\!]^g$ to the designated sub-list of the input structured list $[\![B]\!]^g$. Finally, rule 9 combines a context-setting update $[\![A]\!]^g$ with a follow-up update $[\![B]\!]^g$ into a topic-comment or background-elaboration sequence. Both reduce to plain sequencing, i.e. function composition, if the following centering requirements are met. The context-setting update must add at least one dref entity to the designated sub-list (top sub-list for topic-comment sequencing, bottom sub-list for background-elaboration sequencing). That is, in the output info-state there is a new top-ranked entity of some dref type *a* on the designated sub-list. This entity maintains its status as the top-ranked *a*-entity throughout the follow-up update, which must not add any further entities of type *a* to that sub-list. Finally, the follow-up update must anaphorically refer to (i.e. comment on or elaborate) the top-ranked *a*-entity added by the context-setting update. (We use the standard notation $X[Y/Z]$ for the result of replacing every occurrence of Y in X with Z, and the standard prefix notation for updates. Thus, $\mathsf{c}[\![A]\!]^g := [\![A]\!]^g(\mathsf{c})$ for any info-state $\mathsf{c} \in \mathcal{D}_{st}$ and $A \in Term_{(st)st}$.) If these three centering requirements fail to be met, both centering-sensitive sequencing operators reduce any input info-state to the absurd state, ∅.

Sentences and texts translate into UC update terms of type (*st*)*st*, which are interpreted relative to a model and an input info-state. The latter predictably includes certain drefs because the very act of speaking up gives rise to a *minimal info-state*. In general, speaking up e in a CG p focuses attention and thereby introduces default modal and temporal topics. The modal topics are the initial CG (type ωt =: Ω) and the CG-worlds (type ω), whereas the temporal topics are the speech event itself (type ε) and its CG-instant (type τ) (see definition 7, where the info-state-forming operator $^{st}(\cdot)$ is named after its output, which is of type *st*; compare Stalnaker's 'commonplace effect').

Definition 7 (Minimal info-state). *For any speech act* e *in a common ground* $\mathsf{p} \in \mathcal{D}_{\omega t} \backslash \varnothing$ *we define the* ⟨e, p⟩-minimal info-state, *written* $^{st}\langle \mathsf{e}, \mathsf{p}\rangle$, *as follows*:
$^{st}\langle \mathsf{e}, \mathsf{p}\rangle := \{\langle\langle \mathsf{t}, \mathsf{w}, \mathsf{p}, \mathsf{e}\rangle, \langle\rangle\rangle \mid \mathsf{w} \in \mathsf{p} \subseteq \{\mathsf{v} \mid \langle \mathsf{e}, {\uparrow}\mathsf{e}\rangle \in [\![\boldsymbol{spk}]\!](\mathsf{v}) \ \&\ \mathsf{t} = \vartheta_{\mathsf{v}}\, \mathsf{e}\}\}$

An update term has a truth value just in case it introduces a proposition as the primary topic, i.e. the set of topmost drefs in the output is the singleton set of that proposition. The proposition is the set of worlds where the update term is true. In any other world, the update term is false (see definition 8).

Definition 8 (Primary topics, truth values). *For any input info-state* $\mathsf{c} \in \mathcal{D}_{st}$, *an update term* $K \in Term_{(st)st}$ *introduces the set of primary topics* $\text{TOP}_{\mathsf{c}} K = \{(\mathsf{j}_1)_1 \mid \exists \mathsf{i} \in \mathsf{c} \forall \underline{g}\text{: } \mathsf{i}_1 \prec \mathsf{j}_1 \ \&\ \mathsf{j} \in \mathsf{c}[\![K]\!]^g\}$.
1. *K is* true *on* $\mathcal{M}$ *in* c *at* w *iff* $\exists \mathsf{p} \in \mathcal{D}_\Omega$: $\text{TOP}_{\mathsf{c}} K = \{\mathsf{p}\}$ & $\mathsf{w} \in \mathsf{p}$.
2. *K is* false *on* $\mathcal{M}$ *in* c *at* w *iff* $\exists \mathsf{p} \in \mathcal{D}_\Omega$: $\text{TOP}_{\mathsf{c}} K = \{\mathsf{p}\}$ & $\mathsf{w} \notin \mathsf{p}$.

For example, suppose that a stranger approaches you and says (4). His act of speaking up, e_0, in the CG p_0 focuses attention, giving rise to the minimal info-state $^{st}\langle \mathsf{e}_0, \mathsf{p}_0\rangle$ (5a). This is the context for interpreting the content of what is said (4), which further updates (5a) to (5b). In the output info-state (5b) the CG has been updated to the subset p_1 of p_0 where the speaker is hungry at the speech time.

(4) I am hungry.

(5) a. $\{\langle\langle \mathsf{t}, \mathsf{w}, \mathsf{p}_0, \mathsf{e}_0\rangle, \langle\rangle\rangle \mid \mathsf{w} \in \mathsf{p}_0 \subseteq \{\mathsf{v} \mid \langle \mathsf{e}_0, {\uparrow}\mathsf{e}_0\rangle \in [\![\boldsymbol{spk}]\!](\mathsf{v}) \ \&\ \mathsf{t} = \vartheta_{\mathsf{v}}\, \mathsf{e}_0\}\}$ =: $^{st}\langle \mathsf{e}_0, \mathsf{p}_0\rangle$

b. $\{\langle\langle \mathsf{p}_1, \mathsf{t}, \mathsf{w}, \mathsf{p}_0, \mathsf{e}_0\rangle, \langle \mathsf{s}\rangle\rangle \mid \mathsf{p}_0 \subseteq \{\mathsf{v} \mid \langle \mathsf{e}_0, {\uparrow}\mathsf{e}_0\rangle \in [\![\boldsymbol{spk}]\!](\mathsf{v}) \ \&\ \mathsf{t} = \vartheta_{\mathsf{v}}\, \mathsf{e}_0\}$
& $\langle \mathsf{s}, {\uparrow}\mathsf{e}_0\rangle \in [\![\textit{hungry}]\!](\mathsf{w}) \ \&\ \mathsf{t} \subset \vartheta_{\mathsf{w}}\, \mathsf{s}$
& $\mathsf{w} \in \mathsf{p}_1 = \{\mathsf{v} \in \mathsf{p}_0 \mid \exists \underline{\mathsf{s}}\text{: } \langle \underline{\mathsf{s}}, {\uparrow}\mathsf{e}_0\rangle \in [\![\textit{hungry}]\!](\mathsf{v}) \ \&\ \mathsf{t} \subset \vartheta_{\mathsf{v}}\, \underline{\mathsf{s}}\}\}$

To represent such updates in UC, we follow the standard practice of defining a DRT-style notation (see Table 1). Here and in what follows, we use the following notation for variables of simple types: $x, y, z \in Var_\delta$, $e \in Var_\varepsilon$, $s \in Var_\sigma$, $t \in Var_\tau$, $w, v \in Var_\omega$, $p, q \in Var_\Omega$, $h, i, j, k \in Var_s$, $I, J \in Var_{st}$, and $K \in Var_{(st)st}$. For other expressions, types may be indicated by means of subscripts (e.g. A_τ).

Table 1 DRT-style notation

Abbreviation		*UC term*	*Examples*
Static terms			
$(A_a \in B_{at})$	:=	BA	$w \in p$
$B(A_1, \ldots, A_n)$	:=	$BA_1 \ldots A_n$	$hungry_w(s, x)$
$(A_\tau \leq B_\tau)$	:=	$(A < B \vee A = B)$	$\vartheta_w\, e \leq t$
$(A_\tau \sqsubseteq B_\tau)$	:=	$(A \sqsubset B \vee A = B)$	$t \sqsubseteq t'$
$\boldsymbol{at}(W_\omega, E_\varepsilon, T_\tau)$	:=	$(\vartheta_W E \sqsubset T)$	$\boldsymbol{at}(w, e, t)$
$\boldsymbol{at}(W_\omega, S_\sigma, T_\tau)$	:=	$(T \sqsubset \vartheta_W S)$	$\boldsymbol{at}(w, s, t)$
$^{\varepsilon}S$	:=	◣S	$^{\varepsilon}s$
$^{\varepsilon}E$	:=	E	$^{\varepsilon}e$
$^{\sigma}S$	:=	S	$^{\sigma}s$
$^{\sigma}E$	:=	$^{\triangleright}E$	$^{\sigma}e$
Local projections (type sa for a ∈ DR(*Θ*)) *and conditions (type st)*			
$(A_a)^\circ$	:=	$\lambda i(A)$	$(x)^\circ$
$(A_{sa})^\circ$	:=	$\lambda i(Ai)$	$(\top\delta)^\circ$
$(B_{ab}\, A_{sa})^\circ$	:=	$\lambda i(B\, Ai)$	$(\upharpoonleft\top\varepsilon)^\circ$
$(B_W\, A)^\circ$	:=	$\lambda i(B(W^\circ i, A^\circ i))$	$(\vartheta_{\top\omega}\top\varepsilon)^\circ$
$B_W\langle A_1, \ldots, A_n\rangle$	:=	$\lambda i(B(W^\circ i, A_1{}^\circ i, \ldots, A_n{}^\circ i))$	$hungry_{\top\omega}\langle s, \top\delta\rangle$
$(A\ \mathsf{R}_i\ B)$	:=	$\lambda i(A^\circ i\ \mathsf{R}\ B^\circ i)$	$(\upharpoonleft s =_i \top\delta)$
$(C_1, \ldots, C_n)$	:=	$\lambda i(C_1 i \wedge \ldots \wedge C_n i)$	$(hungry_{\top\omega}\langle s, \upharpoonleft s\rangle, \upharpoonleft s =_i \top\delta)$
Local updates (type (st)st)			
$[C]$	:=	$\lambda I\lambda j(Ij \wedge Cj)$	$[hungry_{\top\omega}\langle\bot\sigma, \top\delta\rangle]$
$[u]$	:=	$\lambda I\lambda j(\exists u\exists i(Ii \wedge j = u\ {}^{\bot}\!\bullet i))$	$[x]$
$^{\top}[u]$	:=	$\lambda I\lambda j(\exists u\exists i(Ii \wedge j = u\ {}^{\top}\!\bullet i))$	$^{\top}[t]$
$[u\mid C]$	:=	$\lambda I\lambda j(\exists u\exists i(Ii \wedge Ci \wedge j = u\ {}^{\bot}\!\bullet i))$	$[x\mid x =_i al]$
$^{\top}[u\mid C]$	:=	$\lambda I\lambda j(\exists u\exists i(Ii \wedge Ci \wedge j = u\ {}^{\top}\!\bullet i))$	$^{\top}[t\mid t <_i \vartheta_{\top\omega}\top\varepsilon]$
Global projections (type s(st)a or s(st)at) and conditions (type s(st)t)			
$(A_a)^*$	:=	$\lambda i\lambda I(A)$	$(x)^*$
$(A_{sa})^*$	:=	$\lambda i\lambda I(Ai)$	$(\top\delta)^*$
$(A_{sa}\|)^*$	:=	$\lambda i\lambda I\lambda u_a(\exists j(Ij \wedge u = Aj))$	$(\top\omega\|)^*$
$(A_{sa}\|_B)^*$	:=	$\lambda i\lambda I\lambda u_a(\exists j(Ij \wedge Bi = Bj \wedge u = Aj))$	$(\top\omega\|_{\top\tau})^*$
$B_W\{A_1, \ldots, A_n\}$	:=	$\lambda i\lambda I(B(W^*iI, A_1{}^*iI, \ldots, A_n{}^*iI))$	$ask_{\top\omega}\{e, x, \bot\Omega\|\}$
$(A\ \mathsf{R}_I\ B)$	:=	$\lambda i\lambda I(A^*iI\ \mathsf{R}\ B^*iI)$	$(\top\Omega =_I \top\omega\|)$
Global updates (type (st)st)			
$[G]$	:=	$\lambda I\lambda j(Ij \wedge GjI)$	$[\top\Omega =_I \top\omega\|]$
$[u\mid G]$	:=	$\lambda I\lambda j(\exists u\exists i(Ii \wedge GiI \wedge j = u\ {}^{\bot}\!\bullet i))$	$[p\mid p =_I \top\omega\|]$
$^{\top}[u\mid G]$	:=	$\lambda I\lambda j(\exists u\exists i(Ii \wedge GiI \wedge j = u\ {}^{\top}\!\bullet i))$	$^{\top}[p\mid p =_I \top\omega\|]$
$(K_1; K_2)$	:=	$\lambda I\lambda j(K_2\,(K_1 I)\,j)$	$^{\top}[x]; [s\mid \upharpoonleft s =_i \top\delta]$
$^{\mathrm{P}}K$	:=	$\lambda I\lambda j(KIj \wedge \forall w(\exists i(Ii \wedge w = \top\omega i) \rightarrow \exists k(KIk \wedge w = \top\omega k)))$	$^{\mathrm{P}}[\top\tau \leq \vartheta_{\top\omega}\top\varepsilon]$

In this notation, sentence (4) can be represented as (6a), which can be simplified to (6b). In (6a), which can be derived compositionally, the first two boxes are contributed by the present tense. Following (Leech, 1971) and (Stone, 1997), I analyze this tense as non-past (NPST), i.e. it presupposes that the topic time coincides with or follows the speech time. To satisfy the presupposition operator, $^{\mathrm{P}}(\cdot)$, this must hold throughout the input CG (input set of topic worlds, $\top\omega||$). In the minimal info-state, this presupposition is satisfied, so the output of the presupposition test (7) is the input info-state, $^{st}\langle \mathrm{e}_0, \mathrm{p}_0\rangle$. The English nonpast tense further asserts that the world of evaluation is in the input CG. In root clauses, the world of evaluation is itself a CG-world, so this requirement is trivially satisfied. Thus, the output of (8) is still $^{st}\langle \mathrm{e}_0, \mathrm{p}_0\rangle$. The next two boxes form a background-elaboration sequence, contributed by the verb phrase. The background-setting update introduces a state of hunger. In the follow-up elaborating update, tense situates this state at the topic time in the topic world, and identifies its central individual with the subject dref. Since the centering requirements of $(A^{\perp}; B)$ are met, this sequence reduces to plain sequencing (see (9)–(10); the final reduction in (10) follows from clause 1 of definition 4). The final box is contributed by the sentence-final intonation (.), which introduces the set of surviving topic worlds — i.e. the updated CG — as the new Ω-topic (p_1 in (11)).

(6) I NPST be hungry.

a. $(^{\mathrm{P}}[\vartheta_{\top\omega}\, \top\varepsilon \leq_i \top\tau];\ [\top\omega \in_I \top\omega||];\ ([s|\ \mathit{hungry}_{\top\omega}\langle s, \uparrow s\rangle]^{\perp};\ [\boldsymbol{at}_{\top\omega}\langle \perp\sigma, \top\tau\rangle, \uparrow\perp\sigma =_i \uparrow\top\varepsilon]));$
$^{\top}[p|\ p =_I \top\omega||]$

b. $^{\mathrm{P}}[\vartheta_{\top\omega}\, \top\varepsilon \leq_i \top\tau];\ [s|\ \mathit{hungry}_{\top\omega}\langle s, \uparrow\top\varepsilon\rangle, \top\tau \sqsubset_i \vartheta_{\top\omega}\, s];\ ^{\top}[p|\ p =_I \top\omega||]$

(7) $^{st}\langle \mathrm{e}_0, \mathrm{p}_0\rangle [\![^{\mathrm{P}}[\vartheta_{\top\omega}\, \top\varepsilon \leq_i \top\tau]]\!]^g$

$= [\![\lambda I\lambda j(Ij \wedge \vartheta_{\top\omega j}\, \top\varepsilon j \leq \top\tau j$
$\wedge\ \forall w(\exists i(Ii \wedge w = \top\omega i) \rightarrow \exists k(Ik \wedge \vartheta_{\top\omega k}\top\varepsilon k \leq \top\tau k \wedge w = \top\omega k)))]\!]^g$

$= \{\langle\langle \mathrm{t, w, p_0, e_0}\rangle, \langle\rangle\rangle|\ \mathrm{w} \in \mathrm{p}_0 \subseteq \{\mathrm{v}|\ \langle \mathrm{e}_0, \uparrow\mathrm{e}_0\rangle \in [\![\boldsymbol{spk}]\!](\mathrm{v})\ \&\ \mathrm{t} = \vartheta_{\mathrm{v}}\, \mathrm{e}_0\}$
$\&\ \forall \mathrm{v}\!: \mathrm{v} \in \mathrm{p}_0 \Rightarrow \vartheta_{\mathrm{v}}\, \mathrm{e}_0 <_\tau \mathrm{t} \vee \vartheta_{\mathrm{v}}\, \mathrm{e}_0 = \mathrm{t}\}$ $\quad =: \mathrm{c}_1 = {}^{st}\langle \mathrm{e}_0, \mathrm{p}_0\rangle$

(8) $\mathrm{c}_1[\![[\top\omega \in_I \top\omega||]]\!]^g$

$= [\![\lambda I\lambda j(Ij \wedge \top\omega j \in \lambda w(\exists i(Ii \wedge w = \top\omega i)))]\!]^g$

$= \{\langle\langle \mathrm{t, w, p_0, e_0}\rangle, \langle\rangle\rangle|\ \mathrm{w} \in \mathrm{p}_0 \subseteq \{\mathrm{v}|\ \langle \mathrm{e}_0, \uparrow\mathrm{e}_0\rangle \in [\![\boldsymbol{spk}]\!](\mathrm{v})\ \&\ \mathrm{t} = \vartheta_{\mathrm{v}}\, \mathrm{e}_0\}$
$\&\ \mathrm{w} \in \mathrm{p}_0\}$ $\quad =: \mathrm{c}_2 = {}^{st}\langle \mathrm{e}_0, \mathrm{p}_0\rangle$

(9) $\mathrm{c}_2[\![[s|\ \mathit{hungry}_{\top\omega}\langle s, \uparrow s\rangle]]\!]^g$

$= [\![\lambda I\lambda j(\exists s\exists i(Ii \wedge \mathit{hungry}_{\top\omega i}(s, \uparrow s) \wedge j = s\, {}^{\perp}\!\bullet i))]\!]^g$

$= \{\langle\langle \mathrm{t, w, p_0, e_0}\rangle, \langle \mathrm{s}\rangle\rangle|\ \mathrm{w} \in \mathrm{p}_0 \subseteq \{\mathrm{v}|\ \langle \mathrm{e}_0, \uparrow\mathrm{e}_0\rangle \in [\![\boldsymbol{spk}]\!](\mathrm{v})\ \&\ \mathrm{t} = \vartheta_{\mathrm{v}}\, \mathrm{e}_0\}$
$\&\ \langle \mathrm{s}, \uparrow\mathrm{s}\rangle \in [\![\mathit{hungry}]\!](\mathrm{w})\}$ $\quad =: \mathrm{c}_3$

(10) $\mathrm{c}_3[\![[\boldsymbol{at}_{\top\omega}\langle \perp\sigma, \top\tau\rangle, \uparrow\perp\sigma =_i \uparrow\top\varepsilon]]\!]^g$

$= [\![\lambda I\lambda j(Ij \wedge \top\tau j \sqsubset \perp\sigma j \wedge \uparrow(\perp\sigma j) = \uparrow(\top\varepsilon j))]\!]^g$

$= \{\langle\langle \mathrm{t, w, p_0, e_0}\rangle, \langle \mathrm{s}\rangle\rangle|\ \mathrm{w} \in \mathrm{p}_0 \subseteq \{\mathrm{v}|\ \langle \mathrm{e}_0, \uparrow\mathrm{e}_0\rangle \in [\![\boldsymbol{spk}]\!](\mathrm{v})\ \&\ \mathrm{t} = \vartheta_{\mathrm{v}}\, \mathrm{e}_0\}$
$\&\ \langle \mathrm{s}, \uparrow\mathrm{s}\rangle \in [\![\mathit{hungry}]\!](\mathrm{w})\ \&\ \mathrm{t} \subset \vartheta_{\mathrm{w}}\, \mathrm{s}\ \&\ \uparrow\mathrm{s} = \uparrow\mathrm{e}_0\}$

$= \{\langle\langle \mathrm{t, w, p_0, e_0}\rangle, \langle \mathrm{s}\rangle\rangle|\ \mathrm{w} \in \mathrm{p}_0 \subseteq \{\mathrm{v}|\ \langle \mathrm{e}_0, \uparrow\mathrm{e}_0\rangle \in [\![\boldsymbol{spk}]\!](\mathrm{v})\ \&\ \mathrm{t} = \vartheta_{\mathrm{v}}\, \mathrm{e}_0\}$
$\&\ \langle \mathrm{s}, \uparrow\mathrm{e}_0\rangle \in [\![\mathit{hungry}]\!](\mathrm{w})\ \&\ \mathrm{t} \subset \vartheta_{\mathrm{w}}\, \mathrm{s}\}$ $\quad =: \mathrm{c}_4$

(11) $\mathrm{c}_4[\![^{\top}[p|\ p =_I \top\omega||]]\!]^g$

$= [\![\lambda I\lambda j(\exists p\exists i(Ii \wedge p = \lambda w(\exists k(Ik \wedge w = \top\omega k)) \wedge j = p\, {}^{\top}\!\bullet i))]\!]^g$

$= \{\langle\langle \mathrm{p_1, t, w, p_0, e_0}\rangle, \langle \mathrm{s}\rangle\rangle|\ \mathrm{p}_0 \subseteq \{\mathrm{v}|\ \langle \mathrm{e}_0, \uparrow\mathrm{e}_0\rangle \in [\![\boldsymbol{spk}]\!](\mathrm{v})\ \&\ \mathrm{t} = \vartheta_{\mathrm{v}}\, \mathrm{e}_0\}$
$\&\ \langle \mathrm{s}, \uparrow\mathrm{e}_0\rangle \in [\![\mathit{hungry}]\!](\mathrm{w})\ \&\ \mathrm{t} \subset \vartheta_{\mathrm{w}}\, \mathrm{s}$
$\&\ \mathrm{w} \in \mathrm{p}_1 = \{\mathrm{v} \in \mathrm{p}_0|\ \exists \underline{\mathrm{s}}\!: \langle \underline{\mathrm{s}}, \uparrow\mathrm{e}_0\rangle \in [\![\mathit{hungry}]\!](\mathrm{v})\ \&\ \mathrm{t} \subset \vartheta_{\mathrm{v}}\, \underline{\mathrm{s}}\}\}$ $\quad = \text{(5b)}$

Thus, the result of updating the minimal info-state (5a) with (6a) is indeed (5b). In general, the UC representation (6a) is equivalent to the simpler representation (6b), as the reader can verify.

3 Centering Theory of English Tense

According to an influential theory, English tenses are temporal anaphors parallel to anaphoric pronouns (see e.g. (Partee, 1973); (Partee, 1984); (Kratzer, 1998)). In the absence of perspectival shifts, past (PST), non-past (NPST), and future (FUT) tense presupposes that the topic time (a.k.a. 'reference time'; see (Reichenbach, 1947); (Klein, 1994)) is past, non-past, or future relative to the speech act (see examples (12)–(15); also e.g. (Leech, 1971); (Stone, 1997)). The topic time includes the verbal eventuality if it is an event, or is included within it if it is a state (see e.g. (Kamp, 1979), (Kamp, 1981); (Partee, 1984)). An event-verb (v^e) may also advance the topic time to the consequent state (as in (14) and (15); see (Moens & Steedman, 1988); (Webber, 1988); (Stone, 1997)).

(12) Jim *has left* (NPST PRF leave^e). I *am* (NPST be^s) sad.
(13) Jim *left* (PST leave^e) today. Sue *was* (PST be^s) asleep.
(14) Jim *leaves* (NPST leave^e) today. Sue *will be* (FUT be^s) sad.
(15) If Jim *leaves* (NPST leave^e) Sue *will be* (FUT be^s) sad.

I propose to implement this well-known theory by combining the directly compositional framework of CG ((Steedman, 1996); (Steedman, 2000)) with UC as the semantic representation language. To analyze the fragment of English exemplified by (12)–(15), I propose four basic categories: *sentence* (s), s*-radical* (**s**), *participial radical* (**s′**)*, pronoun* (pn), and *adjective phrase* (ap) (see E1, clause 1). In addition, English has complex categories, e.g. *verb phrase* vp := **s**\pn (clause 2).

E1 (English categories).
1. s, **s**, **s′**, pn, ap, *are English categories*.
2. *If X and Y are English categories, then so are X/Y and X\Y.*

In categorial grammars the syntactic category determines the semantic type. The English category-to-type rule is given in E2 (using abbreviated types defined in Table 2). Sentences (s) denote updates (type [] := (*st*)*st*); radicals (**s** and **s′**), functions from world drefs to updates (type [W]); pronouns (pn), individual projections (type D); and adjectives (ap), functions from state and world drefs to updates (type [SW]). *X/Y* and *X\Y* denote functions from arguments of the type of *Y* to values of the type of *X*.

Table 2 Notation for UC types and variables

Type	Abbreviation	Variable	Name of objects
$s\delta$	=: D	$\underline{x}, \underline{y}$	*individual projections*
$s\varepsilon$	=: E	$\underline{e}$	*event projections*
$s\sigma$	=: S	$\underline{s}$	*state projections*
$s\tau$	=: T	$\underline{t}$	*time projections*
$s\omega$	=: W	$\underline{w}, \underline{v}$	*world projections*
(st)		I, J	*info-states*
$(st)st$	=: []	K	*updates*
$a_1 \ldots (a_n[\,])$	=: $[a_1 \ldots a_n]$		
[W]		$\underline{V}$	
[DW]		$\underline{P}$	
[SW]		$\underline{A}$	

E2 (English category-to-type rule).
1. TYPE(s) = [], TYPE(**s**) = TYPE(**s′**) = [W], TYPE(pn) = D, TYPE(ap) = [SW]
2. TYPE(*X/Y*) = TYPE(*X\Y*) = TYPE(*Y*)TYPE(*X*)

Table 3 lays out the proposed categories and types for the English items in (12)–(15). (Here and in what follows, *jim*, *tod*, *sad*, and *leave* are constants of type δ, $\omega\varepsilon\tau$, $\omega\sigma\delta t$, and $\omega\varepsilon\delta t$. Following the standard convention, types associate to the right, e.g. $\omega\sigma\delta t$ abbreviates $\omega(\sigma(\delta t))$.)

Table 3 Some English categories and corresponding types

English item	*English category*	*UC type*
sad, asleep, busy	ap	[SW]
be	**s**/ap	[SW][W]
leave	**s**	[W]
have	**s**/**s′**	[W][W]
PRF	**s′**/**s**	[W][W]
PST, NPST, FUT	vp/**s**	[W][DW]
I, you, he	pn	D
Jim	**s**/vp	[DW][W]
today	vp\vp	[DW][DW]
. (s-final prosody)	s**s**	[W][]

Following (Kratzer, 1996), I assume that the subject argument is not represented in the meaning of an English verb. Specifically, intransitive event-verbs (e.g. leave^e) are s-radicals that introduce event drefs. The perfect auxiliary (have^s) combines with a perfect participle (PRF v^e) into an s-radical that introduces the consequent state of the participial event (implementing (Moens & Steedman, 1988)). The stative copula (be^s) introduces a state that is elaborated by the complement adjective phrase.

leave^e **s**: $\lambda \underline{w}([e|\ leave_{\underline{w}}\langle e, \uparrow e\rangle])$
have^s **s**/**s′**: $\lambda \underline{V} \lambda \underline{w}(\underline{V}\ \underline{w}\ ^{\perp}; [s|\ s =_i {}^{\triangleright}\perp\varepsilon])$
PRF **s′**/**s**: $\lambda \underline{V} \lambda \underline{w}(\underline{V}\ \underline{w})$
be^s **s**/ap: $\lambda \underline{A} \lambda \underline{w}([s]\ ^{\perp}; \underline{A}\ \perp\sigma\ \underline{w})$
sad ap: $\lambda \underline{s} \lambda \underline{w}([sad_{\top\omega}\langle \underline{s}, \uparrow \underline{s}\rangle])$

An s-radical combines with tense into a tensed verb phrase (vp). Semantically, tense categories are identified by a presupposition (hereafter, *tense presupposition*) that locates the topic time ($\top\tau$) in relation to the perspective point (by default, the speech act $\top\varepsilon$). Grammatically, they form a paradigm such that exactly one member of the paradigm is required in certain grammatical constructions (e.g. finite clauses). The English tense paradigm includes a past tense (PST, realized by an inflection or auxiliary, e.g. *left/did leave*), non-past tense (NPST, ditto, e.g. *stinks/does stink*), and future tense (FUT, realized by an auxiliary, e.g. *will leave*). In addition, non-past tenses assert (NPST) or presuppose (FUT) that the world of evaluation is realistic (i.e. is a CG-world; see (Stalnaker, 1975), (Stone, 1997)). All tenses locate the top-ranked eventuality in the world of evaluation at the topic time ($[\boldsymbol{at}_{\underline{w}}\langle \perp a, \top\tau\rangle$, with $a \in \{\varepsilon, \sigma\}$) (see (Reichenbach, 1947); (Kamp, 1981); (Klein, 1994); (Muskens, 1995)) and identify the central individual with the subject referent (compare (Kratzer, 1996)).

PST vp/**s**: $\lambda \underline{V} \lambda \underline{x} \lambda \underline{w}({}^{P}[\top\tau <_i \vartheta_{\top\omega}\top\varepsilon]; (\underline{V}\ \underline{w}\ ^{\perp}; [\boldsymbol{at}_{\underline{w}}\langle \perp a, \top\tau\rangle, \uparrow\perp a =_i \underline{x}]))$
NPST vp/**s**: $\lambda \underline{V} \lambda \underline{x} \lambda \underline{w}({}^{P}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau]; [\underline{w} \in_I \top\omega||]; (\underline{V}\ \underline{w}\ ^{\perp}; [\boldsymbol{at}_{\underline{w}}\langle \perp a, \top\tau\rangle, \uparrow\perp a =_i \underline{x}]))$
FUT vp/**s**: $\lambda \underline{V} \lambda \underline{x} \lambda \underline{w}({}^{P}[\vartheta_{\top\omega}\top\varepsilon <_i \top\tau]; {}^{P}[\underline{w} \in_I \top\omega||]; (\underline{V}\ \underline{w}\ ^{\perp}; [\boldsymbol{at}_{\underline{w}}\langle \perp a, \top\tau\rangle, \uparrow\perp a =_i \underline{x}]))$

Discourse-initially, tenses may introduce new topic times (see (Comrie, 1981); (Kehler, 2002)). The input topic time may be updated by an event-verb to a subinterval of the consequent state (Stone & Hardt, 1999). I assume that both options are due to lexical operators that may adjust basic entries.

$^{\top}(\cdot)$ vp/vp: $\lambda \underline{P} \lambda \underline{x} \lambda \underline{w}({}^{\top}[t]\ ^{\top}; \underline{P}\ \underline{x}\ \underline{w})$ (*non-anaphoric tense*)
$(\cdot)^{\top}$ vp/vp: $\lambda \underline{P} \lambda \underline{x} \lambda \underline{w}(\underline{P}\ \underline{x}\ \underline{w}\ ^{\perp}; {}^{\top}[t|\ t \sqsubseteq_i \vartheta_{\underline{w}}{}^{\triangleright}\perp\varepsilon])$ (*recentering tense*)

A tensed verb phrase (vp := **s**\pn) combines with the subject into an s-radical. The subject may be a pronoun (pn), referring to the speaker (I), addressee (you), or some other salient individual (s/he).

I	pn: $\uparrow\top\varepsilon$	s/he	pn: $\top\delta$
you	pn: $\downarrow\top\varepsilon$		pn: $\perp\delta$

Alternatively, a non-pronominal subject introduces its dref as a topic and predicates the verb phrase of that topic. Noun phrases may also serve as object arguments or vp-modifiers (e.g. $today_{\bot a}$).

Jim$^{\top}$ **s**/vp: $\lambda \underline{P} \lambda \underline{w}({}^{\top}[x|\ x =_i jim]\ {}^{\top};\ \underline{P}\ \top\delta\ \underline{w})$
today$_{\bot a}$ vp\vp: $\lambda \underline{P} \lambda \underline{x} \lambda \underline{w}(\underline{P}\ \underline{x}\ \underline{w}\ {}^{\bot};\ [\vartheta_{\underline{w}}\ \bot a \sqsubseteq_i tod_{\top\omega} \top\varepsilon])$ $a \in \{\varepsilon, \sigma\}$

In English, illocutionary force is in part marked by prosody, e.g. the full stop prosody (.) turns an s-radical (**s**) into a full-fledged declarative sentence (s) by predicating the radical of the topic world and introducing the set of surviving topic worlds as the primary topic (output CG).

. s**s**: $\lambda \underline{V}(\underline{V}\ \top\omega;\ {}^{\top}[p|\ p =_I \top\omega||])$

In categorial grammars language-specific lexical items are combined by universal combinatory rules, which determine the category and the semantic representation of the resulting complex word or syntactic phrase. In this paper, the only rules we require are function application and composition (i.e. >, <, >B, <B; see (Steedman, 1996); (Steedman, 2000)). For discourse (12), these rules derive the UC representation (16i–ii). In (16i), the subject first of all introduces Jim as a topical individual. The non-past tense presupposes a non-past topic time. Since in the minimal info-state the topic time is the speech instant, this presupposition is satisfied. The rest of the sentence comments on both topics, by introducing an event of the topical Jim leaving and a consequent state of that departure that holds at the topic time. In the resulting context, (16ii) further introduces a present sad state of the speaker. All of these eventualities are situated in the topical speech world. Moreover, at the end of each sentence, s-final intonation updates the Ω-topic to the set of surviving topic worlds (output CG)

(16) i. Jim$^{\top}$ NPST PRF leave^{e}. = (12)
${}^{\top}[x|\ x =_i jim];\ {}^{P}[\vartheta_{\top\omega} \top\varepsilon \leq_i \top\tau];\ [e|\ leave_{\top\omega}\langle e, \top\delta\rangle];\ [s|\ s =_i {}^{\triangleright}\bot\varepsilon,\ \top\tau \sqsubset_i \vartheta_{\top\omega}\ s];$
${}^{\top}[p|\ p =_I \top\omega||]$
ii. I NPST be^{s} sad.
${}^{P}[\vartheta_{\top\omega} \top\varepsilon \leq_i \top\tau];\ [s|\ sad_{\top\omega}\langle s, \uparrow\top\varepsilon\rangle,\ \top\tau \sqsubset_i \vartheta_{\top\omega}\ s];\ {}^{\top}[p|\ p =_I \top\omega||]$

A sample model is shown in Figure 1, which is to be read as follows. Drefs for events (● or ●●●), states (——), and discourse times (■ or ■■■) are listed vertically in the order of introduction into discourse, whereas the horizontal left-to-right order represents temporal precedence (see the time arrow). We also indicate the world(s) where these eventualities are realized (in (16i–ii), the speech world w_0), and the input as well as the output CG (after (16ii), $p_2 \subseteq p_0$). The top dref of each type on the top sub-list is superscripted with the top symbol (in Figure 1, ${}^{\top}w_0$, for the topical speech world; ${}^{\top}p_2$, for the Ω-topic, i.e. current CG; ${}^{\top}e_0$ for the currently central speech act; and ${}^{\top}t_0$, for the topic time). For each temporal-modal condition, the first two columns indicate the intuitive content by means of a graphic and an informal description, whereas the last column indicates the source (i.e. the minimal info-state due to the act of speaking up, or one or more lexical items that are then uttered).

Figure 1 Model for English discourse (16i–ii): NPST have^{s} PRF v^{e} – NPST v^{s}

————————————> time arrow

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
${}^{\top}w_0 \in {}^{\top}p_2 \subseteq p_0$	${}^{\top}w_0$: candidate for e_0-world		${}^{st}\langle e_0, p_0\rangle$
●	${}^{\top}e_0$: $\uparrow e_0$ speaks up		${}^{st}\langle e_0, p_0\rangle$
■	${}^{\top}t_0$: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\ e_0$	${}^{st}\langle e_0, p_0\rangle$
●	e_1: Jim leaves		v^{e}
———	s_1: Jim is away	$t_0 \subset \vartheta_{w0}\ s_1$, $s_1 = {}^{\triangleright}e_1$	NPST have^{s}
——	s_2: $\uparrow e_0$ is sad	$t_0 \subset \vartheta_{w0}\ s_2$	NPST v^{s}

Strictly speaking, the direct output of the compositional derivation is an equivalent UC term that reduces to (16i–ii). For (16i), the compositional derivation is shown in (16′i).

(16′) i.

Jim$^{\top}$	NPST	have^{s}	PRF	leave^{e}	.
s/vp: 1	vp/**s**: 2	**s**/**s**′: 3	**s**′/**s**: 4	**s**: 5	s\s: 9

4, 5 ——> **s**′: 5

3, 5 ——> **s**: 6

2, 6 ——> vp: 7

1, 7 ——> **s**: 8

8, 9 ——< s: 10

1 $\lambda\underline{P}\lambda\underline{w}({}^{\top}[x|\, x =_i jim]\ {}^{\top};\ \underline{P}\ \top\delta\ \underline{w})$
2 $\lambda\underline{V}\lambda\underline{x}\lambda\underline{w}({}^{\mathrm{P}}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau];\ [\underline{w} \in_I \top\omega\|];\ (\underline{V}\ \underline{w}\ {}^{\bot};\ [\boldsymbol{at}_{\underline{w}}\langle \bot\sigma, \top\tau\rangle, \uparrow\bot\sigma =_i \underline{x}]))$
3 $\lambda\underline{V}\lambda\underline{w}(\underline{V}\ \underline{w}\ {}^{\bot};\ [s|\, s =_i {}^{\triangleright}\bot\varepsilon])$
4 $\lambda\underline{V}\lambda\underline{w}(\underline{V}\ \underline{w})$
5 $\lambda\underline{w}([e|\ leave_{\underline{w}}\langle e, \uparrow e\rangle])$
6 $\lambda\underline{w}([e|\ leave_{\underline{w}}\langle e, \uparrow e\rangle];\ [s|\, s =_i {}^{\triangleright}\bot\varepsilon])$
7 $\lambda\underline{x}\lambda\underline{w}({}^{\mathrm{P}}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau];\ [\underline{w} \in_I \top\omega\|];\ [e|\ leave_{\underline{w}}\langle e, \uparrow e\rangle];\ [s|\, s =_i {}^{\triangleright}\bot\varepsilon,\ \top\tau \sqsubset_i \vartheta_{\underline{w}} s,\ \uparrow s =_i \underline{x}])$
8 $\lambda\underline{w}({}^{\top}[x|\, x =_i jim];\ {}^{\mathrm{P}}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau];\ [\underline{w} \in_I \top\omega\|];\ [e|\ lv_{\underline{w}}\langle e, \top\delta\rangle];\ [s|\, s =_i {}^{\triangleright}\bot\varepsilon,\ \top\tau \sqsubset_i \vartheta_{\underline{w}} s])$
9 $\lambda\underline{V}(\underline{V}\ \top\omega;\ {}^{\top}[p|\, p =_I \top\omega\|])$
10 ${}^{\top}[x|\, x =_i jim];\ {}^{\mathrm{P}}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau];\ [e|\ leave_{\top\omega}\langle e, \top\delta\rangle];\ [s|\, s =_i {}^{\triangleright}\bot\varepsilon,\ \top\tau \sqsubset_i \vartheta_{\top\omega}\, s];$
${}^{\top}[p|\, p =_I \top\omega\|]$

In discourse (13) the presupposition of the past tense in the first sentence cannot be satisfied by the default topic time, which is the speech instant. Therefore, the lexical entry of the discourse-initial past tense must be adjusted to introduce a past topic time (${}^{\top}$(PST)). In the next sentence, the past tense is anaphoric to the input topic time (PST) — i.e. Sue's state of being asleep properly includes the input topical past, which in turn properly includes Jim's departure. We thus derive the UC representation (17i–ii) (see sample model in Figure 2).

(17) i. Jim$^{\top}$ ${}^{\top}$(PST) leave^{e} today$_{\bot\varepsilon}$. = (13)
${}^{\top}[x|\, x =_i jim];\ ({}^{\top}[t]\ {}^{\top};\ ({}^{\mathrm{P}}[\top\tau <_i \vartheta_{\top\omega}\top\varepsilon];\ [e|\ leave_{\top\omega}\langle e, \top\delta\rangle,\ \vartheta_{\top\omega}\, e \sqsubset_i \top\tau,$
$\vartheta_{\top\omega}\, e \sqsubseteq_i tod_{\top\omega}\top\varepsilon\,]));\ {}^{\top}[p|\, p =_I \top\omega\|]$

ii. Sue$^{\top}$ PST be^{s} asleep .
${}^{\top}[x|\, x =_i sue];\ {}^{\mathrm{P}}[\top\tau <_i \vartheta_{\top\omega}\top\varepsilon];\ [s|\ sad_{\top\omega}\langle s, \top\delta\rangle,\ \top\tau \sqsubset_i \vartheta_{\top\omega}\, s];\ {}^{\top}[p|\, p =_I \top\omega\|]$

Figure 2 Model for English discourse (17i–ii): PST v^{e} today$_{\bot\varepsilon}$ – PST v^{s}

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
${}^{\top}w_0 \in {}^{\top}p_2 \subseteq p_0$	${}^{\top}w_0$: candidate for e_0-world		${}^{st}\langle e_0, p_0\rangle$
●	${}^{\top}e_0$: $\uparrow e_0$ speaks up		${}^{st}\langle e_0, p_0\rangle$
■	t_0: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	${}^{st}\langle e_0, p_0\rangle$
■■	${}^{\top}t_1$: e_0-past in p_0	$\forall v \in p_0$: $t_1 <_\tau \vartheta_v\, e_0$	${}^{\top}$PST
●	e_1: Jim leaves	$\vartheta_{w0}\, e_1 \subset t_1$, $\vartheta_{w0}\, e_1 \subseteq [\![tod]\!](w_0, e_0)$	${}^{\top}$PST v^{e} td$_{\bot\varepsilon}$
——	s_2: Sue is asleep	$t_1 \subset \vartheta_{w0}\, s_2$	PST v^{s}

In discourse (14), the nonpast tense in the first sentence combines with an event-verb. This blocks reference to the default topic time, i.e. the speech instant, because an instant cannot properly include anything (compare (12)). So here too, the basic entry of tense must be adjusted by ${}^{\top}(\cdot)$, which applied to a nonpast tense introduces a future topic time. Jim's departure is thus located in the future of the speech act in the speech world. The verb phrase modifier, *today*$_{\bot\varepsilon}$, further restricts this event to the speech day. Since the verb introduces an event, tense can update the topic time to a subinterval of the consequent state. This is done by means of $(\cdot)^{\top}$, which must apply after $^{\top}(\cdot)$, lest the centering constraints of topic-comment sequencing reduce any input info-state to $\varnothing$ (see (18)). This reading of the nonpast tense in the first sentence of (14) yields an output context that satisfies the presupposition of the future tense in the second sentence — that is, both the temporal and the modal presupposition of the future tense are satisfied. Sue's sad state is thus located at the time of the consequent state of Jim's leaving, suggesting a causal relation between Jim's departure and Sue's sadness. Formally, discourse (14) is assigned the UC representation (19i–ii) (see sample model in Figure 3).

(18) $(\cdot)^{\top}$ $^{\top}(\cdot)$ NPST

vp/vp: 1   vp/vp: 2   vp/**s**: 3

——————————>B

vp/**s:** 4

——————————————>B

vp/**s**: 5

1 $\lambda \underline{P} \lambda \underline{x} \lambda \underline{w}(\underline{P}\ \underline{x}\ \underline{w}^{\bot};\ ^{\top}[t|\ t \sqsubseteq_i \vartheta_{\underline{w}}{}^{\triangleright} \bot\varepsilon])$

2 $\lambda \underline{P} \lambda \underline{x} \lambda \underline{w}(^{\top}[t]^{\top};\ \underline{P}\ \underline{x}\ \underline{w})$

3 $\lambda \underline{V} \lambda \underline{x} \lambda \underline{w}(^{P}[\top\tau \leq_i \vartheta_{\top\omega}\top\varepsilon];\ [\underline{w} \in_I \top\omega||];\ (\underline{V}\ \underline{w}^{\bot};\ [\vartheta_{\underline{w}} \bot\varepsilon \sqsubset_i \top\tau,\ \uparrow\bot\varepsilon =_i \underline{x}]))$

4 $\lambda \underline{V} \lambda \underline{x} \lambda \underline{w}(^{\top}[t]^{\top};\ (^{P}[\top\tau \leq_i \vartheta_{\top\omega}\top\varepsilon];\ [\underline{w} \in_I \top\omega||];\ (\underline{V}\ \underline{w}^{\bot};\ [\vartheta_{\underline{w}} \bot\varepsilon \sqsubset_i \top\tau,\ \uparrow\bot\varepsilon =_i \underline{x}])))$

5 $\lambda \underline{V} \lambda \underline{x} \lambda \underline{w}((^{\top}[t]^{\top};\ (^{P}[\top\tau \leq_i \vartheta_{\top\omega}\top\varepsilon];\ [\underline{w} \in_I \top\omega||];\ (\underline{V}\ \underline{w}^{\bot};\ [\vartheta_{\underline{w}} \bot\varepsilon \sqsubset_i \top\tau,\ \uparrow\bot\varepsilon =_i \underline{x}])))^{\bot};$
$^{\top}[t|\ t \sqsubseteq_i \vartheta_{\underline{w}}{}^{\triangleright} \bot\varepsilon])$

(19) i. Jim$^{\top}$ ($^{\top}$NPST)$^{\top}$ leave^{e} today$_{\bot\varepsilon}$. = (14)
$^{\top}[x|\ x =_i jim];\ ^{\top}[t];\ ^{P}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau];\ [e|\ leave_{\top\omega}\langle e, \top\delta\rangle, \vartheta_{\top\omega}\ e \sqsubset_i \top\tau,$
$\vartheta_{\top\omega}\ e \sqsubseteq_i tod_{\top\omega}\top\varepsilon];\ ^{\top}[t|\ t \sqsubseteq_i \vartheta_{\top\omega}{}^{\triangleright}\bot\varepsilon];\ ^{\top}[p|\ p =_I \top\omega||]$

ii. Sue$^{\top}$ FUT be^{s} sad .
$^{\top}[x|\ x =_i sue];\ ^{P}[\vartheta_{\top\omega}\top\varepsilon <_i \top\tau];\ [s|\ sad_{\top\omega}\langle s, \top\delta\rangle, \top\tau \sqsubset_i \vartheta_{\top\omega}\ s];\ ^{\top}[p|\ p =_I \top\omega||]$

Figure 3 Model for English discourse (19i-ii): NPST v^{e} today$_{\bot\varepsilon}$ – FUT v^{s}

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_2 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	t_0: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\ e_0$	$^{st}\langle e_0, p_0\rangle$
■■	t_1: e_0-future in p_0	$\forall v \in p_0$: $\vartheta_v\ e_0 <_{\tau} t_1$	($^{\top}$NPST)$^{\top}$
●	e_1: Jim leaves	$\vartheta_{w0}\ e_1 \subset t_1$, $\vartheta_{w0}\ e_1 \subseteq [\![tod]\!](w_0, e_0)$	($^{\top}$NPST)$^{\top}$ v^{e} td$_{\bot\varepsilon}$
■	$^{\top}t_2$: e_1-consequent time	$t_2 \subseteq \vartheta_{w0}{}^{\triangleright} e_1$	($^{\top}$NPST)$^{\top}$ v^{e}
——	s_2: Sue is sad	$t_2 \subset \vartheta_{w0}\ s_2$	FUT v^{s}

The proposed analysis predicts that the English future auxiliary (*will* 'FUT') does not involve modal quantification in root clauses. In root clauses, the world of evaluation is a topical candidate for the speech world. Since this is a CG-world, the modal presupposition of FUT, which requires the world of evaluation to be a CG-world, reduces to the trivial test, $^{P}[\top\omega \in_I \top\omega||]$. Thus, a future sentence such as (19ii) asserts that in the speech world at the future topic time there is an eventuality that fits the verbal description. No other world is relevant (see e.g. (Kamp & Reyle, 1993)). In contrast, in conditionals FUT quantifies over hypothetical futures (see e.g. (Thomason, 1984)). The reason, I suggest, is that in modal contexts the presupposition that the world of evaluation is a CG-world is non-trivial: $^{P}[\bot\omega \in_I \top\omega||]$ (see (Stalnaker, 1975)). To derive this result, I propose that the complementizer *if* has a meaning that combines classical ordering semantics (see (Lewis, 1973); (Kratzer, 1981); (Lewis, 1981); and the attitude-based implementation in Table 4) with the idea that conditionals are modal topic-comment sequences (see (Bittner, 2001)). The complementizer *if* introduces a topical set of hypothetical worlds that satisfy the antecedent clause ($\underline{V}$), while the consequent clause ($\underline{V}'$) comments on this topical modality by describing the worlds that are optimal according to a salient attitude holder (e.g. most expected according to the speaker).

if $\quad$ **(s/s)/s**: $\lambda\underline{V}\lambda\underline{V}'\lambda\underline{w}([v]^{\perp}; ((\underline{V}\ \perp\omega;\ ^{\top}[p|\ p =_I \perp\omega||])^{\top}; (\underline{V}'\ \perp\omega;\ [\text{OPT}\langle\top\Omega, att_{\underline{w}}\ ?\varepsilon\rangle \subseteq_I \perp\omega||_?]))$

Table 4 Attitude-based ordering semantics

Abbreviation		*UC term*	
Ranking criteria for worlds			
$att_w\ s$	:=	$\lambda p(att_w(s, \uparrow s))$	$att \in \{bel, exp, des, ...\}$
$att_w\ e$	:=	$\lambda p(\exists s(att_w(s, \uparrow e) \wedge \vartheta_w\ e \sqsubseteq \vartheta_w\ s))$	
Order based on set of criteria $Q \in Term_{\Omega t}$			
$w <_Q v$	:=	$\lambda p(p \in Q \wedge w \in p) \subset \lambda p(p \in Q \wedge v \in p)$	*v is Q-better than w*
$\text{OPT}(p, Q)$	:=	$\lambda w(w \in p \wedge \neg\exists v(v \in p \wedge w <_Q v))$	*set of Q-optimal p-worlds*

In the conditional (15), the complementizer *if* introduces a topical set of hypothetical worlds that satisfy the antecedent clause (Jim$^{\perp}$ ($^{\top}$NPST)$^{\top}$ leave^{e}). In particular, they must satisfy the nonpast tense, which restricts the hypothetical worlds to the input CG. Within the input CG, the antecedent worlds that best fit the relevant attitudes of the salient attitude holder in the topical speech world also satisfy the consequent (Sue$^{\top}$ FUT be^{s} sad). In the UC representation (20), the attitudinal underspecification is resolved to the present expectations of the speaker. Finally, s-final prosody updates the Ω-topic to the set of surviving topic worlds, i.e. the output CG (see sample model in Figure 4).

(20) If Jim$^{\perp}$ ($^{\top}$NPST)$^{\top}$ leave^{e} … = (15)

$(([w]; [x|\ x =_i jim];\ ^{\top}[t];\ ^{\mathrm{P}}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau]; [\perp\omega \in_I \top\omega||]; [e|\ leave_{\perp\omega}\langle e, \perp\delta\rangle,$
$\vartheta_{\perp\omega}\ e \sqsubset_i \top\tau];\ ^{\top}[t|\ t \sqsubseteq_i \vartheta_{\perp\omega}{}^{\triangleright}\perp\varepsilon];\ ^{\top}[p|\ p =_I \perp\omega||])^{\top}; \ldots$

Sue$^{\top}$ FUT be^{s} sad .

$^{\top}[x|\ x =_i sue];\ ^{\mathrm{P}}[\vartheta_{\top\omega}\top\varepsilon <_i \top\tau];\ ^{\mathrm{P}}[\perp\omega \in_I \top\omega||]; [s|\ sad_{\perp\omega}\langle s, \top\delta\rangle, \top\tau \sqsubset_i \vartheta_{\perp\omega}\ s];$
$[\text{OPT}\langle\top\Omega, exp_{\top\omega}\top\varepsilon\rangle \subseteq_I \perp\omega||_{\top\tau}]);\ ^{\top}[p|\ p =_I \top\omega||]$

Figure 4 Model for English conditional (20): if NPST v^{e} … FUT v^{s}

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up, expects Q_1		$^{st}\langle e_0, p_0\rangle$, if
■	t_0: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\ e_0$	$^{st}\langle e_0, p_0\rangle$
~~			
$w_1 \in r_1 \subseteq p_0$	r_1: antecedent p_0-worlds		if
■■	t_1: e_0-future in p_0	$\forall v \in p_0$: $\vartheta_v\ e_0 <_\tau t_1$	($^{\top}$NPST)$^{\top}$
●	e_1: Jim leaves	$\vartheta_{w1}\ e_1 \subset t_1$	($^{\top}$NPST)$^{\top}$ v^{e}
■	$^{\top}t_2$: e_1-consequent time	$t_2 \subseteq \vartheta_{w1}{}^{\triangleright}e_1$	($^{\top}$NPST)$^{\top}$ v^{e}
~~			
$w_1 \in \text{OPT}(r_1, Q_1)$	w_1: Q_1-optimal r_1-world		if
——	s_2: Sue is sad	$t_2 \subset \vartheta_{w1}\ s_2$	FUT v^{s}

According to the proposed theory, the English tense paradigm forms a grammatical centering system that monitors and updates topic times. In the next section, this idea is extended to the Kalaalisut mood paradigm. Specifically, I propose that grammatical mood is a modal analogue of tense, i.e. a grammatical centering system that monitors and updates modal discourse referents.

4 Centering Theory of Kalaallisut Mood

In Kalaallisut matrix verbs do not inflect for tense, but for illocutionary mood. The declarative mood (DEC) marks at-issue assertions (21a); the interrogative mood (QUE), questions (21b); the optative mood (OPT), wishes (21c); and the imperative mood (IMP), directives (21d). The declarative and interrogative moods introduce, or inquire about, *currently verifiable facts* — i.e. eventualities that from the perspective of the speech act are already realized, at least in part, in the same world as that speech act. In contrast, the optative and imperative moods introduce *current prospects* — i.e. eventualities that from the perspective of the speech act may be realized in the future.

(21) a. Aallar-*pu*-q.
leave-*DEC*$_{\top}$-3SG
S/he has left.

b. Aallar-*p*.a?
leave-*QUE*.3SG
Has s/he left?

c. Aallar-*li*!
leave-*OPT*.3SG
Let him/her leave!

d. Aallar-*i*-t!
leave-*IMP*-2SG
Leave!

There is a separate mood paradigm for subordinate verbs. In this paradigm currently verifiable not-at-issue facts, in the factual mood (FCT, see (22a)), are in contrast to current prospects, in the hypothetical mood (HYP, (22b)). In addition, subordinate subjects are marked as topical ($\top$) or backgrounded ($\bot$) — i.e. the same or distinct from the matrix subject, which is always topical.

(22) a. Aani aliasug-pu-q Ole aallar-*m(m)*-at.
Ann sad-DEC$_{\top}$-3SG Ole leave-*FCT*$_{\bot}$-3SG$_{\bot}$
Ann is sad because Ole has left.

b. Ole aallar-*(p)p*-at Aani aliasug-ssa-(p)u-q.
Ole leave-*HYP*$_{\bot}$-3SG$_{\bot}$ Ann sad-exp-DEC$_{\top}$-3SG
If/when Ole leaves, Ann will (lit. is expected to) be sad.

Fact-oriented moods assert (DEC, FCT), or inquire whether (QUE), the eventuality of the verb is a currently verifiable fact — i.e. an event that has already happened (23), or a state that has at the very least begun (24), in the same world as the speech act. Temporal modifiers may impose additional constraints, if these are compatible with current verifiability. In general, fact-oriented moods are incompatible with future modifiers (e.g. *'tomorrow' in (23a′, b′) and (24a)), unless the modified element is the propositional object of a future-oriented attitude (e.g. expectation in (24b)).

(23) a. Ole aallar-*pu*-q.
Ole leave-*DEC*$_{\top}$-3SG
Ole has left.

b. Ole aallar-*p*.a?
Ole leave-*QUE*.3SG
Has Ole left?

a′. Ole {*ullumi* |**aqagu*} aallar-*pu*-q.
Ole {*today* | *tomorrow*} leave-*DEC*$_{\top}$-3SG
Ole left {today |*tomorrow}.

b′. Ole {*ullumi* |**aqagu*} aallar-*p*.a?
Ole {*today* | *tomorrow*} leave-*QUE*.3SG
Did Ole leave {today |*tomorrow}?

(24) a. (**Aqagu*) ulapig-*pu*-nga.
(*tomorrow*) busy-*DEC*$_{\top}$-1SG
I am busy (*tomorrow).

b. *Aqagu* siku-mi sivisuu-mik aallar-sima-*ssa*-(p)u-nga.
tomorrow ice-LOC long.time-MOD leave-have-*exp*-DEC$_{\top}$-1SG
I will (*lit.* {expect | am expected} to) be gone out on the ice a long time tomorrow.

To analyze the fragment of Kalaallisut exemplified by (21)–(24), I propose four basic categories: *sentence* (s) and three types of bound *pronouns* (pn_a for $a \in \{\delta, \tau, \omega\}$; see K1). The category-to-type rule is given in K2 and illustrated in Table 5 (where Kalaallisut items are represented by glosses).

K1 (Kalaallisut catgories)
1. s, pn_δ, pn_τ, *and* pn_ω *are Kalaallisut categories*.
2. *If X and Y are Kalaallisut categories, then so are X/Y and X\Y.*

Abbreviations: $\mathbf{s} := \mathrm{s}\backslash\mathrm{pn}_\omega$, $\mathrm{cn}_a := \mathrm{s}_a\backslash\mathrm{pn}_\omega$, $X_\delta := X\backslash\mathrm{pn}_\delta$

K2 (Kalaallisut category-to-type rule)
1. TYPE(s) = [], TYPE(pn_δ) = D, TYPE(pn_τ) = T, TYPE(pn_ω) = W.
2. TYPE(X/Y) = TYPE($X\backslash Y$) = TYPE(Y)TYPE(X)

Table 5 Some Kalaallisut categories and corresponding types

Kalaallisut item	*Kalaallisut category*	*UC type*
leave-, sad-, busy-	$\mathbf{s}_\delta$	[DW]
-exp	$\mathbf{s}\backslash\mathbf{s}$	[W][W]
-have, -OPT, -IMP	$\mathbf{s}_\delta\backslash\mathbf{s}_\delta$	[DW][DW]
-DEC, -QUE	$\mathrm{s}_\delta\backslash\mathbf{s}_\delta$	[DW][D]
-FCT	$(\mathrm{s}\backslash\mathrm{s})_\delta\backslash\mathbf{s}_\delta$	[DW](D[][])
-HYP	$(\mathbf{s}/\mathbf{s})_\delta\backslash\mathbf{s}_\delta$	[DW](D[W][W])
-1SG$_!$, -2SG$_!$, -3SG$_!$	$\mathrm{s}\backslash\mathbf{s}_\delta$	[DW][]
-1SG, -2SG, -3SG$_{(\top)}$, -3SG$_\bot$	$X\backslash X_\delta$	(D…)…
Ole-, ice-, today-, long-	cn_a	[WA], where A := *sa*
$(\mathrm{cn}_a)^\top$, $(\mathrm{cn}_a)^\bot$	$(\mathrm{s}/\mathrm{s})\backslash\mathrm{cn}_a$	[WA][][]
$(\mathrm{cn}_\tau)^\bot$, -MOD, -LOC	$(\mathbf{s}/\mathbf{s})\backslash\mathrm{cn}_a$	[WA][W][W]

In Kalaallisut, verbal roots introduce an eventuality dref as well as an open argument for the subject. Derivational verbal suffixes presuppose that the top-ranked background dref of the verbal base is an eventuality and derive a new verbal base where the top-ranked dref is an eventuality added by the suffix. Specifically, the state-forming suffix *-sima* 'have' (derivational variant of the English auxiliary) adds the consequent state of the base event. The prospective suffix *-ssa* 'exp' adds a state of expectation concerning the consequent state of a salient perspective point ($?\varepsilon$, resolved in context either to the speech act, $\top\varepsilon$, or the last-mentioned event, $\bot\varepsilon$). In the expected worlds a base-event is realized within this future time frame and is a verifiable fact by the end of this attitudinal state.

leave- $\mathbf{s}_\delta$: $\lambda\underline{x}\lambda\underline{w}([e|\ leave_{\underline{w}}\langle e, \underline{x}\rangle])$
sad- $\mathbf{s}_\delta$: $\lambda\underline{x}\lambda\underline{w}([s|\ sad_{\underline{w}}\langle s, \underline{x}\rangle])$
-have $\mathbf{s}_\delta\backslash\mathbf{s}_\delta$: $\lambda\underline{P}\lambda\underline{x}\lambda\underline{w}(\underline{P}\ \underline{x}\ \underline{w}\ ^\bot;\ [s|\ s =_i {}^\triangleright\bot\varepsilon])$
-exp $\mathbf{s}\backslash\mathbf{s}$: $\lambda\underline{V}\lambda\underline{w}(\underline{V}\ \bot\omega\ ^\bot;\ [\vartheta_{\bot\omega}{}^\varepsilon\bot a \sqsubset_i \vartheta_{\bot\omega}{}^\triangleright(?\varepsilon)];\ [s|\ \vartheta_{\bot\omega}{}^f\bot a <_i \vartheta_{\bot\omega}{}^◥ s];$
$[\mathrm{OPT}\langle\top\Omega, exp_{\underline{w}}\ \bot\sigma\rangle \subseteq_I \bot\omega\|_{\bot\sigma}])$

Illocutionary moods in Kalaallisut (-DEC, -QUE, -OPT, -IMP) form a grammatical system for modal (re)centering, parallel to temporal (re)centering by the English tenses. Parallel to *tense presuppositions*, which relate the speech act to the topic time, illocutionary moods have *illocutionary presuppositions*, which relate the speech act to the topic world. Both types of grammatical systems locate eventualities in the world of evaluation ($?\omega$) at the topic time ($\top\tau$). In English this update is local [$\boldsymbol{at}_W\langle A, T\rangle$], whereas in Kalaallisut it is global [$\boldsymbol{at}_W\{A, T\}$], defined as follows. If there is an extended period in the input column for the time dref, then the event-correlate of any surviving eventuality is properly included in the period in its row; otherwise, i.e. if there are only discourse instants, then the state correlate of the eventuality properly includes the discourse instant in its row.

$$[\boldsymbol{at}_W\{A, T\}] := \lambda I\lambda j(Ij \wedge (\exists i(Ii \wedge \vartheta_{Wi}{}^\varepsilon(A^*iI) \sqsubset_i T^*iI) \rightarrow \vartheta_{Wj}{}^\varepsilon(A^*jI) \sqsubset_i T^*jI) \wedge (\neg\exists i(Ii \wedge \vartheta_{Wi}{}^\varepsilon(A^*iI) \sqsubset_i T^*iI) \rightarrow T^*jI \sqsubset_i \vartheta_{Wj}{}^\sigma(A^*jI))$$

Finally, parallel to the topic time update by tense, illocutionary moods introduce modal discourse referents. The declarative mood introduces the updated CG as the primary topic (compare (Stalnaker, 1975)). The interrogative mood introduces a question (i.e. set of possible direct answers) into the background ($\perp\Omega||$; compare (Hamblin, 1973)). Prospective moods introduce background realization spheres (compare (Lewis, 1972); (Schwager, 2005)). By the truth definition 8, a sentence has a truth value just in case it introduces a unique proposition as a primary topic. This correctly predicts that all and only declarative sentences have truth values.

-DEC $\mathrm{s}_\delta\backslash\mathbf{s}_\delta$: $\lambda\underline{P}\lambda\underline{x}({}^{\mathrm{P}}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle]; (\underline{P}\ \underline{x}\ \top\omega^{\perp}; [\boldsymbol{at}_{\top\omega}\{\perp a, \top\tau\}]; [\vartheta_{\top\omega}{}^{\varepsilon}\perp a <_i \vartheta_{\top\omega}\top\varepsilon];$
$\quad {}^{\top}[p|\ p =_I \top\omega||]$

-QUE $\mathrm{s}_\delta\backslash\mathbf{s}_\delta$: $\lambda\underline{P}\lambda\underline{x}({}^{\mathrm{P}}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle; (\underline{P}\ \underline{x}\ \perp\omega^{\perp}; [\boldsymbol{at}_{\perp\omega}\{\perp a, \top\tau\}]; [\vartheta_{\perp\omega}{}^{\varepsilon}\perp a <_i \vartheta_{\top\omega}\top\varepsilon];$
$\quad [p|\ p =_I \perp\omega||]; [ask_{\top\omega}\{\top\varepsilon, \uparrow\top\varepsilon, \perp\Omega||\}]$

-OPT $\mathbf{s}_\delta\backslash\mathbf{s}_\delta$: $\lambda\underline{P}\lambda\underline{x}\lambda\underline{w}({}^{\mathrm{P}}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle, \downarrow\top\varepsilon \neq_i \underline{x}]; (\underline{P}\ \underline{x}\ \perp\omega^{\perp}; [\vartheta_{\perp\omega}{}^{\varepsilon}\perp a \sqsubset_i \vartheta_{\perp\omega}{}^{\triangleright}\top\varepsilon]);$
$\quad [p|\ p =_I \perp\omega||]; [\mathrm{OPT}\langle\top\Omega, des_{\underline{w}}\ \top\varepsilon\rangle \subseteq_I \perp\Omega]$

-IMP $\mathbf{s}_\delta\backslash\mathbf{s}_\delta$: $\lambda\underline{P}\lambda\underline{x}\lambda\underline{w}({}^{\mathrm{P}}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle, \downarrow\top\varepsilon =_i \underline{x}]; (\underline{P}\ \underline{x}\ \perp\omega^{\perp}; [\vartheta_{\perp\omega}{}^{\varepsilon}\perp a \sqsubset_i \vartheta_{\perp\omega}{}^{\triangleright}\top\varepsilon]);$
$\quad [p|\ p =_I \perp\omega||]; [\mathrm{OPT}\langle\top\Omega, direct_{\underline{w}}\ \top\varepsilon\rangle \subseteq_I \perp\Omega]$

Dependent moods turn verbal bases ($\mathbf{s}_\delta$) into elaborating (s\s) or topic-setting (**s**/**s**) modifiers. The factual mood (-FCT) asserts that in every worlds of the input CG the matrix event ($\perp a$) is temporally included in the consequent state of an $\mathbf{s}_\delta$-event ($\perp b$). This assertion suggests a causal link from the $\mathbf{s}_\delta$-event to the matrix event. The hypothetical mood (-HYP) introduces a modal topic: the set of worlds in the anaphoric modal base ($?\omega||$) where an $\mathbf{s}_\delta$-event is a current prospect (from the perspective of $?\varepsilon$). The matrix clause must comment on this modal topic ($\top\Omega$), so it must contain a prospective item (e.g. -exp, -OPT, or -IMP).

-FCT $(\mathrm{s}\backslash\mathrm{s})_\delta\backslash\mathbf{s}_\delta$: $\lambda\underline{P}\lambda\underline{x}\lambda K((K^{\perp}; [t|\ t =_i \vartheta_{\top\omega}{}^{\varepsilon}\perp a])^{\perp}; (\underline{P}\ \underline{x}\ \perp\omega^{\perp}; [\perp\tau \sqsubset_i \vartheta_{\top\omega}{}^{\triangleright}({}^{\varepsilon}\perp b)]); [\top\omega|| \subseteq_I \perp\omega||]$

-HYP $(\mathbf{s}/\mathbf{s})_\delta\backslash\mathbf{s}_\delta$: $\lambda\underline{P}\lambda\underline{x}\lambda\underline{V}\lambda\underline{w}((\underline{P}\ \underline{x}\ \perp\omega^{\perp}; [\vartheta_{\perp\omega}{}^{\varepsilon}\perp a \sqsubset_i \vartheta_{\perp\omega}{}^{\triangleright}(?\varepsilon)]; [\perp\omega \in_i ?\omega||]; {}^{\top}[p|\ p =_I \perp\omega||])^{\top};$
$\quad \underline{V}\ \underline{w})$

The subject argument of a Kalaallisut verb is filled by the subject inflection (i.e. Kalaallisut is a pronominal argument language in the sense of (Jelinek, 1984)). An inflected Kalaallisut 'verb' is thus equivalent to a complete English sentence (s).

-1SG	$\mathrm{s}\backslash\mathrm{s}_\delta$: $\lambda\underline{X}_{[\mathrm{D}]}(\underline{X}\ (\uparrow\top\varepsilon))$	-3SG$_\perp$	$\mathrm{s}\backslash\mathrm{s}_\delta$: $\lambda\underline{X}_{[\mathrm{D}]}(\underline{X}\ \perp\delta)$
-2SG	$\mathrm{s}\backslash\mathrm{s}_\delta$: $\lambda\underline{X}_{[\mathrm{D}]}(\underline{X}\ (\downarrow\top\varepsilon))$	-3SG$_{(\top)}$	$\mathrm{s}\backslash\mathrm{s}_\delta$: $\lambda\underline{X}_{[\mathrm{D}]}(\underline{X}\ \top\delta)$
-2SG$_!$	$\mathrm{s}\backslash\mathbf{s}_\delta$: $\lambda\underline{P}_{[\mathrm{DW}]}(\underline{P}\ (\downarrow\top\varepsilon)\ \top\omega)$	-3SG$_!$	$\mathrm{s}\backslash\mathbf{s}_\delta$: $\lambda\underline{P}_{[\mathrm{DW}]}(\underline{P}\ \top\delta\ \top\omega)$

An inflected noun is a topic-setting or background-setting modifier of s or **s**, if it is in a direct case (e.g. unmarked absolutive, -$^{\top}$ or -$^{\perp}$); or an elaborating modifier of an **s**-event ($\perp a$), if it is in an oblique case (e.g. modifier MOD or locative LOC).

Ole- cn_δ: $\lambda\underline{w}\lambda\underline{x}([\underline{x} =_i ole])$
ice- cn_δ: $\lambda\underline{w}\lambda\underline{x}([ice_{\underline{w}}\langle\underline{x}, ?\tau\rangle])$
today- cn_τ: $\lambda\underline{w}\lambda\underline{t}([\underline{t} \sqsubseteq_i tod_{\top\omega}\top\varepsilon])$
long- cn_σ: $\lambda\underline{w}\lambda\underline{s}([long\langle\vartheta_{\underline{w}}\ \underline{s}\rangle])$

-$_{\top a}$ $(\mathrm{s}/\mathrm{s})\backslash\mathrm{cn}_a$: $\lambda\underline{N}_{[\mathrm{WA}]}\lambda K(\underline{N}\ \top\omega\ \top a^{\top}; K)$
-$_{\perp a}$ $(\mathrm{s}/\mathrm{s})\backslash\mathrm{cn}_a$: $\lambda\underline{N}_{[\mathrm{WA}]}\lambda K(\underline{N}\ \top\omega\ \perp a^{\perp}; K)$
$(\mathbf{s}/\mathbf{s})\backslash\mathrm{cn}_\tau$: $\lambda\underline{N}_{[\mathrm{WT}]}\lambda\underline{V}\lambda\underline{w}(\underline{N}\ \underline{w}\ \perp\tau^{\perp}; (\underline{V}\ \underline{w}^{\perp}; [\vartheta_{\underline{w}}\ \perp a \sqsubseteq_i \perp\tau]))$
-MOD $(\mathbf{s}/\mathbf{s})\backslash\mathrm{cn}_a$: $\lambda\underline{N}_{[\mathrm{WA}]}\lambda\underline{V}\lambda\underline{w}(\underline{V}\ \underline{w}^{\perp}; \underline{N}\ \underline{w}\ \perp a)$
-LOC $(\mathbf{s}/\mathbf{s})\backslash\mathrm{cn}_\delta$: $\lambda\underline{N}_{[\mathrm{WD}]}\lambda\underline{V}\lambda\underline{w}(\underline{V}\ \underline{w}^{\perp}; \underline{N}\ \underline{w}\ \pi_{\underline{w}}\ \perp a)$

Finally, I assume that lexical adjustment can introduce an unspecified topical and background dref for comment or elaboration (see ${}^{\top}(\cdot)$, ${}^{\perp}(\cdot)$). Moreover, a verbal base ($\mathbf{s}_\delta$) may be modified by a preverbal **s**-modifier (licensed by ${}^{+}(\cdot)$), which may itself have undergone type lifting (by $(\cdot)^{+}$).

$^{\top}(\cdot)$	$s_a\backslash s_a$: $\lambda \underline{X}_{[A]}\lambda \underline{u}_A(^{\top}[u]\,^{\top}; \underline{X}\,\underline{u})$
$^{\perp}(\cdot)$	$s_a\backslash s_a$: $\lambda \underline{X}_{[A]}\lambda \underline{u}_A([u]\,^{\perp}; \underline{X}\,\underline{u})$
$(\cdot)^{+}$	$(\mathbf{s/s})\backslash(s/s)$: $\lambda \underline{J}_{[][]}\lambda \underline{V}\lambda \underline{w}(\underline{J}\,(\underline{V}\,\underline{w}))$
$^{+}(\cdot)$	$(\mathbf{s}_\delta\backslash(\mathbf{s/s}))\backslash \mathbf{s}_\delta$: $\lambda \underline{P}\lambda \underline{F}_{[w][w]}\lambda \underline{x}\lambda \underline{w}((\underline{F}\,(\underline{P}\,\underline{x}))\,\underline{w})$

Given this lexicon, the simple declarative (24a) translates into (25) (see also Figure 5). The verbal root introduces a busy state. The declarative mood locates this state in the speech world. It also asserts that the state is verifiable, from the speech act in the speech world, and that it holds at the topic time (the speech instant, by discourse-initial default). The subject is -1SG, so the busy state is a state of the speaker. Finally, the primary topic is updated to the output CG (set of surviving topic worlds).

(25) busy^s-DEC$_{\top}$-1SG = (24a)
$^{P}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle]; [s|\ busy_{\top\omega}\langle s, \uparrow\top\varepsilon\rangle, \top\tau \sqsubset_i \vartheta_{\top\omega}\, s, \vartheta_{\top\omega}{}^{\blacktriangleleft} s <_i \vartheta_{\top\omega}\top\varepsilon]$;
$^{\top}[p|\ p =_I \top\omega||]$

Figure 5 Model for Kalaallisut declarative (25): v^s-DEC

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	$^{\top}t_0$: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
————	s_1: $\uparrow e_0$ is busy	$t_0 \subset \vartheta_{w0}\, s_1$, $\vartheta_{w0}{}^{\blacktriangleleft} s_1 <_\tau \vartheta_{w0}\, e_0$	v^s-DEC

In (23a) an eventive declarative 'verb' is interpreted in the context of a topic-setting absolutive noun, which introduces Ole as a topical individual. The topic time is the speech instant, as in (25), so the global update $[\boldsymbol{at}_{\top\omega}\{\perp\varepsilon, \top\tau\}]$ asserts that the event of the verb has a current consequent state. The predicted UC representation is (26) (see sample model in Figure 6).

(26) $^{\top}$(Ole$_{\top\delta}$) leave^e-DEC$_{\top}$-3SG = (23a)
$^{\top}[x|\ x =_i ole]\,^{\top}$; $(^{P}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle]; [e|\ leave_{\top\omega}\langle e, \top\delta\rangle$,
$\top\tau \sqsubset_i \vartheta_{\top\omega}{}^{\triangleright} e, \vartheta_{\top\omega}\, e <_i \vartheta_{\top\omega}\top\varepsilon]; {}^{\top}[p|\ p =_I \top\omega||])$

Figure 6 Model for Kalaallisut declarative (26): v^e-DEC

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	$^{\top}t_0$: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
●	e_1: Ole leaves, still gone at t_0	$t_0 \subset \vartheta_{w0}{}^{\triangleright} e_1$, $\vartheta_{w0}\, e_1 <_\tau \vartheta_{w0}\, e_0$	v^e-DEC

In (23a′) a temporal topic-setting noun updates the topic time to a subinterval of the speech day. In this context, the global update $[\boldsymbol{at}_{\top\omega}\{\perp\varepsilon, \top\tau\}]$ reduces to the local update $[\boldsymbol{at}_{\top\omega}\langle\perp\varepsilon, \top\tau\rangle]$ so events are located as in English. The predicted UC representation is (27) (see sample model in Figure 7).

(27) $^{\top}$(Ole$_{\top\delta}$) $^{\top}$(today$_{\top\tau}$) leave^e-DEC$_{\top}$-3SG = (23a′)
$^{\top}[x|\ x =_i ole]\,^{\top}$; $(^{\top}[t|\ t \sqsubseteq_i tod_{\top\omega}\top\varepsilon]\,^{\top}$; $(^{P}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle]; [e|\ leave_{\top\omega}\langle e, \top\delta\rangle$,
$\vartheta_{\top\omega}\, e \sqsubset_i \top\tau, \vartheta_{\top\omega}\, e <_i \vartheta_{\top\omega}\top\varepsilon]; {}^{\top}[p|\ p =_I \top\omega||]))$

Figure 7 Model for Kalaallisut declarative (27): $^{\top}$today v^e-DEC

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	t_0: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
■■■■■	$^{\top}t_1$: part of e_0-day	$t_1 \subseteq [\![tod]\!](w_0, e_0)$	$^{\top}$today
●	e_1: Ole leaves	$\vartheta_{w0}\, e_1 \subset t_1$ $\vartheta_{w0}\, e_1 <_\tau \vartheta_{w0}\, e_0$	v^e-DEC

In questions temporal reference is similar, but the interrogative mood does not add any new information to the input CG, except that the present speech act is an act of asking a question. A question also does not introduce any propositional topic, so it has no truth value (by definition 8). Instead, it introduces a set of background propositions — direct answers — and inquires which answer, if any, is true. For example, question (23b) is analyzed in (28) (see also Figure 8).

(28) $^{\top}$(Ole$_{\top\delta}$) $^{\bot}$(leave^{e})-QUE-3SG = (23b)
$^{\top}[x|\ x =_i \mathit{ole}]\ ^{\top};\ (^{P}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle];\ ([w]\ ^{\bot};\ [e|\ \mathit{leave}_{\bot\omega}\langle e, \top\delta\rangle, \top\tau \sqsubset_i \vartheta_{\bot\omega}{}^{\triangleright}e,$
$\vartheta_{\bot\omega}\, e <_i \vartheta_{\top\omega}\top\varepsilon]);\ [p|\ p =_I \bot\omega||];\ [\mathit{ask}_{\top\omega}\{\top\varepsilon, \uparrow\top\varepsilon, \bot\Omega||\}])$

Figure 8 Model for Kalaallisut interrogative (28): v^{e}-QUE

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up, asks $Q_1 = \{q_1\}$		$^{st}\langle e_0, p_0\rangle$, QUE
■	$^{\top}t_0$: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
$w_1 \in q_1$	q_1: *yes*-answer to $Q_1 = \{q_1\}$		QUE
●	e_1: Ole leaves, still gone at t_0	$t_0 \subset \vartheta_{w1}{}^{\triangleright}e_1$, $\vartheta_{w1}\, e_1 <_{\tau} \vartheta_{w0}\, e_0$	v^{e}-QUE

In contrast to fact-oriented moods, prospect-oriented matrix moods introduce eventualities that are temporally located within the consequent state of the speech act and modally, within the input CG. There is no reference to the topic time so any temporal noun must elaborate this CG-realistic future eventuality, as the optative (29) illustrates. The only new information added by an optative sentence is that the speaker has certain wishes. In (29), the speaker's wishes rank as most desirable those CG-worlds where Ole leaves, not only within the consequent state of the speech act, but also within the speech day. Like questions, optatives do not introduce any topical propositions, so they have no truth values. For (29), the proposed UC representation is shown in (29′) (see sample model in Figure 9).

(29) Ole *ullumi* aallar-*li*!
Ole *today* leave-*OPT*.3SG$_!$
Let Ole leave today!

(29′) $^{\top}$(Ole$_{\top\delta}$) $^{\bot}$(today$_{\bot\tau}$) $^{+}$($^{\bot}$(leave^{e}))-OPT-3SG$_!$
$^{\top}[x|\ x =_i \mathit{ole}]\ ^{\top};\ (^{P}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle];\ ([t|\ t \sqsubseteq_i \mathit{tod}_{\top\omega}\, \top\varepsilon]\ ^{\bot};\ ([w]\ ^{\bot};\ [e|\ \mathit{leave}_{\bot\omega}\langle e, \top\delta\rangle,$
$\vartheta_{\bot\omega}\, e \sqsubseteq_i \bot\tau, \vartheta_{\bot\omega}\, e \sqsubset_i \vartheta_{\bot\omega}{}^{\triangleright}\top\varepsilon]));\ [p|\ p =_I \bot\omega||];\ [\mathrm{OPT}\langle\top\Omega, \mathit{des}_{\top\omega}\top\varepsilon\rangle \subseteq_I \bot\Omega])$

Figure 9 Model for Kalaallisut optative (29): $^{\bot}$today v^{e}-OPT

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up, wants Q_1		$^{st}\langle e_0, p_0\rangle$, OPT
■	t_0: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
$w_1 \in \mathrm{OPT}(p_0, Q_1)$	w_1: Q_1-optimal p_0-world		OPT
■■■■■■■■■	$^{\top}t_1$: part of e_0-day	$\vartheta_{w1}\, e_1 \subset t_1 \subseteq [\![\mathit{tod}]\!](w_0, e_0)$	$^{\bot}$today v^{e}
●	e_1: Ole leaves	$\vartheta_{w1}\, e_1 \subset \vartheta_{w1}{}^{\triangleright}e_0$	v^{e}-OPT

Mutatis mutandis, the proposed analysis of optative mood generalizes to semantically similar derivational attitudinal suffixes, such as *-ssa* 'exp(ected)'. In (24b) the verbal base of the suffix is elaborated by three word-external **s**-modifiers. These are combined (by forward composition, >B) into one **s**-modifier, which is licensed by a lexical adjustment of the verbal base (to wit, $^{+}(\cdot)$). On the salient reading, the perspective point is the speech act (i.e. the underspecified perspectival dref $?\varepsilon$ of the attitudinal suffix is resolved to $\top\varepsilon$). Viewed from this perspective point, there is a currently verifiable state of expectation. The grammatically unspecified attitude holder (presumably, the speaker) expects a certain chain of events — to wit, a departure by the speaker resulting in a long consequent state out on the ice the day after this speech act. In the CG-worlds that best fit the attitude holder's expectations, the expected consequent state begins within the consequent state of the perspective point (the current speech act) and its completion is a verifiable fact by the end of this state of expectation (see UC representation (30) and sample model in Figure 10).

(30) $^{\bot}$(tomorrow$_{\bot\tau}$) ice-LOC long-MOD $^{+}$($^{\bot}$(leave^{e}-have^{s}))-exp^{s}-DEC$_{\top}$-1SG = (24b)

$^{P}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle]; [t|\ t \sqsubseteq_i tmr_{\top\omega}\top\varepsilon]; [w]; [e|\ leave_{\bot\omega}\langle e, \uparrow\top\varepsilon\rangle]; [s|\ s =_i {}^{\triangleright}\bot\varepsilon,$
$\vartheta_{\bot\omega}\, s \sqsubseteq_i \bot\tau, ice_{\bot\omega}\langle\pi_{\bot\omega}\, s, \bot\tau\rangle, long\langle\vartheta_{\bot\omega}\, s\rangle, \vartheta_{\bot\omega}{}^{\blacktriangleleft}s \sqsubset_i \vartheta_{\bot\omega}{}^{\triangleright}\top\varepsilon]; [s|\ \vartheta_{\bot\omega}{}^{\blacktriangleright}\bot\sigma <_i \vartheta_{\bot\omega}{}^{\blacktriangleright}s];$
$[\text{OPT}\langle\top\Omega, exp_{\top\omega}\bot\sigma\rangle \subseteq_I \bot\omega||_{\bot\sigma}]; [\top\tau \sqsubset_i \vartheta_{\top\omega}\bot\sigma, \vartheta_{\top\omega}{}^{\blacktriangleleft}\bot\sigma <_i \vartheta_{\top\omega}\top\varepsilon]; {}^{\top}[p|\ p =_I \top\omega||]$

Figure 10 Model for Kalaallisut declarative (30): $^{\bot}$tomorrow … leave^{e}-have^{s}-exp^{s}-DEC

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	t_0: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
————————	s_1: $\uparrow s_1$ expects Q_1	$t_0 \subset \vartheta_{w0}\, s_1$, $\vartheta_{w0}{}^{\blacktriangleleft}s_1 <_\tau \vartheta_{w0}\, e_0$	exp^{s}-DEC
~~	~~~~	~~~~	~~~~
$w_1 \in \text{OPT}(p_0, Q_1)$	w_1: Q_1-optimal p_0-world		-exp^{s}
■■■■■■■	$^{\top}t_1$: part of e_0-tomorrow	$\vartheta_{w1}\, s'_1 \subseteq t_1 \subseteq [\![tmr]\!](w_0, e_0)$	$^{\bot}$tmr … have^{s}
●	e_1: $\uparrow e_0$ leaves	$^{\triangleright}e_1 = s'_1$	v^{e}-have^{s}
———	s'_1: $\uparrow e_0$ is out on ice long time	$\vartheta_{w1}{}^{\blacktriangleleft}s'_1 \subset \vartheta_{w1}{}^{\triangleright}e_0$, $\vartheta_{w1}{}^{\blacktriangleright}s'_1 <_\tau \vartheta_{w1}{}^{\blacktriangleright}s_1$	v^{s}-exp^{s}

In the conditional (22b), the expectation is restricted to a subset of the input CG. More precisely, the antecedent clause in the hypothetical mood introduces the set of CG-worlds where Ole leaves during the consequent state of this speech act as a topical modality. The declarative clause comments that in the antecedent CG-worlds that best fit the expectations of the speaker, Ole's leaving results in a sad state of Ann (see UC representation (31) and sample model in Figure 11).

(31) [($^{\bot}$(Ole$_{\bot\delta}$))$^{+}$ $^{+}$($^{\bot}$leave^{e})-HYP$_{\bot}$-3SG$_{\bot}$] ($^{\top}$(Ann$_{\top\delta}$))$^{+}$ $^{+}$(sad^{s}-exp^{s})-DEC$_{\top}$-3SG = (22b)

$^{P}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle];$
$(([x|\ x =_i ole]; [w]; [e|\ leave_{\bot\omega}\langle e, \bot\delta\rangle, \vartheta_{\bot\omega}\, e \sqsubset_i \vartheta_{\bot\omega}{}^{\triangleright}\top\varepsilon]; [\bot\omega \in_I \top\omega||]; {}^{\top}[p|\ p =_I \bot\omega||])\,^{\top};$
$({}^{\top}[x|\ x =_i ann]; [s|\ sad_{\bot\omega}\langle s, \top\delta\rangle, \vartheta_{\bot\omega}{}^{\blacktriangleleft}s \sqsubset_i \vartheta_{\bot\omega}{}^{\triangleright}\bot\varepsilon]; [s|\ \vartheta_{\bot\omega}{}^{\blacktriangleleft}\bot\sigma <_i \vartheta_{\bot\omega}{}^{\blacktriangleright}s];$
$[\text{OPT}\langle\top\Omega, exp_{\top\omega}\bot\sigma\rangle \subseteq_I \bot\omega||_{\bot\sigma}])); [\top\tau \sqsubset_i \vartheta_{\top\omega}\bot\sigma, \vartheta_{\top\omega}{}^{\blacktriangleleft}\bot\sigma <_i \vartheta_{\top\omega}\top\varepsilon]; {}^{\top}[p|\ p =_I \top\omega||]$

Figure 11 Model for Kalaallisut conditional (31): v^{e}-HYP … v^{s}-exp-DEC

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	t_0: e_0-instant in p_0	$\forall w \in p_0$: $t_0 = \vartheta_w\, e_0$	$^{st}\langle e_0, p_0\rangle$
————————	s_1: $\uparrow s_1$ expects Q_1	$t_0 \subset \vartheta_{w0}\, s_1$, $\vartheta_{w0}{}^{\blacktriangleleft}s_1 <_\tau \vartheta_{w0}\, e_0$	exp^{s}-DEC
~~	~~~~	~~~~	~~~~
$w_1 \in r_1 \subseteq p_0$	w_1: antecedent CG-world		HYP
●	e_1: Ole leaves	$\vartheta_{w1}\, e_1 \subset \vartheta_{w1}{}^{\triangleright}e_0$	v^{e}-HYP
~~	~~~~	~~~~	~~~~
$w_1 \in \text{OPT}(r_1, Q_1)$	w_1: Q_1-optimal r_1-world		-exp^{s}
———	s'_1: Ann is sad	$\vartheta_{w1}{}^{\blacktriangleleft}s'_1 \subset \vartheta_{w1}{}^{\triangleright}e_1$, $\vartheta_{w1}{}^{\blacktriangleleft}s'_1 <_\tau \vartheta_{w1}{}^{\blacktriangleright}s_1$	v^{s}-exp^{s}

Finally, in the factual variant (22a), the declarative matrix clause introduces a currently verifiable sad state of Ann. It locates this state in the speech world at the topic time (the speech instant, by discourse-initial default) and introduces the resulting CG as the primary topic. The factual elaboration adds that in all of these CG-worlds the beginning of Ann's sad state falls within the consequent state of Ole's leaving. The conversational implicature is that Ole's departure is a cause of Ann's sadness.

(32) $^{\top}$(Ann$_{\top\delta}$) sad^{s}-DEC$_{\top}$-3SG [($^{\perp}$(Ole$_{\perp\delta}$))$^{+}$ $^{+}$($^{\perp}$(leave^{e})-FCT$_{\perp}$-3SG$_{\perp}$] = (22a)
$(^{\top}[x|\ x =_i ann];\ ^{\mathrm{P}}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon,\ \uparrow\top\varepsilon\rangle];\ [s|\ sad_{\top\omega}\langle s,\ \top\delta\rangle,\ \top\tau \sqsubset_i \vartheta_{\top\omega}\, s,\ \vartheta_{\top\omega}{}^{\blacktriangleleft}s <_i \vartheta_{\top\omega}\, \top\varepsilon];$
$^{\top}[p|\ p =_I \top\omega\|\|])\ ^{\perp};\ ([t|\ t =_i \vartheta_{\top\omega}{}^{\blacktriangleleft}\perp\sigma];\ [x|\ x =_i ole];\ [w];\ [e|\ leave_{\perp\omega}\langle e,\ \perp\delta\rangle,\ \perp\tau \sqsubset_i \vartheta_{\perp\omega}{}^{\triangleright}e];$
$[\top\omega\| \subseteq_I \perp\omega\|\|])$

Figure 12 Model for Kalaallisut factual (32): v^{s}-DEC … v^{e}-FCT

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	t_0: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
———	s_1: Ann is sad	$t_0 \subset \vartheta_{w0}\, s_1$, $\vartheta_{w0}{}^{\blacktriangleleft}s_1 <_\tau \vartheta_{w0}\, e_0$	v^{s}-DEC
■	t_1: s_1-start time	$t_1 = \vartheta_{w0}{}^{\blacktriangleleft}s_1$	FCT
●	e_1: Ole leaves	$t_1 \subset \vartheta_{w0}{}^{\triangleright}e_1$	v^{e}-FCT
~~			
$w_1 \in r_1$, $p_1 \subseteq r_1$	r_1: p_1-fact		FCT
●	e_1: Ole leaves	$t_1 \subset \vartheta_{w1}{}^{\triangleright}e_1$	v^{e}-FCT

Thus, the proposed centering theory of tense generalizes to a parallel centering theory of mood. The basic idea is that tense and mood are semantically parallel grammatical centering systems: tense monitors and updates topic times, whereas mood monitors and updates modal discourse referents. In a directly compositional framework that combines CG with UC, the proposed semantic representations can be compositionally derived while taking the surface form of each language at face value. Lexical entries are language-specific, but the UC ontology of dref entities as well as the combinatory rules of CG are universal. So far, the proposed theory has been motivated by language-internal evidence. Section 5 provides additional evidence, from cross-linguistic comparison.

5 Translation Equivalence of Tense and Mood

In spite of the fact that languages have different grammatical systems, a discourse in one language can be translated into any other language. For example, the English discourse (33), in the nonpast tense, can be rendered in Kalaallisut, in the declarative mood, as (34).

(33) i. Ole has left. ii. Ann is asleep.
NPST have^{s} PRF leave^{e} NPST be^{s} asleep

(34) i. Ole aallar-pu-q. ii. Aani sinig-pu-q.
leave^{e}-DEC$_{\top}$-3SG asleep^{s}-DEC$_{\top}$-3SG

Translation equivalents have the same truth conditions. English (33) introduces two states that hold at the speech instant: the consequent state of Ole's departure and a state of Ann asleep. Both states are located in the speech world, the default modal topic. Thus, the temporal location in the present is grammatically encoded by the nonpast tense on stative verbs (have^{s}, be^{s}), whereas the modal location in the speech world reflects a universal discourse-initial default (see UC representation (33′)). The converse holds in Kalaallisut. Here, it is the modal location in the speech world that is grammaticaly encoded, by the declarative mood. Temporally, Ole's departure and Ann's state of sleep are both located at the default topic time (see UC representation (34′)). In a given utterance context,

$\langle e_0, p_0\rangle$, we thus predict that English (33i–ii) and Kalaallisut (34i–ii) converge on the same truth condition (see sample models in Figure 13 and Figure 14).

(33′) i. Ole NPST have^s PRF leave^e .
$^{\top}[x|\ x =_i ole]$; $^{P}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau]$; $[e|\ leave_{\top\omega}\langle e, \top\delta\rangle]$; $[s|\ s =_i {}^{\triangleright}\bot\varepsilon,\ \top\tau \sqsubset_i \vartheta_{\top\omega}\, s]$;
$^{\top}[p|\ p =_I \top\omega||]$
ii. Ann NPST be^s asleep .
$^{\top}[x|\ x =_i ann]$; $^{P}[\vartheta_{\top\omega}\top\varepsilon \leq_i \top\tau]$; $[s|\ asleep_{\top\omega}\langle s, \top\delta\rangle,\ \top\tau \sqsubset_i \vartheta_{\top\omega}\, s]$; $^{\top}[p|\ p =_I \top\omega||]$

(34′) i. Ole leave^e-DEC$_{\top}$-3SG .
$^{\top}[x|\ x =_i ole]$; $^{P}[\mathbf{spk}_{\top\omega}\langle \top\varepsilon, \uparrow\top\varepsilon\rangle]$; $[e|\ leave_{\top\omega}\langle e, \top\delta\rangle,\ \top\tau \sqsubset_i \vartheta_{\top\omega}{}^{\triangleright}e,\ \vartheta_{\top\omega}\, e <_i \vartheta_{\top\omega}\top\varepsilon]$;
$^{\top}[p|\ p =_I \top\omega||]$
ii. Ann asleep^s-DEC$_{\top}$-3SG .
$^{\top}[x|\ x =_i ann]$; $^{P}[\mathbf{spk}_{\top\omega}\langle \top\varepsilon, \uparrow\top\varepsilon\rangle]$; $[s|\ asleep_{\top\omega}\langle s, \top\delta\rangle,\ \top\tau \sqsubset_i \vartheta_{\top\omega}\, s,\ \vartheta_{\top\omega}{}^{\blacktriangle}s <_i \vartheta_{\top\omega}\top\varepsilon]$;
$^{\top}[p|\ p =_I \top\omega||]$

Figure 13 Model for English discourse (33i–ii): NPST have^s PRF v^e – NPST v^s

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$^{\top}w_0 \in {}^{\top}p_2 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	$^{\top}t_0$: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
●	e_1: Ole leaves		v^e
———	s_1: Ole is away	$t_0 \subset \vartheta_{w0}\, s_1$, $s_1 = {}^{\triangleright}e_1$	NPST have^s
——	s_2: Ann is asleep	$t_0 \subset \vartheta_{w0}\, s_2$	NPST v^s

Figure 14 Model for Kalaallisut discourse (34i–ii): v^e-DEC – v^s-DEC

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$^{\top}w_0 \in {}^{\top}p_2 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	$^{\top}t_0$: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
●	e_1: Ole leaves, still away at t_0	$t_0 \subset \vartheta_{w0}{}^{\triangleright}e_1$, $\vartheta_{w0}\, e_1 <_\tau \vartheta_{w0}\, e_0$	v^e-DEC
——	s_2: Ann is asleep	$t_0 \subset \vartheta_{w0}\, s_2$, $\vartheta_{w0}{}^{\blacktriangle}s_2 <_\tau \vartheta_{w0}\, e_0$	v^s-DEC

The English discourse (35i–ii) is a past tense variant of (33i–ii). In Kalaallisut this discourse can be rendered as (36), which presents the content of (35i) as the main assertion (DEC) and (35ii), as a background fact (FCT).

(35) i. Ole left. today. ii. Ann was asleep.
$^{\top}$(PST) leave^e today$_{\bot\varepsilon}$ PST be^s

(36) Ole ullumi aallar-pu-q Aani sinig-m(m)-at.
$^{\top}$(today) leave^e-DEC$_{\top}$-3SG asleep^s-FCT$_{\bot}$-3SG$_{\bot}$

In English, the presupposition of the anaphoric past tense, PST, cannot be satisfied in the discourse-initial sentence (35i), so lexical adjustment by $^{\top}(\cdot)$ must introduce a past topic time. The event of (35i) is located within this past topic time, by $^{\top}$(PST), and is further located within the speech day, by a postverbal temporal modifier. The past topic time satisfies the presupposition of the past tense in (35ii). Thus the state of (35ii) includes this topic time, which in turn includes the event of (35i) (see (35′i–ii) and Figure 15). In Kalaallisut (36), the main clause introduces an event of Ole leaving, locates it in the topical speech world within the speech day, asserts that its consequent state still holds at the speech instant, and finally updates the primary topic to the set of surviving topic worlds. The postposed factual clause adds that in all of these worlds Ole leaves during the consequent state of Ann's falling asleep, so she was still asleep at the time of his departure (see (36′i–ii) and Figure 16).

(35′) i. Ole $^{\top}$(PST) leave^{e} today$_{\perp\varepsilon}$.
$^{\top}[x|\ x =_i ole]$; $^{\top}[t]$; $^{P}[\top\tau <_i \vartheta_{\top\omega}\top\varepsilon]$; $[e|\ leave_{\top\omega}\langle e, \top\delta\rangle, \vartheta_{\top\omega}\, e \sqsubset_i \top\tau, \vartheta_{\top\omega}\, e \sqsubseteq_i tod_{\top\omega}\top\varepsilon]$;
$^{\top}[p|\ p =_I \top\omega||]$

ii. Ann PST be^{s} asleep .
$^{\top}[x|\ x =_i ann]$; $^{P}[\top\tau <_i \vartheta_{\top\omega}\top\varepsilon]$; $[s|\ asleep_{\top\omega}\langle s, \top\delta\rangle, \top\tau \sqsubset_i \vartheta_{\top\omega}\, s]$; $^{\top}[p|\ p =_I \top\omega||]$

(36′) Ole $^{\top}$(today) leave^{e}-DEC$_{\top}$-3SG …
$(^{\top}[x|\ x =_i ole]$; $^{\top}[t|\ t \sqsubseteq_i tod_{\top\omega}\top\varepsilon]$; $^{P}[\boldsymbol{spk}_{\top\omega}\langle\top\varepsilon, \uparrow\top\varepsilon\rangle]$; $[e|\ leave_{\top\omega}\langle e, \top\delta\rangle, \vartheta_{\top\omega}\, e \sqsubset_i \top\tau,$
$\vartheta_{\top\omega}\, e <_i \vartheta_{\top\omega}\top\varepsilon]$; $^{\top}[p|\ p =_I \top\omega||])\ ^{\perp}$; …
Ann asleep^{s}-FCT$_{\perp}$-3SG$_{\perp}$.
$([t|\ t =_i \vartheta_{\top\omega}\ \perp\varepsilon]$; $[x|\ x =_i ann]$; $[w]$; $[s|\ asleep_{\perp\omega}\langle s, \perp\delta\rangle, \perp\tau \sqsubset_i \vartheta_{\perp\omega}{}^{\triangleright}(^{\blacktriangle}s)]$; $[\top\omega|| \subseteq_I \perp\omega||]$

Figure 15 Model for English (35i–ii): $^{\top}$PST v^{e} today$_{\perp\varepsilon}$ – PST v^{s}

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$^{\top}w_0 \in {}^{\top}p_2 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	t_0: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
■■	$^{\top}t_1$: e_0-past	$\forall v \in p_0$: $t_1 <_\tau \vartheta_v\, e_0$	$^{\top}$PST
●	e_1: Ole leaves	$\vartheta_{w0}\, e_1 \subset t_1$, $\vartheta_{w0}\, e_1 \subseteq [\![tod]\!](w_0, e_0)$	$^{\top}$PST v^{e} td$_{\perp\varepsilon}$
——	s_2: Ann is asleep	$t_1 \subset \vartheta_{w0}\, s_2$	PST v^{s}

Figure 16 Model for Kalaallisut (36): $^{\top}$today v^{e}-DEC … v^{s}-FCT

Dref	*Symbol: Description*	*Temporal-modal conditions*	*Source*
$^{\top}w_0 \in {}^{\top}p_1 \subseteq p_0$	$^{\top}w_0$: candidate for e_0-world		$^{st}\langle e_0, p_0\rangle$
●	$^{\top}e_0$: $\uparrow e_0$ speaks up		$^{st}\langle e_0, p_0\rangle$
■	$^{\top}t_0$: e_0-instant in p_0	$\forall v \in p_0$: $t_0 = \vartheta_v\, e_0$	$^{st}\langle e_0, p_0\rangle$
■■	$^{\top}t_1$: subinterval of e_0-day	$t_1 \subseteq [\![tod]\!](w_0, e_0)$	$^{\top}$td
●	e_1: Ole leaves	$\vartheta_{w0}\, e_1 \subset t_1$, $\vartheta_{w0}\, e_1 <_\tau \vartheta_{w0}\, e_0$	$^{\top}$td v^{e}-DEC
■	t'_1: e_1-instant	$t'_1 = \vartheta_{w0}\, e_1$	FCT
——	s_1: Ann is asleep	$t'_1 \subset \vartheta_{w0}{}^{\triangleright}(^{\blacktriangle}s_2)$	v^{s}-FCT
~~			
$w_1 \in r_1$, $p_1 \subseteq r_1$	r_1: p_1-fact		FCT
——	s_1: Ann is asleep	$t'_1 \subset \vartheta_{w1}{}^{\triangleright}(^{\blacktriangle}s_2)$	v^{s}-FCT

This analysis accounts for the intuition that translation equivalence holds only up to a point. In the temporal domain, English tenses are more restrictive than Kalaallisut moods. For example, English (37a) is incoherent because the past topic time set by *yesterday* conflicts with the presupposition of the nonpast tense. In contrast, Kalaallisut (37b) is fine because this temporal update is compatible with the meaning of the declarative mood (in particular, with the assertion of current verifiability).

(37) a.* Yesterday I am busy.
$^{\top}$yesterday NPST be^{s}

b. Ippassaq ulapig-pu-nga.
$^{\top}$yesterday busy^{s}-DEC$_{\top}$-3SG

Conversely, in the modal domain, it is Kalaallisut that is more restrictive. For instance, the English nonpast generic (38a) allows an uninstantiated rule reading, which only states what is expected or desired without requiring any currently verifiable instantiating eventuality. In contrast, the Kalaallisut declarative generic (38b) does not have this reading. The declarative mood entails verifiability from the speech act in the speech world. For a habit (E), it follows that at least one instantiating eventuality ($e \in E$) has already been realized in the speech world prior to this speech act (see (Bittner, 2008)).

(38) a. Members of this club help each other.
NPST help^{e}
(✓ club rule, not yet instantiated)

b. Piqatigiivvik-mi ua-ni ilaasurtaq-t ikiur-qatigiig-tar-pu-t.
club-LOC this-LOC member-PL help^{e}-rcp-habit^{E}-DEC$_{\top}$-3PL
(* club rule, not yet instantiated)

In summary, speaking up focuses attention on the speech act and thereby introduces default modal and temporal topics. Because of this universal 'commonplace effect' of speech acts (implementing (Stalnaker, 1978)), different grammatical forms may encode the same truth conditions. What one language encodes by means explicit grammatical marking another may convey via a universal discourse-initial default.

6 Conclusion

Grammatical tense and mood paradigms are semantically parallel and contextually equivalent centering systems. Based on English and Kalaallisut, I propose that tense monitors and updates topic times, whereas mood monitors and updates modal discourse referents. In root clauses, the parallels between tenses and moods begin with presuppositions: matrix tenses carry presuppositions that relate the speech act to the topic time, whereas illocutionary moods carry presuppositions that relate the speech act to the topic world. The two types of grammatical systems converge even more closely on new information: both matrix tenses and illocutionary moods locate eventualities at the topic time in the world of evaluation. In English as well as Kalaallisut these temporal-modal location updates conform to universal aspectual generalizations (see (Bittner, 2008)), but with different details — e.g. local update $[\boldsymbol{at}_{\top\omega}\langle\bot a, \top\tau\rangle]$ in English v. global update $[\boldsymbol{at}_{\top\omega}\{\bot a, \top\tau\}]$ in Kalaallisut. Finally, both grammatical systems give rise to parallel recentering updates: English tenses update topic times, whereas Kalaallisut moods update modal discourse referents.

These semantic parallels were formally implemented in Update with Centering (UC), a typed dynamic logic that keeps track not only of the current discourse referents of each type, but also of their current prominence ranking in the center as well as the periphery of attention. Evidence from English and Kalaallisut suggests that different languages can be translated into UC by universal directly compositional rules of Categorial Grammar (CG).

The proposed centering theory of tense and mood accounts for temporal and modal discourse reference in English as well as Kalaallisut. It also accounts for the translation equivalence of tense-based and mood-based systems in a given utterance context. Following (Stalnaker, 1978), I assume that the very act of speaking up has a 'commonplace effect' on the context. It focuses attention on the speech act and thereby introduces default modal and temporal topics. These universal defaults complement language-specific grammatical systems, such as English tenses and Kalaallisut moods. In a given utterance context the universal discourse-initial defaults plus language-specific grammatical marking may add up to the same truth conditions. As a consequence, temporal reference in mood-based Kalaallisut is predictable and precise, as is modal reference in tense-based English.

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