Chris Barker and Pauline Jacobson, eds. (2007). *Direct Compositionality*, Chap. 11, pp. 363–404. Oxford University Press, Oxford.

Online Update: Temporal, modal, and *de se* anaphora in polysynthetic discourse

MARIA BITTNER
Rutgers University

Abstract

This paper introduces a framework for direct surface composition by *online update*. The surface string is interpreted as is, with each morpheme in turn updating the input state of information and attention. A formal representation language, *Logic of Centering*, is defined and some crosslinguistic constraints on lexical meanings and compositional operations are formulated.

This framework is then used to interpret a set of pairwise equivalent mini-discourses in a polysynthetic language. Each pair illustrates two syntactically diverse but semantically equivalent patterns of temporal, modal, and *de se* anaphora. Online update offers a natural and general explanation, because different surface strings can converge on the same anaphoric dependencies between counterpart lexical items. In contrast, it is argued that these data present a problem for LF-based theories.

1 INTRODUCTION

Temporality, modality, *de se* reports as well as incorporation all present difficult challenges for semantic composition. In LF-based theories (e.g. Bittner 1994, Muskens 1995, Stone and Hardt 1999, Schlenker 2003, among others) the input to semantic composition are not the surface forms that present these challenges. Instead, a more tractable *logical form* (LF) is first derived by means of operations that may involve movement, rebracketing, insertion of covert elements, or deletion of overt material. It might therefore seem that any problem that compounds all four of the above mentioned challenges would be out of reach of any surface compositional theory, committed to interpreting the surface form directly, as is. In this paper I argue for the contrary: even very challenging surface forms can be interpreted directly by *online update*. Moreover, surface-based online update correctly predicts anaphoric dependencies of various types, both within and across sentence boundaries. It thus offers a simpler and more general account of such dependencies than indirect LF-based theories.

The problem to be considered is the interaction of temporal and modal quantifiers with *de se* attitudes in Kalaallisut (Eskimo-Aleut: Greenland). This massively polysynthetic[1] language builds words compositionally—like English, sentences—and has productive suffixes

[1] Sapir 1922 classifies languages based on the average number of morphemes per word, as *analytic* (e.g. English), *synthetic* (French), or *polysynthetic* (Eskimo).

for quantifiers as well as *de se* attitudes (exemplified in (2b), (3b), (4)). The inflectional system of Kalaallisut distinguishes three classes of words: *verbs*, which inflect for mood and agreement; *nouns*, which inflect for agreement and case; and *particles*, which do not inflect.[2] A grammaticized centering system contrasts two forms of dependent inflections: *topical* versus *backgrounded* (e.g. *-mi* '3s$_{\top}$' vs. *-at* '3s$_{\bot}$'). The centering status is explicitly marked on dependent nouns and verbs, but not on the matrix verb, where it is predictable: the subject of the matrix verb is always topical and any direct object, backgrounded.

The problem for semantic composition is semantic convergence across radically different surface forms. For instance, in the context of (1), (2a) is semantically equivalent to (2b), and (3a), to (3b):

(1) *Ataata-ga skakkir-tar-pu-q.*
dad-1s.sg play.chess-habit-IND.IV-3s
My dad$_{\top}$ plays chess.

(2) *Siurna arna-mi uqaluqatigi-mm-ani*
last.year mother-3s$_{\top}$.sg.ERG talk.with-FCT$_{\bot}$-3s$_{\bot}$.3s$_{\top}$
Last year when his$_{\top}$ mother talked with him$_{\top}$, …

a. uqar-*pu-q:* "*Amirlanir-tigut ajugaa-sar-pu-nga*."
say-IND.IV-3s most-VIA win-habit-IND.IV-1s
… he$_{\top}$ said: "I mostly win."

b. *amirlanir-tigut ajugaa-sar*-nirar-*pu-q*.
most-VIA win-habit-*say*-IND.IV-3s
… he$_{\top}$ said that he (= *se*) mostly won.

(3) *Ilaanni skakkir-a-mi*,
once play.chess-FCT$_{\top}$-3s$_{\top}$
Once when he$_{\top}$ was playing, …

a. isuma-qa-*lir-pu-q:* "*Immaqa ajugaa-ssa-u-nga*."
belief-have-begin-IND.IV-3s maybe win-prospect-IND.IV-1s
…he$_{\top}$ began to think: "I might win."

b. *immaqa ajugaa-ssa*-suri-*lir-pu-q*.
maybe win-prospect-*believe*-begin-IND.IV-3s
…he$_{\top}$ began to think that he (= *se*) might win.

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[2] I use standard Kalaallisut orthography minus the allophones (*e*, *o*, *f*) of *i*, *u*, *v*. Glosses for (i) *centering status*: $\top$ = topic, $\bot$ = background; (ii) *dependent moods*: FCT$_{\top}$ = $\top$-factive (old fact about $\top$-subject), FCT$_{\bot}$ = $\bot$-factive, HAB$_{\top}$ = $\top$-habit, HAB$_{\bot}$ = $\bot$-habit (iii) *matrix mood*: IND = indicative (new fact); (iii) *transitivity*: IV = intransitive, TV = transitive; (iv) *case*: MOD = modalis (modifier), VIA = vialis (path).

(2a) and (2b) report *de se* speech, whereas (3a) and (3b) report *de se* beliefs. Both speech and belief reports can be temporally quantified (as in (2a, b)) or modally quantified (see (3a, b)). In addition, *de se* reports with direct quotes (e.g. (2a), (3a)) have polysynthetic paraphrases (see (2b), (3b)). All of these reports are temporally and individually *de se* in the sense of Lewis 1979. That is, they are about the person that the agent or experiencer thinks of as *I* and the time he thinks of as *now*. The compositional problem is to derive the equivalence of type (a)-reports, with quotes, and their polysynthetic paraphrases of type (b), in spite of their radically different surface form.

At first blush, it might seem that this problem requires an LF-based solution. To begin with, in each of these four reports the matrix eventuality—a speech event or belief state—must be located at the time evoked by the initial factive clause. If this is to be accomplished by binding a temporal variable, then the binder must take scope over the initial factive clause as well as the matrix verb. None of the surface forms contains a likely binder. An LF theory can enrich the surface with a covert binder. But a surface compositional theory is committed to interpreting the surface form as is, so it cannot pursue this option.

What it can pursue, though, is dynamic binding. On this view, what matters is linear precedence, not c-command. The initial factive clause can set up a temporal *discourse referent* (*dref*) which can be anaphorically linked to the matrix verb. To represent anaphoric links most dynamic theories enrich the surface form with covert indices (e.g., Kamp and Reyle 1993, Muskens 1995, Stone and Hardt 1999). But adding covert elements has no place in strictly direct composition. So any theory with index-based anaphora is still not truly direct.

To achieve true direct composition, I implement the idea of Grosz *et al* 1995 that anaphora is based, not on covert indices, but on grammatically marked centering status. To make this precise I develop a dynamic system like Muskens 1995 except that anaphora is based on compositionally built stacks (as in Dekker 1994, Bittner 2001) instead of arbitrary indices. A state of information-and-attention is a triple of a world and two stacks of prominence-ranked semantic dref objects. Topical drefs go on the top stack, which models the center of attention; backgrounded drefs, on the bottom stack, which models the periphery. Based on the current stacks, dref objects can then be retrieved by anaphoric demonstratives. The actual morphemes, which stack and retrieve dref objects, thus take over the role of covert indices. The two-stack architecture also permits a simple analysis of the dichotomy found in grammatical centering systems (e.g. obviation: '$3s_{\top}$' vs '$3s_{\bot}$').

Quantification presents additional challenges. Since Lewis 1975 temporal quantification has been analyzed in terms of tripartite structures consisting of a quantifier and its two arguments—the restriction and the matrix. Heim 1982 extended the tripartite analysis to modal quantifiers, and Kamp and Reyle 1993 integrated it with a dynamic theory of tense and aspect. But to derive the requisite tripartite structures from polysynthetic reports like (2b) or (3b), these theories would require rebracketing. That is, they would require a level of LF. Instead, I propose to maintain direct surface composition by encapsulating quantification along the lines of Stone 1997. The idea is that quantifiers relate drefs for functions that characterize distributed patterns. Specifically, I propose that temporal quantifiers relate drefs for *habits*—e.g. (2b) reports a habitual pattern of victories instantiated at the end of most of the chess games that instantiate the antecedent chess-playing habit, evoked in (1). Similarly, modal quantifiers relate drefs for *modal concepts* of eventualities—e.g., in the belief state of (3b) the expected end of the current chess game is realized, in some of the belief worlds, as a victory by the experiencer of this state.

Finally, what about individual and temporal *de se* dependencies? These, too, have been analyzed as variable-binding at LF (see, e.g., Chierchia 1989, Schlenker 2003). To derive the requisite LFs from polysynthetic *de se* reports like (2b) or (3b) these theories would also require rebracketing, as well as assorted covert elements. Instead, I propose to maintain direct surface composition by developing an idea from the original proposal by Lewis 1979. One of Lewis's examples is an insomniac who lies awake at night wondering what time it is. Lewis concludes:

> "To understand how he wonders, we must recognize that it is time-slices of him that do the wondering. […] The slice at 3:49 A.M. may self-ascribe the property of being one slice of an insomniac who lies awake all night on such-and-such date at such-and-such place in such-and-such kind of world, and yet may fail to self-ascribe the property of being at 3:49 A.M. That is how this slice may be ignorant, and wonder what time it is, without failing in any relevant way to locate the continuant to which it belongs. It is the slice, not the continuant, that fails to self-ascribe a property." (Lewis 1979: Section VII)

Unlike Lewis, I do not think that we ever talk about time-slices of people. But we do talk about speech acts that people perform and belief states they experience. I suggest that (2a, b) and (3a, b) exemplify such talk. A pair of a person and an eventuality—be it a speech act or a belief state—is as good as a time-slice for analyzing *de se* speech or *de se* belief. Better, in fact, since it also provides a location in space. And we get such pairs for free if we assume that report verbs—like all other verbs—have a Davidsonian argument: e.g., 'say' refers to a speech event, and 'believe', to a belief state. This must be assumed anyway in order to apply current theories of temporal anaphora to report verbs (see e.g. Kamp and Reyle 1993, Stone and Hardt 1999).

For Lewis, *de se* speech (or *de se* belief) was self-ascription of a property by a time-slice of the speaker (or the believer). Instead, I propose that the speaker (or the believer) is conscious of performing a certain speech act (experiencing a certain mental state) and identifies himself as the agent of that event (experiencer of that state). When an insomniac says *I am awake*, what he means is that the agent of this speech event is awake at the time of this event. This the insomniac can know even if he does not know that the time happens to be 3:49 A.M. Or if he is too sleepy to remember that he—the agent—is Mr. Brown. Likewise for *de se* belief, *de se* desire, *de se* fear, etc. The *se* of a *de se* attitude state is the experiencer of that mental state.

This adaptation of Lewis's proposal is compatible with surface-based online update, if we assume an ontology of dref objects that includes events and states (following Partee 1984 and related work). As we will see, the proposed account will then also generalize to habitual reports—e.g., (4a) and (4b), which illustrate one more pair of quantified *de se* reports that can coherently follow the habitual sentence (1). In (4a) as well as (4b), the temporal description *aqagu-a-ni* 'the next day' can be either outside or inside the scope of the temporal quantifier *-(g)ajut* 'often' (as in the similarly ambiguous English translation). For standard tripartite quantification this too would require rebracketing at LF. But if we instead posit drefs for habits, then we can maintain surface-based online update simply by associating *-(g)ajut* 'often' with an ambiguous anaphoric presupposition.

(4) Aqagu-*a-ni*
next.day-3s$_{\perp}$.sg-LOC
The next day…

a. *uqar*-ajut-*tar-pu-q:* "*Ajugaa-sima-vu-nga.*"
say-*often*-habit-IND.IV-3s win-prf-IND.IV-1s
…he$_{\top}$ often says: "I won."

b. *ajugaa-sima-nirar*-ajut-*tar-pu-q*.
win-prf-say-*often*-habit-IND.IV-3s
…he$_{\top}$ often says that he (= *se*) won.

In general, by replacing tripartite LFs and index-based LF-anaphora with drefs for patterns and stack-based surface-anaphora we can maintain direct surface interpretation even in a massively polysynthetic language. The rest of this paper develops this basic idea as follows. In Section 2 I introduce a framework for online update and illustrate it with a simple English example. Further lexical meanings are then added as needed for online interpretation of increasingly more complex Kalaallisut discourses: episodics in Section 3, habituals in Section 4, reported habits and attitudes in Sections 5 and 6, respectively, and habitual reports in Section 7. Section 8 returns to the comparison with LF-based theories. Finally, Section 9 is the conclusion.

2 FRAMEWORK FOR ONLINE UPDATE

The basic idea of *online update* is that the surface string is interpreted as is, with each morpheme in turn updating the current state of information and attention. To implement this idea, I first define *Logic of Centering* (LC), a variant of the Logic of Change of Muskens 1995 with stack-based anaphora a la Bittner 2001. As usual, updating an input state yields a set of possible outputs. But in LC a state of information and attention is a triple of a world (information) and two stacks of prominence-ranked dref objects. Topical dref objects go on the *top stack* (⊤, focal attention), while backgrounded dref objects go on the *bottom stack* (⊥, peripheral attention). As in the stack-based system of Dekker 1994, LC drefs are semantic objects, not variables. Two sets of variables, $Var^{\top}$ and $Var^{\perp}$, serve to add semantic dref objects to the top and bottom stack, respectively. Table 1 lays out the ontology of LC and the notation for the two sets of variables.

TABLE 1. LC ontology and two sets of variables

Type	Abr.	Name of objects	$^{\top}Var$	$^{\perp}Var$
t		truth values		
ω		worlds	$\mathbf{w}$	w
τ		times	$\mathbf{t}$	t
π		places	$\mathbf{l}$	l
α		animate entities	$\mathbf{a}$	a
β		inanimate entities	$\mathbf{b}$	b
ε		events	$\mathbf{e}$	e
σ		states of entities	$\mathbf{s}$	s
$\varepsilon \vee \sigma$	$\varepsilon^{\bullet}$	atomic episodes	$\mathbf{e}^{\bullet}$	$e^{\bullet}$
$\varepsilon\varepsilon$		ε-chains	$\mathbf{ee}$	ee
$\omega\tau\mathrm{V}$	η^{V}	V-habits ($\mathrm{V} \in \{\varepsilon, \sigma, \varepsilon\varepsilon\}$)	$\mathbf{h}^{\mathrm{V}}$	h^{V}
$\omega\varepsilon^{\bullet}\mathrm{N}$	κ^{N}	N-kinds ($\mathrm{N} \in \{\alpha, \beta, \tau, \pi, \omega t\}$)	$\mathbf{k}^{\mathrm{N}}$	k^{N}
ωt	Ω	ω-domains	$\mathbf{p}$	p
$\omega\omega$	$\underline{\omega}$	ω-concepts	$\underline{\mathbf{w}}$	$\underline{w}$
$\omega\sigma$	$\underline{\sigma}$	σ-concepts	$\underline{\mathbf{s}}$	$\underline{s}$
$\omega\varepsilon$	$\underline{\varepsilon}$	ε-concepts	$\underline{\mathbf{e}}$	$\underline{e}$
$\underline{\varepsilon}(\varepsilon)$	$\underline{\varepsilon\varepsilon}$	ε-concept chains	$\underline{\mathbf{ee}}$	$\underline{e}$
$\varepsilon\underline{\sigma}$		ε-dependent σ-concepts	$\underline{\mathbf{s}}_{\varepsilon}$	$\underline{s}_{\varepsilon}$
$\varepsilon\underline{\varepsilon}$		ε-dependent ε-concepts	$\underline{\mathbf{e}}_{\varepsilon}$	$\underline{e}_{\varepsilon}$
$\alpha\kappa^{\alpha}$		α-dependent α-kinds	$\mathbf{k}^{\alpha}_{\alpha}$	k^{α}_{α}
ζ		stacks (of dref objects)		z
$\omega{\times}\zeta{\times}\zeta$	s	states of information-&-attention		i, j
sst		update		

The ontology is crucial for stack-based anaphora: adding a dref object of type R to a stack demotes any other R-objects one notch, but has no effect on objects of types other than R. Stacked dref objects of type R can be referred to by *anaphoric demonstratives*, of the form $\mathbf{d}\text{R}_n$ or $d\text{R}_n$ (type sR). The demonstrative $\mathbf{d}\text{R}_n$ refers to the (n + 1)-st dref object of type R on the current top stack. Similarly, the demonstrative $d\text{R}_n$ refers to the (n + 1)-st dref object of type R on the current bottom stack. Unlike the covert indices of index-based theories, stack positions cannot be assigned at will, for they must accord with grammatically marked prominence status (e.g., subject vs. object, '$3\text{s}_\top$' vs. '$3\text{s}_\perp$', etc).

The ontology in Table 1 is empirically motivated by grammatical marking in Kalaallisut, Yukatek, Mohawk, and English (see text studies at http://www.rci.rutgers.edu/~mbittner). Their grammars are very different, but they all motivate seven basic types of drefs: *worlds* (ω), *times* (τ), *places* (π), entities sorted into *animates* (α) and *inanimates* (β), and atomic episodes sorted into *events* (ε) and *states* (σ).

For online update we also need drefs of functional types. In all languages nouns evoke drefs of *nominal types*. Basic nominal types are animates, inanimates, times, places, and propositions (N $\in \{\alpha, \beta, \tau, \pi, \omega t\}$); nominal functions return values of nominal types. In Kalaallisut there are two classes of nouns, common (cn) and relational (rn), which take different inflections. Translated into LC, cn-roots evoke *kinds* (κ^{N}), while rn-roots evoke dependent kinds (e.g. type $\alpha\kappa^{\text{N}}$; see Appendix).

Crosslinguistically, verbs evoke drefs of *verbal types*—that is, basic episodes (type ε or σ) or episode-valued functions. The latter include *processes*, represented in this ontology as chains of eventive stages (type $\varepsilon\varepsilon$); and *habits*, represented as modal patterns of recurrent episodes (type $\eta^{\text{V}} := \omega\tau\text{V}$, with V $\in \{\sigma, \varepsilon, \varepsilon\varepsilon\}$). Finally, the remaining functions in Table 1 will serve to encapsulate other forms of modal and temporal quantification (e.g. 'maybe' in (3), 'often' in (4)) as well as *de se* dependencies. All of these and other functions may be partial. This is important, for the domain of a functional dref may encode information that is necessary for online update (e.g., see (8) below).

Turning now to constants, a representative sample is laid out in Table 2. Note that a Kalaallisut process-verb (e.g. *skakkir-* 'play chess') can be translated into LC by means of an event-predicate distributed down to the eventive stages of the process. Therefore, Table 2 only includes LC-predicates of basic aspectual types: events and states. Events, states and other semantic domains are connected by a network of world-dependent mappings: *state onset* (BEG), *result state* (RES), *agent* (AGT), *experiencer* (EXP), *time* (ϑ), and *place* (Π). These functions, too, are partial. For instance, only actions have agents. Formally: $\forall w \in \text{Dom AGT}: \text{Dom AGT}_w = (D_{\varepsilon,\, w} - \text{Ran BEG}_w)$, where $D_{\varepsilon,\, w}$ is the domain of atomic *events* in w.

TABLE 2. LC constants

Type	Name of objects	Con
$\omega\alpha\sigma t$	stative α-property	*sleep*, *busy*, …
$\omega\alpha\varepsilon t$	eventive α-property	*wake.up*, *play.chess*, …
$\omega\Omega\alpha\sigma t$	stative (α, Ω)-relation	*believe*, *doubt*, …
$\omega\Omega\alpha\varepsilon t$	eventive (α, Ω)-relation	*say*, *think*, …
⋮	⋮	⋮
$\omega\sigma\varepsilon$	state onset (beginning)	BEG
$\omega\varepsilon\sigma$	result state	RES
$\omega\varepsilon\alpha$	agent	AGT
$\omega\varepsilon^{\bullet}\alpha$	experiencer	EXP
$\omega\varepsilon^{\bullet}\tau$	time	ϑ
$\omega\varepsilon^{\bullet}\pi$	place	Π

Following the usual practice, I use DRT-style abbreviations for type-logical terms. I also freely mix type-logical terms with set-theoretic counterparts. For type uniformity, stacks are formalized as primitive semantic objects of type ζ. But they are constrained by a set of axioms, Ax1–5, to behave as sequences of stacked objects of *dref types* $\mathrm{R} \in \Theta$, where Θ is the set of types based on $\{t, \omega, \tau, \pi, \alpha, \beta, \varepsilon, \sigma\}$ (cf. Dekker 1994 and Muskens 1995):

Ax1 $\exists z_{\zeta}$: $\forall n({}^{n}(z) = \dagger) \wedge \forall \mathrm{R}({}^{\mathrm{R}}(z) = z)$
Ax2 $\forall z_{\zeta} \forall \mathrm{R} \forall x_{\mathrm{R}}$: ${}^{1}(x \cdot z) = x \wedge \forall n(n > 1 \rightarrow {}^{n}(x \cdot z) = {}^{n-1}(z))$
Ax3 $\forall z_{\zeta} \forall \mathrm{R} \forall x_{\mathrm{R}}$: ${}^{\mathrm{R}}(x \cdot z) = (x \cdot {}^{\mathrm{R}}(z)) \wedge \forall \mathrm{R}'(\mathrm{R}' \neq \mathrm{R} \rightarrow {}^{\mathrm{R}'}(x \cdot z) = {}^{\mathrm{R}'}(z))$
Ax4 $\forall z_{\zeta} \forall \mathrm{R} \forall x_{\mathrm{R}} \exists z'_{\zeta}$: $(x \cdot z) = z'$
Ax5 $\forall z_{\zeta} \forall z'_{\zeta}$: $\forall n({}^{n}(z) = {}^{n}(z')) \rightarrow z = z'$

A sequence can be characterized by two projection functions: ${}^{n}(\ )$, which returns the nth coordinate, if it exists, or error $\dagger$, otherwise; and ${}^{\mathrm{R}}(\ )$, which returns the sub-sequence of type R coordinates. Ax1 defines ${}^{n}(\ )$ and ${}^{\mathrm{R}}(\ )$ for the empty ζ-stack, and Ax2–3, for other ζ-stacks. Ax2–3 also define an operation which adds an R-object to a ζ-stack. On the resulting recentered stack, the newly added object is the most prominent R-object and any other R-objects are demoted one notch. The prominence ranking of other types of drefs is not affected. Ax4 ensures that any object of any dref type R can be added to any ζ-stack. Finally, Ax5 guarantees that a ζ-stack is fully identified by its coordinates.

This conception of stacks informs definition A1. This is the distinctive core of LC, which all of the other definitions will build on:

A1 For any information-and-attention state $i_s = \langle w_i, \top_i, \bot_i \rangle$, we write:

i.	$\mathbf{v}_{\mathrm{R}} \cdot i_s$	for $\langle w_i, (\mathbf{v} \cdot \top_i), \bot_i \rangle$	if $\mathbf{v}_{\mathrm{R}} \in {}^{\top}\mathrm{Var}_{\mathrm{R}}$
	$v_{\mathrm{R}} \cdot i_s$	for $\langle w_i, \top_i, (v \cdot \bot_i) \rangle$	if $v_{\mathrm{R}} \in {}^{\bot}\mathrm{Var}_{\mathrm{R}}$
ii.	$(\mathbf{d}\mathrm{R}_n)_i$	for ${}^{n+1}({}^{\mathrm{R}}(\top_i))$	
	$(d\mathrm{R}_n)_i$	for ${}^{n+1}({}^{\mathrm{R}}(\bot_i))$	
	$\mathbf{d}\mathrm{R}_i$	for $(\mathbf{d}\mathrm{R}_0)_i$	
	$d\mathrm{R}_i$	for $(d\mathrm{R}_0)_i$	

Information-and-attention update:

iii.	$[\mathrm{v}_1 \ldots \mathrm{v}_n \mid C]$	for $\lambda ij\, \exists \mathrm{v}_1 \ldots \mathrm{v}_n (j = (\mathrm{v}_1 \cdot \ldots (\mathrm{v}_n \cdot i)) \wedge Ci)$
	$[\mid C]$	for $\lambda ij\, (j = i \wedge Ci)$
	$(D_1; D_2)$	for $\lambda ij\, \exists i'(D_1 ii' \wedge D_2 i'j)$

Recall that an LC-state of information and attention, i_s, is a triple of a world and two stacks. These three coordinates are designated as follows: w_i for the *i-world* (or *i-reality*); $\top_i$, for the *i-top stack* of topical objects; and $\bot_i$ for the *i-bottom stack* of backgrounded objects.

By A1.i, we can add a semantic R-object to the top (or bottom) stack by means of a $\top$- (or $\bot$-) R-variable. This is a stack-building operation in the sense of the axioms: the value of the variable becomes the new most prominent R-object on the output stack.

A stacked R-object is a discourse referent (Karttunen 1976), for it can be referred to by an *anaphoric demonstrative*, $\mathbf{d}\mathrm{R}_n$ or $d\mathrm{R}_n$ (of type *s*R). By A1.ii, in any information-and-attention state i_s the $\top$-demonstrative $\mathbf{d}\mathrm{R}_n$ (or $\bot$-demonstrative $d\mathrm{R}_n$) refers to the $(n + 1)$st R-object on the top (or bottom) stack. That is, we apply to $\top_i$ (or $\bot_i$) two projection functions: first ${}^{\mathrm{R}}(\ )$, which only the R-coordinates survive; and then ${}^{n+1}(\ )$, which returns the $(n + 1)$st of these surviving R-objects. Since anaphora usually targets the most prominent drefs, A1.ii allows the default rank, $n = 0$, to be omitted—e.g. $\mathbf{d}\varepsilon_i$ abbreviates $(\mathbf{d}\varepsilon_0)_i$.

Clause (iii) of A1 is similar to Muskens 1995. However, in an LC box the order of the variables in the universe is important: it reflects the ranking of the new dref objects on the output stack(s). Also, LC conditions apply to the input state, not the output (see e.g. (7); compare Muskens 1995). Tests and sequencing are interpreted in the usual way.

Following Stalnaker 1978:323, I assume that the very fact that somebody speaks up has a 'commonplace effect' on the context, which is crucial for the 'essential effect'—that is, interpreting the content of what is said. 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 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."

Formally, I implement Stalnaker's 'commonplace effect' as a *start-up update*. As soon as somebody begins to speak, this very fact is noted, focusing the attention on three default topics. The speech reality becomes the default *modal topic*; the speech event, the default *perspective point*; and the speech time, the default *topic time*.

A2. Speech start-up conditions:

- $\mathbf{w} = r$ for $\lambda i.\ \mathbf{w} = w_i$
- $(\mathbf{e}\text{: AGT } \mathit{speak.up}_{\mathbf{d}\omega})$ for $\lambda i.\ \mathit{speak.up}_{\mathbf{d}\omega i}(\mathbf{e}, \text{AGT}_{\mathbf{d}\omega i}\,\mathbf{e})$
- $\mathbf{t} =_{\mathbf{d}\omega} \vartheta\mathbf{d}\varepsilon$ for $\lambda i.\ \mathbf{t} = \vartheta_{\mathbf{d}\omega i}\,\mathbf{d}\varepsilon_i$

Indexicals—*I* ('1s'), *you* ('2s'), *he* ('3sm'), *was*, *is*, *here*, *there*, *today*, etc—have anaphoric presuppositions concerned with the relation to the current perspective point. For example, '1s' refers to the agent of the speech act (default perspective $\mathbf{d}\varepsilon_i$) in the topical modality; '1p', refers to the agent's group; '2s', to the (singular) experiencer; and '3s', to a singular non-participant (cf. Kaplan 1978, Schlenker 2003).

A3. Indexical persons:

- $\mathit{1s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha$ for $\lambda i(\mathit{sg}\ \mathbf{d}\alpha_i \wedge \text{AGT}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i = \mathbf{d}\alpha_i)$

  $\mathit{1p}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha$ for $\lambda i(\neg \mathit{sg}\ \mathbf{d}\alpha_i \wedge \text{AGT}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i \in \mathbf{d}\alpha_i)$
- $\mathit{2s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha$ for $\lambda i(\mathit{sg}\ \mathbf{d}\alpha_i \wedge \text{EXP}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i = \mathbf{d}\alpha_i)$
- $\mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha$ for $\lambda i(\mathit{sg}\ \mathbf{d}\alpha_i \wedge \neg(\mathbf{d}\alpha_i \circ (\text{AGT}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i + \text{EXP}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i)))$

To see how this works, consider a simple example. Suppose you enter the office of a stranger, who says (5):

(5) I am busy.

Just before he speaks, the input context—initial 'common ground'—is a set of information-and-attention states such as (6), where w_0 is a candidate reality.[3]

(6) $i_0 = \langle w_0, \langle\,\rangle, \langle\,\rangle\rangle$

As soon as the speech act begins, the input state (6) is updated by the *start-up update* (7), which sets up three default topics:

(7) $[\mathbf{w} |\ \mathbf{w} = r]; [\mathbf{e} |\ \mathbf{e}\text{: AGT } \mathit{speak.up}_{\mathbf{d}\omega}]; [\mathbf{t} |\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\mathbf{d}\varepsilon]$

---

[3] $\langle\,\rangle$ for $\iota z_\zeta\ \forall n({}^n(z) = \dagger)$

$\langle x_1, \ldots, x_n\rangle$ for $(x_1 \cdot \ldots (x_n \cdot \langle\,\rangle)\ldots)$

First of all, the reality of the input state of information and attention is set up as the default modal topic. Applied to i_0, this update yields i_1, by the definitions on the right:

(7a)	$i_0[\mathbf{w}\vert\ \mathbf{w} = r]i_1$	
	$\equiv\ \exists\mathbf{w}(i_1 = \langle w_{i0}, \mathbf{w} \cdot \top_{i0}, \bot_{i0}\rangle \wedge \mathbf{w} = w_{i0})$	A1, A2
	$\equiv\ (i_1 = \langle w_0, (w_0 \cdot \langle\ \rangle), \langle\ \rangle\rangle)$	(6)
	$\equiv\ (i_1 = \langle w_0, \langle w_0\rangle, \langle\ \rangle\rangle)$	ftn. 3

Next, the real speech act that has just begun is set up as the default perspective point. (Note that $\mathbf{d}\omega_{i1} = {}^{0+1}({}^{\omega}\langle w_0\rangle) = {}^{1}\langle w_0\rangle = w_0$.)

(7b)	$i_1[\mathbf{e}\vert\ \mathbf{e}$: AGT $speak.up_{\mathbf{d}\omega}]i_2$	
	$\equiv\ \exists\mathbf{e}(i_2 = \langle w_{i1}, \mathbf{e} \cdot \top_{i1}, \bot_{i1}\rangle$	A1, A2
	$\quad \wedge\ speak.up_{\mathbf{d}\omega i1}(\mathbf{e}, \text{AGT}_{\mathbf{d}\omega i1}\ \mathbf{e}))$	
	$\equiv\ \exists\mathbf{e}(i_2 = \langle w_0, \langle \mathbf{e}, w_0\rangle, \langle\ \rangle\rangle$	(7a), ftn. 3,
	$\quad \wedge\ speak.up_{w0}(\mathbf{e}, \text{AGT}_{w0}\ \mathbf{e}))$	A1, Ax1–3

And finally, the time of the topical perspective point in the topical reality is set up as the default temporal topic. (Note that $\mathbf{d}\varepsilon_j = {}^{1}({}^{\varepsilon}(\mathbf{e} \cdot \langle w_0\rangle)) = {}^{1}\langle \mathbf{e}\rangle = \mathbf{e}$.) We thus arrive at the state i_3, as the final output of the start-up update (Stalnaker's 'commonplace effect'):

(7c)	$i_1([\mathbf{e}\vert\ \mathbf{e}$: AGT $speak.up_{\mathbf{d}\omega}];\ [\mathbf{t}\vert\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\mathbf{d}\varepsilon])i_3$	
	$\equiv\ \exists j(\exists\mathbf{e}(j = \langle w_{i1}, \mathbf{e} \cdot \top_{i1}, \bot_{i1}\rangle$	A1, A2
	$\qquad \wedge\ speak.up_{\mathbf{d}\omega i1}(\mathbf{e}, \text{AGT}_{\mathbf{d}\omega i1}\ \mathbf{e}))$	
	$\quad \wedge\ \exists\mathbf{t}(i_3 = \langle w_j, \mathbf{t} \cdot \top_j, \bot_j\rangle$	
	$\qquad \wedge\ \mathbf{t} = \vartheta_{\mathbf{d}\omega j}\ \mathbf{d}\varepsilon_j))$	
	$\equiv\ \exists\mathbf{e}\exists\mathbf{t}(i_3 = \langle w_0, \langle \mathbf{t}, \mathbf{e}, w_0\rangle, \langle\ \rangle\rangle$	(7a), ftn. 3,
	$\qquad \wedge\ speak.up_{w0}(\mathbf{e}, \text{AGT}_{w0}\ \mathbf{e})$	A1, Ax1–5
	$\qquad \wedge\ \mathbf{t} = \vartheta_{w0}\ \mathbf{e})$	

A model for i_3 is shown below. Indexed symbols stand for semantic values of unindexed variables, and currently topical semantic objects of various types are indicated by $^{\top}$-superscripts.

Model for i_3

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

In this context sentence (5) can now be interpreted directly and online, by processing each morpheme in turn as in (8). (From now on new conditions are spelled out as they become relevant.)

(8) I

$[\mathbf{a}|\ 1s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{a}];$

$\equiv\quad \lambda ij\ \exists\mathbf{a}(j = \langle w_i, (\mathbf{a}\cdot\top_i), \bot_i\rangle \wedge \mathrm{AGT}_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i = \mathbf{a})$

be-

$[s\ k^{\alpha}|\ \mathbf{d}\alpha =_{\mathbf{d}\omega} k^{\alpha}\{s\}];$

$\equiv\quad \lambda ij\ \exists s\ k^{\alpha}(j = \langle w_i, \top_i, (s\cdot k^{\alpha}\cdot\bot_i)\rangle \wedge \mathbf{d}\alpha_i = k^{\alpha}\mathbf{d}\omega_i s)$

-PRS

$^{\mathrm{P}}[|\ \mathbf{d}\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];\ [|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma];$

$\equiv\quad \lambda ij(j = i \wedge \vartheta_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_i \subseteq \mathbf{d}\tau_i)\ ;\ \lambda ij(j = i \wedge \mathbf{d}\tau_i \subseteq \vartheta_{\mathbf{d}\omega i}\ d\sigma_i)$

busy

$[|\ busy\ d\kappa^{\alpha}]$

$\equiv\quad \lambda ij(j = i \wedge \forall w \in \mathrm{Dom}\ d\kappa^{\alpha}{}_i \forall e^{\bullet} \in \mathrm{Dom}\ d\kappa^{\alpha}{}_i w \exists s:$
$\qquad s = e^{\bullet} \wedge busy_w(s, d\kappa^{\alpha}{}_i ws))$

The pronoun *I* refers to the agent of the topical speech act (e_0) in the topical world (w_0). In addition, since the pronoun *I* is the subject, it sets up its animate referent as the α-topic. Next, the verbal root *be-* introduces two background drefs: a state (s_1) and an α-kind ($k^{\alpha}{}_1$). In the topical world the α-topic instantiates this α-kind in this state. The present tense then first of all tests that the input topic time (t_0) includes the topical perspective point (e_0). This presuppositional test is met by i_3 (since $\vartheta_{w0}\ e_0 \subseteq t_0$). The new state evoked by *be-* is then located at the topic time in the topical world ($t_0 \subseteq \vartheta_{w0}\ s_1$). Finally, the adjective *busy* elaborates the α-kind: in any world where this kind is instantiated, it is instantiated in states of business by the experiencer. So the content of (5) is that in the speech reality at the speech time the speaker is in a state of some kind of business. The degree of business, its nature, etc, are not specified. That is, the adjective *busy* refers to a kind in the same way as the non-specific indefinite *a man* refers to a person.

Formally, (8) updates the output i_3 of the speech start-up to encode the content of what is said, by further updating the stack structure and the associated conditions. A sample output of this update (Stalnaker's 'essential effect') is spelled out in (8a), along with a model:

(8a) $i_4 = \langle w_0, \langle a_1, t_0, e_0, w_0\rangle, \langle s_1, k^{\alpha}{}_1\rangle\rangle$

s.t. $speak.up_{w0}(e_0, \mathrm{AGT}_{w0}\ e_0)$

$t_0 = \vartheta_{w0}\ e_0 \wedge t_0 \subseteq \vartheta_{w0}\ s_1$

$a_1 = \mathrm{AGT}_{w0}\ e_0 \wedge a_1 = k^{\alpha}{}_1 w_0 s_1$

$\forall w \in \mathrm{Dom}\ k^{\alpha}{}_1 \forall e^{\bullet} \in \mathrm{Dom}\ k^{\alpha}{}_1 w \exists s: e^{\bullet} = s \wedge busy_w(s, k^{\alpha}{}_1 ws)$

i_4-reality: $^{\top}w_0$ • $^{\top}e_0$: e_0-agent speaks up

| $^{\top}t_0 = \vartheta_{w0}\ e_0$: e_0-time

—— s_1: e_0-agent $^{\top}a_1$ is $k^{\alpha}{}_1$-busy

The morpheme-by-morpheme analysis in (8) exemplifies direct composition by *online update*. In general, online update interprets the surface string as is, with each morpheme in turn updating the input state of information-and-attention. I assume that each morpheme may lexically contribute up to three updates: *presupposition*, *assertion*, and *implicature*. Presupposition is an anaphoric test on the input. The tested drefs should be familiar (*pace* van der Sandt 1992), but the test conditions need not be (*contra* Heim 1983). For instance, the presuppositions of tenses or pronouns often add new information about the antecedent topic time (*Today I am/was busy*) or about the nominal antecedent (*A doctor came in. He/She looked tired*). Assertion updates the state of attention and/or information by updating stacks and/or eliminating worlds. Implicature is a default extra update: it is defeated if it conflicts with either assertion or presupposition (cf. Gazdar 1979).

This basic conception gives rise to some fundamental questions. First of all, what is a possible lexical meaning? Secondly, adjacent morphemes often interact, i.e., the update by one morpheme is adapted to fit the next one (cf. assimilation of one phoneme to the next). In such cases what is an admissible adaptation? And since each morpheme is thus assigned a whole family of meanings (see Appendix), which of these related meanings is to be selected in any given local context? Last but not least, if sentences are composed by sequencing updates, as in discourse, why is compositional anaphora unambiguous? It is beyond the scope of this paper to answer these questions in full. But I can offer some partial answers, based on crosslinguistic text studies (see Bittner 2003 and http://www.rci.rutgers.edu/~mbittner)

Crosslinguistically, there is a limit of at most two new drefs per morpheme, and of these, at most one may be topical. Topical drefs cannot be introduced by open-class items (nouns, verbs, etc), only by items from closed classes. Typical sources of topical drefs are particles, and grammatical markers forming closed paradigms (mood, tense, case, etc). The highest dref of a verb (or noun) must be an eventuality (nominal object) or an eventuality-valued function (nominal object-valued function). These basic meaning constraints are crosslinguistically stable. No exceptions have been found in any language.

Meaning adaptations concern the level of abstraction. For instance, by default, an event-root evokes a real event. But this may be adapted to something more abstract—e.g., an event concept, to fit a modal suffix; an event-valued habit, to fit a habitual suffix; or a dependent event-concept, to fit a habitual report (see Appendix). The principles at work are difficult to formalize, but the basic idea is simple. By default, the simplest meaning is selected as long as it fits the next morpheme. But this morpheme may have a presupposition that forces a certain adaptation. Later morphemes may also require adaptations, but the likelihood drops off sharply with the distance. In actual texts most meaning adaptations involve only adjacent morphemes (see text studies at http://www.rci.rutgers.edu/~mbittner). Finally, any morpheme may either introduce or anaphorically retrieve its drefs—*ceteris paribus* anaphora is preferred—subject to the above morphological constraints on dref number, centering, and type, and subject to any local familiarity/novelty presuppositions (see e.g. *skakkir-* in Appendix).

The meanings thus selected are composed by one of the following two *linking rules* (adapted from Bittner 2001):

($^{\perp}$;) BACKGROUND-ELABORATION LINK
If A $\rightsquigarrow$ α and B $\rightsquigarrow$ β, then [A B] $\rightsquigarrow$ (α; β), provided that a demonstrative dR (:= $d\mathrm{R}_0$) in β is anaphoric to an R-dref in α.

($^{\top}$;) TOPIC-COMMENT LINK
If A $\rightsquigarrow$ α and B $\rightsquigarrow$ β, then [A B] $\rightsquigarrow$ (α; β), provided that a demonstrative **d**R (:= $\mathbf{d}\mathrm{R}_0$) in β is anaphoric to an R-dref in α.

These two linking rules account for assertion and implicature; presupposition may require less local links. Productive word building generally proceeds by Background-Elaboration: a non-initial morpheme elaborates a background dref from the last morpheme. That is, a suffix elaborates the last morpheme of the base, while a prefix is elaborated by the first morpheme of the base. Background-Elaboration may also link some words. Otherwise, words are linked by Topic-Comment. For instance, the inflection on one word may introduce a topical dref for comment by the next word or word group.

In terms of these two linking rules, the online update proposed in (8) can be analyzed as follows (ignoring presuppositions):

(9) I be- -PRS

$([\mathbf{a}|\ \mathit{1s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{a}]\ ^{\top};\ ([s\ k^{\alpha}|\ \mathbf{d}\alpha =_{\mathbf{d}\omega} k^{\alpha}\{s\}]\ ^{\perp};\ (\ldots;\ [|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma])))$

busy

$^{\perp}$; $[|\ \mathit{busy}\ d\kappa^{\alpha}]$

Within the verb, the tense inflection (-PRS) elaborates the background state dref evoked by the verbal root (*be-*). The verb comments on the topical α-dref set up by the subject (*I*). And the postverbal adjective (*busy*) elaborates the background α-kind dref evoked by the verbal root (*be-*), which selects this adjectival complement.

I now turn to show how this simple example of online update in a tense-based analytic language naturally extends to the other extreme of the typological spectrum—mood-based polysynthesis.[4]

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[4] In Sections 3-7 I gradually develop an account of (1)–(4), adding lexical meanings as needed. To get a sense of the lexical patterns, see the final list in the Appendix.

3 KALAALLISUT EPISODICS ONLINE

In episodic discourse in Kalaallisut temporal location depends on two factors: aspectual type (*state*, *event*, or *process*), and whether the topic time is a *discourse instant*—the time of an atomic event—or a *period*.

Discourse-initially, the topic time (start-up now) is the time of an atomic event, i.e., an *instant*. This yields the temporal pattern in (10).

(10)a. *Anaana-ga* sinip-*pu-q*. state
mum-1s.sg *asleep*-IND.IV-3s
My mum is asleep.

b. *Anaana-ga* itir-*pu-q*. event
mum-1s.sg *wake.up*-IND.IV-3s
My mum has woken up.

c. Skakkir-*pu-gut*. process
play.chess-IND.IV-1p
We are playing chess.

Relative to a topical instant, a state (e.g., sleep in (10a)) is understood to be current. An event (e.g., waking up in (10b)) is understood to have a current result state. And a process (e.g., playing chess in (10c)) is understood to have a current result state of the first stage. Depending on the context, the first stage of a chess game may be the first move, the opening gambit, or perhaps some larger chunk.

In (11) an initial factive clause updates the topic time to the time of the result state of a presupposed event (entry by the father). Unlike the time of an event, the time of a state is a (*discourse*) *period*.

(11) *Ullu-mi* *ataata-ga* *isir-m-at…*
day-sg.LOC dad-1s.sg enter-FCT$_{\perp}$-3s$_{\perp}$
Today when my dad came by,…

a. …sinip-*pu-tit*. state
…*asleep*-IND.IV-2s
…you were asleep.

b. …itir-*pu-nga*. event
…*wake.up*-IND.IV-1s
…I woke up.

c. …skakkir-*pu-gut*. process
…*play.chess*-IND.IV-1p
…we played chess.

This makes no difference if the matrix verb is stative: the state of (11a) is understood to be current, just like the state of (10a). Events, however, are located differently. Unlike an instant, a period can frame an event. Accordingly, the event of (11b), as well as the start event of the process of (11c), are located *within* the topical period (result time of the father's entry) evoked by the initial factive clause.

To analyze verbal roots and realis verbal inflections in episodic discourse I propose the conditions in A5 and A6. For states and events, these conditions are mostly standard (see Partee 1984, Webber 1988). But the paradigm in (10)–(11) further motivates a third aspectual type: *processes*, similar to events but with discourse-transparent stages. To model the discourse-transparent structure of processes I use functional drefs of type εε. As stated in A4, a process function sends each non-final stage to the next stage and locates the latter during the result state of the former. The process stages that are often referred to in discourse are the first stage (${}^{1}ee$), the next stage (${}^{n+1}ee$), and the end (${}^{f}ee$).

A4. Processes and stages.

- $process_w\, ee$ for $\forall e \in \text{Dom}\, ee$: $\vartheta_w\, ee(e) \subseteq \vartheta_w \text{RES}_w\, e$
- $e \in ee$ for $e \in (\text{Dom}\, ee \cup \text{Ran}\, ee)$
  ${}^{1}ee$ for $\iota e.\ e \in (\text{Dom}\, ee - \text{Ran}\, ee)$
  ${}^{n+1}ee$ for $ee({}^{n}ee)$
  ${}^{f}ee$ for $\iota e.\ e \in (\text{Ran}\, ee - \text{Dom}\, ee)$

A5. Episodic predicates.

- s: EXP $sleep_{\mathbf{d}\omega}$ for $\lambda i.\ sleep_{\mathbf{d}\omega i}(s, \text{EXP}_{\mathbf{d}\omega i}\, s)$
- e: EXP $wake.up_{\mathbf{d}\omega}$ for $\lambda i.\ wake.up_{\mathbf{d}\omega i}(e, \text{EXP}_{\mathbf{d}\omega i}\, e)$
- ee: AGT $play.chess_{\mathbf{d}\omega}$ for $\lambda i.\ process_{\mathbf{d}\omega i}\, ee$
  $\wedge\ \forall e \in ee: play.chess_{\mathbf{d}\omega i}(e, \text{AGT}_{\mathbf{d}\omega i}\, e)$
  $\wedge\ \text{AGT}_{\mathbf{d}\omega i}\, ee = \bigcup\{\text{AGT}_{\mathbf{d}\omega i}\, e: e \in ee\}$

A6. Episodic temporal anaphora and update.

- BEG $d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon$ for $\lambda i.\ \vartheta_{\mathbf{d}\omega i}\, \text{BEG}_{\mathbf{d}\omega i}\, d\sigma_i < \vartheta_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon_i$
  $d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon$ for $\lambda i.\ \vartheta_{\mathbf{d}\omega i}\, d\varepsilon_i < \vartheta_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon$
  ${}^{1}d\varepsilon\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon$ for $\lambda i.\ \vartheta_{\mathbf{d}\omega i}\, {}^{1}d\varepsilon\varepsilon_i < \vartheta_{\mathbf{d}\omega i}\, \mathbf{d}\varepsilon$
- $\mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma$ for $\lambda i.\ \mathbf{d}\tau_i \subseteq \vartheta_{\mathbf{d}\omega i}\, d\sigma_i$
  $d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau$ for $\lambda i.\ \vartheta_{\mathbf{d}\omega i}\, d\varepsilon_i \subseteq \mathbf{d}\tau_i$
  ${}^{1}d\varepsilon\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau$ for $\lambda i.\ \vartheta_{\mathbf{d}\omega i}\, {}^{1}d\varepsilon\varepsilon_i \subseteq \mathbf{d}\tau_i$
- $\mathbf{t} =_{\mathbf{d}\omega} \vartheta\, d\sigma$ for $\lambda i.\ \mathbf{t} = \vartheta_{\mathbf{d}\omega i}\, d\sigma_i$
  $\mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES}\, d\varepsilon$ for $\lambda i.\ \mathbf{t} = \vartheta_{\mathbf{d}\omega i}\, \text{RES}_{\mathbf{d}\omega i}\, d\varepsilon_i$
  $\mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES}\, {}^{1}d\varepsilon\varepsilon$ for $\lambda i.\ \mathbf{t} = \vartheta_{\mathbf{d}\omega i}\, \text{RES}_{\mathbf{d}\omega i}\, {}^{1}d\varepsilon\varepsilon_i$

The paradigm in (11)—with a topical period—can now be interpreted directly and online, as in (11′). First, 'day-sg.LOC' updates the topic time to the day of the speech event (${}^{\top}e_0$ in the model below). Kalaallisut factives are verbal definites: they presuppose familiar events.

Here, the presupposed entry (e_1) by the speaker's father is located within the current topic time (t_{11}), which is then updated to the time of the result state (t_{12}). The background agreement ($3s_\perp$) indicates that the main clause is about some α-topic other than the backgrounded father.

(11′) day-[5] -sg.LOC
$[k^\tau | \, k^\tau \, \mathit{day.of} \, \varepsilon^\bullet]$; $[\mathbf{t} | \, \mathbf{t} \subseteq_{\mathbf{d}\omega} d\kappa^\tau\{\mathbf{d}\varepsilon\}]$;

dad-[6] -1s.sg (⊥-dref)[7]
$[k^\alpha_\alpha | \, k^\alpha_\alpha \, \mathit{dad.of} \, \alpha]$; $[a | \, \mathit{1s}_{\mathbf{d}\omega, \mathbf{d}\varepsilon} \, a]$; $[a | \, a =_{\mathbf{d}\omega} d\alpha\kappa^\alpha\{d\alpha, \mathbf{d}\varepsilon\}]$;

enter-
$[l | \, d\varepsilon\text{: AGT } \mathit{enter}_{\mathbf{d}\omega} \, l]$;

-FCT$_\perp$
$[| \, d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon, \text{AGT } d\varepsilon =_{\mathbf{d}\omega} d\alpha]$; $[| \, d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]$; $[\mathbf{t} | \, \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES } d\varepsilon]$;

-3s$_\perp$
$[| \, \mathit{3s}_{\mathbf{d}\omega, \mathbf{d}\varepsilon} \, d\alpha]$; $[\mathbf{a} | \, \mathbf{a} \neq d\alpha]$

The main verb comments on these topics. Thus in (11′a) the comment is that in the topical world (w_0) during the topical period (t_{12}), the α-topic ('2s') is asleep:

(11′a) asleep-
$[s | \, s\text{: EXP } \mathit{sleep}_{\mathbf{d}\omega}]$;

-IND. .IV -2s
$[| \, \text{BEG } d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]$; $[| \, \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma]$; $[| \, \text{EXP } d\sigma =_{\mathbf{d}\omega} \mathbf{d}\alpha]$; $[| \, \mathit{2s}_{\mathbf{d}\omega, \mathbf{d}\varepsilon} \, \mathbf{d}\alpha]$

In (11′b), the α-topic ('1s') wakes up within the topical period:

(11′b) wake.up-
$[e | \, e\text{: EXP } \mathit{wake.up}_{\mathbf{d}\omega}]$;

-IND. .IV -1s
$[| \, d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]$; $[| \, d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]$; $[| \, \text{EXP } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]$; $[| \, \mathit{1s}_{\mathbf{d}\omega, \mathbf{d}\varepsilon} \, \mathbf{d}\alpha]$

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5 Any k^τ-time is the day of the instantiating episode:
$k^\tau \, \mathit{day.of} \, \varepsilon^\bullet$ for $\lambda i. \, \forall w \in \text{Dom } k^\tau \forall e^\bullet \in \text{Dom } k^\tau w\text{: } \mathit{day}_w \, k^\tau we^\bullet \wedge \vartheta_w \, e^\bullet \subseteq k^\tau we^\bullet$

6 For any animate $a \in \text{Dom } k^\alpha_\alpha$, $k^\alpha_\alpha awe^\bullet$ is a's dad in w at the time of $e^\bullet$:
$k^\alpha_\alpha \, \mathit{dad.of} \, \alpha$ for $\lambda i. \, \forall a \in \text{Dom } k^\alpha_\alpha \forall w \in \text{Dom } k^\alpha_\alpha a \forall e^\bullet \in \text{Dom } k^\alpha_\alpha aw \exists t\text{:}$
$\vartheta_w \, e^\bullet \subseteq t \wedge \mathit{dad.of}_{w,t}(k^\alpha_\alpha awe^\bullet, a)$

7 In $\mathbf{d}\omega$, a instantiates in $\mathbf{d}\varepsilon$ the kind $d\alpha\kappa^\alpha$-of-$d\alpha$:
$a =_{\mathbf{d}\omega} d\alpha\kappa^\alpha\{d\alpha, \mathbf{d}\varepsilon\}$ for $\lambda i. \, a = d\alpha\kappa^\alpha_i d\alpha_i \mathbf{d}\omega_i \mathbf{d}\varepsilon_i$

And in (11′c) the α-topic (‘1p’, e.g., the speaker and his father) start—and possibly finish—a chess game within the topical period:

(11′c) play.chess-
$[ee|\ ee\text{: AGT } play.chess_{\mathbf{d}\omega}];$

-IND. .IV
$[|\ {}^{1}d\varepsilon\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];\ [|\ {}^{1}d\varepsilon\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];\ [|\ \text{AGT } d\varepsilon\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha];$

-1p
$[|\ 1p_{\mathbf{d}\omega,\, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

We thus predict the following models for (11′a, b, c), given an initial input of the form $\langle w_0, \langle\ \rangle, \langle e_1\rangle\rangle$:

i-reality: ${}^{\top}w_0$	•	${}^{\top}e_0$: e_0-agent speaks up
	|	$t_0 = \vartheta_{w0}\ e_0$
	|||||||||||||||||||||||||	$k^{\tau}{}_1 w_0 e_0$: e_0-day
	||	${}^{(\top)}t_{11} \subseteq k^{\tau}{}_1 w_0 e_0$
	•	e_1: e_0-agent’s dad enters l_1
	||	${}^{\top}t_{12} = \vartheta_{w0}\ \text{RES}_{w0}\ e_1$
11′a.	___	s_2: e_0-experiencer is asleep
11′b.	•	e_2: e_0-agent wakes up
11′c.	•••	ee_2: (e_0-agent + ?) play chess

The start-up update models Stalnaker’s ‘commonplace effect’, so the default topics which it sets should be universal: the speech world ($\mathbf{d}\omega$), the speech event ($\mathbf{d}\varepsilon$), and the speech time (initial $\mathbf{d}\tau$). Often, the speaker wants to talk about a past period, so he first updates the topic time—e.g. by means of an initial updating verb (as in (11′)). The new topic time then depends on the aspect of that verb, as stated in the last column of Table 3. That is, depending on whether the updating verb refers to a state, event, or process, the new topic time is the time of the state, the result time of the event, or the result time of stage one of the process.

TABLE 3. Real episodes ($\mathbf{d}\tau$ period)

Base	*Reality presup.*	*Location test*	*Temporal update*
$[s\|\ldots];$	$[\|\ \text{BEG } d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];$	$[\|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma];$	$[\mathbf{t}\|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta d\sigma]$
$[e\|\ldots];$	$[\|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];$	$[\|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];$	$[\mathbf{t}\|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES } d\varepsilon]$
$[ee\|\ldots];$	$[\|\ {}^{1}d\varepsilon\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];$	$[\|\ {}^{1}d\varepsilon\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];$	$[\mathbf{t}\|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES } {}^{1}d\varepsilon\varepsilon]$

In the updated context the episode of the next verb is located in relation to the current temporal and modal topics. The location tests too depend on the aspect, as stated in the penultimate column of Table 3 and illustrated in (8) (for English) and (11′a, b, c) (for Kalaallisut).

In Kalaallisut factual moods (IND and FCT) presuppose reality. That is, they test whether the episode qualifies as a fact in the topical world (**d**ω) from the topical perspective (**d**ε). As stated in Table 3, reality presuppositions likewise depend on aspect. To be reported as a fact, an event (e.g. waking up in (11′b)) must have already happened, while a state or a process must, at the very least, have begun (e.g. sleep in (11′a), chess playing in (11′c)). So all real episodes must, at the very least, begin in the past of the speech event (**d**ε). Thus, the reality presuppositions of factual moods also contribute to temporal anaphora.

4 KALAALLISUT HABITUALS ONLINE

In Kalaallisut habitual aspect is explicitly marked by suffixes (e.g. *-tar*):

(12) *Ataata-ga sapaati-kkut isir*-tar-*pu-q*.
dad-1s.sg Sunday-VIA enter-*habit*-IND.IV-3s
My dad comes by on Sundays.

(13) *Ilaanni-kkut skakkir*-tar-*pu-gut*.
sometime-VIA play.chess-*habit*-IND.IV-1p
Sometimes we play chess.

Habits are understood to be current at the topic time, like states and processes. This might suggest that a habitual suffix evokes a state or a process. But in Kalaallisut episodic states and processes are morphologically unmarked (as in (10a, c)). Without a habitual suffix, a state or process verb is ungrammatical with temporal quantifiers, e.g. *ilaanni-kkut* ‘sometimes’ in (13). It is also incompatible with other habitual modifiers, including *sapaatikkut* ‘on Sundays’ in (12), and the habit-based reading of *siullirmik* ‘the first time’ in (23). That is, Kalaallisut grammatically distinguishes episodic states and processes, on the one hand, from habits, on the other.

This can be understood if episodic verbs evoke discourse referents for episodes, i.e. particular states, events, or processes, while habitual verbs evoke referents for habits, i.e. modally and temporally distributed patterns. For example, (12) evokes a habit instantiated by events of the father coming by on a Sunday. Not necessarily every Sunday, just enough to call it a habit. (13) evokes another habit, instantiated by processes of playing chess. The quantifier ‘sometimes’ correlates these two habits: some instances of the antecedent entering habit of (12) result in an instance of the chess-playing habit of (13).

More formally, a habit is (characterized by) a function that sends each world and time when the habit is instantiated to the episode that instantiates that habit in that world at that time. Any episodic predicate has a related habitual reading. A7 spells this out for a habitual state, habitual event, and habitual process. Note that an instance of a habitual state, event, or process relates to its instantiation time like an episodic state, event, or process, to the current topic time (cf. Table 3).

A7. Habitual predicates

- h^{σ}: EXP *sleep* for
  $\lambda i. \forall w \in \text{Dom } h^{\sigma} \forall t \in \text{Dom } h^{\sigma}w \exists s: s = h^{\sigma}wt \wedge t \subseteq \vartheta_w\, s$
  $\wedge\ (s: \text{EXP } sleep_w)$
- h^{ε}: AGT *win* $d\eta^{\varepsilon\varepsilon}$ for
  $\lambda i. \forall w \in \text{Dom } h^{\varepsilon} \forall t \in \text{Dom } h^{\varepsilon}w \exists e: e = h^{\varepsilon}wt \wedge \vartheta_w e \subseteq t$
  $\wedge\ \exists ee \in \text{Ran } d\eta^{\varepsilon\varepsilon}{}_i w: e = {}^{f}ee \wedge win_w(e, \text{AGT}_w\, e, ee)$
- $h^{\varepsilon\varepsilon}$: AGT *play.chess* for
  $\lambda i. \forall w \in \text{Dom } h^{\varepsilon\varepsilon} \forall t \in \text{Dom } h^{\varepsilon\varepsilon}w \exists ee: ee = h^{\varepsilon\varepsilon}wt$
  $\wedge\ \vartheta_w{}^{1}ee \subseteq t \wedge (ee: \text{AGT } play.chess_w)$

Habitual modifiers like ‘on Sundays’ evoke kinds of time, while temporal quantifiers evoke sub-kinds of antecedently given kinds.

A8. Temporal (sub-)kinds

- *sunday.time* k^{τ} for
  $\lambda i. \forall w \in \text{Dom } k^{\tau} \forall e^{\bullet} \in \text{Dom } k^{\tau}w \exists t$:
  $sunday.at_w(t, \Pi_w\, e^{\bullet}) \wedge k^{\tau}we^{\bullet} \subseteq t$
- $Q\{\vartheta\text{RES } d\eta^{\varepsilon}, k^{\tau}\}$ for
  $\lambda i. \forall w \in \text{Dom } k^{\tau}: \text{Ran } k^{\tau}w \subseteq \{\vartheta_w\, \text{RES}_w\, e: e \in \text{Ran } d\eta^{\varepsilon}{}_i w\}$
  $\wedge\ Q(\{\vartheta_w\, \text{RES}_w\, e: e \in \text{Ran } d\eta^{\varepsilon}{}_i w\}, \text{Ran } k^{\tau}w)$

Habitual aspect markers presuppose antecedent habits and, possibly, kinds of time. Antecedent habits are also required by descriptions like ‘the *n*th time’, which evoke the *n*th instance of a habit.

A9. Habitual anaphora

- $\text{Dom } d\eta^{v} = \mathbf{d}\kappa^{\tau}$ for
  $\lambda i. \langle \text{Dom } d\eta^{v}{}_i w: w \in \text{Dom } d\eta_i{}^{v} \rangle$
  $= \langle \text{Ran } \mathbf{d}\kappa^{\tau}{}_i w: w \in \text{Dom } \mathbf{d}\kappa^{\tau}{}_i \rangle$
- $e =_{\mathbf{d}\omega} {}^{n}(d\eta^{\varepsilon})$ for
  $\lambda i.\ e = {}^{n}(\text{Ran } d\eta^{\varepsilon}{}_i \mathbf{d}\omega_i)$

Finally, to interpret verbal inflections, temporal anaphora and update must be extended from episodes (A6) to habits (A10). A habit can be reported as a fact as soon as it begins (cf. states and processes in A6). It is understood to be current at the topic time in the relevant modality (real or reported, cf. states in A6). If a habitual verb updates the temporal topic, it evokes a new kind of time rather than a particular time. But the dependence on the aspectual type of the instantiating episodes is the same as for episodic verbs (cf. A6).

A10. Habitual temporal anaphora and update. [8]

- ${}^{1}d\eta^{\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon$ for
  $\lambda i.\ \vartheta_{\mathbf{d}\omega}\ {}^{1}(\mathrm{Ran}\ d\eta^{\varepsilon}{}_{i}\mathbf{d}\omega_{i}) < \vartheta_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_{i}$
- $\mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon}$ for
  $\lambda i.\ \mathbf{d}\tau_{i} \subseteq \cup_{\tau}(\mathrm{Dom}\ d\eta^{\varepsilon}{}_{i}\mathbf{d}\omega_{i})$
  $\mathbf{d}\tau \subseteq_{\mathbf{d}\Omega} d\eta^{\varepsilon}$ for
  $\lambda i.\ \forall w \in \mathbf{d}\Omega_{i}\text{: } \mathbf{d}\tau_{i} \subseteq \cup_{\tau}(\mathrm{Dom}\ d\eta^{\varepsilon}{}_{i}w)$
  $\vartheta e \subseteq_{p} d\eta^{\varepsilon}$ for
  $\lambda i.\ \forall w \in p\text{: } \vartheta_{w}\ e \subseteq \cup_{\tau}(\mathrm{Dom}\ d\eta^{\varepsilon}{}_{i}w)$
- $\mathbf{k}^{\tau} = \vartheta d\eta^{\sigma}$ for
  $\lambda i.\ \mathbf{k}^{\tau} = \langle\{\langle s, \vartheta_{w}\ s\rangle\text{: } s \in \mathrm{Ran}\ d\eta^{\sigma}{}_{i}w\}\text{: } w \in \mathrm{Dom}\ d\eta^{\sigma}{}_{i}\rangle$
  $\mathbf{k}^{\tau} = \vartheta\mathrm{RES}\ d\eta^{\varepsilon}$ for
  $\lambda i.\ \mathbf{k}^{\tau} = \langle\{\langle e, \vartheta_{w}\mathrm{RES}_{w}\ e\rangle\text{: } e \in \mathrm{Ran}\ d\eta^{\varepsilon}{}_{i}w\}\text{: } w \in \mathrm{Dom}\ d\eta^{\varepsilon}{}_{i}\rangle$
  $\mathbf{k}^{\tau} = \vartheta\mathrm{RES}\ {}^{1}d\eta^{\varepsilon\varepsilon}$ for
  $\lambda i.\ \mathbf{k}^{\tau} = \langle\{\langle {}^{1}ee, \vartheta_{w}\mathrm{RES}_{w}{}^{1}ee\rangle\text{: } ee \in \mathrm{Ran}\, d\eta^{\varepsilon\varepsilon}{}_{i}w\}\text{: } w \in \mathrm{Dom}\ d\eta^{\varepsilon\varepsilon}{}_{i}\rangle$

The habitual discourse (12)–(13) can now be interpreted directly and online, as in (12′)–(13′). First, sentence (12) introduces a habitual pattern of events ($h^{\varepsilon}{}_{1}$ in the model below), instantiated by the speaker's father coming by on a Sunday. This habit is real and current (in ${}^{\top}w_{0}$ at ${}^{\top}t_{0}$), and its distribution is set up as a topical kind of time (${}^{\top}k^{\tau}{}_{1}$):

(12′) dad- -1s.sg (⊤-dref)
$[k^{\alpha}{}_{\alpha}|\ k^{\alpha}{}_{\alpha}\ \mathit{dad.of}\ \alpha]; [a|\ \mathit{1s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ a]; [\mathbf{a}|\ \mathbf{a} =_{\mathbf{d}\omega} d\alpha\kappa\{d\alpha, \mathbf{d}\varepsilon\}];$

Sunday- -VIA
$[k^{\tau}|\ \mathit{sunday.time}\ k^{\tau}]; [\mathbf{k}^{\tau}|\ \mathbf{k}^{\tau} = d\kappa^{\tau}];$

enter- -habit (*-tar*)
$[h^{\varepsilon}\ l|\ h^{\varepsilon}\text{: AGT } \mathit{enter}\ l]; [|\ \mathbf{d}\varepsilon \subseteq_{\mathbf{d}\omega} d\pi]; [|\ \mathrm{Dom}\ d\eta^{\varepsilon} = \mathbf{d}\kappa^{\tau}];$

-IND. .IV[9] -3s
$[|\ {}^{1}d\eta^{\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon}]; [|\ \mathrm{AGT}\ d\eta^{\varepsilon} =_{\mathbf{d}\omega} \mathbf{d}\alpha]; [|\ \mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

Next, in (13) the quantifier 'sometimes' updates the topical kind of time to a new kind, instantiated by some of the result times of the

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8 The minimal period that includes every *T*-time:
$\cup_{\tau} T$ for $\min\{t \in D_{\tau}|\ \forall t' \in T\text{: } t' \subseteq t\}$

9 In $\mathbf{d}\omega$, $d\eta^{\varepsilon}$ is a habitual action by $\mathbf{d}\alpha$:
$(\mathrm{AGT}\ d\eta^{\varepsilon} =_{\mathbf{d}\omega} \mathbf{d}\alpha)$ for $\lambda i.\forall e \in \mathrm{Ran}\ d\eta^{\varepsilon}{}_{i}\mathbf{d}\omega_{i}\text{: } \mathrm{AGT}_{\mathbf{d}\omega i}\ e = \mathbf{d}\alpha_{i}$

father's entries ($^{\top}k^{\tau}{}_2$). This topical selection is then linked, by the habitual suffix *-tar*, to a chess playing habit ($h^{\varepsilon\varepsilon}{}_2$). That is, each of the selected result times frames the start of a chess game. The chess playing habit is likewise real and current (in $^{\top}w_0$ at $^{\top}t_0$):

(13′) sometimes- -VIA
$[k^{\tau}|\ some\{\vartheta\text{RES}\ d\eta^{\varepsilon}, k^{\tau}\}]$; $[\mathbf{k}^{\tau}|\ \mathbf{k}^{\tau} = d\kappa^{\tau}]$;

play.chess- -habit (*-tar*)
$[h^{\varepsilon\varepsilon}|\ h^{\varepsilon\varepsilon}\text{: AGT}\ play.chess]$; $[|\ \text{Dom}\ d\eta^{\varepsilon\varepsilon} = \mathbf{d}\kappa^{\tau}]$;

-IND.
$[|\ {}^{1}d\eta^{\varepsilon\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]$; $[|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon\varepsilon}]$;

.IV -1p
$[|\ \text{AGT}\ d\eta^{\varepsilon\varepsilon} =_{\mathbf{d}\omega} (\text{AGT}\ \mathbf{d}\varepsilon + \mathbf{d}\alpha)]$; $[|\ 1p_{\mathbf{d}\omega,\mathbf{d}\varepsilon}\ (\text{AGT}\ \mathbf{d}\varepsilon + \mathbf{d}\alpha)]$

Model for (7); (12′); (13′)
i-reality: $^{\top}w_0$ • $^{\top}e_0$: e_0-agent speaks up
| $^{\top}t_0 = \vartheta_{w0}\ e_0$
… ||||| ||||| ||||| … Ran $^{(\top)}k^{\tau}{}_1w_0$ = Dom $h^{\varepsilon}w_0$
$k^{\tau}{}_1$-Sundays spanning $^{\top}t_0$
… • • • … Ran $h^{\varepsilon}{}_1w_0$: e_0-speaker's dad a_1
enters e_0-here
… || || … Ran $^{\top}k^{\tau}{}_2w_0$ = Dom $h^{\varepsilon\varepsilon}{}_2w_0$
$some(\{\vartheta_{w0}\ \text{RES}_{w0}\ e\text{: } e \in \text{Ran}\ h^{\varepsilon}{}_1w_0\}.$
$\text{Ran}\ k^{\tau}{}_2w_0)$
… •• •• … Ran $h^{\varepsilon\varepsilon}{}_2w_0$: ($e_0$-spkr + a_1) play chess

According to this analysis, the habitual suffix *-tar* is not an operator. Instead, it has an anaphoric presupposition ($d\eta^{\vee}$) which defeats the default episodic reading of the base in favor of the habitual reading. The interpretation of the indicative mood on the habitual verbs of (12′)–(13′) illustrates more general patterns, spelled out in Table 4.

TABLE 4. Real habits

Base	*Reality presup.*	*Location test*	*Temporal update*
$[h^{\sigma}\|\ldots]$;	$[\|\ {}^{1}d\eta^{\sigma} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]$;	$[\|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\sigma}]$	$[\mathbf{k}^{\tau}\|\ \mathbf{k}^{\tau} = \vartheta d\eta^{\sigma}]$
$[h^{\varepsilon}\|\ldots]$;	$[\|\ {}^{1}d\eta^{\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]$;	$[\|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon}]$	$[\mathbf{k}^{\tau}\|\ \mathbf{k}^{\tau} = \vartheta\text{RES}\ d\eta^{\varepsilon}]$
$[h^{\varepsilon\varepsilon}\|\ldots]$;	$[\|\ {}^{1}d\eta^{\varepsilon\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]$;	$[\|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon\varepsilon}]$	$[\mathbf{k}^{\tau}\|\ \mathbf{k}^{\tau} = \vartheta\text{RES}\ {}^{1}d\eta^{\varepsilon\varepsilon}]$

As already noted, these patterns of habitual temporal anaphora depend on aspect in much the same way as their episodic counterparts (recall Table 3). And both patterns generalize to *de se* reports, as I now proceed to show in Sections 5 through 7.

5 REPORTED HABITS ONLINE

Recall that, in the context of the habitual (1) the *de se* report in (2a), with the root verb *uqar-* and direct first person quote is equivalent to (2b), with the v\v suffix *-nirar*. The data are repeated in (14)–(15):

(14) *Ataata-ga skakkir-tar-pu-q.*
dad-1s.sg play.chess-habit-IND.IV-3s
My dad$_{\top}$ plays chess.

(15) *Siurna arna-mi uqaluqatigi-mm-ani,*
last.year mother-3s$_{\top}$.sg.ERG talk.with-FCT$_{\perp}$-3s$_{\perp}$.3s$_{\top}$
Last year when his$_{\top}$ mother talked with him$_{\top}$, …

a. uqar-*pu-q:* "*Amirlanir-tigut ajugaa-sar-pu-nga.*"
say-IND.IV-3s most-VIA win-habit-IND.IV-1s
…he$_{\top}$ said: "I mostly win."

b. *amirlanir-tigut ajugaa-sar*-nirar-*pu-q.*
most-VIA win-habit-*say*-IND.IV-3s
…he$_{\top}$ said that he (= *se*) mostly won.

Since the surface forms are radically different, the equivalence of (14)–(15a) and (14)–(15b) is difficult to explain in LF-based semantics. In contrast, online update offers a natural account. The second habit is anaphorically linked to the first just as in (12)–(13). But in (15a, b) the second habit is only reported, not necessarily real. Therefore, it is not located in reality, but in the modality evoked by the report verb 'say' (i.e., by *uqar-* or *-nirar*). In the reported modality, the second habit is current at the time of the report (temporal *de se*) and is instantiated by events in which the reporting agent wins (individual *de se*):

(14′) My dad plays chess.

dad- -1s.sg ($\top$-dref)
$[k^{\alpha}{}_{\alpha} |\ k^{\alpha}{}_{\alpha}\ \mathit{dad.of}\ \alpha];\ [a|\ \mathit{1s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ a];\ [\mathbf{a}|\ \mathbf{a} =_{\mathbf{d}\omega} d\alpha\kappa\{d\alpha, \mathbf{d}\varepsilon\}];$

play.chess- -habit (*-tar*)
$[h^{\varepsilon\varepsilon}\ k^{\alpha}|\ h^{\varepsilon\varepsilon}\text{: } (\text{AGT} + k^{\alpha})\ \mathit{play.chess}];\ [k^{\tau}|\ \text{Dom}\ d\eta^{\varepsilon\varepsilon} = k^{\tau}];$

-IND. .IV
$[|\ {}^{1}d\eta^{\varepsilon\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];\ [|\ \mathbf{d}\boldsymbol{\tau} \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon\varepsilon}];\ [|\ \text{AGT}\ d\eta^{\varepsilon\varepsilon} =_{\mathbf{d}\omega} \mathbf{d}\alpha];$

-3s
$[|\ \mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

(15′) Last year when his$_{\top}$ mother talked with him$_{\top}$…

last.year (⊤-dref)

$[k^{\tau}|\ k^{\tau}\ \mathit{last.year.of}\ \varepsilon^{\bullet}];\ [\mathbf{t}|\ \mathbf{t} =_{\mathbf{d}\omega} d\kappa^{\tau}\{\mathbf{d}\varepsilon\}];$

mother- -3s$_{\top}$.sg .ERG (⊥-dref)

$[k^{\alpha}{}_{\alpha}|\ k^{\alpha}{}_{\alpha}\ \mathit{ma.of}\ \alpha];\ [|\ \mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha];\ [a|\ a =_{\mathbf{d}\omega} d\alpha\kappa\{\mathbf{d}\alpha, \mathbf{d}\varepsilon\}];$

talk.with-

$[ee\ k^{\alpha}|\ ee\text{: AGT}\ \mathit{talk.with}_{\mathbf{d}\omega}\ k^{\alpha}];$

-FCT$_{\perp}$

$[|\ ({}^{1}d\varepsilon\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon),\ (\text{AGT}\ d\varepsilon\varepsilon =_{\mathbf{d}\omega} d\alpha)];$

$[|\ {}^{1}d\varepsilon\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];[\mathbf{t}|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES}\ {}^{1}d\varepsilon\varepsilon];$

-3s$_{\perp}$. .3s$_{\top}$

$[|\ \mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ d\alpha,\ d\alpha \neq \mathbf{d}\alpha];\ [|\ \mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha,\ \mathbf{d}\alpha =_{\mathbf{d}\omega} d\kappa^{\alpha}\{d\varepsilon\varepsilon\}];$

a. …he$_{\top}$ said: "I mostly win."

say- (*uqar-*)

$[e\ p|\ e\text{: AGT}\ \mathit{say}_{\mathbf{d}\omega}\ p];$

-IND. .IV -3s

$[|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];\ [|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];\ [|\ \text{AGT}\ d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha];\ [|\ \mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha];$

"(quote start-up)

$[\mathbf{p}|\ \mathbf{p} = d\Omega];\ [\mathbf{e}|\ \mathbf{e} = d\varepsilon];\ [\mathbf{t}|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\mathbf{d}\varepsilon];$

most- -VIA

$[k^{\tau}|\ \mathit{most}\{\vartheta\text{RES}\ {}^{1}d\eta^{\varepsilon\varepsilon},\ k^{\tau}\}];\ [\mathbf{k}^{\tau}|\ \mathbf{k}^{\tau} = d\kappa^{\tau}];$

win- -habit (*-tar*)

$[h^{\varepsilon}|\ h^{\varepsilon}\text{: AGT}\ \mathit{win}\ d\eta^{\varepsilon\varepsilon}];\ [|\ \text{Dom}\ d\eta^{\varepsilon} = \mathbf{d}\kappa^{\tau}];$

-IND. .IV -1s

$[|\ {}^{1}d\eta^{\varepsilon} <_{\mathbf{d}\Omega} \mathbf{d}\varepsilon];\ [|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\Omega} d\eta^{\varepsilon}];\ [|\ \text{AGT}\ d\eta^{\varepsilon} =_{\mathbf{d}\Omega} \mathbf{d}\alpha];\ [|\ \mathit{1s}_{\mathbf{d}\Omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha];$

"(unquote)

$[\mathbf{w}|\ \mathbf{w} = \mathbf{d}\omega];\ [\mathbf{e}|\ \mathbf{e} = \mathbf{d}\varepsilon_{1}];$

b. …he$_{\top}$ said that he (= *se*) mostly won.

most- -VIA

$[k^{\tau}|\ \mathit{most}\{\vartheta\text{RES}\ {}^{1}d\eta^{\varepsilon\varepsilon},\ k^{\tau}\}];\ [\mathbf{k}^{\tau}|\ \mathbf{k}^{\tau} = d\kappa^{\tau}];$

win- -habit (*-tar*)

$[h^{\varepsilon}|\ h^{\varepsilon}\text{: AGT}\ \mathit{win}\ d\eta^{\varepsilon\varepsilon}];\ [|\ \text{Dom}\ d\eta^{\varepsilon} = \mathbf{d}\kappa^{\tau}];$

-say (*-nirar*)

$[e\ p|\ (e\text{: AGT}\ \mathit{say}_{\mathbf{d}\omega}\ p),\ (\vartheta e \subseteq_{p} d\eta^{\varepsilon}),\ (\text{AGT}\ e =_{p} \text{AGT}\ d\eta^{\varepsilon})];$

-IND. .IV -3s

$[|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];\ [|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];\ [|\ \text{AGT}\ d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha];\ [|\ \mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

This analysis captures the equivalence of the two discourses, (14)–(15a) and (14)–(15b). They converge on the model shown below, but differ in centering. In (15′a) the quote begins with a start-up update that temporarily shifts the modal, perspectival, and temporal topics until the end of the quote. The shift of perspective means that, within the quote ‘1s’ refers to the quoted speaker. Also, ‘IND’ locates the winning habit at the time of the quoted report (current topic time) in the reported modality (current modal topic). So individual and temporal *de se* is due to a temporary topic shift by the quote. The suffixal report (15′b) does not involve any topic shift. Instead, the v\v suffix *-nirar* ‘say’ lexically encodes temporal and individual *de se*. Thus, by different routes, (14)–(15a) and (14)–(15b) converge on the following model:

Model for (7); (14′); (15′a, b)

i-reality: $^{\top}w_0$ •	$^{\top}e_0$: e_0-agent speaks up
|	$^{\top}t_0 = \vartheta_{w0}\, e_0$
… •• •• •• •• …	Ran $h^{\varepsilon\varepsilon}{}_1w_0$: e_0-speaker’s dad $^{\top}a_1$ plays chess with a $k^{\alpha}{}_1$-partner
… ǁ ǁ ǁ ǁ …	Ran $k^{\tau}{}_1w_0$ = Dom $h^{\varepsilon\varepsilon}{}_1w_0$
ǁ	$^{(\top)}t_{2.1}$: during last year of $^{\top}e_0$
•••	ee_2: $^{\top}a_1$’s mother $^{\perp}a_2$ talks with $^{\top}a_1$
ǁ	$^{\top}t_{2.2} = \vartheta_{w0}\, \mathrm{RES}_{w0}\, {}^{1}ee_2$
•	e_3: $^{\top}a_1$ says p_3

~~~~~~

$w_3 \in p_3$	(e_3-report)
… •• •• •• …	Ran $h^{\varepsilon\varepsilon}{}_1w_3$: e_3-speaker plays chess with a $k^{\alpha}{}_1$-partner
… ǁ ǁ …	Ran $^{\top}k^{\tau}{}_3w_3$ = Dom $h^{\varepsilon}{}_3w_3$ *most*($\{\vartheta_{w3}\, \mathrm{RES}_{w3}\, {}^{1}ee$: $ee \in$ Ran $h^{\varepsilon\varepsilon}{}_1w_3\}$, Ran $k^{\tau}{}_3w_3$)
… • • …	Ran $h^{\varepsilon}{}_3w_3$: e_3-speaker wins a $h^{\varepsilon\varepsilon}{}_1$-chess.game

Lexical *de se* anaphora is not peculiar to the v\v suffix *-nirar*. It instantiates a general pattern in Kalaallisut. Verbal moods relate the (last) eventuality of the v-base to the currently topical modality, perspective, time, and individual. In contrast, v\v suffixes—like *-nirar* ‘say’, *-suri* ‘believe’, *-ssa* ‘prospect’, etc—relate the base eventuality to their own perspective and a modality they evoke. Therefore, reports with v\v suffixes are temporally *de se* (like nonfinite reports in English, e.g. *claim to have won*, *expect to win, dread losing*). Intransitive v\v reports are also individually *de se*: the agent (or experiencer) of the v-base is identified with the reporting agent (or experiencer) of the v\v suffix—as we saw in (15′b) and will see again in Sections 6 and 7.
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6. REPORTED ATTITUDES ONLINE

Mutatis mutandis online update for reported habits generalizes to reported attitudes. Thus, for example, in the context of (14), (3a, b) (repeated as (16a, b)) can be interpreted online essentially like (15a, b):

(16) *Ilaanni* *skakkir-a-mi,*
once play.chess-FCT$_{\top}$-3s$_{\top}$
Once when he$_{\top}$ played (chess), …

a. isuma-qa-*lir-pu-q:* "*Immaqa* *ajugaa-ssa-u-nga*."
belief-have-begin-IND.IV-3s maybe win-prospect-IND.IV-1s
…he$_{\top}$ began to think: "I might win."

b. *immaqa* *ajugaa-ssa*-suri-*lir-pu-q*.
maybe win-prospect-*believe*-begin-IND.IV-3s
…he$_{\top}$ began to think that he (= *se*) might win.

Reference to habitual events and their temporal domains (by 'win-' and '-habit' in (15a, b)) is replaced with reference to concepts of prospective events and their modal domains (by 'win-' and '-prospect' in (16a, b)). Quantification over temporal domains (by 'mostly' in (15a, b)) is replaced with quantification over modal domains (by 'maybe' in (16a, b)). In the context of (14), (16a) and (16b) thus converge on the following model, which is point for point parallel to the model that (15a) and (15b) converged on in the same context (see above):

Model for (7); (14′); (16′a, b)

i-reality: $^{\top}w_0$	•	$^{\top}e_0$: e_0-agent speaks up
	I	$^{\top}t_0 = \vartheta_{w0}\, e_0$
	… •• • • •• •• …	Ran $h^{\varepsilon\varepsilon}{}_1 w_0$: e_0-speaker's dad $^{\top}a_1$ plays chess with a $k^{\alpha}{}_1$-partner
	… ‖ ‖ ‖ ‖ …	Ran $k^{\tau}{}_1 w_0$ = Dom $h^{\varepsilon\varepsilon}{}_1 w_0$
	‖	$^{(\top)}t_{2.1} \in$ Dom $h^{\varepsilon\varepsilon}{}_1 w_0$
	•	$[^1\underline{ee}_2]w_0 = {}^1h^{\varepsilon\varepsilon}{}_1 w_0 t_{2.1}$ 1st stage of $t_{2.1}$-instance of $h^{\varepsilon\varepsilon}{}_1$
	IIIII	$^{\top}t_{2.2} = \vartheta_{w0}$ RES$_{w0}$ $[^1\underline{ee}_2]w_0$
	—	s_3: $^{\top}a_1$ believes p_3
	•	e_3 = BEG$_{w0}$ s_3
∼∼∼∼∼∼∼∼∼∼∼∼∼∼∼∼∼∼∼∼		
$w_3 \in$ Ran $^{\top}\underline{w}_3 \subseteq p_3$		(s_3-believed possibility $^{\top}\underline{w}_3$)
	• •	$\langle [^1\underline{ee}_2]w_3, [^f\underline{ee}_2]w_3 \rangle = \langle {}^1[h^{\varepsilon\varepsilon}{}_1 w_3 t_{1.2}], {}^f[h^{\varepsilon\varepsilon}{}_1 w_3 t_{1.2}] \rangle$
	—	$\underline{s}_3 w_3$ = RES$_{w3}$ $[^1\underline{ee}_2]w_3$
	•	$\underline{e}_3 w_3 = [^f\underline{ee}_2]w_3$: s_3-exp. wins $\underline{ee}_2$

The following online updates for (16a) and (16b) implement these ideas. The proposed adaptations are explicated in footnotes.

(16′) Once when he$_{\top}$ was playing…

once[10]
$[\mathbf{t}\ \underline{ee}|\ \underline{ee} = d\eta^{\varepsilon\varepsilon}\{\mathbf{t}\}]$;

play.chess- [11]
$[|\ d\underline{\varepsilon\varepsilon}$: (AGT + $d\kappa^{\alpha}$) *play.chess*];

-FCT$_{\top}$ [12]
$[|\ {}^{1}d\underline{\varepsilon\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon$, AGT $d\underline{\varepsilon\varepsilon} = \mathbf{d}\alpha]$;
$[|\ {}^{1}d\underline{\varepsilon\varepsilon} \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]$; $[\mathbf{t}|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta$RES ${}^{1}d\underline{\varepsilon\varepsilon}]$;

-3s$_{\top}$
$[|\ 3s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$;

a. …he$_{\top}$ began to think: "I might win."

belief.of- (*isuma-*) -have (*-qar*)[13]
$[k^{\Omega}_{\alpha}|\ k^{\Omega}_{\alpha}$ *belief.of* $\alpha]$; $[s\ p|\ p =_{\mathbf{d}\omega} d\alpha\kappa^{\Omega}\{EXP, s\}]$;

-begin
$[e|\ (e =_{\mathbf{d}\omega}$ BEG $d\sigma)$, (EXP $e =_{\mathbf{d}\omega}$ EXP $d\sigma)]$;

-IND. .IV -3s
$[|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]$; $[|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]$; $[|$ EXP $d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]$; $[|\ 3s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

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10 $\underline{ee}$ is the chain of concepts of the stages of the $d\eta^{\varepsilon\varepsilon}$-process that begins at $\mathbf{t}$

- $\underline{ee} = d\eta^{\varepsilon\varepsilon}\{\mathbf{t}\}$ for $\lambda i.\ \exists W, n(W = \{w \in \text{Dom } d\eta^{\varepsilon\varepsilon}_{i}: \mathbf{t} \in \text{Dom } d\eta^{\varepsilon\varepsilon}_{i}w\}$
  $\wedge\ \forall w \in W({}^{n}d\eta^{\varepsilon\varepsilon}_{i}w\mathbf{t} = {}^{f}d\eta^{\varepsilon\varepsilon}_{i}w\mathbf{t} = {}^{f}\underline{ee}w)$
  $\wedge\ \forall m \leq n({}^{m}\underline{ee} = \langle{}^{m}(d\eta^{\varepsilon\varepsilon}_{i}w\mathbf{t}): w \in W\rangle))$

11 $\underline{ee}$ is a process-chain of (contingent and causally linked) stage-concepts

- *process* $\underline{ee}$ for $\forall \underline{e} \in \text{Dom } \underline{ee}$: $(\varnothing \subset \text{Dom } \underline{ee}(\underline{e}) \subseteq \text{Dom } \underline{e}$
  $\wedge\ \forall w \in \text{Dom } \underline{ee}(\underline{e}): \vartheta_{w}\ \underline{ee}(\underline{e})w \subseteq \vartheta_{w}\ \text{RES}_{w}\ \underline{e}w)$

$\underline{ee}$ is a process s.t. at each stage the current agent and $d\kappa^{\alpha}$-partner play chess

- $\underline{ee}$: (AGT + $d\kappa^{\alpha}$) *play chess* for $\lambda i.$ *process* $\underline{ee} \wedge (\forall \underline{e} \in \underline{ee}\forall w \in \text{Dom } \underline{e}$:
  $play.chess_{w}(\underline{e}w, \text{AGT}_{w}\ \underline{e}w + d\kappa^{\alpha}_{i}w\underline{e}w))$

12 In $\mathbf{d}\omega$, $d\underline{\varepsilon\varepsilon}$ is real from the perspective of $\mathbf{d}\varepsilon$ (i.e. stage one is real)

- ${}^{1}d\underline{\varepsilon\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon$ for $\lambda i.\ \vartheta_{\mathbf{d}\omega i}{}^{1}[d\underline{\varepsilon\varepsilon}_{i}]\mathbf{d}\omega_{i} < \vartheta_{\mathbf{d}\omega i}\ \mathbf{d}\varepsilon_{i}$

Any realization of any stage of $d\underline{\varepsilon\varepsilon}$ is an action by $\mathbf{d}\alpha$

- AGT $d\underline{\varepsilon\varepsilon} = \mathbf{d}\alpha$ for $\lambda i.\ \forall \underline{e} \in d\underline{\varepsilon\varepsilon}_{i}\forall w \in \text{Dom } \underline{e}$: $\text{AGT}_{w}\ \underline{e}w = \mathbf{d}\alpha_{i}$

13 $\forall a \in \text{Dom } k^{\Omega}_{\alpha}$, any instance of $k^{\Omega}_{\alpha}a$ is a current belief of a

- k^{Ω}_{α} *belief.of* α for $\lambda i.\ \forall a \in \text{Dom } k^{\Omega}_{\alpha}\forall w \in \text{Dom } k^{\Omega}_{\alpha}a\forall e^{\bullet} \in \text{Dom } k^{\Omega}_{\alpha}aw\exists s$:
  $(s = e^{\bullet} \vee e^{\bullet} = \text{BEG}_{w}\ s) \wedge believe_{w}(s, a, k^{\Omega}_{\alpha}awe^{\bullet})$

In $\mathbf{d}\omega$, p instantiates in s the Ω-kind $d\alpha\kappa^{\Omega}$-of-the experiencer of s

- $p =_{\mathbf{d}\omega} d\alpha\kappa^{\Omega}\{\text{EXP}, s\}$ for $\lambda i.\ p = d\alpha\kappa^{\Omega}_{i}(\text{EXP}_{\mathbf{d}\omega i}\ s)\mathbf{d}\omega_{i}s$

“(quote start-up)
$[\mathbf{p}|\ \mathbf{p} = d\Omega]; [\mathbf{s}|\ \mathbf{s} = d\sigma]; [\mathbf{t}|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{BEG}\ \mathbf{d}\sigma];$

maybe [14]
$[\underline{e}|\ can\{^f d\underline{\varepsilon\varepsilon}, \underline{e}\}]; [\underline{\mathbf{w}}|\ (poss\ \underline{\mathbf{w}}), (d\underline{\varepsilon} =_{\underline{\mathbf{w}}} {}^f d\underline{\varepsilon\varepsilon})];$

win- [15]
$[|\ d\underline{\varepsilon}: \text{AGT}\ win\ d\underline{\varepsilon\varepsilon}];$

-prospect[16]
$[|\ \mathbf{d}\Omega = \text{Dom}\ \mathbf{d}\underline{\omega}];$
$[\underline{s}|\ (\underline{s} =_{\mathbf{d}\Omega} \text{RES}\ {}^1 d\underline{\varepsilon\varepsilon}), (d\underline{\varepsilon} \subseteq_{\mathbf{d}\underline{\omega}} \vartheta\underline{s}), (\text{AGT}\ d\underline{\varepsilon} =_{\mathbf{d}\underline{\omega}} \text{EXP}\ \underline{s})];$

-IND. .IV
$[|\ \text{BEG}\ d\underline{\sigma} <_{\mathbf{d}\Omega} \mathbf{d}\sigma]; [|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\Omega} d\underline{\sigma}]; [|\ \text{EXP}\ d\underline{\sigma} =_{\mathbf{d}\Omega} \mathbf{d}\alpha];$

-1s [17] ” (unquote)
$[|\ 1s_{\mathbf{d}\Omega,\, \mathbf{d}\sigma}\ \mathbf{d}\alpha]; [\mathbf{w}|\ \mathbf{w} = \mathbf{d}\omega]; [\mathbf{e}|\ \mathbf{e} = \mathbf{d}\varepsilon];$

b. …he$_{T}$ began to think that he (= *se*) might win.
maybe
$[\underline{e}|\ can\{^f d\underline{\varepsilon\varepsilon}, \underline{e}\}]; [\underline{\mathbf{w}}|\ (poss\ \underline{\mathbf{w}}), (d\underline{\varepsilon} =_{\underline{\mathbf{w}}} {}^f d\underline{\varepsilon\varepsilon})];$

win-
$[|\ d\underline{\varepsilon}: \text{AGT}\ win\ d\underline{\varepsilon\varepsilon}];$

-prospect
$[p|\ p = \text{Dom}\ \mathbf{d}\underline{\omega}];$
$[\underline{s}|\ (\underline{s} =_{d\Omega} \text{RES}\ {}^1 d\underline{\varepsilon\varepsilon}), (d\underline{\varepsilon} \subseteq_{\mathbf{d}\underline{\omega}} \vartheta\underline{s}), (\text{AGT}\ d\underline{\varepsilon} =_{\mathbf{d}\underline{\omega}} \text{EXP}\ \underline{s})];$

-believe (-*suri*)
$[s|\ (s: \text{EXP}\ believe_{\mathbf{d}\omega}\ d\Omega), (\vartheta s \subseteq_{d\Omega} d\underline{\sigma}), (\text{EXP}\ s =_{d\Omega} \text{EXP}\ d\underline{\sigma})];$

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[14] The end of $d\underline{\varepsilon\varepsilon}$ can be realized as $\underline{e}$
- $can\{^f d\underline{\varepsilon\varepsilon}, \underline{e}\}$ for $\lambda i.(\forall w \in \text{Dom}\ \underline{e}: \underline{e}w = {}^f d\underline{\varepsilon\varepsilon}_i w) \wedge some(\text{Dom}\ {}^f d\underline{\varepsilon\varepsilon}_i, \text{Dom}\ \underline{e})$

Ran $\underline{\mathbf{w}}$ is a possibility within Dom $\underline{\mathbf{w}}$
- $poss\ \underline{\mathbf{w}}$ for $\lambda i.\ \varnothing \subset \text{Ran}\ \underline{\mathbf{w}} \subseteq \text{Dom}\ \underline{\mathbf{w}}$

In Ran $\mathbf{d}\underline{\omega}$, $d\underline{\varepsilon}$ is the end of $d\underline{\varepsilon\varepsilon}$
- $d\underline{\varepsilon} =_{\underline{\mathbf{w}}} {}^f d\underline{\varepsilon\varepsilon}$ for $\lambda i.\ \forall w \in \text{Dom}\ \underline{\mathbf{w}} \exists w': w' = \underline{\mathbf{w}}w \wedge d\underline{\varepsilon}_i w' = {}^f d\underline{\varepsilon\varepsilon}_i w'$

[15] Any $d\underline{\varepsilon}$-event is the end of $d\underline{\varepsilon\varepsilon}$-(competition) and victory for $d\underline{\varepsilon}$-agent
- $d\underline{\varepsilon}: \text{AGT}\ win\ d\underline{\varepsilon\varepsilon}$ for $\lambda i.\ \forall w \in \text{Dom}\ d\underline{\varepsilon}_i \exists ee: (ee = \langle [{}^1 d\underline{\varepsilon\varepsilon}_i]w, \ldots [{}^f d\underline{\varepsilon\varepsilon}_i]w \rangle$
  $\wedge\ d\underline{\varepsilon}_i w = {}^f ee \wedge win_w(d\underline{\varepsilon}_i w, \text{AGT}_w\ d\underline{\varepsilon}_i w, ee))$

[16] In $\mathbf{d}\Omega$, $\underline{s}$ is the result state of stage one of $d\underline{\varepsilon\varepsilon}$
- $\underline{s} =_{\mathbf{d}\Omega} \text{RES}\ {}^1 d\underline{\varepsilon\varepsilon}$ for $\lambda i.\ \forall w \in \mathbf{d}\Omega_i: \underline{s}w = {}^1 d\underline{\varepsilon\varepsilon}_i w$

In Ran $\mathbf{d}\underline{\omega}$, $d\underline{\varepsilon}$ is realized during $\underline{s}$
- $d\underline{\varepsilon} \subseteq_{\mathbf{d}\underline{\omega}} \vartheta\underline{s}$ for $\lambda i.\ \forall w \in \text{Dom}\ \mathbf{d}\underline{\omega}_i \exists w': w' = \mathbf{d}\underline{\omega}_i w \wedge \vartheta_{\underline{w'}}\ d\underline{\varepsilon}_i w' \subseteq \vartheta_{w'}\ \underline{s}w'$

[17] In $\mathbf{d}\Omega$, $\mathbf{d}\alpha$ is the experiencer of $\mathbf{d}\sigma$
$1s_{\mathbf{d}\Omega,\, \mathbf{d}\sigma}\ \mathbf{d}\alpha$ for $\lambda i.\ \forall w \in \text{Dom}\ \mathbf{d}\Omega_i: \text{EXP}_w\ \mathbf{d}\sigma_i = \mathbf{d}\alpha_i$

-begin
$[e|\ (e =_{\mathbf{d}\omega} \text{BEG}\ d\sigma), (\text{EXP}\ e =_{\mathbf{d}\omega} \text{EXP}\ d\sigma)];$

-IND -IV -3s
$[|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];\ [|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];\ [|\ \text{EXP}\ d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha];\ [|\ 3s_{\mathbf{d}\omega,\, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

As promised, the online updates in (16′a) and (16′b), for modally quantified *de se* belief, converge on the above model and are point for point parallel to the online updates in (15′a) and (15′b), respectively, for temporally quantified *de se* speech.

The analyses in (15′a, b) and (16′a, b) explicate the parallel between temporal and modal quantification in a new way. Traditionally, temporal and modal quantifiers have been analyzed as first-order operators that bind variables for times or worlds, respectively, in verb meanings that are also used for simple predication. Unfortunately, this simple and elegant first-order semantics is not transparently related to surface forms such as (15a, b) or (16a, b). Therefore, the interpretation of such sentences cannot proceed without transformations that are neither simple nor elegant. Indeed, even for English, there is still no formally explicit theory that would build all and only the requisite LFs.

In contrast, the direct online updates in (15′a, b) and (16′a, b) draw the semantic parallel directly, interpreting each surface form as is. On this neo-Fregean view, natural language quantifiers are higher-order predicates. They do not combine with ordinary verb meanings used for simple predication (A5). Instead, they presuppose adapted meanings that are distributed over a suitable domain (temporal in (15′), modal in (16′)). They presuppose distributed meanings because they restrict the domain of such distribution to a topical subdomain.

The analysis of the modal in (16′a, b) can also be related to the ordering semantics developed, with varying details, by Stalnaker 1968, Lewis 1973, and Kratzer 1981. The common idea is that modals quantify over a subset of the ‘contextually salient’ set of worlds (Kratzer’s *modal base*)—to wit, the worlds ranked highest by the ‘contextually salient’ order (Kratzer’s *ordering source*). In (16a, b) the modal base is the set of worlds the experiencer currently believes he inhabits. The ordering source ranks these worlds according to what the experiencer believes to be the most likely future developments. A key problem, which remains unsolved (even in the dynamic implementation of Stone 1997), is just how the context determines the modal base and the ordering source. Online update in (16′a, b) offers a surface-based solution, composing lexical meanings by prominence-guided anaphora.

More precisely, the predicate ‘believe’ (*isuma-qar-* or *-suri*) evokes a belief state (in the above model, the belief state s_3, newly formed at ${}^{\top}t_{2.2}$). The experiencer of this state of *de se* belief is a habitual chess player (agent of $h^{\varepsilon\varepsilon}{}_1$). He has just completed the first stage of the current chess game ($[^1\underline{ee}_2]w_0$), so he locates himself in a set of worlds where this is the case (p_3). This set of worlds is the modal base for the modal *immaqa* ‘maybe’. The modal quantifies only over the worlds with the most likely future developments—i.e. those worlds where the final stage ($^f\underline{ee}_2$) of the current chess game accords with the aforementioned chess playing experience ($h^{\varepsilon\varepsilon}{}_1$). What the modal ‘maybe’ asserts—and this is the content of this *de se* belief—is that these most likely futures include some (Ran $^\top\underline{w}_3$) where the anticipated final stage ($^f\underline{ee}_2$) of this game is realized as a victory ($\underline{e}_3$) by the believer.

Compositionally, in (16′a, b) the key dref for the current chess game ($\underline{ee}$) is set up by the very first word: *ilaanni* ‘once’. This dref is not new. It is induced by the currently prominent chess playing habit ($d\eta^{\varepsilon\varepsilon}$), evoked in the last sentence (14′), and a topic time (**t**) selected from the temporal domain of this chess playing habit by *ilaanni* ‘once’ itself. The subsequent factive verb, *skakkirami* ‘when he$_\top$ played’, is a verbal definite. It tests that the induced dref ($d\underline{\varepsilon\varepsilon}$) is a game with a completed first stage ($^1d\underline{\varepsilon\varepsilon}$) and updates the topic time to the result time of this stage. (Accordingly, *skakkirami* can be omitted without materially changing the meaning of (16′a, b).) The modal *immaqa* ‘maybe’ anaphorically retrieves the expected final stage of the current chess game ($^fd\underline{\varepsilon\varepsilon}$). Based on this prospect, it evokes a possible realization ($\underset{\smile}{e}$), along with a topical concept of a world where this possibility comes to pass ($\underline{\mathbf{w}}$). Both concepts, in turn, are anaphorically linked to the prospective suffix *-ssa*. This modal distributor requires a modally distributed meaning of its verbal base (‘win-’) and identifies the domain of this distribution by anaphora to salient modal drefs.

Thus, for episodic *de se* reports with temporal or modal quantifiers, online update makes more detailed predictions than previous analyses. The relation to prior discourse and to the surface form is also more transparent. Last but not least, surface-based online update generalizes to habitual *de se* reports, as I now proceed to show.

7 HABITUAL REPORTS ONLINE

To complete the paradigm, consider the last semantically equivalent pair of discourses, (1)–(4a) and (1)–(4b). The data are repeated in (17)–(18a) and (17)–(18b).

(17) *Ataata-ga skakkir-tar-pu-q.*
dad-1s.sg play.chess-habit-IND.IV-3s
My dad$_\top$ plays chess.

(18) Aqagu-*ani*
next.day-3s$_\perp$.sg.LOC
The next day…

a. *uqar*-ajut-*tar-pu-q:* “*Ajugaa-sima-vu-nga*.”
say-*often*-habit-IND.IV-3s: win-prf-IND.IV-1s
…he$_\top$ often says: “I won.”

b. *ajugaa-sima-nirar*-ajut-*tar-pu-q*.
win-prf-say-*often*-habit-IND.IV-3s
…he$_\top$ often says that he (= *se*) won.

In different speech events that instantiate this reporting habit the uttered sentence—quoted in (18a)—is the same. But the proposition expressed is not. Each report is about the outcome of the previous day's game. In addition, both (18a) and (18b) can mean either: (i) that many days directly after the day of a chess game are reporting days, or (ii) that, for each chess game, there are many reports the next day.

To encapsulate these quantificational patterns, I propose that habitual reports relate report-valued habits to proposition-valued kinds. A verb (e.g. ‘win-’) in the scope of a habitual *de se* report evokes a report-dependent concept (of *se*'s victory reported on that occasion), and may induce other report-dependent concepts (e.g. the result state): Habitual *de se* can then be captured by distributing such concepts over the reporting habit. Temporal quantification can also be distributed.

The online updates in (18′a, b) implement these ideas. I assume that the opening sentence (17) (= (14)) is still interpreted as in (14′), and so again yields the following context for interpreting the next sentence:

i-reality: ${}^\top w_0$ • ${}^\top e_0$: e_0-agent speaks up
| ${}^\top t_0 = \vartheta_{w0}\, e_0$
… •• •• •• •• … Ran $h^{\varepsilon\varepsilon}{}_1 w_0$: e_0-speaker's dad ${}^\top a_1$ plays chess with a $k^\alpha{}_1$-partner
… || || || || … Ran $k^\tau{}_1 w_0$ = Dom $h^{\varepsilon\varepsilon}{}_1 w_0$

(18′) The next day…
next.day- (*aqagu-*) -3s$_\perp$.sg.LOC [18]
$[k^\tau{}_\eta |\ k^\tau{}_\eta$ *day.after* $\eta^\varepsilon]$; $[\mathbf{k}^\tau |\ \mathbf{k}^\tau \subseteq_{::} d\eta\kappa^\tau\{{}^1 d\eta^{\varepsilon\varepsilon}\}]$;

---

18 $\forall h^\varepsilon \in$ Dom $k^\tau{}_\eta$, $k^\tau{}_\eta h^\varepsilon$ is the **τ**-kind instantiated, for each h^ε-event, by the next day
- $k^\tau{}_\eta$ *day.after* η^ε for $\lambda i.\forall h^\varepsilon \in \text{Dom } k^\tau{}_\eta \forall w \in \text{Dom } k^\tau{}_\eta h^\varepsilon \forall e \in \text{Dom } k^\tau{}_\eta h^\varepsilon w$:
  Dom $k^\tau{}_\eta h^\varepsilon$ = Dom $h^\varepsilon \wedge$ Dom $k^\tau{}_\eta h^\varepsilon w$ = Ran $h^\varepsilon w \wedge$
  $k^\tau{}_\eta h^\varepsilon we = day.after_w(day.of_w\ e)$

$\mathbf{k}^\tau$-times are subintervals of the corresponding $d\eta\kappa^\tau$-of-${}^1 d\eta^{\varepsilon\varepsilon}$ times
- $\mathbf{k}^\tau \subseteq_{::} d\eta\kappa^\tau\{{}^1 d\eta^{\varepsilon\varepsilon}\}$ for $\lambda i.$ Dom $\mathbf{k}^\tau$ = Dom $d\eta\kappa^\tau{}_i{}^1 d\eta^{\varepsilon\varepsilon}{}_i$
  $\wedge\ \forall w \in$ Dom $\mathbf{k}^\tau$: (Dom $\mathbf{k}^\tau w$ = Dom $d\eta\kappa^\tau{}_i{}^1 d\eta^{\varepsilon\varepsilon}{}_i w$
  $\wedge\ \forall e^\bullet \in$ Dom $\mathbf{k}^\tau w$: $\mathbf{k}^\tau w e^\bullet \subseteq d\eta\kappa^\tau{}_i{}^1 d\eta^{\varepsilon\varepsilon}{}_i w e^\bullet$)

a. …he$_{T}$ often says: "I won."

say- (*uqar-*) [19]

$[h^{\varepsilon}\ k^{\Omega}|\ h^{\varepsilon}\text{: AGT } say\ k^{\Omega}];$

-often (-*gajut*) [20] -habit (-*tar*)

$^{1}[|\ often\{\mathbf{d}\kappa^{\tau}, d\eta^{\varepsilon}\}];$ $[k^{\tau}|\ \text{Dom}\ d\eta^{\varepsilon} = k^{\tau}]$:

$^{2}[|\ \mathbf{d}\kappa^{\tau}{::}\ often\{d\kappa^{\Omega}, d\eta^{\varepsilon}\}];$ $[k^{\tau}|\ \text{Dom}\ d\eta^{\varepsilon} = k^{\tau}]$:

-IND. .IV -3s

$^{P}[|\ ^{1}d\eta^{\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];\ [|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon}];\ [|\ \text{AGT}\ d\eta^{\varepsilon} =_{\mathbf{d}\omega} \mathbf{d}\alpha];\ ^{P}[|\ 3s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

"(quoted habitual speech) [21]

$[\mathbf{k}^{\Omega}|\ \mathbf{k}^{\Omega} = d\kappa^{\Omega}];\ [\mathbf{h}^{\varepsilon}|\ \mathbf{h}^{\varepsilon} = (d\eta^{\varepsilon}|\mathbf{d}\omega)];\ [\mathbf{k}^{\tau}|\ \mathbf{k}^{\tau} = \vartheta\mathbf{d}\eta^{\varepsilon}];$

win- [22] -prf [23]

$[\underline{e}_{\varepsilon}|\ \underline{e}_{\varepsilon}\text{: AGT } win\ d\eta^{\varepsilon\varepsilon}];\ [\underline{s}_{\varepsilon}|\ (\underline{s}_{\varepsilon} = \text{RES}\ d\varepsilon\underline{\varepsilon}), (\text{EXP}\ \underline{s}_{\varepsilon} = \text{AGT}\ d\varepsilon\underline{\varepsilon})];$

-IND [24]

$^{P}[|\ \mathbf{d}\eta^{\varepsilon}{::}\ \text{BEG}\ d\varepsilon\underline{\sigma} <_{\mathbf{d}\kappa\Omega} \varepsilon];\ [|\ \mathbf{d}\eta^{\varepsilon}{::}\ \mathbf{d}\kappa^{\tau} \subseteq_{\mathbf{d}\kappa\Omega} d\varepsilon\underline{\sigma}];$

.IV -1s " (as in (16′a))

$[|\ \mathbf{d}\eta^{\varepsilon}{::}\ \text{EXP}\ d\varepsilon\underline{\sigma} =_{\mathbf{d}\kappa\Omega} \mathbf{d}\alpha];\ [|\ \mathbf{d}\eta^{\varepsilon}{::}\ 1s_{\mathbf{d}\kappa\Omega,\,\varepsilon}\ \mathbf{d}\alpha];\ [\mathbf{w}|\ \ldots];\ [\mathbf{e}|\ \ldots]$

---

[19] Any h^{ε}-event is a speech act whose agent expresses a k^{Ω}-proposition

- $h^{\varepsilon}\text{: AGT } say\ k^{\Omega}$ for $\lambda i.\forall w \in \text{Dom}\ h^{\varepsilon}\forall t \in \text{Dom}\ h^{\varepsilon}w\exists e$:
  $e = h^{\varepsilon}wt \wedge \vartheta_{w}\ e \subseteq t \wedge say_{w}(e, \text{AGT}_{w}\ e, k^{\Omega}we)$

[20] $d\eta^{\varepsilon}$-times are $\mathbf{d}\kappa^{\tau}$-times, and $\mathbf{d}\kappa^{\tau}$-times are often $d\eta^{\varepsilon}$-times

- $often\{\mathbf{d}\kappa^{\tau}, d\eta^{\varepsilon}\}$ for $\lambda i.\forall w \in \text{Dom}\ d\eta^{\varepsilon}_{i}$: $\text{Dom}\ d\eta^{\varepsilon}_{i}w \subseteq \text{Dom}\ \mathbf{d}\kappa^{\tau}_{i}w$
  $\wedge\ often(\text{Ran}\ \mathbf{d}\kappa^{\tau}_{i}w, \text{Dom}\ d\eta^{\varepsilon}_{i}w)$

For any $\mathbf{d}\kappa^{\tau}$-time t, $d\eta^{\varepsilon}$-events in t are $d\kappa^{\Omega}$-events & $d\kappa^{\Omega}$-evts in t are often $d\eta^{\varepsilon}$-evts

- $\mathbf{d}\kappa^{\tau}{::}\ often\{d\kappa^{\Omega}, d\eta^{\varepsilon}\}$ for $\lambda i.\forall w \in \text{Dom}\ \mathbf{d}\kappa^{\tau}_{i}\forall t \in \text{Ran}\ \mathbf{d}\kappa^{\tau}_{i}$:
  $\{e \in \text{Ran}\ d\eta^{\varepsilon}_{i}w\text{: } \vartheta_{w}\ e \subseteq t\} \subseteq \text{Dom}\ d\kappa^{\Omega}_{i}w$
  $\wedge\ often(\{e \in \text{Dom}\ d\kappa^{\Omega}_{i}w\text{: } \vartheta_{w}\ e \subseteq t\}, \text{Ran}\ d\eta^{\varepsilon}_{i}w)$

[21] $\mathbf{h}^{\varepsilon}$ is the restriction of $d\eta^{\varepsilon}$ to $\mathbf{d}\omega$; $\mathbf{k}^{\tau}$-times are times of $\mathbf{d}\eta^{\varepsilon}$-events

- $\mathbf{h}^{\varepsilon} = (d\eta^{\varepsilon}|\ \mathbf{d}\omega)$ for $\lambda i.\ \text{Dom}\ \mathbf{h}^{\varepsilon} = \{\mathbf{d}\omega_{i}\} \wedge \forall w \in \text{Dom}\ \mathbf{h}^{\varepsilon}\text{: } \mathbf{h}^{\varepsilon}w = d\eta^{\varepsilon}_{i}w$
- $\mathbf{k}^{\tau} = \vartheta\mathbf{d}\eta^{\varepsilon}$ for $\lambda i.\ \mathbf{k}^{\tau} = \langle\langle\vartheta_{w}\ e\text{: } e \in \text{Ran}\ \mathbf{d}\eta^{\varepsilon}_{i}w\rangle\text{: } w \in \text{Dom}\ \mathbf{d}\eta^{\varepsilon}_{i}\rangle$

[22] For any $e \in \text{Dom}\ \underline{e}_{\varepsilon}$, any realization of $\underline{e}_{\varepsilon}e$ is an action of winning a $d\eta^{\varepsilon\varepsilon}$-(game)

- $\underline{e}_{\varepsilon}\text{: AGT } win\ d\eta^{\varepsilon\varepsilon}$ for $\lambda i.\forall e \in \text{Dom}\ \underline{e}_{\varepsilon}\forall w \in \text{Dom}\ \underline{e}_{\varepsilon}e\exists ee \in \text{Ran}\ d\eta^{\varepsilon\varepsilon}_{i}w$:
  $\underline{e}_{\varepsilon}ew =^{f} ee \wedge win_{w}(\underline{e}_{\varepsilon}ew, \text{AGT}_{w}\ \underline{e}_{\varepsilon}ew, ee)$

[23] $\underline{s}_{\varepsilon}$ sends all $e \in \text{Dom}\ d\varepsilon\underline{\varepsilon}$ to the concept of the result state of $d\varepsilon\underline{\varepsilon}$-of-$e$

- $\underline{s}_{\varepsilon} = \text{RES}\ d\varepsilon\underline{\varepsilon}$ for $\lambda i.\ \underline{s}_{\varepsilon} = \langle\langle\text{RES}_{w}\ d\varepsilon\underline{\varepsilon}_{i}ew\text{: } w \in \text{Dom}\ d\varepsilon\underline{\varepsilon}_{i}e\rangle\text{: } e \in \text{Dom}\ d\varepsilon\underline{\varepsilon}_{i}\rangle$

[24] For any $\mathbf{d}\eta^{\varepsilon}$-event e, in $\mathbf{d}\kappa^{\Omega}$-of-$e$ the state $d\varepsilon\underline{\sigma}$-of-$e$ is real from perspective of e

- $\mathbf{d}\eta^{\varepsilon}{::}\ \text{BEG}\ d\varepsilon\underline{\sigma} <_{\mathbf{d}\kappa\Omega} \varepsilon$ for $\lambda i.\forall w \in \text{Dom}\ \mathbf{d}\eta^{\varepsilon}_{i}\forall e \in \text{Ran}\ \mathbf{d}\eta^{\varepsilon}_{i}\forall w' \in \mathbf{d}\kappa^{\Omega}_{i}we$:
  $\vartheta_{w'}\ \text{BEG}_{w'}\ d\varepsilon\underline{\sigma}_{i}ew' < \vartheta_{w'}\ e$

For any $\mathbf{d}\eta^{\varepsilon}$-event e, in $\mathbf{d}\kappa^{\Omega}$-of-$e$ the state $d\varepsilon\underline{\sigma}$-of-$e$ holds at $\mathbf{d}\kappa^{\tau}$-of-e

- $\mathbf{d}\eta^{\varepsilon}{::}\ \mathbf{d}\kappa^{\tau} \subseteq_{\mathbf{d}\kappa\Omega} d\varepsilon\underline{\sigma}$ for $\lambda.\forall w \in \text{Dom}\ \mathbf{d}\eta^{\varepsilon}_{i}\forall e \in \text{Ran}\ \mathbf{d}\eta^{\varepsilon}_{i}\forall w' \in \mathbf{d}\kappa^{\Omega}_{i}we$:
  $\mathbf{d}\kappa^{\tau}_{i}w'e \subseteq \vartheta_{w'}\ d\varepsilon\underline{\sigma}_{i}ew'$

b. …he$_{\top}$ often says that he (= *se*) won.
win- -prf
$[\underline{e}_{\varepsilon} |\ \underline{e}_{\varepsilon}\text{: AGT } \mathit{win}\ d\eta^{\varepsilon\,\varepsilon}]; [\underline{s}_{\varepsilon} |\ (\underline{s}_{\varepsilon} = \text{RES } d\varepsilon\underline{\varepsilon}), (\text{EXP } \underline{s}_{\varepsilon} = \text{AGT } d\varepsilon\underline{\varepsilon})];$

-say (*-nirar*)
$[h^{\varepsilon}\ k^{\Omega} |\ (h^{\varepsilon}\text{: AGT } \mathit{say}\ k^{\Omega}), (h^{\varepsilon}\text{:: } \vartheta\varepsilon \subseteq_{k\Omega} d\varepsilon\underline{\sigma}),$
$(h^{\varepsilon}\text{:: AGT } \varepsilon \subseteq_{k\Omega} \text{EXP } d\varepsilon\underline{\sigma})];$

-often (*-gajut*) -habit (*-tar*)
$^{1}[|\ \mathit{often}\{\mathbf{d}\kappa^{\tau}, d\eta^{\varepsilon}\}];$ $[k^{\tau} |\ \text{Dom } d\eta^{\varepsilon} = k^{\tau}]:$
$^{2}[|\ \mathbf{d}\kappa^{\tau}\text{:: } \mathit{often}\{d\kappa^{\Omega}, d\eta^{\varepsilon}\}];$ $[k^{\tau} |\ \text{Dom } d\eta^{\varepsilon} = k^{\tau}]:$

-IND. .IV -3s
$^{P}[|\ ^{1}d\eta^{\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon}]; [|\ \text{AGT } d\eta^{\varepsilon} =_{\mathbf{d}\omega} \mathbf{d}\alpha]; {}^{P}[|\ \mathit{3s}_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

The reader can verify that the online updates in (18′a) and (18′b) converge on the same model but differ in centering. That is, yet again, direct online update accounts for the semantic convergence of radically different surface forms. In this case, the convergence extends to the apparent scope interaction between the initial temporal description *aqagu-a-ni* ‘next.day-3s$_{\perp}$.sg-LOC’ and the suffixal temporal quantifier *-gajut* ‘often’. But according to the surface-based analysis in (18′a, b), what is ambiguous is not structure, but an anaphoric presupposition.

The suffix ‘often’ presupposes a salient domain of quantification. On one reading (^{1}), this domain is identified with the set of days after a chess game, evoked by ‘next.day-3s$_{\perp}$.sg-LOC’. In effect, the suffix ‘often’ takes wide scope: many days after a chess game are reporting days. More precisely, though, ‘next.day-3s$_{\perp}$.sg-LOC’ evokes not just a set of days but a kind of day ($\mathbf{k}^{\tau}$): in each chess playing world, each game is mapped to the next day. This kind-level referent supports a distributed reading (^{2}), with apparently reversed scope: for each chess game, many ($d\kappa^{\Omega}$-)events the next day are reporting events.

On either reading, each of these habitual reports is about the reporting agent (individual *de se*) at the time of the report (temporal *de se*). On each occasion the agent expresses a report-dependent proposition, claiming to be in the result state of winning one of the aforementioned chess games (anaphorically retrieved from (17′)).

So ‘scope ambiguities’ do not require an LF-based account. Instead, we can attribute them to ambiguous lexical items, such as the suffixal quantifier *-gajut* ‘often’. This lexical alternative maintains direct surface-based interpretation by online update.

The evidence presented so far shows that surface-based online update is a viable alternative to LF-based semantics. I now turn to two examples of compositionality puzzles where surface-based online anaphora has a clear advantage over variable binding at LF.

8 LF-BASED SEMANTICS VERSUS ONLINE UPDATE

One puzzle concerns a general characteristic of polysynthetic verbs, namely, that they can form sentences all by themselves. In particular, the Kalallisut verbs of (15b) and (16b) can stand alone, as complete sentences, without any external quantifiers. The quantification is then understood to be universal, as in (19) and (20).

(19) [My father plays chess. Once when he came by we talked about it.]
Ajugaa-sar-*nirar-pu-q*.
win-*habit*-say-IND.IV-3s
He said that he (*always*) won.

(20) [My father plays chess. Once he started off well.]
Ajugaa-ssa-*suri-lir-pu-q*.
win-*prospect*-believe-begin-IND.IV-3s
He began to think that he *would* win.

The puzzle is how the meanings of such lone verbs relate to the meanings of the same verbs construed with external quantifiers.

If we assume the direct online analysis proposed in (15′b) and (16′b), then this question has a straightforward answer. The universal temporal or modal quantification characteristic of lone habitual or prospective verbs is the default case of pure distributivity. The domain of the distribution is determined by the antecedent, in prior discourse, of the verb-internal distributor. Thus, in (19) the habitual *-tar* is linked to the aforementioned habit ($d\eta^{\varepsilon\varepsilon}$), and in (20) the prospective *-ssa* is linked to the aforementioned chess game in progress ($d\underline{\varepsilon\varepsilon}$). These discourse-anaphoric readings are spelled out in (19′) and (20′).

(19′) win- -habit (*-tar*)
$[h^{\varepsilon} |\ h^{\varepsilon}\text{: AGT } win\ d\eta^{\varepsilon\varepsilon}];\ [|\ \text{Dom } d\eta^{\varepsilon} = \vartheta\text{RES } {}^{1}d\eta^{\varepsilon\varepsilon}];$

-say
$[e\ p |\ (e\text{: AGT } say_{\mathbf{d}\omega}\ p), (\vartheta e \subseteq_{p} d\eta^{\varepsilon}), (\text{AGT } e =_{p} \text{AGT } d\eta^{\varepsilon})];$

-IND. .IV -3s
${}^{\text{P}}[|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];\ [|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau];\ [|\ \text{AGT } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha];\ {}^{\text{P}}[|\ 3s_{\mathbf{d}\omega,\, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

(20′) win-
$[\underline{e} |\ \underline{e}\text{: AGT } win\ d\underline{\varepsilon\varepsilon}];$

-prospect (*-ssa*)
$[p |\ p = \text{Dom } {}^{f}d\underline{\varepsilon\varepsilon}];$
$[\underline{s} |\ (\underline{s} =_{d\Omega} \text{RES } {}^{1}d\underline{\varepsilon\varepsilon}), (d\underline{\varepsilon} \subseteq_{d\Omega} \vartheta\underline{s}), (\text{AGT } d\underline{\varepsilon} =_{d\Omega} \text{EXP } \underline{s})];$

-believe
$[s|\ (s\text{: EXP } believe_{\mathbf{d}\omega}\ d\Omega), (\vartheta\text{BEG } s \subseteq_{d\Omega} d\underline{\sigma}), (\text{EXP } s =_{d\Omega} \text{EXP } d\underline{\sigma})];$

-begin
$[e|\ (e =_{\mathbf{d}\omega} \text{BEG } d\sigma), (\text{EXP } e =_{\mathbf{d}\omega} \text{EXP } d\sigma)];$

-IND .IV -3s
$^{\mathrm{P}}[|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [|\ \text{EXP } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]; {}^{\mathrm{P}}[|\ 3s_{\mathbf{d}\omega,\ \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

What the optional external quantifier (e.g. 'mostly' or 'maybe') does is to restrict the domain of the verb-internal distributor by evoking a topical subdomain ($\mathbf{k}^{\tau}$, in (15′b) and (21); $\underline{\mathbf{w}}$, in (16′b) and (22)). The verb-internal distributor must then be anaphorically linked to this topical subdomain ($\mathbf{d}\kappa^{\tau}$ or $\mathbf{d}\underline{\omega}$). Otherwise, there would be a topic without a comment, which would be infelicitous.

(21) He said that he *mostly* won.
most- (*amirlanir-*) -VIA (*-tigut*)
$[k^{\tau}|\ most\{\vartheta\text{RES } {}^{1}d\eta^{\varepsilon\varepsilon}, k^{\tau}\}];\ [\mathbf{k}^{\tau}|\ \mathbf{k}^{\tau} = d\kappa^{\tau}];$

win- -habit (*-tar*)
$[h^{\varepsilon}|\ h^{\varepsilon}\text{: AGT } win\ d\eta^{\varepsilon\varepsilon}]; [|\ \text{Dom } d\eta^{\varepsilon} = \mathbf{d}\kappa^{\tau}];$

-say
$[e\ p|\ (e\text{: AGT } say_{\mathbf{d}\omega}\ p), (\vartheta e \subseteq_{p} d\eta^{\varepsilon}), (\text{AGT } e =_{p} \text{AGT } d\eta^{\varepsilon})];$

-IND. .IV -3s
$[|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [|\ \text{AGT } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]; [|\ 3s_{\mathbf{d}\omega,\ \mathbf{d}\varepsilon}\ \mathbf{d}\alpha];$

(22) He began to think that *maybe* he would win.
maybe (*immaqa*)
$[\underline{e}|\ can\{{}^{f}d\underline{\varepsilon\varepsilon}, \underline{e}\}]; [\underline{\mathbf{w}}|\ (poss\ \underline{\mathbf{w}}), (d\underline{\varepsilon} =_{\underline{\mathbf{w}}} {}^{f}d\underline{\varepsilon\varepsilon})];$

win-
$[|\ d\underline{\varepsilon}\text{: AGT } win\ d\underline{\varepsilon\varepsilon}];$

-prospect (*-ssa*)
$[p|\ p = \text{Dom } \mathbf{d}\underline{\omega}];$
$[\underline{s}|\ (\underline{s} =_{d\Omega} \text{RES } {}^{1}d\underline{\varepsilon\varepsilon}), (d\underline{\varepsilon} \subseteq_{\mathbf{d}\underline{\omega}} \vartheta\underline{s}), (\text{AGT } d\underline{\varepsilon} =_{\mathbf{d}\underline{\omega}} \text{EXP } \underline{s})];$

-believe
$[s|\ (s\text{: EXP } believe_{\mathbf{d}\omega}\ d\Omega), (\vartheta\text{BEG } s \subseteq_{d\Omega} d\underline{\sigma}), (\text{EXP } s =_{d\Omega} \text{EXP } d\underline{\sigma})];$

-begin
$[e|\ (e =_{\mathbf{d}\omega} \text{BEG } d\sigma), (\text{EXP } e =_{\mathbf{d}\omega} \text{EXP } d\sigma)];$

-IND .IV -3s
$[|\ d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [|\ d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [|\ \text{EXP } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]; [|\ 3s_{\mathbf{d}\omega,\ \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$

In contrast, the standard LF theory (Heim 1982) makes a bizarre prediction. If this theory is applied to Kalaallisut, then (19) and (20) both involve a covert, habitual or modal, quantifier plus rebracketing at LF. But then the verb is no longer a constituent at LF and is therefore not assigned any meaning at all. So a Kalaallisut verb is predicted to be meaningful only if it does not contain any suffix, like the habitual *-tar* or prospective *-ssa*, which can be construed with an external quantifier. This is a bizarre result. It is comparable to predicting that an English noun is meaningful only if it does not contain the plural suffix *-s*.

The second puzzle is for a complete theory of semantics and pragmatics. Whatever the division of labor, the complete theory must be able to interpret heavily context-dependent sentences, since everyday talk is full of continuations like (23):

(23) [(17) My father plays chess. (18b) The next day he often says that he won.]
Siullir-mik *uanga* *tamanna* *qulara-a-ra.*
first-sg.MOD 1s that$_\Omega$ doubt-IND.TV-1s.3s
The first time I doubted it.

Intuitively, this continuation is coherent: one has no sense of 'something missing', characteristic of presuppositions in need of accommodation. The online update in (23′) is faithful to this intuition:

(23′) first- -MOD
$[e|\ e =_{\mathbf{d}\omega}\ {}^{1}d\eta^{\varepsilon}];\ [\mathbf{t}|\ \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES}\ e];$

1s that$_\Omega$
$[\mathbf{a}|\ 1s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{a}];\ [p|\ p =_{\mathbf{d}\omega} d\kappa^{\Omega}\{d\varepsilon\}];$

doubt-
$[s|\ s\text{: EXP}\ doubt_{\mathbf{d}\omega}\ d\kappa^{\Omega}];$

-IND. .TV
$[|\ \text{BEG}\ d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon];\ [|\ \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma];\ [|\ \text{EXP}\ d\sigma =_{\mathbf{d}\omega} \mathbf{d}\alpha];$

-1s .3s
$[|\ 1s_{\mathbf{d}\omega,\,\mathbf{d}\varepsilon}\ \mathbf{d}\alpha];\ [|\ d\kappa^{\Omega}\{d\sigma\} =_{\mathbf{d}\omega} d\Omega]$

The initial modifier 'first-MOD' retrieves the reporting habit ($d\eta^{\varepsilon}$) from (18′b). It evokes the first speech event that instantiates this habit, and updates the topic time to the result time. The verb comments on this topic ($\mathbf{d}\tau$), as usual. But in (23′) it also elaborates a background dref: the reported proposition ($d\Omega$). This is introduced by a propositional anaphor, 'that$_\Omega$', as the proposition that instantiates, in that first reporting event, the aforementioned kind of proposition ($d\kappa^{\Omega}$).

In contrast, even the dynamic theory of Kamp and Reyle 1993 has no drefs to retrieve because it does not encapsulate habitual quantification. To interpret the continuation in (23), this LF-based theory appeals to *subordination*—a structure-building operation that copies LF constituents and may also insert other inaudibila (Roberts 1989). So far nobody has succeeded in formalizing this operation, but let us suppose for the sake of argument that it could be done. What worries me is the best case scenario. For instance, if we try to match the predictions of (23′), a subordination account would have to build the LF equivalent of something like:

(LF$_{23}$) ~~There is a current period *t* such that~~ the first time ~~my father played chess during *t* and claimed the next day to have won~~ I doubted ~~the proposition he expressed when he claimed, for the first time, the day after playing chess during *t*, to have won~~.

So the best case scenario for subordination is massive redundancy: endlessly rebuilding and recomposing LF constituents.[25] In contrast, direct online update simply retrieves familiar dref objects that are currently most prominent, given their type. So this puzzle too favors direct online update, which offers a cleaner and more intuitive account.

9 CONCLUSION

I have presented a new framework for direct composition: *online update*. The basic idea is that the surface string is interpreted as is, with each morpheme in turn updating the current state of information and attention. A formal representation language, *Logic of Centering*, with stack-based anaphora, was defined and some general constraints on basic meanings and compositional operations were formulated.

This framework was then used to analyze a series of mini-discourses in Kalaallisut, with increasingly more complex polysynthetic morphology. After some paradigm examples of episodic and habitual discourse, we analyzed three cases of semantic convergence across surface diversity—to wit, a pair of mini-discourses with reported habits, a pair with reported beliefs, and a pair with habitual reports. Each pair illustrated two patterns—morphosyntactically far apart but semantically equivalent—of interacting temporal, modal, and *de se* anaphora. Direct online update naturally accounted for the semantic convergence by positing parallel anaphoric links, within and across sentence boundaries.

In LF-based semantics temporal, modal, and *de se* dependencies are generally analyzed in terms of variable binding. Since variable binding is sentence-bound, it cannot match the present, more general, theory. In direct online update variable binding operations are

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[25] Some LF theories represent 'missing material' as free variables. But since they do not say how these variables get their values, this is hardly a solution.

'encapsulated' in the sense of Stone 1997. That is, they are recast as anaphora to discourse referents for entire patterns. The encapsulation strategy is viable even for highly complex dependencies. In the present analysis temporal quantification was encapsulated by means of discourse referents for habits and kinds of time; modal quantification, by means of discourse referents for analogous modal concepts; and *de se* dependencies in habitual reports, by means of discourse referents for report-dependent modal concepts. Parallel anaphoric links within and across sentence boundaries are then an automatic consequence of encapsulation. Once a discourse referent for a pattern has been introduced, it is available for anaphora. That is, it is possible to talk about that pattern, both later in that sentence and later in the discourse.

APPENDIX: FROM NL LEXICON TO LC

Class	Kalaallisut	LC (basic meaning listed first)	E.g.
<u>n-roots</u>			
α-cn	*angut-*	$[k^{\alpha} \mid \textit{man}\ k^{\alpha}]$	
α-rn	*ataata-*	$[k^{\alpha}_{\alpha} \mid k^{\alpha}_{\alpha}\ \textit{dad.of}\ \alpha]$	(11′)
τ-cn	*amirlanir-*	$[k^{\tau} \mid \textit{most}\{\vartheta\text{RES}\ {}^{1}d\eta^{\varepsilon\varepsilon}, k^{\tau}\}]$	(15′a, b)
τ-rn	*aqagu-*	$[k^{\tau}_{\eta} \mid k^{\tau}_{\eta}\ \textit{day.after}\ \eta^{\varepsilon}]$	(18′)
Ω-cn	*uqaluttualia-*	$[k^{\Omega} \mid \textit{story}\ k^{\Omega}]$	
Ω-rn	*isuma-*	$[k^{\Omega}_{\alpha} \mid k^{\Omega}_{\alpha}\ \textit{belief.of}\ \alpha]$	(16′a)
<u>v-roots</u>			
σ-iv	*sinig-*	$[s \mid s\text{: EXP}\ \textit{asleep}_{\mathbf{d}\omega}]$	(11′a)
σ-tv	*qulari-*	$[s \mid s\text{: EXP}\ \textit{doubt}_{\mathbf{d}\omega}\ d\kappa^{\Omega}]$	(23′)
ε-iv	*uqar-*	$[e\ p \mid e\text{: AGT}\ \textit{say}_{\mathbf{d}\omega}\ p]$	(15′a)
		$[h^{\varepsilon}\ k^{\Omega} \mid h^{\varepsilon}\text{: AGT}\ \textit{say}\ k^{\Omega}]$	(18′a)
	ajugaa-	$[e \mid e\text{: AGT}\ \textit{win}_{\mathbf{d}\omega}\ d\varepsilon\varepsilon]$	
		$[\underline{e} \mid \underline{e}\text{: AGT}\ \textit{win}\ d\underline{\varepsilon\varepsilon}]$	(16′a, b)
		$[h^{\varepsilon} \mid h^{\varepsilon}\text{: AGT}\ \textit{win}\ d\eta^{\varepsilon\varepsilon}]$	(15′a, b)
		$[\underline{e}_{\varepsilon} \mid \underline{e}_{\varepsilon}\text{: AGT}\ \textit{win}\ d\eta^{\varepsilon\varepsilon}]$	(18′a, b)
ε-tv	*tillug-*	$[e \mid e\text{: AGT}\ \textit{hit}_{\mathbf{d}\omega}\ d\kappa^{\alpha}]$	
εε-iv	*skakkir-*	$[ee\ k^{\alpha} \mid ee\text{: (AGT} + k^{\alpha})\ \textit{play.chess}_{\mathbf{d}\omega}]$	(12′)
		$[\underline{ee}\ k^{\alpha} \mid \underline{ee}\text{: (AGT} + k^{\alpha})\ \textit{play.chess}]$	
		$[\mid d\underline{\varepsilon\varepsilon}\text{: (AGT} + d\kappa^{\alpha})\ \textit{play.chess}]$	(16′)
		$[h^{\varepsilon\varepsilon}\ k^{\alpha} \mid h^{\varepsilon\varepsilon}\text{: (AGT} + k^{\alpha})\ \textit{play.chess}]$	(14′)
εε-tv	*uqaluqatigi-*	$[ee\ k^{\alpha} \mid ee\text{: AGT}\ \textit{talk.with}_{\mathbf{d}\omega}\ k^{\alpha}]$	(15′)
<u>derivational suffixes</u>			
•	*-qar* (n\v)	$[s\ p \mid p =_{\mathbf{d}\omega} d\alpha\kappa^{\Omega}\{\text{EXP}, s\}]$	(16′a)
.	*-lir* (v\v)	$[e \mid (e =_{\mathbf{d}\omega} \text{BEG}\ d\sigma), (\text{EXP}\ e =_{\mathbf{d}\omega} \text{EXP}\ d\sigma)]$	(16′a)
<•	*-sima* (v\v)	$[s \mid (s =_{\mathbf{d}\omega} \text{RES}\ d\varepsilon), (\text{EXP}\ s =_{\mathbf{d}\omega} \text{AGT}\ d\varepsilon)]$	
		$[\underline{s}_{\varepsilon} \mid (\underline{s}_{\varepsilon} = \text{RES}\ d\varepsilon\underline{\varepsilon}), (\text{EXP}\ \underline{s}_{\varepsilon} = \text{AGT}\ d\varepsilon\underline{\varepsilon})]$	(18′a, b)
se•	*-suri* (v\v)	$[s\ p \mid (s\text{: EXP}\ \textit{believe}_{\mathbf{d}\omega}\ p),$ $(\vartheta s \subseteq_{p} d\underline{\sigma}), (\text{EXP}\ s =_{p} \text{EXP}\ d\underline{\sigma})]$	(16′b)
	-nirar (v\v)	$[e\ p \mid (e\text{: AGT}\ \textit{say}_{\mathbf{d}\omega}\ p),$ $(\vartheta e \subseteq_{p} d\eta^{\varepsilon}), (\text{AGT}\ e =_{p} \text{AGT}\ d\eta^{\varepsilon})]$	(15′b), (19)
		$[h^{\varepsilon}\ k^{\Omega} \mid (h^{\varepsilon}\text{: AGT}\ \textit{say}\ k^{\Omega}),$ $(h^{\varepsilon}{::}\ \vartheta\varepsilon \subseteq_{k\Omega} d\varepsilon\underline{\sigma}), (h^{\varepsilon}{::}\ \text{AGT}\ \varepsilon =_{k\Omega} \text{EXP}\ d\varepsilon\underline{\sigma})]$	(18′b)

se>	*-ssa* (v\v)	$[\mid \mathbf{d}\Omega = \text{Dom } \mathbf{d}\underline{\omega}]; [\underline{s}\mid \underline{s} =_{\mathbf{d}\Omega} \text{RES } {}^{1}d\underline{\varepsilon\varepsilon}), (d\underline{\varepsilon} \subseteq_{\mathbf{d}\underline{\omega}} \vartheta s), (\text{AGT } d\underline{\varepsilon} =_{\mathbf{d}\underline{\omega}} \text{EXP } \underline{s})]$	(16′a)
		$[p\mid p = \text{Dom } \mathbf{d}\underline{\omega}]; [\underline{s}\mid \underline{s} =_{d\Omega} \text{RES } {}^{1}d\underline{\varepsilon\varepsilon}), (d\underline{\varepsilon} \subseteq_{\mathbf{d}\underline{\omega}} \vartheta s), (\text{AGT } d\underline{\varepsilon} =_{\mathbf{d}\underline{\omega}} \text{EXP } \underline{s})]$	(16′b)
		$[p\mid p = \text{Dom } {}^{f}d\underline{\varepsilon\varepsilon}]; [\underline{s}\mid \underline{s} =_{d\Omega} \text{RES } {}^{1}d\underline{\varepsilon\varepsilon}), (d\underline{\varepsilon} \subseteq_{d\Omega} \vartheta s), (\text{AGT } d\underline{\varepsilon} =_{d\Omega} \text{EXP } \underline{s})]$	(20′)
••	*-tar* (v\v)	$[\mid \text{Dom } d\eta^{\text{V}} = \mathbf{d}\kappa^{\tau}]$	(12′), (13′)
		$[\mid \text{Dom } d\eta^{\text{V}} = \vartheta\text{RES } {}^{1}d\eta^{\varepsilon\varepsilon}]$	(19′)
		$[k^{\tau}\mid \text{Dom } d\eta^{\text{V}} = k^{\tau}]$	(18′a, b)
	-gajut (v\v)	$[\mid \mathit{often}\{\mathbf{d}\kappa^{\tau}, d\eta^{\text{V}}\}]$	(18′a, b)
		$[\mid \mathbf{d}\kappa^{\tau}\text{:: } \mathit{often}\{d\kappa^{\Omega}, d\eta^{\text{V}}\}]$	(18′a, b)
<u>n-inflection</u>			
$\text{CN}^{\top}$	-(ERG)	$[\mathbf{t}\mid \mathbf{t} =_{\mathbf{d}\omega} d\kappa^{\tau}\{\mathbf{d}\varepsilon\}]$	(15′)
	-LOC	$[\mathbf{t}\mid \mathbf{t} \subseteq_{\mathbf{d}\omega} d\kappa^{\tau}\{\mathbf{d}\varepsilon\}]$	(11′)
	-VIA	$[\mathbf{k}^{\tau}\mid \mathbf{k}^{\tau} = d\kappa^{\tau}]$	(12′), (13′)
$\text{RN}^{\top}$	-LOC	$[\mathbf{k}^{\tau}\mid \mathbf{k}^{\tau} \subseteq_{::} d\eta\kappa^{\tau}\{{}^{1}d\eta^{\varepsilon\varepsilon}\}]$	(18′)
$\text{RN}^{\perp}$	-(ERG)	$[a\mid a =_{\mathbf{d}\omega} d\alpha\kappa^{\alpha}\{d\alpha, \mathbf{d}\varepsilon\}]$	(15′)
<u>v-inflection</u>			
main	-IND	$[\mid \text{BEG } d\sigma <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\sigma]$	(11′a)
		$[\mid d\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [\mid d\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]$	(11′b)
		$[\mid {}^{1}d\varepsilon\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [\mid {}^{1}d\varepsilon\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]$	(11′c)
		$[\mid {}^{1}d\eta^{\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\omega} d\eta^{\varepsilon}]$	(12′)
		$[\mid {}^{1}d\eta^{\varepsilon} <_{\mathbf{d}\Omega} \mathbf{d}\varepsilon]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\Omega} d\eta^{\varepsilon}]$	(15′a)
		$[\mid \text{BEG } d\underline{\sigma} <_{\mathbf{d}\Omega} \mathbf{d}\sigma]; [\mid \mathbf{d}\tau \subseteq_{\mathbf{d}\Omega} d\underline{\sigma}]$	(16′a)
		$[\mid \mathbf{d}\eta^{\varepsilon}\text{:: BEG } d\varepsilon\underline{\sigma} <_{\mathbf{d}\kappa\Omega} \varepsilon]; [\mid \mathbf{d}\eta^{\varepsilon}\text{:: } \mathbf{d}\kappa^{\tau} \subseteq_{\mathbf{d}\kappa\Omega} d\varepsilon\underline{\sigma}]$	(18′a)
	.IV	$[\mid \text{AGT } d\varepsilon =_{\mathbf{d}\omega} \mathbf{d}\alpha]$	(15′a)
dep	$\text{-FCT}_{\top}$	$[\mid ({}^{1}d\underline{\varepsilon\varepsilon} <_{\mathbf{d}\omega} \mathbf{d}\varepsilon), (\text{AGT } d\underline{\varepsilon\varepsilon} = \mathbf{d}\alpha)]; [\mid {}^{1}d\underline{\varepsilon\varepsilon} \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [\mathbf{t}\mid \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES } {}^{1}d\underline{\varepsilon\varepsilon}]$;	(16′)
	$\text{-FCT}_{\perp}$	$[\mid ({}^{1}d\varepsilon\varepsilon <_{\mathbf{d}\omega} \mathbf{d}\varepsilon), (\text{AGT } d\varepsilon\varepsilon =_{\mathbf{d}\omega} d\alpha)]; [\mid {}^{1}d\varepsilon\varepsilon \subseteq_{\mathbf{d}\omega} \mathbf{d}\tau]; [\mathbf{t}\mid \mathbf{t} =_{\mathbf{d}\omega} \vartheta\text{RES } {}^{1}d\varepsilon\varepsilon]$;	(15′)
agr	-1s	$[\mid \mathit{1s}_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha]$	(11′b)
	$\text{-3s}_{\perp}.\text{3s}_{\top}$	$[\mid \mathit{3s}_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ d\alpha, d\alpha \neq \mathbf{d}\alpha]; [\mid \mathit{3s}_{\mathbf{d}\omega, \mathbf{d}\varepsilon}\ \mathbf{d}\alpha, \mathbf{d}\alpha =_{\mathbf{d}\omega} d\kappa^{\alpha}\{d\varepsilon\}]$	(15′)
<u>particle</u>			
◇	*immaqa*	$[\underline{e}\mid \mathit{can}\{{}^{f}d\underline{\varepsilon\varepsilon}, \underline{e}\}]; [\underline{\mathbf{w}}\mid \mathit{poss}\ \underline{\mathbf{w}}, (d\underline{\varepsilon} =_{\underline{\mathbf{w}}} {}^{f}d\underline{\varepsilon\varepsilon})]$	(16′a, b)

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REFERENCES

Bittner, M. (1994) *Case, Scope, and Binding*. Kluwer, Dordrecht.
Bittner, M. (2001) 'Surface composition as bridging'. *Journal of Semantics* **18**:127–177.
Bittner, M. (2003) 'Word order and incremental update'. *Proceedings from CLS* **39**-1. Chicago Linguistic Society, Chicago.
Chierchia, G. (1989) 'Anaphora and attitudes *de se*'. In R. Bartsch *et al* (eds.) *Semantics and Contextual Expression*. Foris, Dordrecht.
Dekker, P. (1994) 'Predicate Logic with Anaphora'. *Proceedings from SALT* IV, 79–95. CLC, Ithaca.
Gazdar, G. (1979) 'A solution to the projection problem'. In Ch. Oh *et al* (eds.) *Syntax and Semantics* 11. Academic Press, New York.
Grosz, B., A. Joshi, and S. Weinstein (1995) 'Centering: A framework for modeling the local coherence of discourse'. *Computational Linguistics* **21**:203–225
Heim, I. (1982) *The Semantics of Definite and Indefinite Noun Phrases*. Ph.D. thesis, University of Massachussetts at Amherst.
Heim, I. (1983) 'On the projection problem for presuppositions'. *Proceedings of WCCFL* 2, 114–125. Stanford University, CA.
Kamp, H. and U. Reyle. (1993) *From Discourse to Logic*. Kluwer, Dordrecht.
Kaplan, D. (1978) 'On the logic of demonstratives'. *Journal of Philosophical Logic* **8**:81–98.
Karttunen, L. (1976) 'Discourse referents'. In J. McCawley (ed.) *Syntax and Semantics* **7**, 363–85. Academic Press, New York.
Kratzer, A. (1981) 'The notional category of modality'. In H. Eikmeyer *et al* (eds.) *Words, Worlds and Contexts*, 38–74. De Gruyter, Berlin.
Lewis, D. (1973) *Counterfactuals*. Blackwell, Oxford.
Lewis, D. (1975) 'Adverbs of quantification'. In E. Keenan (ed.) *Formal Semantics of Natural Language*. Cambridge University Press, Cambridge.
Lewis, D. (1979) 'Attitudes *de dicto* and *de se*'. *Philosophical Review* **88**:513–543.
Muskens, R. (1995) 'Tense and the Logic of Change'. In U. Egli *et al* (eds) *Lexical Knowledge in the Organization of Language*, 147–184. John Benjamins, Philadelphia.
Partee, B. (1984) 'Nominal and temporal anaphora'. *Linguistics and Philosophy* **7**:243–286.
Roberts, C. (1989) 'Modal subordination and pronominal anaphora in discourse'. *Linguistics and Philosophy* **12**:683–722.
Sandt, R. van der (1992) 'Presupposition projection as anaphora resolution'. *Journal of Semantics* **9**:333–377.
Sapir, E. (1922) *Language*. Harcourt and Brace, New York.
Schlenker, P. (2003) 'A plea for monsters'. *Linguistics and Philosophy* **20**:29–120.
Stalnaker, R. (1968) 'A theory of conditionals'. *Studies in Logical Theory*, No. 2, Blackwell, Oxford.
Stalnaker, R. (1978) 'Assertion'. In P. Cole (ed) *Syntax and Semantics* 9, 315–322. Academic Press, New York.
Stone, M. (1997) 'The anaphoric parallel between modality and tense'. Technical Report IRCS 97–6. http://www.cs.rutgers.edu/~mdstone
Stone, M. and D. Hardt (1999) 'Dynamic discourse referents for tense and modals' In H. Bunt and R. Muskens (eds.) *Computing Meaning*, Vol. 1, 301–320. Kluwer, Dordrecht.
Webber, B. (1988) 'Tense as discourse anaphor'. *Computational Linguistics* **14**:61–73.