The temporal orientation of infinitives [1]

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Abstract. In this paper, we present a compositional semantics for a covert future operator which derives the distribution of future oriented infinitival complements to attitude predicates. We then show that the account makes correct predictions concerning the temporal orientation of prejacents to modal auxiliaries.

Keywords: infinitival tense, attitude predicates, covert future.

1. Introduction

1.1. Three types of infinitive

There are three attested temporal orientations of infinitival complements to attitude predicates: (i) obligatorily simultaneous, where the event time of the embedded clause is understood to overlap with the event time of the matrix clause (1a), (ii) obligatorily future oriented, where the embedded event time is understood to follow the matrix event time (1b), or (iii) optionally future oriented, where the embedded event time is typically understood to follow the matrix event time, although under certain conditions they may also be understood to overlap (1c).

(1) a. Mikhail {claimed/pretended/was glad/believed Judit} to be at the party.
     b. Mikhail {promised/asked/ordered Judit} to be at the party.
     c. Mikhail {hoped/expected/wanted} to be at the party.

Abusch (2004) noted this trifurcation for passive ECM constructions of the form *x is V-ed to P*. She called the verbs in each class: B-verbs, F-verbs, and P-verbs respectively (the following judgments reflect Absuch's classification).[2]

(2) a. Judit is believed to be at the party ({already/*tomorrow}).
     b. Judit is forecast to be at the party ({tomorrow/*already}).
     c. Judit is predicted to be at the party ({tomorrow/already}).

Yet, despite insights such as those of Katz (2001), Abusch (2004), von Stechow (2005), Wurmbrand (2014), and others, Portner (2018) notes that work on the temporal orientation of infinitives is still fragmentary. Additionally, the majority of work on infinitival tense is primarily concerned with the status of the infinitival subject (i.e., PRO, trace, or ECM subject), with only secondary interest in temporality (e.g., Stowell, 1982; Pesetsky, 1992; Landau, 2000; Martin, 2001; Grano, 2015; Pearson, 2016). The present paper puts the question of the infinitival subject aside and aims to solely address the data in (1) and (2).

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[2] Abusch called F-verbs as such because she took the predicate *forecast* to typify these verbs. However, for most people *forecast* seems to behave much like *predict* in permitting simultaneous readings (i).

(i)   A: What is the weather like outside?
       B: It is forecast to be raining.

1.2. Two types of approaches

In the cases above (1)-(2), the infinitival complements themselves are ostensibly identical. There have largely been two ways to go about handling this disparity between surface form and interpretation: (i) positing a covert future operator (e.g., Abusch, 2004; von Stechow, 2005; Wurmbrand, 2014; Grano, 2015) as in (3), or (ii) building it into the selecting verbs lexical semantics (Katz, 2001; Pearson, 2016) as in (4).

(3) $[\![\text{FUT}]\!]^{w,t} = \lambda p. \exists t' > t : [\![p]\!]^{w,t'} = 1$

(4) $[\![\text{expect}_{Katz\ (2001)}]\!]^{w,t} = \lambda p.\lambda x. \forall \langle w',t' \rangle \in \text{Dox}_{w,t,x} : \exists t'' > t' : [\![p]\!]^{w',t''} = 1$

Both Abusch (2004) and Williamson (2017) argue explicitly in favor of something like (3). However, proposals of this sort need to account for the distribution of the putative future operator. How can its distribution be restricted to give us the observed data? Wurmbrand (2014), Grano (2015), and Williamson (2017) treat the future operator as a covert instantiation of *woll*, the abstract future modal underlying present tense *will* and past tense *would* (Abusch, 1998). However, this raises a number of questions: firstly, why can an overt *woll* appear in finite complements to predicates like *believe* and *claim* but a covert *woll* cannot occur in infinitival complements to the same predicates? Secondly, why is it that infinitival complements to predicates like *expect* feature a covert *woll* but not, for instance, a covert deontic *must*?

(5)   Mikahil expected to tidy his room.
        a. $\approx$ Mikhail expected he would tidy his room.
        b. $\not\approx$ Mikhail expected he must tidy his room.

Here, we will assume that the future operator is dissociated from modal auxiliaries (Matthewson, 2012; Giannakidou and Mari, 2018) but may be licensed in their scope. Infinitival complements cannot license modal auxiliaries (Stowell, 2004; Iatridou and Zeijlstra, 2013) and as a result the semantics of the selecting verb itself is responsible for the licensing of the future operator. To achieve the observed distribution of future oriented infinitives, we argue that the future operator carries a presupposition that the modal context – introduced below – is diverse with respect to the future oriented proposition. We also suggest that an obligatorily future oriented reading is necessary for the verbs discussed above due to the notion of intention to act (Grano, 2017b). The resulting picture is that the distribution of future orientation in infinitival complements is dictated by the modal force and flavor of the embedding verb. We further note that these generalisations hold equally for the temporal orientation of prejacents to different types of modal auxiliaries.

In the next section, we outline the background assumptions necessary to formulate our proposal.

2. Kratzerian modal semantics and some extensions

2.1. The modal base and the ordering source

Kratzer (1977, 1981, 2012) develops a doubly relativized theory of modality, which makes use of two contextually determined *conversational backgrounds* (a function from worlds, times, and potentially individuals to a set of propositions). The first relevant conversational background is the *modal base* function f which returns a set of propositions which, when intersected, provides a set of accessible worlds.

(6) $\llbracket \text{must } \varphi \rrbracket^{w,t,f} = 1$ iff $\forall w' \in \bigcap f(w)(t) : \llbracket \varphi \rrbracket^{w',t} = 1$

A theory of modality with only a modal base runs in to some well-known problems providing truth conditions for deontic statements like that in (7).

(7) The person who killed Mikhail must go to prison.

It is tempting to assume that, in (7), the relevant propositions returned by f are those that make up the law.[3]

(8) a. $\llbracket (7) \rrbracket^{w,t,f} = 1$ iff $\forall w' \in \bigcap f(w)(t) : \left\llbracket \begin{array}{c} \text{the person who killed Mikhail} \\ \text{goes to prison} \end{array} \right\rrbracket^{w',t} = 1$

b. where $f(w)(t) = \text{LAW}_{w,t} = \{p \mid p \text{ is a law in } w \text{ at } t\}$

However, the prejacent *the person who killed Mikhail goes to prison* (Strawson) entails that Mikhail was killed. If the law entails the person who killed Mikhail goes to prison, then the law also entails Mikhail was killed (!). So, the following inference is predicted to hold.[4]

(9) The person who killed Mikhail must go to prison.
$\not\Rightarrow$ Mikhail must have been killed.

Kratzer's solution is to suggest that deontic modals rank accessible worlds according to how well they satisfy, for example, the law. But the only worlds considered are those compatible with the circumstances (e.g., worlds in which Mikhail has been murdered). Deontic modals, then, have a *circumstantial* modal base, and the worlds in the modal base are ranked according to a second conversational background: the *ordering source*. We pick out the best worlds in the modal base (MB) according to the ordering source (OS) with the operator MAX (von Fintel, 1999; von Fintel and Heim, 2011).

(10) a. $\text{MAX}_{\text{OS}}(\bigcap \text{MB}) = \{w \in \bigcap \text{MB} \mid \neg \exists w' \in \text{MB} : w' \prec_{\text{OS}} w\}$
b. where $w' \prec_{\text{OS}} w$ iff $\{p \in \text{OS} \mid \llbracket p \rrbracket^w = 1\} \subset \{p \in \text{OS} \mid \llbracket p \rrbracket^{w'} = 1\}$

We can now propose a revised semantics for (7) (where g is the ordering source function).

(11) a. $\llbracket (7) \rrbracket^{w,t,f,g} = 1$ iff $\forall w' \in \text{MAX}_{g(w)(t)}(\bigcap f(w)(t)) :$
$\llbracket \text{the person who killed Mikhail goes to prison} \rrbracket^{w',t} = 1$
b. where $f(w)(t) = \text{CIRC}_{w,t} = \{p \mid p \text{ is a fact in } w \text{ at } t\}$
c. and $g(w)(t) = \text{LAW}_{w,t}$

These new truth conditions require that, given the facts, all the most law-abiding worlds are such that the person who killed Mikhail goes to prison. While this is intuitively a more appropriate semantics for (7), given (11), we should still be able to draw the undesirable inference in (9). Since all the worlds in the modal base are worlds in which there are murderers, it follows that in the best worlds there are murders. This issue is resolved by assuming that, whenever a modal has an ordering source, the modal base must be diverse with respect to the prejacent. (i.e., it must contain φ and $\neg\varphi$ worlds). This ensures that the restriction on the domain of quantification imposed by the ordering source is not redundant.

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[3]We will use all uppercase letters for a set of propositions, and a mix of upper and lowercase for its intersection (e.g., $\text{Dox}_{w,t,x} = \bigcap \text{DOX}_{w,t,x}$).
[4]That this inference is predicted, yet does not hold, is known as the Paradox of the Good Samaritan (Prior, 1958).

2.2. Attitude predicates

Since Hintikka (1969) the verb *believe* is generally assumed to be a universal quantifier over doxastically accessible worlds (those worlds compatible the attitude holder's beliefs).

(12) $[\![\alpha \text{ believe } \varphi]\!]^{w,t} = 1$ iff $\forall w' \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w',t} = 1$

However, if we treat bouletic predicates such as *want* in a manner similar to *believe*, we encounter the same type of problem observed for deontic modals above (Stalnaker, 1984; Heim, 1992).

(13)   a.   I believe Judit will get better.
                   $\Rightarrow$ I believe Judit is sick.
          b.   I want Judit to get better.
                   $\not\Rightarrow$ I want Judit to be sick.

von Fintel (1999) proposes an ordering semantics for bouletic predicates, and a diversity requirement on the modal base of the attitude. The following semantics for *hope* is von Fintel's. The modal base is the doxastic alternatives of the attitude holder, and the ordering source is the propositions which constitute the desires of the attitude holder.

(14) $[\![\alpha \text{ hopes } \varphi]\!]^{w,t} =$
          a.   defined iff $\exists w' \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w',t} = 1 \wedge \exists w'' \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w'',t} = 0$
          b.   if defined, $= 1$ iff $\forall w''' \in \text{MAX}_{\text{DES}_{w,t,\alpha}}(\text{Dox}_{w,t,\alpha}) : [\![\varphi]\!]^{w''',t} = 1$

On this semantics, *hope* φ presupposes that the attitude holder is uncertain whether φ, thereby avoiding the undesireable Stalnaker/Heim inferences in (13b), while asserting that φ is true in all the most desirable belief worlds.

2.3. Modal contexts

In addition to the above, we will adopt the notion of a *modal context*. It has been proposed that certain operators are sensitive to an additional parameter *S* on the denotation assignment function which relativizes the function to a set of worlds. The most notable items of this sort are epistemic modals (see Yalcin, 2007; Anand and Hacquard, 2013).[5] We will call such a parameter the *modal context* (Portner, 1992).[6] Crucially, the modal context can be shifted by various modal operators. We propose that modal operators shift the modal context to their modal base.[7]

(15) $[\![\alpha \text{ believe } \varphi]\!]^{w,t,S} = 1$ iff $\forall w' \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w',t,\text{Dox}_{w,t,\alpha}} = 1$

This essentially ensures that the modal base of an attitude predicate is accessible to certain operators in the clause embedded directly under it.

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[5]See also Portner (2018) for a recent overview of this idea.

[6]We will also use this term to refer to the environment which is interpreted against this parameter: corresponding to the immediate syntactic scope of the modal operator.

[7]There may be an additional need for a second modal context which tracks the ordering source in some way. Such a modal context could play a role in accounting for mood selection.

3. Defining the future

The focus of this paper is on, what we will call, the *contingent future* which is typically used in predictive contexts and is generally introduced by the modal auxiliary *will* in English finite clauses.

(16)   The Red Sox will win tomorrow.

This is in contrast to to the *scheduled future* which looks morphologically like the simple present, or the present progressive (17a). This type of future can only be used when describing states of affairs which are in some sense planned (cf. (17b)) (see Copley, 2009, 2008).

(17)   a.   The Red Sox {play/are playing} tomorrow.
         b.   #The Red Sox {win/are winning} tomorrow.

In order to provide a semantics for the contingent future which will derive the observed phenomena, it is worth considering what it means for a future state of affairs to be contingent. Contingency should be defined with respect to a set of possible worlds X. Informally, a future state of affairs is contingent wrt X iff there are worlds in X for which there is a future time at which the state of affairs holds and there are worlds in X for which there is no future time at which the state of affairs holds. To capture this intuition, we need to make our modal contexts more fine-grained. We treat modal operators (e.g., *believe*) as quantifying not just over worlds, but rather over world-time pairs. Where the temporal variable corresponds to the attitude holder's (e.g., doxastic) candidate for NOW (Abusch, 1998: a.m.o). The evaluation time of an infinitival complement is bound by the temporal coordinate quantified over by the selecting verb (Schlenker, 1999; Katz, 2001; Stephenson, 2007; Pearson, 2016).

(18) $\llbracket \alpha \text{ believe } \varphi \rrbracket^{w,t,S} = 1$ iff $\forall \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : \llbracket \varphi \rrbracket^{w',t',\text{Dox}_{w,t,\alpha}} = 1$

We can now propose a future operator like (3) above but with a contingency presupposition where the relevant set of worlds with respect to which the proposition is contingent is the local modal context.

(19) $\llbracket \text{FUT}(p) \rrbracket^{w,t,S} =$
         a.   defined iff $\exists \langle w',t' \rangle \in S : \exists t'' > t' : \llbracket p \rrbracket^{w',t''} = 1$
                $\land \exists \langle w',t' \rangle \in S : \neg \exists t'' > t' : \llbracket p \rrbracket^{w',t''} = 1$
         b.   if defined, $= 1$ iff $\exists t' > t : \llbracket p \rrbracket^{w,t'} = 1$

With this semantics for the contingent future operator FUT, let us see what distribution we derive with infinitival complements to attitude predicates based on standardly assumed denotations for these predicates.

4. Simultaneous predicates

Recall that the following predicates are unable to embed a future oriented infinitive (where *be glad* is representative of the entire class of emotive factives).

(20)   *Mikhail $\left\{ \begin{array}{c} \text{believed Judit} \\ \text{claimed} \\ \text{pretended} \\ \text{was glad} \end{array} \right\}$ to win the match tomorrow.

4.1. *Believe*

Given a Hintikkan semantics for *believe*, it should be clear that if its complement φ is of the form FUT(p), then the presupposition of the future operator will contradict the assertion.[8]

(21) $[\![\alpha \text{ believes FUT}(p)]\!]^{w,t,S} =$
    a.   defined iff $\exists \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : \exists t'' > t' : [\![p]\!]^{w',t'',\text{Dox}_{w,t,\alpha}} = 1$
                                   $\wedge \exists \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : \neg \exists t'' > t' : [\![p]\!]^{w',t'',\text{Dox}_{w,t,\alpha}} = 1$
    b.   if defined, $= 1$ iff $\forall \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : \exists t'' > t : [\![p]\!]^{w',t'',\text{Dox}_{w,t,\alpha}} = 1$

This sort of systematic contradiction has been proposed to result in ungrammaticality (Gajewski, 2002, 2009; Chierchia, 2013; Abrusán, 2014).[9] We thus derive the fact that *believe* will be ungrammatical when embedding a future oriented infinitive, as the sentence can never be defined and true.

4.2. *Claim*

Anand and Hacquard (2009) give an event semantics for *claim* φ, in which *claim* is taken to consist of an asserting event, with the goal of updating the *common ground* (Stalnaker, 1978) with φ. Putting aside event semantics, we might propose something along the lines of (22).

(22) $[\![\alpha \text{ claims } \varphi]\!]^{w,t,S} = 1$ iff α says $\varphi \wedge \forall w' \in \text{Goals}_{w,t,\alpha} :$
                                      $\forall \langle w'',t'' \rangle \in \bigcap \text{CG}_{w'} : [\![\varphi]\!]^{w'',t'',\bigcap \text{CG}_{w'}} = 1$

If φ in (22) is of the form FUT(p), then the presupposition would be such that the set of worlds compatible with the common ground ($\bigcap$CG) in α's goal worlds is diverse with respect

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[8]The presupposition of FUT must project out of attitude contexts or else we make a weaker prediction that the attitude holder has an inconsistent belief (Patrick Elliot, pc). We propose that the presupposition of the contingent future is akin to presuppositions triggered by (e.g., gender) features in that they project out of attitude environments. An interesting possibility is that there is only one future operator, which carries either a CONTINGENT feature or SCHEDULED feature. The present proposal could then be seen as defining the semantics for the CONTINGENT feature.

[9]Perhaps the best known account of this sort is that of Gajewski (2002, 2009) and his notion of L(ogical)-Analyticity. The account can be summarized as follows.
(i)   *L-Analyticity*
    a.   A sentence is ungrammatical if its LF contains a L-analytic constituent.
    b.   A constituent α of type t is L-analytic iff α's logical skeleton receives the denotation 1 (or 0) under every variable assignment for which it is defined.
    c.   where α's logical skeleton is determined by the process of
       i.   Identifying the maximal constituents containing no permutation invariant items (van Bentham, 1989).
       ii.   Replacing each such constituent with a distinct variable of the same type.
Adopting an account of this type will require syntactic decomposition of attitude predicates in order to ensure the relevant parts are permutation invariant (see Theiler et al., 2018). A Hintikkan attitude predicate selects a modal base accessibility function $\mathcal{M}$ as an argument (ii). A predicate with an ordering source takes an additional ordering source argument O (iii).
(ii)   a. $[\![\mathcal{M}_{\text{Dox}}]\!]^{w,t} : \langle e, \langle i,st \rangle \rangle = \lambda x. \text{Dox}_{w,t,x}$
     b. $[\![\text{PRED}]\!]^{w,t} = \lambda \mathcal{M}.\lambda p.\lambda x. \forall \langle w',t' \rangle \in \mathcal{M}(x) : [\![p]\!]^{w',t',\mathcal{M}(x)} = 1$
(iii)   a. $[\![O_{\text{DES}}]\!]^{w,t} : \langle e, \langle \langle i,st \rangle, t \rangle \rangle = \lambda x. \text{DES}_{w,t,x}$
     b. $[\![\text{PRED}_{\text{OS}}]\!]^{w,t} = \lambda \mathcal{M}.\lambda O.\lambda p.\lambda x. \forall \langle w',t' \rangle \in \text{MAX}_{O(x)}(\mathcal{M}(x)) : [\![p]\!]^{w',t',\mathcal{M}(x)} = 1$
For the sake of simplicity we suppress these syntactic complications in the main text.

to FUT(p). The second conjunct of the assertion, however, would require that $\bigcap$CG in α's goal worlds is uniform with respect to FUT(p).

4.3. *Be glad* and emotive factives

The emotive factive *be glad* has a preference semantics, and so should have a diversity condition on its modal base. However, *be glad* also presupposes belief (Schlenker, 2003). That is, α *is glad that* φ presupposes α believes that φ. This presupposition can be seen to project in entailment cancelling environments (e.g., the *family-of-sentences* paradigm (Chierchia and McConnell-Ginet, 1990; Tonhauser et al., 2013)).

(23)   a.   Mikhail is not glad that Judit won.
         b.   If Mikhail is glad that Judit won, he will buy her a present.
         c.   Is Mikhail glad that Judit won?

The modal base of emotive factives, then, cannot be doxastic (or else the presupposition of *be glad* will always result in a contradiction). Rather, the modal base of *be glad* must be a superset of the doxastic alternatives which includes some $\neg\varphi$ worlds. The important point for our purposes is that *be glad* will not be able to embed FUT(p) due to the following definedness conditions.

(24) $[\![\alpha \text{ is glad FUT}(p)]\!]^{w,t,S} = $ defined iff $[\![\alpha \text{ believes FUT}(p)]\!]^{w,t,S}$ is defined $\wedge$
$$[\![\alpha \text{ believes FUT}(p)]\!]^{w,t,S} = 1 \wedge ...$$

This says that *be glad FUT(p)* can only be defined when *believe FUT(p)* is defined and true. As we have seen above this condition can never be met.

At first, the emotive factive *be excited* appears to be a counterexample to the above generalisation. It is factive, and yet individuals are typically excited about future events. However, note that infinitival complements to *be excited* can only be about the future when the complement involves a scheduled event.

(25)   a.   Judit is excited to {meet/be meeting} Mikhail later.
         b.   *Judit is excited to {win/be winning} the match tomorrow.

Thus, even the apparently problematic *be excited* obeys the generalisation that emotive factives are unable to embed the contingent future, as predicted by the present proposal.

4.4. *Pretend*

The verb *pretend* similarly cannot embed future oriented infinitives (Pearson, 2016). The explanation for this is similar in nature to that for emotive factives. However, this verb presupposes that the attitude holder believes the complement to be false: the doxastic alternatives of the attitude holder are uniform with respect to $\neg\varphi$. As such, when it embeds FUT(p), it will have the definedness conditions in (26), which can never be satisfied.

(26) $[\![\alpha \text{ pretends FUT}(p)]\!]^{w,t,S} = $
defined iff $[\![\alpha \text{ believes } \neg(\text{FUT}(p))]\!]^{w,t,S}$ is defined $\wedge$
$$[\![\alpha \text{ believes } \neg(\text{FUT}(p))]\!]^{w,t,S} = 1 \wedge ...$$

In contrast, consider *wish*. When *wish* takes a finite complement it presupposes that the attitude holder believes the complement to be false.

(27)   Mikhail wishes he could travel to Paris next year.
         ⇒ Mikhail believes he can't travel to Paris next year.

However, when it takes a non-finite complement, this counterfactivity disappears (likely due to the lack of counterfactual morphology in its complement).

(28)   Mikhail wishes to travel to Paris next year.
         ⇏ Mikhail believes he won't travel to Paris next year.

Since *wish+to* lacks a counterfactual presupposition, we correctly predict that infinitival complements to *wish* need not be obligatorily simultaneous, as can be seen in (28).

5. Optionally future oriented predicates

Let us turn our attention to the optionally future oriented predicates *want*, *hope*, and *expect*. The presuppositions of these predicates not only account for their possible future orientations, but also constrain the conditions under which they can embed simultaneous infinitives (Banerjee, 2017; Williamson, 2017).

5.1. *Hope* and *expect*

The following is based on von Fintel's (1999) semantics for *hope*.

(29) $[\![\alpha \text{ hopes } \varphi]\!]^{w,t,S} =$
         a.   defined iff $\exists \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w',t',\text{Dox}_{w,t,\alpha}} = 1 \wedge$
         $$\exists \langle w'',t'' \rangle \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w'',t'',\text{Dox}_{w,t,\alpha}} = 0$$
         b.   if defined, $= 1$ iff $\forall \langle w''',t''' \rangle \in \text{MAX}_{\text{DES}_{w,t,\alpha}}(\text{Dox}_{w,t,\alpha}) : [\![\varphi]\!]^{w''',t''',\text{Dox}_{w,t,\alpha}} = 1$

The presupposition of this verb ensures that the modal base is diverse wrt φ, while the assertive content involves quantification over a subset of the modal base (the most desirable doxastic alternatives). Given this semantics, *hope* is correctly predicted to be able to embed FUT.

As for the verb *expect*, Katz (2001) proposes a semantics as follows (repeated from (4), where the quantification over future times is built into the verb.

(30) $[\![\text{expect}_{Katz\ (2001)}]\!]^{w,t} = \lambda p.\lambda x. \forall \langle w',t' \rangle \in \text{Dox}_{w,t,x} : \exists t'' > t' : [\![p]\!]^{w',t''} = 1$

Conversely, Williamson (2017) argues that *expect* has a semantics more or less identical to *hope* modulo replacing the bouletic ordering source with one of likelihood.

(31) $[\![\alpha \text{ expects } \varphi]\!]^{w,t,S} =$
         a.   defined iff $\exists \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w',t',\text{Dox}_{w,t,\alpha}} = 1 \wedge$
         $$\exists \langle w'',t'' \rangle \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w'',t'',\text{Dox}_{w,t,\alpha}} = 0$$
         b.   if defined, $= 1$ iff $\forall \langle w''',t''' \rangle \in \text{MAX}_{\text{LIKELY}_{w,t,\alpha}}(\text{Dox}_{w,t,\alpha}) : [\![\varphi]\!]^{w''',t''',\text{Dox}_{w,t,\alpha}} = 1$

Evidence for this affinity between *hope* and *expect* comes in several forms. Most notably, their doxastic uncertainty requirements can be seen in examples like the following (cf. *want*), based on Scheffler (2008). If the attitude holder believes either φ or $\neg\varphi$, then it is infelicitous to

expect or hope φ. This is straightforwardly accounted for if *expect*, like *hope*, has a doxastic uncertainty requirement.

(32)   A: It is raining.
      B: I want it to be / That is what I want.
      C: #I hope it is / I expect it to be.

(33)   A: It is raining.
      B: I want it not to be / That is not what I want.
      C: #I hope it isn't / I expect it to not be.

Furthermore, these predicates both asymmetrically embed epistemic modals (Anand and Hacquard, 2013). They may embed epistemic possibility modals, but not epistemic necessity modals (see Williamson (2017: fn.11) for a formalisation of how to capture this with a von Fintel-style semantics). The most suggestive evidence, however, is that English *hope* and *expect* are translated as one and the same verb in several Romance languages (e.g., *esperar* in Spanish). We can capture this by fixing the modal base, while the ordering source is partially determined by a conversational background supplied by *g*.

(34) $[\![\alpha \text{ esperar } \varphi]\!]^{w,t,g,S} =$
    a.   defined iff $\exists \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w',t',\text{Dox}_{w,t,\alpha}} = 1 \wedge$
$$\exists \langle w'',t'' \rangle \in \text{Dox}_{w,t,\alpha} : [\![\varphi]\!]^{w'',t'',g,\text{Dox}_{w,t,\alpha}} = 0$$
    b.   if defined, $= 1$ iff $\forall \langle w''',t''' \rangle \in \text{MAX}_{g(w)(t)(\alpha)}(\text{Dox}_{w,t,\alpha}) : [\![\varphi]\!]^{w''',t''',g,\text{Dox}_{w,t,\alpha}} = 1$

With this semantics for *expect*, it is no surprise that it too can embed future oriented infinitives. Interestingly, this semantics also constrains the distribution of simultaneous infinitival complements to these verbs. Pesetsky (1992) notes that *expect* can embed a simultaneous ECM complement and when it does it means something akin to *believe but not know*.[10]

(35)   I expect there to be flowers on the table.

Abusch (2004) makes a similar observation for *predict* in passive ECM constructions.

(36)   Judit is predicted to be pregnant.

Williamson (2017) shows that *expect* and *hope* can embed simultaneous complements only when their doxastic uncertainty requirement holds. This is more likely to be the case with ECM complements (for *expect* or *predict*). However, control complements can also be interpreted simultaneously given the appropriate context.[11]

(37)   SCENARIO: *Judit is running for office. She has not viewed the polls, nor has she heard any news. Mikhail asks her how she thinks she is doing. She replies*
    a.   I {hope/expect} to be winning (already).
    b.   I {hope/expect} to have won by a landslide (by now).

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[10]While our semantics does not correspond exactly to Pesetsky's informal characterization, it is analogous.

[11]Williamson (2017) suggests that, due to PRO's interpretation *de se* (Chierchia, 1989), the uncertainty requirement is easier to fulfil with an ECM complement than with a control complement. It is intuitively less common for an individual to be uncertain whether a property currently holds of herself, while she can often be uncertain whether such a property holds of another individual, or herself at a future time.

A similar observation for simultaneous subjunctive complements to *esperar* is found in Laca (2015).

5.2. *Want*

That *want* has on ordering semantics, and can embed FUT is not surprising. What is perhaps more interesting is how it differs from the verb *hope*. In contrast to *hope*, *want* has often been argued to lack a doxastic component (Anand and Hacquard, 2013), or to have a modal base which is a superset of the doxastic alternatives, containing some non-belief worlds (Rubinstein, 2017). Unlike *hope*, this allows *want* to embed a proposition which the attitude holder believes to be impossible (Heim, 1992) (38a), or true (38b) (Iatridou, 2000).

(38)   a.   I want this weekend to last forever.
         b.   I live in Bolivia because I want to live in Bolivia.

It is thus less constrained in that it can embed simultaneous infinitives even when the attitude holder is certain of the truth (38b) or falsity (39) of the complement.

(39)   Mikhail wanted to be sitting on a beach somewhere, but he was stuck in the office.

We have seen here that *hope*, *expect*, and *want* permit the embedding of FUT, but do not necessitate it. In the next section, we will see that there are a class of predicates which *must* embed FUT and that this correlates with other behavior particular to this class of verbs.

6. Obligatorily future oriented predicates

Given that *forecast* is not an obligatorily future oriented predicate in English (fn.2), it appears that the generalisation tying together this class is that they involve commitment to act (whether private or public). They are all verbs of intention (list adapted from Grano (2017b)).

(40)   a.   Verbs of private commitment: *aim, choose, decide, endeavour, intend, plan*
         b.   Verbs of public commitment: *agree, offer, pledge, promise, swear, threaten*
         c.   Verbs of influence: *advise, ask, command, order, persuade, convince, urge*

Grano (2017b) suggests that the verbs in (40) all encode the RESP relation of Farkas (1988) as part of their semantics. Intentional verbs are all infelicitous with complements that describe states of affairs which are not under the control of the understood subject of the embedded infinitive.

(41)   a.   #Mihail {promised/asked/decided} to be tall.
         b.   #Mikhail {promised/asked/decided} to resemble his father.

Compare this to the other verbs we have considered above.

(42)   a.   Mihail {hoped/wanted/expected} to be tall.
         b.   Mikhail {hoped/wanted/expected} to resemble his father.

(43)   a.   Mikhail {claimed/pretended/believed Judit} to be tall.
         b.   Mikhail {claimed/pretended/believed Judit} to resemble his father.

In the literature it is often noted that states of affairs at a time prior to, or equal to, NOW are *presupposed to be settled* (Condoravdi, 2002; Kaufmann, 2005; Kaufmann et al., 2006) in the

sense that they can no longer be influenced (intentionally or otherwise). We propose that it is systematically infelicitous for an individual to be in the RESP relation to φ whenever the truth or falsity of φ is presupposed to be metaphysically settled. Let us propose, therefore, that the RESP relation has a *metaphysical unsettledness* requirement. The truth or falsity of φ must not be metaphysically settled at the time of the intention. The only propositions which are not metaphysically settled are those that involve a future operator.

7. Potential counter examples

There are three potential counterexamples to the above generalisations that we are aware of: *try*, *suspect*, and *be certain*. Fristly, Grano (2017b) classes the verb *try* with verbs of intention. If so, it should be obligatorily future oriented (counter to fact).

(44)   Judit tried to win (*tomorrow).

However, it is potentially incorrect of Grano to class *try* with the other verbs of intention. It is possible that although *try* involves intention in the intuitive sense, it is less clear that it involves the RESP relation as it can embed some predicates which cannot be embedded under other verbs of intention. For instance, Jackendoff and Culicover (2003) note that the predicate *understand physics* cannot be embedded under verbs of intention. However, it can readily be embedded under *try*.[12]

(45)   a.   #Mikhail {promised/asked/decided} to understand physics.
         b.   Mikhail tried to understand physics.

More problematic is the verb *suspect*. If we were to give *suspect* a similar semantics to that of *expect* then we should predict that it can embed FUT (counter to fact).

(46)   a.   *Judit suspects Mikhail to win tomorrow.
         b.   Judit suspects Mikhail to be the murderer.

It is possible, then, that diversity is a necessary but not sufficient condition for licensing FUT. Nonetheless, further research is certainly required here.[13]

Lastly, it intuitively appears that we predict that the raising predicate *be certain* should be obligatorily simultaneous. Rather, it behaves like its weaker, optionally future oriented counterpart *be likely* in also allowing future orientation.

(47)   Judit is {likely/certain} to win tomorrow.

It is possible, however, that *be certain* does not have a quantificational structure comparable to *believe* or modals like epistemic *must*. Rather, it is a probability operator which maps its prejacent to the maximal degree on a probability scale (e.g., [0,1]). Portner (2009: pp.73-9) notes that, while we need a compositional account of such operators, they are fundamentally different from run-of-the-mill modals. Of course, whether these facts are consistent with the

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[12]For more on *try* see Sharvit (2003); Grano (2011, 2017a).

[13]Angelika Kratzer and Daniel Rothschild (pc) point out that *suspect*'s apparent weakness (e.g., compared to *believe*) is not necessarily indicative of an ordering semantics, but rather could be attributable to the modal base simply being a subset of the doxastic alternatives (similar to how, in the general case, doxastic alternatives are a subset of epistemic alternatives). If this were so, then *suspect* would not be a counter example to the present proposal. However, it remains to be seen whether or not this move would be justified.

current proposal ultimately depends on what turns out to be the most appropriate way to model probability operators.

So far, we have shown how the proposed semantics for FUT derives the distribution of the contingent future in infinitival complements to attitude predicates. However, since our semantics for attitude predicates shares its quantificational structure with modal auxiliaries, we would ideally derive the distribution of FUT under modal auxiliaries too. In the next section, we will show how this proposal extends straightforwardly to epistemic modals and directive uses of deontic modals.

8. Modal auxiliaries

8.1. Epistemic modals

8.1.1. The generalisation

Epistemic modals have the following temporal properties: 'strong' necessity modals cannot be future oriented, while 'weak' necessity modals and possibility modals can. Firstly, consider the the following epistemic possibility modals, which all permit a reading in which the prejacent holds of a future time.

(48)   Judit {might/may/could} be sick tomorrow.

Even in the absence of temporal adverbials, a future reading is forced if the prejacent receives an episodic reading of an eventive predicate.

(49)   Judit {might/may/could} win.

This is likely due to the constraint against the simple present with eventive predicates in English and many other languages (Giorgi and Pianesi, 1997). Since a simultaneous reading is ruled out, the future oriented reading is forced.

Next consider epistemic strong necessity modals. These permit an epistemic reading when interpreted simultaneously.

(50)   Judit {must/has to/can't} be at home (already).

However, when the prejacent is modified by a future adverbial like *tomorrow* an epistemic reading is impossible (Enç, 1986; Stowell, 2004; Lekakou and Nilsen, 2008; Portner, 2009).

(51)   *Judit {must/has to/can't} be sick tomorrow.   (*epistemic*)

Likewise, they cannot receive an epistemic reading when their prejacent is a episodic eventive predicate.

(52)   *Judit {must/has to/can't} win.   (*epistemic*)

Finally, consider epistemic weak necessity modals. While these are harder to construe with an epistemic reading, they nonetheless pattern with possibility modals rather than strong necessity modals (see especially Banerjee, 2018a: who independently proposes a similar account to the one developed here).

(53)   Judit {should/ought to} be sick tomorrow.   (*epistemic*)

(54)   Judit {should/ought to} win.   (*epistemic*)

In sum, epistemic possibility modals and weak necessity modals permit future orientation. Epistemic strong necessity modals do not.

8.1.2. The account

Epistemic modals have been proposed to have a special architecture. Yalcin (2007) and Anand and Hacquard (2013) propose that epistemic modals quantify directly over worlds in the modal context. In matrix declaratives, the modal context is the epistemic alternatives of the speaker in the evaluation world, at the evaluation time. Based on these assumptions, we predict that FUT should not be embedded under an epistemic which encodes that its modal base is uniform with respect to its prejacent. This is precisely what epistemic strong necessity modals have been proposed to encode. von Fintel and Gillies (2010) argue that strong necessity modals do not have a ordering source, and thus do not have a diversity requirement.[14]

(55) $[\![\text{must } \varphi]\!]^{w,t,S} = 1$ iff $\forall \langle w',t' \rangle \in S : [\![\varphi]\!]^{w',t',S} = 1$

If we were to assume a diversity condition on epistemic strong necessity modals (Werner, 2006; Giannakidou and Mari, 2018: *inter alia*) then we would be without an account as to why they cannot embed contingent future prejacents. To account for the future orientation of weak necessity modals, on the other hand, we appeal to the idea that weak necessity encodes the promotion of an ordering source (von Fintel and Iatridou, 2008; Rubinstein, 2012). A modal like epistemic *should* would quantify over only the most likely of the worlds in *S*. Epistemic possibility modals existentially quantify over *S*, and can consequently satisfy the contingency presupposition of the FUT. On this picture, what distinguishes epistemic strong necessity modals from weak necessity modals and possibility modals is that only in the case of strong necessity modals is the modal base required to be uniform with respect to the prejacent. FUT is therefore ruled out under epistemic *must* for much the same reason as it cannot be embedded directly under *believe*.

Kaufmann (2005) suggests that matrix assertions involve a covert necessity modal $\emptyset$. He further shows that *woll*, realised as present tense *will* and past tense *would*, is weaker than $\emptyset$ and thus requires an ordering source. Unfortunately, space limitations preclude a more complete discussion of *woll* here. However, Kaufmann's suggestion that *woll* is weaker than $\emptyset$ should be sufficient for it to license FUT.[15,16]

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[14]According to von Fintel and Gillies (2010) the apparent weakness of *must* when compared to a bare assertion is due to a presupposition that φ is established indirectly (see also Mandelkern, 2016). On the other hand, Lassiter (2014) and Goodhue (2017) provide alleged arguments against a strong semantics for *must*. Angelika Kratzer (pc) observes that apparent normalcy conditions which restrict the domain of *must* are always defeasible and as such we should refrain from building them into the semantics. Nonetheless, whether the semantics of *must* involves domain restriction is still a topic of serious debate (e.g., von Fintel and Gillies, 2018).

[15]For evidence that *woll* is a genuine modal and not simply a future marker see Klecha (2014).

[16]It is worth noting that *woll* does not obligatorily embed FUT. There are instances where *will* can be used with a present reference time (Kaufmann, 2005; Giannakidou and Mari, 2018).

(i)   a.   Mikhail will be in his office already.
       b.   [Upon hearing the doorbell] That will be Judit now.

Before moving on, it is worth considering how a modal like *might* licenses FUT in embedded finite clauses.

(56) $[\![\alpha \text{ believes that it might FUT rain}]\!]^{w,t,S} =$
   a.   defined iff $\exists \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : \exists t'' > t' : [\![\text{rain}]\!]^{w',t'',\text{Dox}_{w,t,\alpha}} = 1 \wedge$
$\exists \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} : \neg \exists t'' > t' : [\![\text{rain}]\!]^{w',t'',\text{Dox}_{w,t,\alpha}} = 1$
   b.   if defined, $= 1$ iff $\forall \langle w',t' \rangle \in \text{Dox}_{w,t,\alpha} :$
$\exists \langle w'',t'' \rangle \in \text{Dox}_{w,t,\alpha} : \exists t''' > t'' : [\![\text{rain}]\!]^{w'',t''',\text{Dox}_{w,t,\alpha}} = 1$

Here the universal quantification of *believe* in the first line of (56b) is vacuous, and FUT(rain) need not be true throughout the modal base. This is in contrast to non-finite complements where no modal auxiliary is present to license FUT.

8.1.3. A note on Klecha (2016)

Recent work by Klecha (2016) proposes that epistemics never permit a future oriented reading, and the instances of future readings for *might* is due to it being interpreted metaphysically (Condoravdi, 2002: *inter alia*). Moreover, Klecha maintains that *hope* and *expect* do not have a doxastic modal base when future oriented. Again, he suggests that in such instances they have a metaphysical modal base.

Klecha's proposal differs from the present account, and it is worth considering whether there is any reason to prefer one over the other. Firstly, concerning attitude predicates, Banerjee (2018b) shows convincingly that the modal base of *hope* cannot be metaphysical when future oriented, as this makes incorrect predictions. Secondly, there is good reason to think that modals like *might* can be truly epistemic even when future oriented. This is because the metaphysical reading of epistemics can take narrow scope with respect to other operators (such as the past marker *have*), while true epistemics are notorious for taking wide scope, so-called *epistemic containment* (von Fintel and Iatridou, 2003). The canonical contrast is given in (57). Example (57a) conveys epistemic possibility about a past event, while (57b) conveys a metaphysical possibility from some past time (Condoravdi, 2002).

(57)   a.   Mikhail might already have won the race.   ($\exists > have$, *have $> \exists$)
        b.   At that time, Mikhail might still have won the race.   (*have* $> \exists$)

Crucially, quantificational subjects cannot scope over the modal when it is construed epistemically. Given that a race can only have one winner, it is infelicitous to assert that it is possible that every runner won (58a). However, when the modal is construed metaphysically, the universal can take wide scope (58b) and the claim is that every runner is such that, at that time, they might go on to win the race.

(58)   a.   #Every runner might already have won the race.   (#$\exists > \forall$, *$\forall > \exists$)
        b.   At that time, every runner might still have won the race.   ($\forall > \exists$)

Now note that, on its future oriented reading, *might* nonetheless appears to exhibit epistemic containment. The universal in (59) only very marginally scopes over the epistemic with awkward stress. In fact, many speakers judge (59) infelicitous altogether, suggesting that they are

not accessing a metaphysical reading at all. However, if future oriented *might* is always metaphysical, we should expect (59) to be completely sensible on the reading intended. The fact that it is not suggests that the default reading for future oriented *might* is nonetheless epistemic.

(59)   #Every runner might win the race tomorrow.   (#∃ > ∀, *∀ > ∃)

8.2. Directive uses of deontic modals

Deontic *may* and *must* cannot be used to place someone under an obligation or grant someone permission to bring about a state of affairs which cannot be done so intentionally.

(60)   a. #You must {be tall/resemble your father}!   (*deontic*)
         b. #You may {be tall/resemble your father}.   (*deontic*)

Similarly, their prejacent cannot be about a past time (Ninan, 2005).

(61)   a. #You must have tidied your room yesterday!   (*denotic*)
         b. #You may have eaten a cookie earlier.   (*deontic*)

Above, we proposed to capture similar data by proposing that the RESP relation bears certain constraints. The data in (60) and (61) would suggest that the same constraints are at play with directive uses of deontic modals. Whatever the status of the RESP relation, it is nonetheless clear that directive uses of *may* and *must* pattern like obligatorily future oriented predicates both with respect to what sort of prejacent they can have, as well as their temporal orientation.

9. Conclusion

This paper has proposed a compositional semantics for the (contingent) future which places a constraint on the environments in which it can be embedded. We focused specifically on deriving the distribution of future orientation in infinitives in English. Beyond English, however, Laca (2015) has shown that similar constraints are at play in Spanish subjunctive complement clauses. We further showed how our semantics made correct predictions for epistemic modals and directive uses of deontic modals. The account proposed has a similar motivation to that of Klecha (2016) in that it aims to give a unified account for the temporal orientation of modal prejacents and attitude complements. However, it differs from Klecha's account in that it takes the determining factor to be, not modal flavor *per se*, but rather modal diversity. In that respect, it has much in common with Banerjee (2018a, b), who has independently arrived at a similar conclusion. Crucially, this account rests on the assumption that not all modal bases have a diversity requirement. This last point is a contentious issue, and one which is still under debate. If the above proposal is correct, then it may support the notion that diversity is not a prerequisite for every modal base.

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