

Final prepublication version, August 1999. The final version appears in The Syntax of Time, J. Gueron and J. Lecarme (eds). Cambridge: MIT Press, 2004.

On the Temporal Composition of Infinitives

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**1. Introduction**

Non-tensed intensional complements in English often have a future interpretation. (1) illustrates this, in order, for a control to-infinitive, raising-to-object to-infinitive, raising-to-passive-subject to-infinitive, passive participle small clause, intensional NP, raising to-infinitive, and accusative-ing argument of a predicative noun phrase.

- (1) a. Solange hopes to be in Stockholm next week.  
b. Guido expects Solange to be in Stockholm next week.  
c. Barak is predicted to win.  
d. I want this dispute resolved.  
e. Guido needs a bike.  
f. Guido is likely to flunk out of college.  
g. Guido flunking out of college is a certainty.

This paper investigates the logical form (compositional structure) of to-complements. Much of what I say, though, seems to apply to the other types of futurate complements too. One issue I will address is the interaction between

futurate verbs and embedded tenses. In (2), the verb intends affects not only the temporal location of the answering events corresponding to the untensed head answer of its complement, but also the location of the sending events corresponding to the present tense verb sends in the relative clause.

(2) Solange intends to answer every email Guido sends.

Another related issue I will address is whether to-infinitive complements have a propositional structure similar to that of tensed complements. Does the complement in (1b) have the same denotation as the complement in (3)? If so, is the compositional structure of the two complements isomorphic, so that (1b) includes an element semantically similar to will?

(3) Guido expects that Solange will be in Stockholm next week.

The paper is organized as follows. Section 2 considers the interpretations available for to-complements. Section 3 reviews a semantic-interpretive framework and an analysis of the English future auxiliary will developed in Abusch (1998), which involves temporal substitution. Section 4 shows that arguments which motivate temporal substitution with will also apply with future-oriented

infinitives. Section 5 gives an argument that meaning-elements identified in Section 4 are syntactically overt.

## 2. Possible Readings of to-complements

### 2.1 Diagnostics for B-verbs

In this section I consider the interpretation of to-infinitive complements in one syntactic class, with the aim of characterizing the readings available and establishing diagnostics for them. In (4), sixteen verbs taking a raising-to-passive-subject complement structure are listed in their past participle forms. Example (5) illustrates the raising-to-passive-subject complement structure.

(4)	I	II
	asserted	anticipated
	believed	expected
	claimed	forecast
	confessed	intended
	known	meant
	reported	planned
	said	predicted
	thought	projected

- (5) a. Barak is believed to be in the lead.  
 b. Barak is forecast to win by about 8 percentage points.

Criteria such as the possibility of an expletive subject indicate that these are raising structures, with the subject filling no argument position of the higher verb (e.g. believed or predicted). (6) gives examples with an expletive there subject.

- (6)a. There is believed to be a linguistics dept. in Geneva.
- b. There is predicted to be a volcanic eruption in Oregon next year.

This and other syntactic diagnostics for raising-structures are discussed in Postal (1974). Turning to semantics, the verbs in column I of (4) allow only for simultaneous readings of the complement infinitive. This is reflected in three properties.

- (i) Incompatibility with past and future frame adverbs modifying the top-level predicate in the complement.
- (ii) Incompatibility with non-stative complements.
- (iii) Equivalence with present tense or sequence-of-tense past tense tensed complements.

The first property is illustrated below.

- (7)a. \* Guido is believed to be at Monique's place last night.

- b. \*/ok Guido is believed to be at Monique's place tomorrow night.
- c. Guido is believed to be at Monique's place (now).

As used in (7a), last night is a past-denoting temporal frame adverb in the sense that last night precedes the attitude time, which in our example is the believing time. In a similar sense, tomorrow night in (7b) is future denoting. Last night in (7a) modifies the top level predicate be at Monique's place in the complement, and so the star in (7a) illustrates (i). Notice that (7a) contrasts with the tensed complement (8a), and with the version with an infinitival temporal have in (8b).

- (8) a. It is believed that Guido was at Monique's place last night.
- b. Guido is believed to have been at Monique's place last night.

In (8b), last night does not modify the top-level predicate have, but instead the embedded predicate be at Monique's place. Therefore (8b) does not violate property (i).

In (7b) with the future adverb there is a twist: the example is good on a scheduling interpretation of the complement. This interpretation also shows up with present tense non-stative verbs.

(9) Guido is at Monique's place tomorrow night.

In (9) it is understood that Guido has a schedule, perhaps a regular one, for where he is to stay. The scheduling interpretation can be controlled for by adjusting the content. While (10a) is fine as a description of the scheduled begin of a party, (10b) is a bit odd as break up suggests a non-scheduled end. The same distinction carries over to the to-infinitives in (10c,d). This supports the claim that (10c) involves a distinct scheduling interpretation.

- (10) a. The party starts at 10 p.m.  
       b. ?#The party breaks up at 4 a.m.  
       c. The party is thought to start at 10 p.m.  
       d. ?#The party is thought to break up around 4 a.m.

The examples below make the same point. Many electronic components have a fixed probability of failing over any year starting at a time when the component has not failed yet. Such components will fail sooner or later, but one does not know when it will happen. (11a) is a good description of this situation, but (11b) is odd, presumably because of an incompatibility between the scheduling modality and the undeterminedness of the time of failure. Keeping the scenario the same, (12c) is odd in

the same way as (11b), because the scenario makes the scheduling interpretation implausible.

- (11) a. The component will sooner or later fail.  
       b. #The component sooner or later fails.
- (12) a. It is believed that the component will sooner or  
       later fail.  
       b. #It is believed that the component sooner or  
       later fails.  
       c. #The component is believed to sooner or later  
       fail.

With the scheduling interpretation eliminated, the hash marks in (10d) and (12c) illustrate the part of property (i) having to do with future adverbs: column-one verbs with future time adverbs modifying the to-infinitive do not have an ordinary, non-scheduling interpretation.<sup>1</sup> We will call verbs in column I like believe, and thought B-verbs, while column II verbs like forecast and predict will be referred to as F-verbs.

In contrast with the B-verbs in (4), the F-verbs are compatible with future adverbs in the complement.<sup>2</sup>

- (13) a. Bibi is predicted to be in the lead next  
       week.  
       b. A solar eclipse is forecast to occur in  
       Württemberg in August 1999.

c. The meeting is meant to end at 3:00 p.m.

(The utterance time for example (13b) is in 1999, before August.)

Property (ii) refers to the following paradigm.

- (14) a. \*/gen Guido is believed to visit Stockholm.  
 b. \*/gen Guido is claimed to visit Stockholm.  
 c. \*/gen Guido is reported to visit Stockholm.  
 d. \*/gen Guido is said to visit Stockholm.
- (15) a. Guido is expected to visit Stockholm.  
 b. Guido is meant to visit Stockholm.  
 c. Guido is predicted to visit Stockholm.  
 d. Guido is projected to visit Stockholm.
- (16) a. Guido is believed to be in Stockholm.  
 b. Guido is claimed to be in Stockholm.  
 c. Guido is reported to be in Stockholm.  
 d. Guido is said be in Stockholm.
- (17) a. Guido is expected to be in Stockholm.  
 b. Guido is meant to be in Stockholm.  
 c. Guido is predicted to be in Stockholm.  
 d. Guido is projected to be in Stockholm.

The predicate visit Stockholm is a non-stative one, while the predicate be in Stockholm is a stative one. This is evidenced by the fact that (18) has no episodic interpretation---it only has a generic/habitual

interpretation 'Guido has the habit or practice of visiting Stockholm'. (19) does have an episodic interpretation, which describes a simple fact about location.

(18) \*/gen Guido visits Stockholm.

(19) Guido is in Stockholm.

In (14) and (16) the contrast between (18) and (19) is duplicated in the complement infinitive of B-verbs. The sentences in (14) only have generic interpretations for the complements. We can attribute this to B-verbs allowing only stative complements.<sup>3</sup>

I assume the generic reading involves a top-level covert generic operator, which makes the complement stative (as evidenced by the possibility of the generic reading of (18)). It's easy to control for the generic interpretation by considering meaning. When we put this reading aside, the stars in (14) illustrate the stativity restriction (ii).

The examples in (15) of F-verbs with a non-stative complements have episodic future interpretations, generic simultaneous interpretations, and also generic future interpretations. They have no episodic simultaneous interpretations. The stativity restriction is in fact a

general restriction on simultaneous readings, which is also observed with tensed complements:

- (20) a. \*/gen It is thought that Solange sleeps.  
 b. It is thought that Solange is sleeping.

Because sleep is non-stative, (20a) has no episodic interpretation approximately equivalent to (20b). Since all simultaneous readings are stative, we can attribute the stativity restriction on B-verbs (i.e. that B-verbs complements are always stative) to B-verbs only having simultaneous readings.

Property (iii) refers to the equivalence of pairs such as the following.

- (21) a. Guido was thought to be in Stockholm.  
 b. It was thought that Guido was in Stockholm.  
 (22) a. Guido is claimed to be in Stockholm.  
 b. It is claimed that Guido is in Stockholm.

This diagnostic can be seen to derive from the fact (or assumption) that the present tense complement (22b) and the sequence of tense past complement (21b) have simultaneous interpretations. The test can not be applied totally mechanically, because the tensed complement may have other interpretations. When an antecedent is set up for the embedded past tense verb as in (23), a reading is

possible where eventualities corresponding to the embedded clause (in this case the finishing) precede the attitude time.

- (23) As demonstrated in the present study, Nabokov was in Flims when he finished Laughter in the Dark. In a talk given last year, Prof. Schmetterling incorrectly claimed that he was in Montreux.

Also, with a small set of verbs, a present tense complement has a future interpretation.

- (24) a. Guido hopes Monique wins.  
 b. I pray that the snow stops soon.  
 c. ?I predict Baraks wins by at least 10 points.

So actually, there is something circular about diagnostic (iii), on a weakened understanding which allows the exceptions above. It in effect says that the infinitival complements of B-verbs are equivalent to tensed complements with simultaneous interpretations.

Summing up, properties (i)-(iii) distinguish B-verbs from F-verbs. Especially in the case of property (i), the connection with simultaneous interpretations should be clear.

## 2.2. Past Readings

In the previous subsection we saw that F-verbs with to-infinitives complement are compatible with future frame adverbs. As illustrated in (25), such F-verbs are incompatible with past adverbs.

(25) \*Guido is predicted (by almost everyone) to spend the night of last Friday's party at Monique's place.

Curiously, the intended reading can be expressed by F-verbs with past tense complements.

- (26) a. I predict that Guido spent the night of last Friday's party at Monique's place.  
 b. It is predicted (by almost everyone) that Guido spent the night of last Friday's party at Monique's place.

Note that there is a special pragmatics for these examples: it is suggested that it is not known at the predicting time where Guido spent that night.

The same data are observed with other F-verbs: anticipated, forecast, planned, and projected.<sup>4</sup>

- (27) a. It is anticipated that a meteor impact took place yesterday afternoon in a remote part of

Quebec. Scientists have not arrived at the scene yet.

- b.\*A meteor impact is anticipated to take place yesterday afternoon in a remote part of Quebec.

Past readings are also impossible for B-verbs with to-infinitives complements.

- (28) \*Guido is thought to be at Monique's place last night.

This perhaps suggests that the compositional semantics of infinitives should exclude past readings.

The examples in (26) and (27a) indicate that the obvious element of futurity in predict has nothing immediately to do with the temporal location of the event described by the main verb in the complement. Note that (26a) is roughly paraphrasable as follows.

- (29) I say that the proposition that Guido spent the night of last Friday's party at Monique's place will turn out true.

This goes along with the implicature that at the predicting time it is not known whether this proposition is true or not. The curious possibility such examples suggest is that in (30), futurity is represented twice,

once by will in the complement, and once internal to the lexical meaning of predict. This results in a paraphrase (31), with two occurrences of will.

(30) It is predicted that Barak will win.

(31) I say that the proposition that Barak will win  
will turn out true.

It is conceivable that predict with an infinitival complement has a similar compositional structure. This would be the case if the to-complement contained a discrete element FUT whose compositional role is similar to that of will. A past reading for to-infinitive complement of predict would be impossible for the same reason that (30) has no past reading.

### 2.3. Simultaneous Readings of F-verbs

We have seen that infinitival complements of F-verbs have no past interpretations. However, contrary to the impression that the infinitival complements of these verbs are uniformly futurate, simultaneous readings are possible. Consider the scenario below.

A petition for a ballot initiative is being circulated. A lot of signatures have been collected, but not yet summed up. In (32) what is at issue is how many signatures have already been obtained, and in this sense the complement has a simultaneous interpretation. In view

of the pragmatics mentioned in the previous subsection and the fact that the present number of signatures being unknown, a use of projected in this context should make perfect sense. As indeed it does.

(32) The petition is projected to have over 20,000 signatures now.

(33) Monique is predicted to already be pregnant.

(33) is another example of an F-verb with a simultaneous reading. Monique is trying to get pregnant with the new technology. Her doctor is confident of the efficacy of his treatments, and is pretty sure she is pregnant now. They will not find out for sure until tests are possible in a few days. Again, what is at issue is her being pregnant now, and because of the epistemic situation, a use of predicted with a simultaneous complement is pragmatically licensed.

Raising adjectives such as likely and certain are also compatible with both simultaneous and future scenarios:

(34) a. Monique is likely/certain to be in Stockholm now.

b. Monique is likely/certain to be in Stockholm next weekend.

c. Monique is likely/certain to win.

Note that with an event verb win in (34c), the aspectual restriction on simultaneous readings is observed, and only a future interpretation is possible.

A compendious analysis of verb classes is beyond the scope of this paper. But it is relevant to ask whether there are any exclusively future-oriented infinitive-embedding verbs, i.e. ones which exclude a simultaneous interpretation. This is the case with a control use of promise. While promised with a tensed complement in (35a) has a simultaneous reading, the version with a to-infinitive in (35b) does not.<sup>5</sup>

- (35) a. In her phone call to Guido, Monique promised that she was in the office, not at Paul's place.
- b. In her phone call to Guido, Monique promised to be in the office, not at Paul's place.

It is relevant to ask whether promise in (35a) and ordinary examples of promise with an infinitival complement as in (36) involve the same root word sense.

- (36) Monique promised to be home before midnight.

If they do, then there has to be something structural about (35b) (such as an additional futurity morpheme

being present in the complement) which excludes the simultaneous reading. Notice that future-oriented to-complements can be conjoined with simultaneous that-complements:

(37) In her phone call to Guido, Monique promised to be home before midnight, and that she was in her office.

This supports the hypothesis of a single word sense for promise in (35a) and (36). However promise with a to-complement seems to have a narrower range of meaning than with the corresponding that-complement.

(38) a. Monique promised that she would eventually fall asleep tonight.  
 b. Monique promised to eventually fall asleep tonight.

There is a way of reading (38a) which does not imply the same kind of lasting commitment which (38b) implies. Assume Monique realizes she is tired and knowing herself well is sure she would fall asleep tonight. (38a) can describe her making an emphatic statement, the truth of which she is committed to when she makes the statement, without making a promise in the ordinary sense. Suppose that after all, Monique does not fall asleep. If she made

a promise, she would have to do something to fall asleep, such as take a sleeping pill. If she merely made a statement, she need not be committed in the same way to making it turn out true. The interesting point now is that (38b) with the to-infinitive can only describe a speech act of making a promise. So, promise with a to-infinitive has a narrower range of meaning. This might suggest a lexical ambiguity in the tensed version of promise between a commitment and statement reading.

The argument can be clarified by substituting make a promise which seems not to be ambiguous in the same way. Intuitively, (39a) is not ambiguous in its force, and (39a) is equivalent to (39b).

- (39) a. Monique made a promise that she would fall asleep tonight.
- b. Monique made a promise to fall asleep tonight.

The crucial contrast is the one in (40). The first example with a tensed complement has a simultaneous reading, while the second example with a to-complement has no simultaneous reading.

- (40) a. In her phone call to Guido, Monique made a promise that she was in the office, not at Paul's place.

- b. In her phone call to Guido, Monique made a promise to be in the office, not at Paul's place.

It is perhaps puzzling what kind of promise (40a) on a simultaneous reading describes. It is clear though that (40b) with the to-infinitive can not be read as equivalent to (40a).

The conclusion is that with some verbs, to-infinitives have strictly future interpretations. Another verb with this property is decide, where contrasts similar to (35) are observed:

- (41) a. Sitting on the train and looking at the landscape, Monique decided that she was in France.  
 b. #Sitting on the train and looking at the landscape, Monique decided to be in France.
- (42)a. Monique decided that she would not see Paul again.  
 b. Monique decided not to see Paul again.

(41a) with the tensed complement has a simultaneous reading which (41b) lacks, even if an adverb now or already is inserted. As with promise, correlated with or in addition to the temporal difference there is a

difference in the kind of act which can be described. (41a) describes a mental act of drawing a conclusion: observing the landscape, Monique concludes that she is in France. Example (42a) where decide embeds would can describe either an act of drawing a conclusion, or entering a state of intention. In the first interpretation, Monique might want to see Paul and try to see him, but know that it is not going to happen. If the second interpretation entailing intention is true, than Monique would not try to see Paul. Example (42b) with the to-infinitive can describe only a mental act of entering a state of intention.

Returning to F-predicates which are consistent with both simultaneous and future scenarios, the question arises whether this is a matter of non-specificity or ambiguity. The following example mixes simultaneous and future interpretations.

(43) Monique is likely to be in Stockholm both now and next Saturday.

This suggests that likely to has a single representation which is compatible both with simultaneous and future scenarios. This will be my working hypothesis. A possible problem with this is that it is hard or impossible to read the following as being non-committal as to whether

Monique is in Stockholm now or will be in Stockholm in the future.

(44) Monique is likely to be in Stockholm.

But the reading becomes possible if one makes it explicit, by inserting either now or later.

#### 2.4. Summary

Three classes of interpretations for verbs taking to-infinitive complements were identified:

- (i) B-verbs such as believed which permit only simultaneous interpretations of their to-infinitive complements.
- (ii) Futurate verbs like predicted where the to-infinitive complement is interpreted in a way which is consistent with both simultaneous and future scenarios.
- (iii) Futurate Verbs like promised where the to-infinitive has only a future interpretation.

Representations for these readings will be discussed later. We first turn to an independent line of evidence on the LF of infinitives having to do with interpretive interactions with embedded tenses.

### 3. Temporal substitution

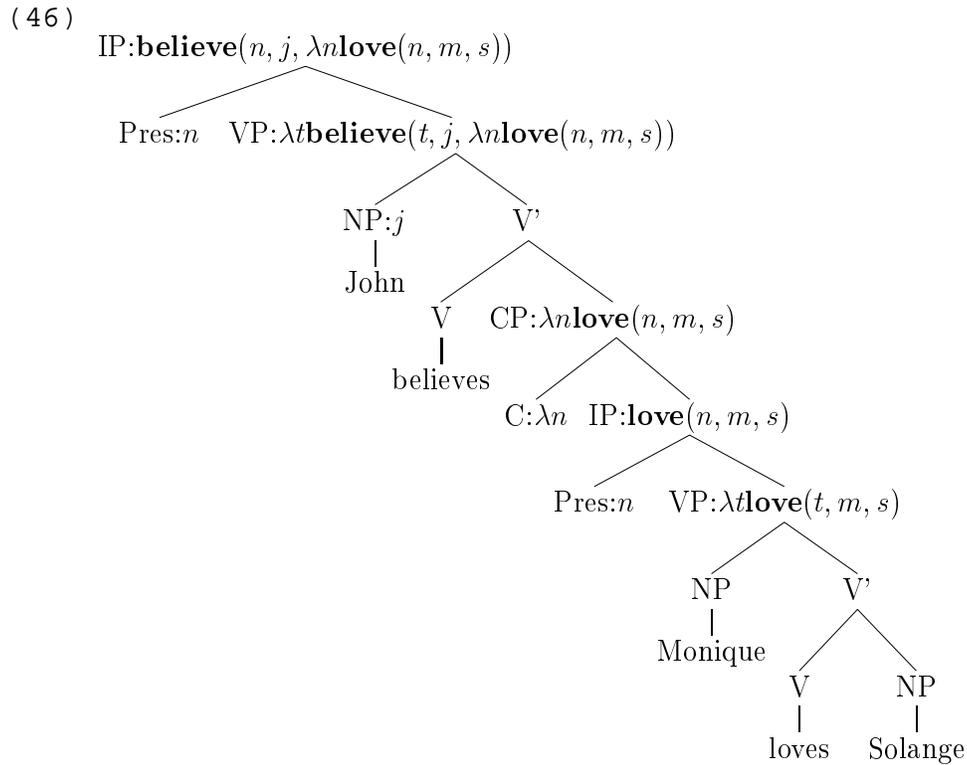
### 3.1 Interpretive framework

This and the next sections use a grammatical framework in which:

- (i) Meaning is represented explicitly at LF, and semantic composition is limited to function application, variable binding, and type raising.
- (ii) Temporal aspects of meaning are modeled with semantic objects built using a distinct type  $i$  of time intervals. Tenses denote time-intervals or type-raised versions of them, rather than being propositional operators.

Applying this framework to (45), we arrive at representation (46), which is an LF tree annotated with terms naming the denotations of phrases.

(45) John believes Monique loves Solange.



The verb loves in (46) denotes a function which maps two individuals (type  $e$ ) and a time interval (type  $i$ ) to a proposition. I assume a possible-worlds construction, and take propositions to be characteristic functions of sets of worlds, with type label  $wt$ . Under these circumstances, the type label for the verb loves is  $eeiwt$ . I use Link's (1979) notation for type labels, with right association. The type  $eeiwt$  written with commas and brackets is  $\langle e, \langle e, \langle i, \langle w, t \rangle \rangle \rangle \rangle$ .

In this system, a VP including its subject is a tenseless clause, and has type  $iwt$ . A tense fills the interval argument, giving an IP with the proposition type  $wt$ . A complement CP has a lambda binder in C or spec of

CP of the interval variable, and therefore denotes a property of times (type *iwt*). In general, the type of a CP depends on the operator in C---for instance a relative clause might have type *ewt*. The type and category labels are summarized below.<sup>6</sup>

VP	<i>iwt</i>	tenseless clause
IP	<i>wt</i>	tensed clause
CP	<i>iwt</i>	complement clause

In order to achieve simpler types, interpretations, and syntactic structures, I am assuming that the subject is in VP at LF.<sup>7</sup>

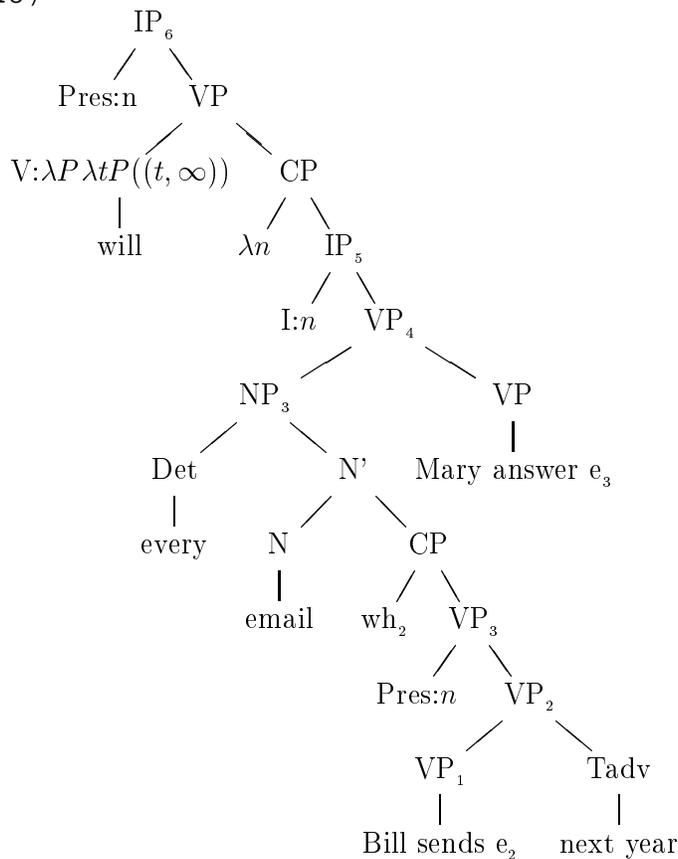
The interpretation of the term *n* is straightforward---in the logic it is a variable. Its particular role comes from being used in particular ways at the syntax-semantics interface in the grammars of particular languages, in the general theory of natural language (universal grammar), and in the theory of language use (pragmatics). The most relevant points for the purposes of this paper are that an intensional clausal complement starts with a lambda binder of *n* which creates a property of times, and that the lexical entries for tenses have free occurrences of *n*. This allows for the characterization of interactions between tense and intensionality.

## 3.2 Semantics of the future auxiliary

In Abusch (1998) I proposed an account where the logical form for the future auxiliary will/would expresses a substitution for  $n$ . The analysis is exemplified below, with adjustments in notation relative to the earlier paper.<sup>8</sup>

(47) Mary will answer every email Bill sends next year.

(48)



The surface form will corresponds to the four heads  $\text{Pres:n}$ ,  $[\lambda P \lambda t P((t, \infty))]$ ,  $\lambda n$ ,  $n$ . The subject Mary is

represented as reconstructed into the VP headed by answer, which corresponds to the overt base-form VP. The top  $n$  is the present tense on will.  $[_V \lambda P \lambda t P((t, \infty))]$  is a temporal substitution operator which is the core meaning of will. In the substitution operator,  $t$  is a bound variable which corresponds to the tense argument of will. For a top-level occurrence of will, the effect is to substitute  $(n, \infty)$  for  $n$ . One consequence of this is that eventualities corresponding the main-verb complement of will are located in the interval  $(n, \infty)$ .

Notice that the complement structure in (48) is the same as in the tensed complement in (46); the CP/IP layer between the two VP nodes is syntactically covert, since will has a base form complement. The extra structure has semantic motivation in the interaction between futurity and tense: the  $\lambda n$  on the complement of will binds two occurrences of  $n$ . One corresponds to the present tense on sends. The other is the temporal argument of the base form verb answer; this temporal argument is treated as a covert I heading IP. The property of times denoted by CP, together with the top-level present tense, are arguments of a core meaning  $\lambda P \lambda t P((t, \infty))$  for will.  $(t, \infty)$  is an interval stretching from the bound time variable  $t$  to positive infinity. In the given configuration the

denotation for will substitutes a future interval  $(t, \infty)$  for both occurrences of  $n$  in the complement.

Shifted present tenses The event time for an overt present tense verb in the argument of will/would falls in the future, rather than at the utterance time. This accounts for the interpretation of sends in (47), where the possible sending events follow the utterance time.

Shifted past tenses Past tenses in the scope of will/would measure back from a time within the future interval  $(u, \infty)$ , rather than from the utterance time.<sup>9</sup> On February 1 at the beginning of the spring semester I say (49). The contemplated turning in events are understood as ordered before May 21, rather than February 1. (Though if some student had turned in a term paper satisfying the required length before the start of the semester on February 1, he should also get an A according to what I said.)

(49) On May 21, I will give an automatic A to the first student who turned in a term paper at least 15 pages long.

Non-complementarity Fixing the location of described events, past and present tense under the scope of will/would are not in complementary distribution. Consider the following scenario. In November 1999, the

members of a program committee discuss procedures for the review of abstracts which are to be submitted in the first two months of the year 2000. The abstract deadline is February 21, 2000. In this scenario, the committee members can use either (50a) or (50b).

(50) a. On March 1, we will discuss the abstracts which are submitted by email.

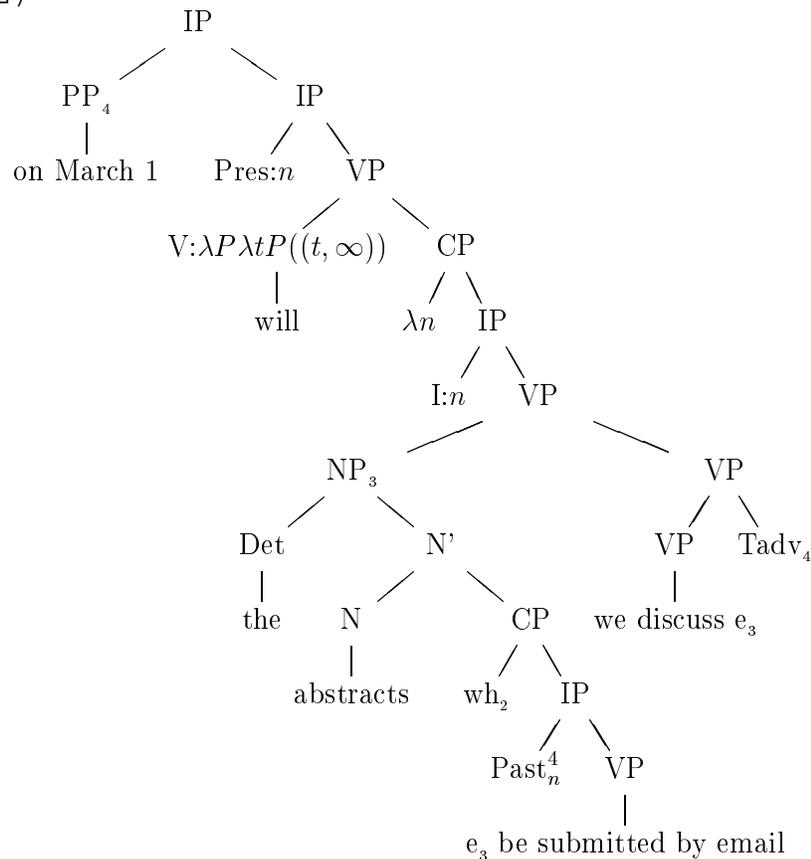
b. On March 1, we will discuss the abstracts which were submitted by email.

The above listed three consequences follow from logical forms along the lines of (48), with lambda binding of  $n$  and a node introducing the interval  $(t, \infty)$ , and from specific denotations for tenses. In the case of present tense, the analysis is simple: present tense denotes  $n$ . (51) is a semantic derivation corresponding to the LF (48). The important thing about the result is that the sending events are ordered inside the interval  $(n, \infty) \cap \text{year}(1, u)$ , which, given that next year falls in the future interval  $(n, \infty)$ , amounts to just next year. This is a result of the substitution for  $n$  performed by the material corresponding to will.

- (51)
- VP 1  $\lambda t \exists e [e \subseteq t \wedge \mathbf{send}(e, b, x_3)]$   
Tadv  $\lambda Q \lambda t [Q(t \cap \mathbf{year}(1, u))]$   
VP 2  $\lambda t \exists e [e \subseteq t \cap \mathbf{year}(1, u) \wedge \mathbf{send}(e, b, x_3)]$   
IP 3  $\exists e [e \subseteq n \cap \mathbf{year}(1, u) \wedge \mathbf{send}(e, b, x_3)]$   
N1  $\lambda x [\mathbf{email}(x) \wedge \exists e [e \subseteq n \cap \mathbf{year}(1, u) \wedge \mathbf{send}(e, b, x)]]$   
VP 4  $\lambda t \mathbf{every} \left( \begin{array}{l} \lambda x [\mathbf{email}(x) \wedge \exists e [e \subseteq n \cap \mathbf{year}(1, u) \wedge \mathbf{send}(e, b, x)]], \\ \lambda x \exists e [e \subseteq t \wedge \mathbf{answer}(e, m, x)] \end{array} \right)$   
IP 5  $\mathbf{every} \left( \begin{array}{l} \lambda x [\mathbf{email}(x) \wedge \exists e [e \subseteq n \cap \mathbf{year}(1, u) \wedge \mathbf{send}(e, b, x)]], \\ \lambda x \exists e [e \subseteq n \wedge \mathbf{answer}(e, m, x)] \end{array} \right)$   
IP 6  $\mathbf{every} \left( \begin{array}{l} \lambda x [\mathbf{email}(x) \wedge \exists e [e \subseteq (n, \infty) \cap \mathbf{year}(1, u) \wedge \mathbf{send}(e, b, x)]], \\ \lambda x \exists e [e \subseteq (n, \infty) \wedge \mathbf{answer}(e, m, x)] \end{array} \right)$

Tree (52) is the LF for the past example (50b). As before, the important point is that the lambda operator on the complement of the substitution operator associated with will binds a variable associated with the relative clause tense, which in this case is the past tense on submitted. Semantically, this has the effect of shifting the time which the past tense measures back from to March 1. See Abusch (1998) for details about the semantics of past tense, and how it interacts via indexing with other elements of an LF.

(52)



Summing up, an LF for will involving a temporal substitution operator and lambda binding of *n* has the consequences of shifted present and past tenses, and of the non-complementarity of present and past tenses in future contexts. These properties will be used as diagnostic for an LF with a substitution operator.

#### 4. Tense Interactions in to-Complements

#### 4.1 Data

Future-oriented infinitives interact with tense in the same way as the future auxiliary will/would.

Shifted present tenses In the example below, the possible submission times follow the utterance time.

(53) Mary intends to give an automatic A to every student who submits a term paper at least 15 pages long.

Shifted past tenses Below, the past tense can be understood as measuring back from a time following the utterance time (June 1), rather than measuring back from the utterance time.

(54) On June 1, Mary intends to give an automatic A to every student who submitted a term paper at least 15 pages long.

Non-complementarity (55) and (56) uttered on New-Years Eve quantify possible sending, receiving, and answering events which are distributed throughout the year following the utterance time in an interleaved fashion. In (56), the present tense receive and the past tense received correspond to the very same eventualities.

(55) This coming year, I intend to immediately answer every email I receive which was sent by a friend.

(56) I intend to immediately answer every email I receive  
which was received from a friend.

Other future-oriented infinitives behave in the same way.  
This is illustrated for present tenses in (57) and for  
past tenses in (58).

(57) a. Solange is predicted to win most of the races she  
enters.

b. Monique hopes to live in a house her parents buy  
her.

(58) a. Solange is predicted to win all of the matches  
she enters which she had adequate time to prepare  
for.

b. Monique hopes to tell Paul about something  
outrageous she did on the trip.

#### 4.2 Analysis

These data suggest that the compositional representations  
of future-oriented infinitives include operators which  
make a substitution for  $n$  by means of binding and  
function application. As a starting point, it is useful  
to compare future-oriented infinitives with tensed  
complements headed by will. The tensed and infinitival  
versions in (59) and (60) are equivalent.<sup>10</sup>

(59) a. Solange hopes to visit Björn next week.

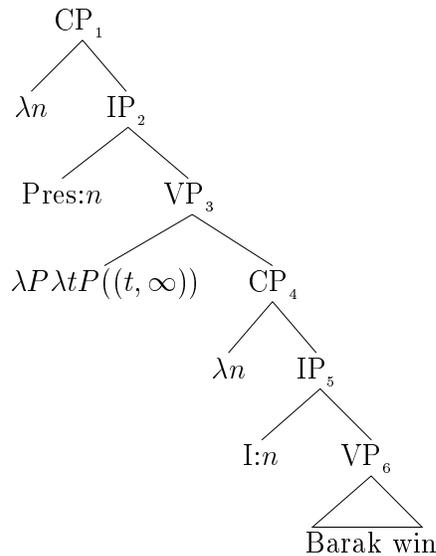
b. Solange hopes that she will visit Björn next week.

(60) a. Barak is predicted to win.

b. It is predicted that Barak will win.

Below is the representation of the tensed complement in (60b) on the theory reviewed in section 3.

(61)



The clausal nodes are numbered from the top; temporal substitution is performed by the head of  $VP_3$ , which is the root of will. The idea is to use this tree as a starting point for the representation of (60a). Given the mechanics of temporal substitution, something which must be included in the LF of (60a) is the lambda operator heading  $CP_4$ , which binds occurrences of  $n$  in the complement, in particular ones coming from tenses. Above

this level, there are some choices to make regarding what structure is to be maintained. First, notice that the CP<sub>1</sub>/IP<sub>2</sub> layer in (61) is semantically redundant, because of the identity

$$\lambda n\phi(n) = \phi \quad \text{if } \phi \text{ contains no free occurrences of } n.$$

In (61), and in fact in all the representations for tensed complements with will considered above, VP<sub>3</sub> has no free occurrences of *n*. This suggests the possibility of dropping the CP<sub>1</sub>/IP<sub>2</sub> layer in the LF for the to-infinitive.

Second, for some embedding predicates, the temporal substitution operator should be changed. We saw in section 3 that predict and be likely allow simultaneous scenarios for the eventualities corresponding to their infinitival complements, in addition to future ones. A direct way of dealing with this is to use the interval  $[t, \infty)$  in the substitution operator in place of the interval  $(t, \infty)$ . The interval  $[t, \infty)$  is an interval which includes the left boundary *t*. We will see below that this gives the right results for simultaneous scenarios.

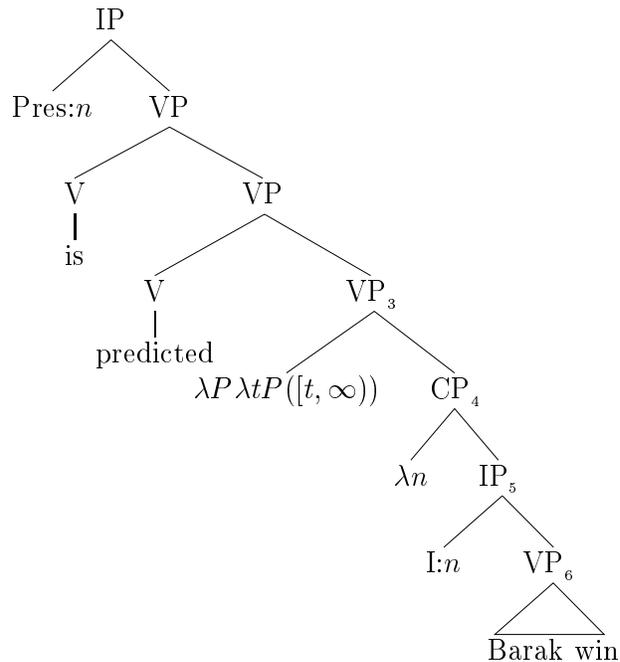
Third, there is the question of what layers of structure are overt in the LF of (60a). In particular, is the substitution operator  $\lambda P\lambda tP([t, \infty))$  a part of the complement, perhaps as the semantics of the morpheme to?

Is it "part" of the model theoretic interpretation of the embedding verb? Or is it part of a compositionally interpreted structured lexical entry for the verb? It is not easy to answer such questions definitively, because they tie in with general questions of how lexical decomposition is represented. But in section 5, I will mention an argument (based on rather intricate assumptions) that even the highest levels of structure in (61) are overt in the LF of (60a), in that they are visible to scope interactions.

#### 4.3 LFs for futurate infinitives

As a working hypothesis, I will leave out the redundant  $CP_1/IP_2$  layer in the LF of futurate infinitives, but include an overt substitution operator. This results in the LF below for (60a). (The substitution operator is written as the head of VP. Its actual syntactic position might be different though, e.g. in I.)

(62)



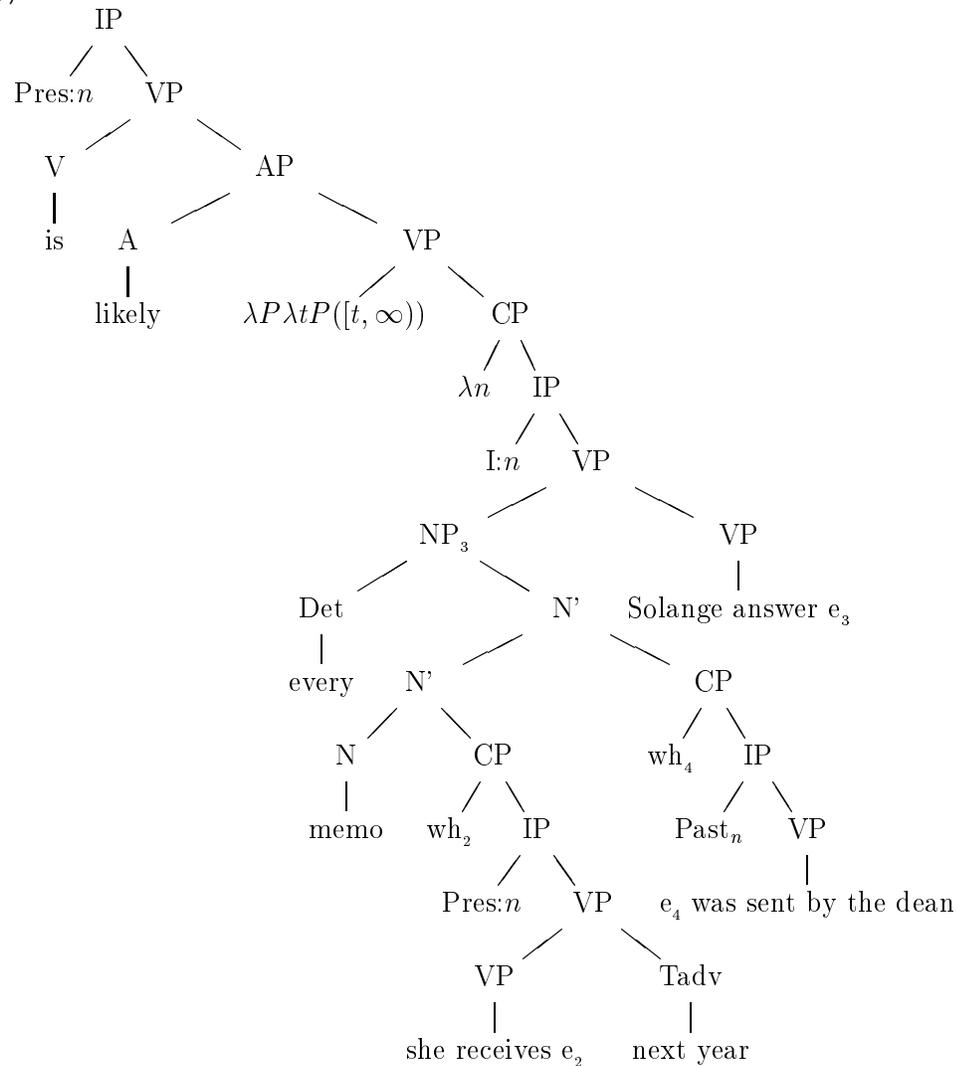
Assuming an overt substitution operator has the advantage that the predicate predict in (62) can be treated as being the very same predicate as predict which embeds the tensed complement in (61). This works because VP<sub>3</sub> in (62) and CP<sub>1</sub> in (61) denote the same property of times.

If the structure with a temporal substitution operator is postulated, the interaction of tense with future-oriented infinitives is accounted for in the same way as the parallel data with will. For instance, in example (63) the answering and receiving events can fall in the future, because the *n* relative to which the present tense on receive and the past tense on sent are interpreted is an expanded interval  $[t, \infty)$ .

(63) Solange is likely to answer every memo she receives  
this year which was sent by the dean.

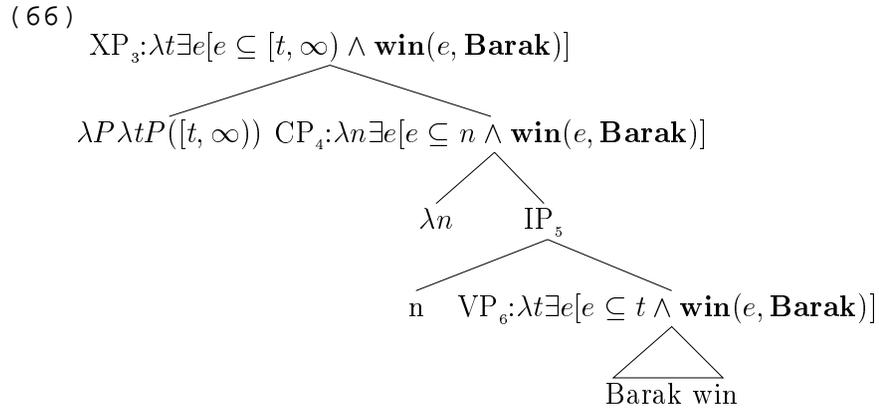
This works because in the LF below, both tenses are under  
the scope of the substitution operator.

(64)



The following simpler example illustrates the recursive  
semantics of the complement.

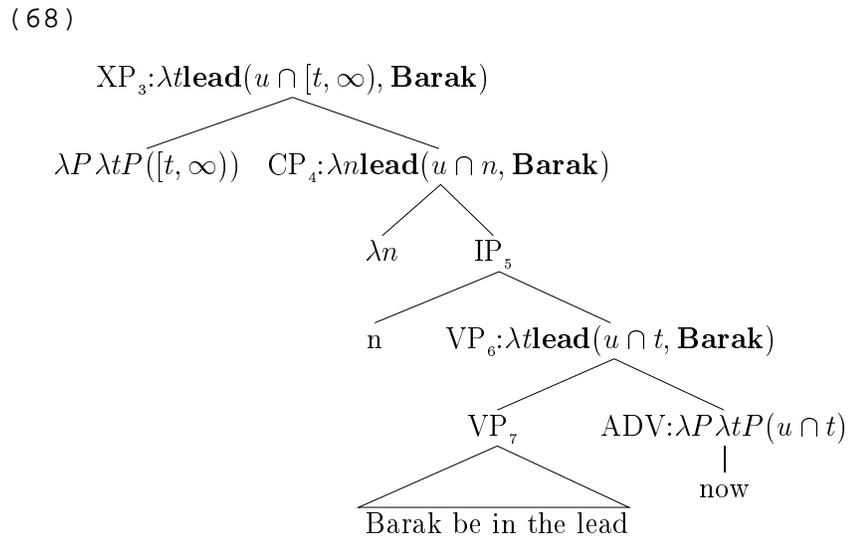
(65) Barak is predicted to win.



### Simultaneous readings

The tree below illustrates a simultaneous reading.

(67) Barak is predicted to be in the lead now.



The compositional semantics is such that the interval denoted by now gets intersected with the interval contributed by the substitution operator. I assume that

now denotes the utterance time  $u$ . The LF (68) is in fact semantically unsatisfactory, since quite generally, deictic elements must be assumed to be interpreted de re. An LF scheme for de re interpretation is presented in Cresswell and von Stechow (1982), and is applied to temporal data in Abusch (1997). The mechanics of de re interpretation goes beyond the scope of this paper, but the bottom line in this example is straightforward. Employing an acquaintance relation of temporal identity  $\lambda x \lambda t \lambda t' [t=t']$  has the result that  $t$  (with the interpretation of the internal now of the attitude) is substituted for  $u$ . Since  $t \cap [t, \infty) = t$ , this results in the denotation  $\lambda t \mathbf{in-lead}(t, \mathbf{b})$  for the complement. This is a simultaneous reading.

This approach to simultaneous readings in which a substitution operator is present, is supported by the fact that simultaneous readings can be mixed in various ways with future ones. Example (69) is similar to one from section 3.

(69) Solange is likely to be in Paris now and in  
Stockholm next Friday.

(70) Solange is likely to already know all of the men she  
dates next year.

In the gapping sentence (69), the time for the locative predication in the right conjunct is in the future. According to the analysis developed here, this means that it must be under the scope of a temporal substitution operator. A standard analysis of gapping copies the predicate for the right conjunct from the left conjunct. This would require the substitution operator being present in the left conjunct also. (70) makes the same point. On one reading, the dating times are in the future, while the knowing time is simultaneous.

The frame adverb now is essential in obtaining the simultaneous reading of (67), because the reading results when the extended future interval is intersected with the interval contributed by now. However, the sentence also has a simultaneous reading when now is dropped. In this case, I assume there is a null frame adverb having the same function as now. This is an innocuous assumption, since such null frame adverbs are quite freely available (Abusch 1997:Section 8). In (70), either know is modified by a null frame adverb, or already serves the same function as now in (67).

#### 4.4 LFs for strictly futurate readings

In section 3, we saw that the to-complement of promise has a strictly future interpretation. If this is to be directly stated in the representation, a substitution

operator with the interval  $(t, \infty)$  rather than the interval  $[t, \infty)$  should be used in the LF of promise. I will assume for now that promise has an LF just like predict in (64), except for the change in the interval involved in the substitution operator, and except for differences having to do with control vs. raising.

Obviously, the different substitution operators are lexically conditioned. I am inclined to assume that the presence of one operator rather than another follows from the structured lexical representation of the embedding verb. This can be realized strictly in the lexicon, or more syntactically by allowing lexical entries to stipulate local parts of LF trees.

##### **5. Overtness of LF structure for infinitives**

The argument having to do with tense interactions motivates substitution for the  $n$  parameter in the representation of future-oriented infinitives. This does not give us much information about the LF representation though. All we can definitely conclude is that the lambda binder of  $n$  which is the head of node  $CP_4$  in (62) is present. It might be that the substitution itself is built into the lexical semantics of the verb. However, I will present evidence that the substitution operator, and also higher levels of structure, are syntactically overt. The argument

suggests that what I call the contemporary now of the attitude is represented in the LF of future-oriented infinitives.

In section 3, I presented a logical form for the complement of believe where the contemporary now is the temporal argument of the property of times denoted by the complement. In the example below, by virtue of lambda binding of  $n$ , the complement CP denotes a property of times (type  $iwt$ ). In the lexical semantics of the embedding attitude predicate, the time argument functions as a counterpart of the attitude time.<sup>11</sup>

(71) Guido believes [<sub>CP</sub>  $\lambda n$ [<sub>TP</sub> he is lying down]].

In cases where the tensed complement of a verb such as believe is headed by will, the contemporary now is represented in the same way as in (71). The complement in (72) has the structure (73), where sub is the substitution operator which is the core meaning of will.

(72) Paul believes he will have dinner with Monique today.

(73) [<sub>CP</sub>  $\lambda n$  [<sub>TP</sub>  $n$  [<sub>VP</sub> SUB [<sub>CP</sub>  $\lambda n$  [<sub>TP</sub>  $n$  [<sub>VP</sub> have dinner with Monique today]]]]]

This follows from the requirement for a systematic syntax and compositional semantics. For instance, given

that the higher  $\lambda n$  of (73) is present in (71), an analysis which maintained that it was absent in (73) would involve complications in syntax and in the syntax-semantics map. There is also semantic evidence for the higher levels of structure in (73) being present. If an NP takes scope inside the higher  $\lambda n$  in (73) but outside the lower one, we would expect a free  $n$  in that NP to pick up a contemporary now. Examples where this is so can indeed be constructed. In Abusch (1997), I suggested that the representation of the modal might includes a free  $n$ . This is designed to account for the fact that in a top-level context such as (74), the temporal perspective for might is the utterance time, while in an attitude context such as (75), the perspective is the internal now of the attitude.

(74) Paul married a girl who might become rich.

(75) Paul believed his bride might become rich.

Example (76) shows that might in a relative clause which is syntactically below will can take scope outside will and pick up the internal contemporary now. Some time ago, Paul misidentified a co-worker of Guido's as Guido's sister. This dictates an LF for (76a) in which a sister has narrow scope.

- (76) a. Paul<sub>1</sub> believed that Guido had a sister<sub>2</sub>, and  
that she<sub>2</sub> might have a crush on him<sub>1</sub>.
- b. He believed that eventually he would have a  
long frank conversation with the woman who  
might have a crush on him.
- c. But he believed that at that point she would  
not have a crush on him any more.

In (76b), the definite description the woman who might have a crush on him also must have narrow scope, because its presuppositional antecedent has scope inside the attitude. The content of (76b) makes clear that the time parameter for might is the contemporary now; this is also indicated by the continuation (76c). Assuming this is to be achieved by means of scope, this dictates the following logical form.

- (77) believed [<sub>CP</sub>λn [<sub>NP</sub>the woman who might(n) have a crush  
on him]<sub>1</sub> [n [<sub>SUB</sub> [<sub>CP</sub> λn [<sub>TP</sub> n [<sub>VP</sub>he eventually have a  
long conversation with e<sub>1</sub>]]]]]]

The n on might is bound by the λn which represents the contemporary now, and so the reading under discussion is obtained. None of this is surprising: it is what we would expect given independently motivated denotations

and the independently motivated scope mechanism. The point of the example is to show how to use might as a diagnostic for the presence of a contemporary now in LF. In future-oriented infinitives, the same kind of reading for might shows up as is observed with believe:

(78) Paul hopes to eventually have a conversation with the woman who might have a crush on him.

(79) Paul decided to eventually have dinner with the woman who might have a crush on him.

(80) Paul promised to eventually have dinner with the woman who might have a crush on him.

Examples (79) and (80) are the significant ones. Because promise excludes a simultaneous reading for its complement, I postulated the same substitution operator in the LF of promise as is used in will. (The same reasoning applies to decide.)

If this reading is to be represented with promise in the same way as with believe (and why should the story be any different?), then the  $\lambda n$  outside the substitution operator in (77) has to be present in the LF for (80), as in (81). Here the  $n$  parameter in  $\text{might}(n)$  is captured by a  $\lambda n$  which creates a property with a simultaneous representation.

(81) Paul promised/decided [<sub>CP</sub>  $\lambda n$  [the woman who  
 might(n) have a crush on him]  $\lambda e_3$ [n [SUB  $\lambda n$  [PRO  
 have dinner with  $e_3$ ]]]]

Crucially, for this to work, there must be a  $\lambda n$  corresponding to the contemporary now in the representation. Suppose there were no such binder: suppose the LF had the following form, which corresponds to the structure (62) discussed in section 4.

(82) Paul promised/decided [SUB  $\lambda n$  [PRO have dinner with  $e_3$ ]]

Wherever the noun phrase containing might(n) takes scope, the  $n$  gets the wrong interpretation. If it takes scope under the  $\lambda n$  inside SUB, then the  $n$  in might(n) gets a future interpretation. If it takes scope outside this lambda binder, then the  $n$  in might(n) remains free, and is interpreted as the utterance time. Neither of these gives the desired interpretation, where the  $n$  parameter in might is the internal now of the attitude.<sup>12</sup>

If this argument is sustainable (and it should be remembered that the argument depends on specific assumptions) then it shows that the highest levels of structure which are present in tensed complements with will are present in futurate to-complements (at least the ones in the promise/decide class). If so, the lower

levels, and in particular the SUB operator, must also be syntactically overt at the level where scope is represented.

## 6. Conclusion

This paper has motivated logical forms for futurate to- complements which contain operators which make a substitution for the parameter  $n$ . This indicates that the representation of such predicates is decomposed into a core meaning and an operator which introduces futurity. In addition to capturing data having to do with the interaction between tense and futurity, this allows us to assume a single core meaning for verbs such as promise which take both tensed and infinitival complements.

In the course of the discussion, two classes of futurate complement infinitives were identified---ones which are purely futurate (as with promise) and ones which are also consistent with simultaneous scenarios (as with predict and be likely). The methodology of decompositional approaches to predicate meaning would suggest trying to explain this difference in terms of a motivated account of structured lexical semantics. Conceivably, what makes promise and decide purely futurate has to do with their representation in the calculus of causation and change---they describe acts of entering states of commitment and intention.

The argument for a substitution operator being syntactically present does not tell us anything about the specific syntactic location of the operator. But locating the substitution operator higher than to would agree with the fact that there are three different semantic classes of to-complements (simultaneous, purely future, and non-specific future-simultaneous). Below are the LFs proposed for predict, promise, and believe with to-complements. SUB<sub>1</sub> is the substitution operator using (t,∞), and SUB<sub>2</sub> is the substitution operator using [t,∞). In the LF of believe, there is no substitution operator.

- (83) a. promise [<sub>CP</sub> λn [<sub>IP</sub> n [<sub>SUB<sub>1</sub></sub> [<sub>CP</sub> λn [<sub>IP</sub> n VP]]]]]
- b. predict [<sub>CP</sub> λn [<sub>IP</sub> n [<sub>SUB<sub>2</sub></sub> [<sub>CP</sub> λn [<sub>IP</sub> n VP]]]]]
- c. believe [<sub>CP</sub> λn [<sub>IP</sub> n VP]]

A simple way of matching these representations up with syntax is to identify to with the most embedded n in I. The different structures above the most embedded CP could then be treated as lexically stipulated syntactic structures, as implemented e.g. via incorporation (Baker 1988).<sup>13</sup>

The analysis proposed here is consistent with the clausal complement hypothesis suggested in Abusch (1998): all clausal complements have (either overtly or covertly) a full CP/IP/VP structure. In the to-infinitive LFs of

(83), the complements of predict promise, believe, SUB<sub>1</sub> and SUB<sub>2</sub> all have this structure.

Other examples of this complementation structure are tensed complements (where the CP and IP are overt), and the LF of will as in tree (48), which is like the LF (83a) with a SUB<sub>1</sub> operator and a CP/IP layer embedded under it.

### Notes

Acknowledgement: The research for this paper was supported by SFB 340, funded by the DFG.

1. Under plausible assumptions, a representation of the scheduling interpretation also agrees with property (i). Suppose we analyze this interpretation by means of a modal operator according to schedule with top-level scope in the complement. Then in (10c), the future-denoting adverb at 10:00 pm modifies the embedded predicate start rather than the top-level covert modal operator. Since the modal is stative, this representation is compatible with property (i).

2. There is a curious point about how property (i) applies to the sentences in (13). It might be that the LF of (13a) contains a future operator.

(i) predicted [FUT [vp[Bibi be in the lead][next week]]]

We want to apply property (i) in the main text to (13a) as evidence that predicted is an F-verb. For this to work we would have to treat be in the lead rather than FUT in (i) as the top-level predicate in the complement.

Otherwise structure (i) would not be relevant for my diagnostic, as next week would not modify the top level predicate.

3. This is because simultaneous readings involve stative complements. Performatives are an exception, assuming that below, the complement predicate headed by promise is non-stative.

(i) I affirm that I promise to clean up.

4. With expect, where the data in (i)-(ii) below are parallel to those with predict in (26), there is some feeling of a distinct elevated register, and perhaps a distinct word sense. I do not know what to make of this, since the experienced meaning seems parallel to what is found with predict and its synonyms, where there is no feeling of an elevated register.

(i) I expect that Guido spent the night of last  
Friday's party at Monique's place.

(ii) \*I expect Guido to spend the night of last  
Friday's party at Monique's place.

5. A simultaneous interpretation is possible in the example below.

- (i) The treatment went so well that Monique promises to be pregnant.

Example (i) does not describe a speech act, since Monique is not making a promise to be pregnant, but showing promise of being pregnant. In this example promises does not have the standard control sense---rather, this is the raising sense noted in Postal (1974).

6. In Abusch (1998), I used the syntactic label S where I now use VP and IP.

7. The system can easily be extended to accommodate a structure with a I' node and a subject raised into IP:

- (i) [IP NP [I' I [vp e V']]]

Rooth (ms.) modifies the system in this way in order to theorize about VP ellipsis.

8. One might want to compare this analysis to the proposal of Dowty (1982) and Nerbonne (1986), where a future operator makes a substitution for a tense-logical parameter known as pseudo-speech time.

9. Technically, in this example the future interval comes out as  $(n, \infty)$ , where  $n$  is contributed by the upstairs tense on will. A free  $n$  is pragmatically interpreted as the utterance time.

10. Apart from the fact that (59a) has only a de se reading for the PRO complement subject (cf. Chierchia 1989).

11. This discussion is simplified, because it ignores de re and de se interpretation. In actuality, I follow Lewis (1979) and take the argument of believe to have an argument position for an individual (corresponding to the self), so that the type is  $eiwt$  rather than  $iwt$ . In the LF of (71), the individual argument is introduced by de re interpretation of he, using an acquaintance relation of identity.

12. There is a further possibility of de re interpretation. This also gives the wrong reading, since the position of the res would be occupied by a counterpart of the utterance time, rather than a counterpart of the attitude time.

13. It is necessary to assume that in LF, operators and verbs are in the right-branching configurations of (83).

An incorporation structure such as the following would be uninterpretable.

(i) [ $\lambda n$  [SUB<sub>1</sub> [ $\lambda n$  predict]]] [CP e [IP e [VP e[CP e[IP n VP]]]]]

Since lambda is a binding operator, no compositional interpretation can be given for the traces of  $\lambda n$ .

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