Tense Meanings and Temporal Interpretation

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Abstract

For any theory of tense meanings, subordinate sentences are particularly problematic because embedded tenses do not seem to receive the same interpretations as their non-embedded counterparts. Previous approaches to this problem have often proposed some syntactic mechanism or sequence of tense rule that allows the embedded tense morphemes to receive interpretations that differ from those typically assumed for non-embedded tenses. This paper explores an alternative view in which tenses are assumed to be uniformly defined for both independent and embedded occurrences. It argues that the problematic subordinate interpretations can be explained if appropriate definitions of tense meanings are provided and independent factors influencing the temporal interpretation are taken into account. Specifically, it is suggested that the meaning of the tense morphemes alone do not completely determine the temporal interpretation of a sentence. In a systematic and predictable way, aktionsart properties further specify the exact duration and location of the interval in which the sentence is true. Thus, the interaction of tense meanings and general facts of the grammar such as aktionsart properties, rather than sequence of tense specific mechanisms, conspire to explain temporal interpretation in both embedded and non-embedded sentences.

1 INTRODUCTION

In English, subordinate sentences are particularly problematic because embedded tenses do not seem to receive the same interpretations as their non-embedded counterparts. This contrasts with languages like Japanese or Russian, in which uniform interpretations apply to both embedded and non-embedded tenses. Previous approaches to this problem have proposed language specific syntactic mechanisms or sequence of tense rule such as tense deletion or tense agreement rules. Such rules allow embedded tense morphemes in English to receive interpretations that differ from those typically assumed for non-embedded tenses.

In this paper, I explore an alternative view in which English tenses are uniformly defined for both non-embedded and embedded occurrences and consequently, no language specific syntactic mechanism is required. I argue that the problematic subordinate interpretations can be explained if appropriate definitions of tense meanings are provided

and independent factors influencing the temporal interpretation are taken into account. I suggest that truth-conditional tense meanings sometimes underdetermine the actual temporal interpretation in a particular utterance situation. The exact duration and location of the interval denoted by the sentence may depend on other facts of the grammar such as aktionsart and pragmatic implicatures. In particular, I claim that aktionsart properties systematically influence temporal interpretation. For example, stative sentences are typically assumed to persist in time in a way that differs from eventive sentences. This allows stative sentences to obtain beyond the interval specified by the tense morphemes and therefore, to overlap with the truth intervals of sentences previously mentioned in discourse. This property, generally available in discourse contexts, is also operative in subordinate constructions, thus accounting for non-canonical temporal interpretations identified in the literature.

The result of this proposal is that lexical tense meanings and lexical/sentential aktionsart, rather than language specific mechanisms, interact to explain temporal interpretation in both embedded and non-embedded sentences. If correct, this approach would simplify the syntax–semantics interface and would further illuminate the interaction of tense meanings with aktionsart and pragmatic considerations.

1.1   *The problem*

A basic task of any theory of tense meanings is to predict the temporal interpretations of tenses embedded under the scope of other tenses. The difficulty arises when determining the meaning of a given tense in a uniform manner for both independent and embedded occurrences: It seems that embedded tenses and their independent counterparts do not receive the same interpretation. Consider simple past tense:

(1)   The senator heard about the president's secret meetings.

(2)   The secretary believed that the senator was happy.

Assume for the sake of argument that each past tense in (2) denotes any time prior to the speaker's speech time (ST), as suggested by (1). Then, (2) should be true in a situation in which the interval of being happy is prior to the ST but later than the attitude time, i.e. the secretary's believing (a *forward shifted reading*). However, this interpretation is not available in (2). The interval in which the embedded sentence is true can either overlap with or precede the attitude time. Therefore, if past tense is evaluated solely relative to the ST, incorrect predictions are

made. I will call a view of a tense meaning in which the temporal interpretations is exclusively relative to the ST *the indexical view.*

Suppose now that past tense does not always denote an interval prior to the ST, but rather, an interval prior to whichever time happens to occur in its immediate context. That is, suppose that in non–embedded sentences, past tense is evaluated relative to the ST, but in embedded sentences is evaluated relative to the time of the reported attitude. This view predicts that the embedded sentence in (2) is true at an interval prior to the attitude time (a *backward shifted reading*) and thus fails to predict the overlapping reading of (2). I will call such a view of tense meaning *the relative view.*

Both the present and the future tense also show non-uniform interpretations in embedded and independent occurrences. While independent sentences are interpreted relative to the ST (suggesting an indexical meaning), embedded sentences might also be interpreted relative to the attitude time:

(3)   The president believed that his party is furious.
(4)   The press will think that the president is out of town.
(5)   In two days, an official will announce that the president will apologize (*tomorrow).
(6)   A journalist said that the president will resign (*yesterday).

(3) is true if the interval at which the complement is true overlaps with both the attitude time and the ST. This is the so-called *double access* reading, (Abusch 1991, 1997), because the truth-interval of the embedded sentence has 'access' to both the attitude and the ST. In contrast, (4) could be true in situations in which the embedded interval of truth either overlaps with both the future attitude time and the ST (another double access reading) or simply overlaps with the future attitude time. As the reader can confirm, neither the indexical view nor the relative view explains the double access readings of the present tense.

Likewise, neither view accounts for the temporal interpretations of future tense. The indexical view (future of the ST) would allow the embedded complement of (5) to be true at an interval later than the ST but prior to the attitude time. However, this reading is not possible as the starred adverbial modification in (5) shows. In turn, the relative view (future of the attitude time) would incorrectly predict a reading of (6) in which the embedded complement is true at an interval later than the attitude time but earlier than the ST (i.e. an interpretation equivalent to the use of *would*).

1.2 *Previous solutions*

Given the failure of a uniform approach to tense meanings, the solution proposed by most theorists is to claim that embedded tenses make a semantic contribution different from that of their independent morphological counterparts (non-uniform theories). Some surface embedded tense morphemes are assumed to be semantically vacuous and are underlyingly analysed as overlapping the attitude time. The way in which the embedded tense morphology is semantically nullified varies from theory to theory. Ladusaw (1977), for example, proposes a transformation that changes an underlying tense morpheme (e.g. present) into a past morpheme if embedded under past morphology, while the semantic interpretation of the underlying tense (e.g. overlap with the attitude time) remains. Enç (1987) proposes two different mechanisms to licence tense references. In one case, the tense is bound by the matrix's tense yielding identity of reference (simultaneous readings). In the other, the tense is licenced by other temporal elements in the clause so that it can refer to a different time relative to the attitude time (non-vacuous readings). Abusch (1997) proposes a feature passing mechanism specifically for the case of past embedded under past whereby the tense information of the matrix verb is transmitted to the embedded tense. The effect of such a mechanism is that the semantic contribution of the embedded past tense is interpreted as co-indexed with the attitude time. The overlapping reading is thus predicted (see also Stechow 1995). Finally, Ogihara (1996) proposes an optional deletion rule applying at LF whereby a tense c-commanded by another morphologically identical tense can be erased. The resulting tenseless clause (a set of world–time pairs) is interpreted as holding at the attitude time via the truth conditions of *belief*-sentences, thus predicting the overlapping reading.

As an illustration of this non-uniform solution, consider Ogihara's account in more detail. For the case of past embedded under past, the deletion rule would turn (2), with the surface structure in (2a), into an LF representation and corresponding semantic translation given in (2b), where t = interval in Ogihara's notation and st = speech time (all translations are taken from Ogihara's proposal):

(2) The secretary believed that the senator was happy.

    a. SS: The secretary PAST believe that the senator PAST be happy.

    b. LF$_1$: The secretary PAST believe that the senator Ø be happy.
$\exists t[t < st \,\&\, believe'(t,$
$the\_secretary', {}^{\wedge}\lambda t_1[be\_happy'(t_1, the\_senator')])]$

    c. LF$_2$: The secretary PAST believe that the senator PAST be happy.
$$\exists t[t < st \,\&\, believe'(t,$$
$$the\_secretary', \,^{\wedge}\lambda t_1 \exists t_2[t_2 < t_1 \,\&\, be\_happy'(t_2, the\_senator')])]$$

Given the optionality of the rule, the two readings available in (2) are predicted. If the rule does not apply as in (2c), the embedded PAST is interpreted relative to the believer's attitude time t_1 (representing the believer's now, counterpart of the actual attitude time) and the backward shifted reading is obtained. If the rule applies, the resulting LF representation in (2b) gives rise to the overlapping reading. Note that in (2b), no temporal relation is expressed in the embedded sentence. The embedded sentence in (2b) denotes a set of world-time pairs, i.e. $\{\langle w', t' \rangle |$ the senator is happy at t' in $w'\}$. The overlapping reading is not obvious in (2b) but is obtained via the truth conditions. The truth conditions say that (2b) is true iff every world compatible with the secretary's beliefs in the actual world at the secretary's believing time belongs to $\{\langle w', t' \rangle |$ the senator is happy at t' in $w'\}$, i.e. if the secretary locates her/himself at a world and time in which the senator is happy. Thus, if the attitude attribution is true and the secretary's belief worlds–time pairs contain the ascribed world-time pairs at the attitude time, it follows that the senator is happy at the secretary's believing time (see Ogihara 1996: 120).

For the case of embedded present, the deletion mechanism yields the following surface and LF representations and translation:

(4)   The press will think that the president is out of town.

    a. SS: The press PRES[woll] think that the president PRES be out of town.

    b. LF$_1$: The press PRES[woll] think that the president Ø be out of town.
$$\exists t[st < t \,\&\, think'(t, the\_press', \,^{\wedge}\lambda t_1[be\_out'(t_1, the\_president')])]$$

In (4a), the crucial assumption is the non-overt morphological analysis of *will*, paralleled by that of *would*. *will* is morphologically analysed as a combination of present and future morphology represented as *Pres*[*woll*], while *would* is analysed as a combination of past and future morphology *Past*[*woll*]. Semantically, *woll* is interpreted as an operator shifting the evaluation time into the future. The application of the rule under identity of present tense morphology in (4b) results in the overlapping reading as in (2b) before.

However, the non-application of the rule in (4a) does not yield the double access reading because present tense is assumed to be indexical.

A similar situation also obtains in present under past reports. As in Abusch (1997), this situation triggers other mechanisms needed to obtain the double access reading of embedded present. Because in Abusch's and Ogihra's approaches, a general constraint prohibits the occurrence of indexical tenses within intensional domains, the tense should move outside this domain and be interpreted *de re*, in a way parallel to *de re* interpretations of NPs. The intuition here is that there is a mismatch between the content reported and that intuitively believed. In (4), for example, the press will surely represent the president as being out of town at the attitude time, but not necessarily at the ST, a past time from the press' perspective. Likewise for (7) below, where the ST is future relative to Bill's attitude time.

The *de re* analysis (taken from Lewis 1979; Cresswell & Stechow 1982) accounts for the content-report mismatch intuition by proposing that the speaker, rather than representing the *de dicto* content of the attitude, refers to some state in the actual world. This state is the entity or *res* that the attitude is about. The *res* must be related to the attitude holder via a causal acquaintance relation R which is provided by context. Intuitively, R gives the way the attitude holder represents the *res* in the belief worlds. The truth conditions for the attitude verb specify that the attitude holder ascribes a temporal property to the *res* state to which he/she must be acquainted. For example, in (7), the most discussed example in the literature, Bill is acquainted with the state of Hillary having a big belly, and he believed this state to be the state of Hillary's pregnancy. The semantic representations proposed for (4) and (7) are as follows:

(4)   The press will think that the president is out of town.

      c. LF$_2$: [$_{CP}$ Pres$_2$ [$_S$ the press Pres[woll] think s$_2$ [$_{CP_1}$ that [$_S$ the president s$_1$ be out of town]]]]
$\exists s_2[exist(st, s_2) \,\& \,\exists t[t > st \,\& \,think'(t,$
the_press', s_2, $^\wedge \lambda s_1[be\_out\_of\_town'(s_1, the\_president')])]]$

(7)   Bill believed that Hillary is pregnant.

      a. LF: [$_{CP}$ Pres$_2$ [$_S$ Bill Past believe s$_2$ [$_{CP_1}$ that [$_S$ Hillary s$_1$ be pregnant]]]]
$\exists s_2[exist(st, s_2) \,\& \,\exists t[t < st \,\& \,believe'(t,$
b, s_2, $^\wedge \lambda s_1[be\_pregnant'(s_1, h)])]]$

s is a state and $exist$ is an 'operator' such that $[[exist]](s)(t) = 1$ iff t is included in the duration of s. According to the truth conditions proposed for *de re* attitude verbs, the translation in (4c) says that there

exists a state s_2 at the ST such that the press ascribes to s_2 the property of being a state in which the president is out of town. In Ohigara's formulation, (4) is true iff (a) there is a *res* states s_2 at the ST, (b) there is an acquaintance relation R such that s_2 is the state to which the press is connected via R at the time of saying t in the actual world w, and (c) for all worlds $\langle w', t' \rangle$ compatible with what the press thinks in w at t, the state to which the press is acquainted via R in w' at t' has the property $\lambda s_1[be\_out\_of\_town'(s_1,\ the\_president')]$. Similar truth conditions are proposed for (7). The truth conditions thus require both an acquaintance relation R and the existence of the *res* state in the actual world.

The double access reading comes about because on the one hand, R requires the attitude holder to be acquainted with the *res* at the time of the attitude t (condition (b) above). This automatically guarantees that the *res* state in the actual world overlaps with the attitude time t. On the other hand, the truth conditions also require that the *res* state picked up by R obtains in the actual world w at the ST (condition (a) above). This ensures that the *res* state also overlaps with the ST. The double access reading is thus achieved through the fact that whatever state the attitude holder is acquainted with via R at the attitude time is also the state that obtains at the ST in the actual world.

1.2.*1 Some problematic consequences* One problem with the non–uniform approach is that, for every embedded sentence, the proposed syntactic mechanisms predict a systematic ambiguity of the tense morphology: an embedded past tense should receive both an overlapping and a backward shifted reading. However, this is not the correct empirical prediction for eventive embedded sentences:

(8)   The president believed that the senator called him.

(9)   The president denied that he hung up.

The overlapping interpretation is not possible in these cases. As discussed in detail in the next section, past sentences of eventive aktionsart only receive one possible interpretation in a consistent and systematic fashion, while stative sentences are the only ones that allow an overlapping interpretation.

Consider also Ogihara's analysis of *would*-sentences, where *would* $=$ PAST[woll]:

(10) The president said that he would clarify his position.

    a. LF$_1$: The president say PAST that he Ø[woll] clarify his position.

    b. LF$_2$: The president say PAST that he PAST[woll] clarify his position.

The application of the rule in (10a) predicts a future reading relative to the attitude time, as expected. However, the non-application of the rule in (10b) incorrectly predicts other possible readings which are not attested. For example, it predicts a backward shifted interpretation in which the time of clarifying is prior to the time of the president's saying. The situation is that of PAST$_1$...[PAST$_2$...[FUT...]] where the operators are relative. Since the time denoted by PAST$_2$ may be located long before PAST$_1$, some future times relative to the time of PAST$_2$ could still be located in the past of PAST$_1$, thus yielding an incorrect reading.

    Another problem with the non-uniform accounts (particularly those of Ogihara and Abusch) relates to the treatment of the double access readings. The proposed analyses treat all double access readings as involving a *de re* interpretation. Such an interpretation truth-conditionally requires the following conditions:

(a) the existence of a state in the actual world overlapping both the ST and the believing time;

(b) the existence of an acquaintance relation causally connecting the believer with the actual *res* state the belief is about.

Because the truth conditions for double access sentences must satisfy these two requirements, the proposals imply that when these conditions do not obtain, the sentences are false or perhaps infelicitous. However, neither of these requirements is necessary to yield an obviously true double-access sentence. The examples below show the intuitive inadequacy of conditions (a) and (b) above.

    Consider the following. Imagine a situation in which Bill sees Hillary wearing a pretty loose dress at a party that made her look pregnant. Now, the party is over, Bill is in a business trip and Hillary of course does not look pregnant any more, as in fact, she never was. In this context, it is perfectly fine to utter (7):

(7)   Bill believed that Hillary is pregnant.

Here, Bill is only acquainted with Hillary's loose-dress state in the past and this state does not obtain in the actual world at the ST. Of course, because Bill was deceived, it follows from his belief worlds that Hillary is pregnant at an interval including the ST (some future time from Bill's

perspective). The state to which the believer is acquainted need not be true in the actual world at the ST as required by the *de re* account in the factuality condition (a). Consider also the following cases:

(11) Betty told little Bill that an angel is watching him.[1]
(12) The detective reasoned (concluded) that the murderer is still in town.
(13) After another suspicious excuse, Hillary believed (concluded) that her husband is having an affair.
(14) Socrates believed that the soul is located in the stomach.

In (11)–(14), the belief worlds entail the truth of the embedded state at the ST, but the attitude holder need not intuitively be acquainted with any particular actual state that overlaps with both the attitude time and the ST. The situations in which these reports could be true require neither the existence of the embedded state nor the acquaintance relation (condition (a) and (b) above). This is clear in (11). For (12)–(14), one can imagine situations that led the attitude holders to make certain conclusions, but such situations are not *necessarily* the actual *res* states the attitudes are *about*. In (13), for example, Hillary does not seem to believe *of* some state or event (e.g. the excuse) that it has the property of being the state/event of her husband having an affair. The excuse and the affair are two different things in her mind. She simply makes a conclusion from other beliefs previously acquired or from her knowledge of her husband. Similarly, Socrates may have believed the complement of (14) as a statement compatible with his system of beliefs. This belief, a belief true of all times, may have followed from others he had, without requiring an acquaintance relation with any particular or generic state that also obtains at the ST.

In all these cases, intuition suggest that the existence of an acquaintance relation and/or an actual state overlapping with both the ST and the believing time is not truth-conditionally required. Rather, the states in question may only exist *de dicto*-like in the belief worlds. The belief worlds entail the truth of the embedded state at the ST in the belief worlds (a future time from the perspective of the believer) but the factuality of this state is not required. This thus challenges the adequacy of the temporal *de re* analysis.

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[1] Note that it does not matter that Betty lies to little Bill. From the perspective of the speaker, the attribution could be true.

1.3 *A new approach*

Given the difficulties of the non–uniform approach, I will maintain the following: (a) tenses can have a single uniform meaning in all embedded and independent occurrences, provided that this meaning is properly characterized, and (b) the temporal interpretation of a given sentence depends on the interaction of the tenses' meanings with the sentence's aktionsart. The latter is an old observation that I intend to systematically integrate into a uniform theory of tense interpretation (see for example Hinrichs 1986; Hornstein 1990; Dowty 1986; Parsons 1990; Kamp & Reyle 1993; Ter Meulen 1995). To motivate this latter point, consider the following:

(15) The secretary said that

    a. the president was sad.
    b. the president was arriving.
    c. the president arrived at 9 am.
    d. the president prepared a speech.
    e. the president worked hard.

(16) The president decided that in ten days he would say to his party that

    a. he was in trouble.
    b. they were having their last meal together.
    c. his lawyers left him.
    d. his friends asked for more money.
    e. his executive committee talked too much.

Note that contrary to current theories' predictions, the overlapping reading is not possible in the cases (c) and (d) of (15). Similarly, the overlapping reading between the interval denoted by the innermost past tense and that of *would* in (16) is not available in cases (c) and (d). The difference between these examples and those in (a) and (b) is the aktionsart of the embedded sentence. The examples in (a) and (b) have stative complements while those in cases (c) and (d) have eventive ones (an achievement and an accomplishment, according to Vendler's (1967) classification).

Note that (15e) and (16e) could receive two possible interpretations. If they are interpreted as a single occurrence of the activity (sometimes called an episodic reading), only the backward shifted reading obtains. One would think that the overlapping interpretation should be possible because activities are atelic predicates and no pragmatic information precludes such a reading. For example, the president could have been

working hard at the time the secretary said so in (15e). However, if (15e) and (16e) are interpreted as a single occurrence of the activity, the overlapping interpretation is not available. The overlapping reading only arises if the embedded sentence in (15e) and (16e) is understood as generic or as a habitual activity, and it is well known that generic sentences are stative.[2]

Note also that sentences (15b) and (16b) with progressive aspect may receive an overlapping interpretation. Progressive aspect, which shares some properties with stative aktionsart (unlike activities *per se*), coerces any type of event into what Moens & Steedman (1988) call progressive states. Thus, examples in (15) and (16) suggest that aktionsart has predictable effects on temporal interpretation. Stative properties (shared by habitual and progressive sentences) are associated with overlapping readings while eventive sentences only generate sequential readings.

A similar influence of stativity on the temporal reading can be observed in future and modal sentences. Such sentences may receive an overlapping reading relative to the ST as in (17), particularly in a context in which the speaker makes a supposition about the president's current whereabouts (see Boyd & Thorne 1969; Wekker 1976; Steedman 1997; Palmer 1969; Condoravdi 2001):

(17) The president will/may/must be at home (now).
(18) The president will/may/must leave (now).
(19) The president thought that the secretary would/may/must be at home (and decided to call her).
(20) The president thought that the secretary would/may/must leave.

In contrast, the overlapping reading is not available in (18), despite the fact that the adverbial modification is *now*. As before, overlapping readings only arise with statives, while eventive sentences receive sequential readings. The same generalization holds for (19) and (20).[3]

Independent evidence that aktionsart determines the temporal readings comes from the interpretations of perfect and imperfect past tenses in Romance. While perfect aspect in embedded sentences correlates with sequential readings, imperfect aspect is usually correlated with overlapping readings. Imperfect in Romance, like the progressive in English, shares entailments and semantic properties with statives (Cipria & Roberts 2001; Gennari 1999a). Consider the following:

[2] Generic sentences satisfy all the tests of stative predicates so that as far as aktionsart properties are concerned, generic sentences are statives (see Carlson & Pelletier 1995).

[3] See also Klein 1994, for observations along these lines regarding the interpretation of German present tense.

(21) a.   Juan dijo que María estaba enferma.
              John say-past-perf that Mary be-past-**imperf** sick.
        b.   Juan dijo que María estuvo enferma.
              John say-past-perf. that Mary be-past-**perf** sick.

(21a) receives an overlapping reading, like (2) in English, although a backward shifted reading may also be available with an appropriate context. In contrast, (21b) only has the backward shifted reading. Thus, in Spanish, stative properties (manifested through aspect) are also determinant of the temporal readings available in embedded sentences.[4]

More importantly, independent evidence for the influence of aktionsart on temporal interpretations also comes from discourse contexts, although the relation affected in this domain is inter-sentential, i.e. that between the interval in which a sentence is true and the truth interval of the previous sentence in discourse. As noted in Discourse Representation Theory (Hinrichs 1986; Partee 1984; Kamp & Reyle 1993, see also Ter Meulen 1995), stative and progressive sentences usually yield overlapping readings relative to the truth interval of the previous sentence while event sentences generate sequential readings.

Given these facts, the question arises as to why and how aktionsart properties have an effect on temporal interpretations. To answer this, I will argue that stative predicates and sentences (including habitual and progressive ones) all share the property of logically entailing or lexically specifying a superinterval which contains the truth interval of the sentence provided by the tense operator. It follows from this that the superinterval of stative sentences (if large enough) may overlap with the ST or other times contextually provided. In contrast, event verbs and sentences have the property of lexically specifying or logically entailing that the event in question is maximally contained within their intervals of truth. This excludes the possibility of an overlapping interpretation with the ST or other times contextually provided, given the meaning of the temporal operators. Thus, rather than non-uniform meanings, tenses have the same meaning in all contexts but aktionsart properties lead to the overlapping readings. This would be, in principle, a simpler and more desirable theory, since (a) it would not claim vacuous temporal morphology, (b) it would not require any syntactic mechanism insensitive to aktionsart; and (c) it would explain tense meanings in a uniform way.

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[4] See also Kamp & Rohrer's (1983) analysis of simple past and past imperfect in French.

2 THEORETICAL FRAMEWORK

2.1 *Basic definitions*

In this paper, I assume the traditional view of tenses as quantifiers, and of embedded sentences as sets of world-interval pairs (within a single temporal structure). Thus, *a believes Q* at *w* and interval *i* is true iff for all *w′* and *i′* compatible with *a*'s beliefs at *w* and *i*, $Q(w')(i') = 1$ (as in Stechow 1995).[5] Because I will not be concerned with *de se* or *de re* readings here, the traditional definition of belief reports will do. The putative *de re* interpretations of tenses are treated below as reports of implicit attitudes (as in Gennari 1999b), which do not require any *de re* mechanism. Also, the notion of local evaluation time is understood as in the traditional logical sense: the evaluation time (or interval) of a quantifier tense is the time with respect to which the truth of the sentence is evaluated. For example, in an expression such as $\exists i[i < i_0 \,\&\, Q(i)]$, i_0 is the local evaluation time. This time can be bound by a lambda operator or indexically refer to the ST. Finally, I will refer to the event time or interval (ET) of a sentence and occasionally, to its reference time (RT). By *event time*, I mean the interval specified by the tense operator in which a sentence is true. In $\exists i[i < i_0 \,\&\, Q(i)]$, the ET is *i*. Following Dowty (1986), Hinrichs (1986), Nerbonne (1986) and others, I assume that the reference time of a sentence is given either by adverbs that temporally locate the sentence or by the event time of the previous sentence in discourse.

To illustrate these concepts, consider some examples:

(22) David received a letter yesterday.
$\exists i \, [i < st \,\&\, receive'(i, d, a\_letter') \,\&\, i \subset yesterday']$

(23) Anna believed that David received a letter yesterday.
$\exists i' \, [i' < st \, believe'(i', a, {}^{\wedge}\lambda i_0 \exists i \, [i < i_0 \,\&\, receive'(i, d, a\_letter') \,\&\, i \subset yesterday']$

(22) is true iff at an interval before the ST (and included in yesterday), David received a letter. The ET is the interval *i* at which David received the letter, some (short) interval within the RT *yesterday*. The ST is the local evaluation time for the past operator, because the truth of the sentence is evaluated relative to the ST (non-embedded sentences in general take the ST as their evaluation time). In an embedded sentence, the evaluation time will be the time representing the attitude time in

the belief worlds, as i_0 in (23). Sentence (23) is true at the ST iff at a time i' previous to the ST, Anna has a belief and for all $\langle w_0, i_0 \rangle$ compatible with Anna's beliefs at w and i', there is a time prior to i_0 at which David received a letter in w_0. The world-time pairs $\langle w_0, i_0 \rangle$ represent Anna's belief worlds (Anna's here and now) at the actual time of the belief. Therefore, the time of these pairs are the evaluation time relative to which the truth of the embedded sentence is evaluated.

2.2   *The effect of aktionsart on temporal readings*

In this paper, I adopt Taylor's (1977) and Dowty's (1979, 1986) defining criteria of aktionsart classes. The criteria are logical entailments of a sentence Q at any interval i if Q is a sentence of a given class as determined by the internal semantic composition (Verkuyl 1993). A sentence $Q(i)$ is stative iff it entails that Q is true at all instants within i. A sentence $Q(i)$ is an accomplishment/achievement (or a telic event) iff it entails that Q is false at all subintervals of i (where i is the minimal interval at which the change of state takes place).[6] $Q(i)$ is an activity (or an atelic event) iff it entails that Q is true at all subintervals of i down to a certain limit of size. Note that in general, the duration of the interval or subinterval at which any sentence is true depends on world knowledge about the event or state in question (Dowty 1986). For example, activities such as *gardening* may not hold at very small subintervals. Similarly, the intervals of *being sad* or *writing a letter* are typically shorter than those of *being German* or *living a corrupt life*.

  I also adopt Dowty's (1986) general treatment of the relationship between aktionsart and temporal interpretation, but while Dowty's proposal referred to the effect of aktionsart on discourse interpretation (specifically, to the relation between the sentence's ET and the discourse RT), I interpret it to apply to intra-sentential domains, i.e. to the relation between a sentence's ET and its local evaluation time. As an illustration, consider the interpretation of independent sentences of different aktionsart with future tense:

(24) John will leave (now).
      $\text{FUT}'(\text{leave}'(j)(i)) = \exists i\ [i > st\ \&\ leave'(j)(i)]$

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[6] This entailment follows from Dowty's truth conditions of telic events represented with the $BECOME$ operator. $BECOME[Q]$ is true at an interval i iff (a) Q is false at an interval j containing the initial moment of i, (b) Q is true at an interval k containing the final instant of i, and (c) there is no subinterval of i in which conditions (a) and (b) hold. It follows that the event is not true at any subinterval of i and that this interval is the **minimal interval** at which the relevant change of state could take place.

Under the standard analysis of future tense, (24) is true at the ST iff there is an interval i after the ST such that John leaves at i. Note that (24) does not mean that John is leaving at the ST but that he is about to leave (near future). To understand why an overlapping reading with the ST is not possible, consider the aktionsart entailments. First, a telic sentence $Q(i)$ entails that Q is false at all subintervals of i. Second, this entailment in turn entails that if Q is true at an interval i, Q is false at all superintervals of i as well (Dowty 1986), for if Q were true at some superinterval i' of i and at i itself, it would be false at all subintervals of i', including i, according to the telicity entailment, contradicting the assumption. Thus, if *John leaves* is true at some future interval i, the sentence entails that John's leaving does not hold at any subinterval within i, and therefore, it does not hold at any superinterval of i either. Given this and the standard meaning of future, it follows that *John will leave now* crucially cannot overlap with the ST, despite the adverbial modification.[7]

Now consider a stative sentence:

(25) John will be at home (tomorrow/now).
      FUT$'$(be_at_home$'$(j)(i)) = $\exists i$ [$i > st$ & $be\_at\_home'(j)(i)$]

(25) can have a future or an overlapping interpretation relative to the ST, as each of possible temporal adverbs indicates. In the present reading, *will* is inferential: it requires a context in which the speaker makes an inference from certain background assumptions (cf. Kratzer 1981), and is roughly equivalent to the use of *must* in the same context. As indicated earlier, the overlapping reading only arises with stative sentences but not eventive ones. The state/event distinction also causes a differential effect on temporal interpretation with other expressions that are clearly modal, as in (17) and (18) above. This indicates that the possible temporal location of the sentence in question depends on aktionsart, but not on modality per se.

Leaving aside the problem of whether modality is conveyed with future tense,[8] the question of interest here is why the effect of aktionsart

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[7] What I have just said seems incompatible with the occurrence of *now* in (24). If the adverb modifies the ET of the sentence (the leaving time), this information contradicts the future tense. The solution to this puzzle is that *now* denotes an interval and not an instant. Such an interval could be extended enough to include both the interval in which John leaves and the ST. The punctuality of the event still obtains as in the case without the adverbial *now*, because *now* is an interval that may encompass both the ST and the (punctual) event of leaving.

[8] Several arguments have been put forward to treat *will* as conveying both temporal and modal information. Since the purpose of this article is not to elucidate its modal meaning, I will assume that *will* conveys future temporal information and that its modality can be independently explained (following Gennari 1997, 2000; Condoravdi 2001; and others).

on temporal interpretation occurs. The answer, suggested in different forms in the literature (Dowty 1986; Kamp & Reyle 1993; Lascarides & Asher 1993), is that stative sentences have temporal properties that distinguish them from event sentences. Note that (25) entails its truth at all subinstants of i. In contrast to (24), this does not exclude the possibility that the sentence is actually true at a larger interval that properly includes its ET, the future interval i. In fact, when states are asserted, the normal assumption is that they are true at a larger interval surrounding their ETs and their RTs, if any (Dowty 1986). I call this assumption the superinterval property. This property conveys the information that $be\_at\_home(i)$ in (25) holds at a superinterval surrounding i. It follows that this superinterval can include the future interval i and the ST. This inference is schematically represented below, where P represents the modal operator *possibly*, i_s is a superinterval and bold material highlights the key statements of the inference:

(26) John will be at home.

$\quad$ (1) $\quad \exists i\ [\mathbf{i} > \mathbf{st}\,\&\,be\_at\_home'(j)(i)]$
$\quad$ (2) $\quad \exists i_s\ [\exists i\,[i > st\,\&\,\mathbf{i} \subset \mathbf{i_s}\,\&\,be\_at\_home'(j)(i_s)]]$

$$\exists i_s\ [\exists i\,[i > st\,\&\,i \subset i_s\,\&\,be\_at\_home'(j)(i_s)\,\&\,\mathbf{P}\,st \subset \mathbf{i_s}]]$$

The meaning of (26) in (1) and the assumption of the superinterval in (2) entail the possibility that the ST is included (or overlaps with) the superinterval i_s surrounding i. The overlapping reading comes about because the superinterval i_s at which the state of being at home holds is able to overlap with the evaluation time of the entire sentence. However, this is a mere possibility. Whether the overlapping or future reading obtains depends on the RT and our knowledge of the typical duration of the state involved.

$\quad$ When an adverb such as *now* or *today* is added to (26), the state's superinterval is interpreted as surrounding this RT. With this assumption plus the lexical meaning of *now*, it follows that *John will be at home now* entails that John will be at home for a superinterval that includes the interval *now*, i.e. John is and will be at home for a while. This is schematically represented in (27). Line (3) below assumes that *now'* denotes an interval including the ST:

(27) John will be at home now.

$\quad$ (1) $\quad \exists i\ [i > st\,\&\,be\_at\_home'(j)(i)\,\&\,\mathbf{i} \subset \mathbf{now'}]$
$\quad$ (2) $\quad \exists i_s\ [\exists i\,[i > st\,\&\,i \subset i_s\,\&\,be\_at\_home'(j)(i_s)\,\&\,\mathbf{now'} \subset \mathbf{i_s}]]$
$\quad$ (3) $\quad \mathbf{st} \subset \mathbf{now'}$

$$\exists i_s\ [\exists i\,[i > st\,\&\,i \subset i_s\,\&\,be\_at\_home'(j)(i_s)\,\&\,now' \subset i_s\,\&\,\mathbf{st} \subset \mathbf{i_s}]]$$

Instead, if the RT is *tomorrow night*, the superinterval is not necessarily interpreted to overlap with the ST, although the possibility is open as in (26). The superinterval of *being at home* would include the interval denoted by *tomorrow night*. But because *being at home* denotes a temporary state that does not typically hold for a long period, the superinterval of the state is most likely entirely located in the future of the ST. Knowledge of the contextual situation can also support a particular interpretation, such as the time of the day in which the assertion is made, the knowledge of John's home habits, etc. Thus, the knowledge of the typical duration of the state in question plus discourse considerations will determine the actual temporal duration and location of the superinterval relative to the evaluation time.

Finally, consider what happens if an activity sentence is used:

(28) John will run (now).
      $\mathrm{FUT}'(\mathrm{run}'(\mathrm{j})(\mathrm{i})) = \exists i\ [i > st\ \&\ run'(j)(i)]$

(28) entails its truth at all subintervals of i. As with states, but unlike telic events, this entailment is in principle logically compatible with an implication of a superinterval so that the overlapping reading with the ST should be possible. However, this reading is not available, so that activities pattern with telic events in this respect. This is because activities have temporal and causal internal developments (i.e. lexically specified aktionsart properties) that negate the possibility of a superinterval surrounding the ET. The kind of events that activities denote is such that they can be sustained for a while, but because their duration is contingent on a causal force initiating and sustaining the relevant action, they stop when the causal force does. So, they are not typically assumed to obtain indefinitely. On the contrary, activities are normally assumed to be contained within their interval of evaluations. In contrast to states, they typically implicate that they take place within some arbitrary initial and end point of their interval of truth (Smith 1991). Consider the following (where $\rightsquigarrow$ means *implicates*):

(29) John danced (this morning). $\rightsquigarrow$ He started and stopped dancing at some point (this morning).
(30) John was sick (this morning). *$\rightsquigarrow$ He started and stopped being sick at some point (this morning).

As expected on the basis of the superinterval property, states are not implied to be wholly contained within their ETs (whichever interval specified by the past tense) or their RTs. But this inference is available with episodic activities (see next section for more details). This explains

why (28) only receives a future reading (the running obtains within the future interval i) and indicates that the superinterval property is not operative with activities. Thus, episodic activities are understood to be maximally contained within the limits of their ETs and RTs. Therefore, activities do not yield overlapping readings relative to the evaluation time but sequential ones.

In sum, different aktionsarten have different effects on the temporal interpretations. Telic events and activities have internal temporal developments that are incompatible with the possibility of their truth at larger intervals. Therefore, they do not overlap with the local evaluation time. In contrast, states have the superinterval property. This property is an inference that there is a larger interval (containing the state's ET and/or RT) at which the state holds. Given this, the inferred superinterval is able to overlap with the local evaluation time.

2.3   *The superinterval property*

Since my analysis of temporal interpretations heavily relies on the superinterval implication of states, in this section, I discuss in details its presence with states, as opposed to events, based on their lexical aktionsart and discourse interpretation. To start with, note that typically, states are facts: they characterize the static structure of the world describing locations and physical or psychological properties of entities. To start or stop being in a state depends on other events (e.g. *being German*), but the state's persistence does not. States remain true without the aid of an external force and their persistence is independent of whatever caused them. In principle, if a stative sentence holds at an interval i, and no intervening event occurs between i and $i + 1$ that changes this state, then the sentence also holds at $i + 1$ (Katz 1994; Ter Meulen 1995). This is the intuition underlying the superinterval property of states. Dowty (1986) calls it the principle of inertia.[9]

This situation radically contrasts with that of events. Eventive verbs in general have the change-of-state entailment (Dowty 1979). Telic events entail one definite change, while activities entail a sequence of small changes. These changes are caused by some agentive force, which may be sustained for a while. Given this, we do not assume that eventive sentences hold at a superinterval because there is an intervening cause-event bringing about the changes, and the

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[9] See also Lascarides & Asher's (1993) principle of *States Overlap*, which they interpret to express Grice's maxim of relevance.

cause-effect relation is sequential. For example, if an activity is true at interval i, intuitively, it does not necessarily hold at a later time $i + 1$ because the causal force applying at i may not apply at $i + 1$. The persistence of activities contingently depends on other events. These observations suggest that stative sentences are fundamentally different from eventive ones.[10] States have the property of obtaining for relatively long periods, while events do not.

Evidence for this temporal contrast between states and events comes from discourse interpretation. Dowty (1986) observes that the assumption that states persist in time makes (31) infelicitous, no matter how many events intervene between the sentences given, unless information is given otherwise. Also, as noted in DRT, a stative sentence in a narrative is most usually interpreted to obtain before and after the event denoted by the previous sentence as in (32). As suggested by examples (29) and (30) above, the superinterval of a state can obtain even beyond the RT or the temporal location given in discourse (in (32), beyond *this morning*):

(31) ?? The book was on the table at t_0........Mary put the book on the table at t_n.

(32) Mary went to see the president this morning. He was sick.

This contrasts with activities and events in general which normally receive sequential interpretations as in (33). Some authors (e.g. Hinrichs 1986; Dowty 1986), claim that activities, by virtue of being atelic events, may overlap with other events in discourse. This is possible as in (34), because the temporal relations between events in discourse ultimately depends on the contingency and causal relations established between them.

(33) Mary went to see the president (this morning). She asked him questions about the project.

(34) Mary talked to the president (this morning). She asked him questions about the project.

Even when overlapping readings are possible, it is critical that activities are not implied to obtain beyond their RTs. In (34), for example, interpreters do not assume that the questions lasted for longer than the

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[10] For more about the contrast between states and events, see Katz (1994).

morning or the duration of the meeting. This indicates that, even when activities may overlap other events in discourse, they do not behave like states. In sum, lexical aktionsart properties and discourse interpretation support the claim that states are assumed to hold for periods larger than those specified by the tense and adverbials (if any). This contrasts with events in general which are normally interpreted to be maximally contained within a given spatio-temporal domain.[11]

2.4   *The superinterval property: semantics or pragmatics?*

An important question that needs to be addressed is the exact nature of the superinterval property. Dowty (1986) argues that the superinterval is a pragmatic implication because it can be cancelled when statives receive inceptive readings. Such readings are exemplified in (35), taken from Dowty (1986):

(35)   Away in front, the engine whistled. Trees, hills and road, slid sideways and were gone.

  This reading differs from other readings in that each state (the trees, the hills and the road being gone) cannot obtain *before* each corresponding thing has slid sideways, i.e. they do not overlap with these events. This is because each event of sliding sideways entails its resulting state (the things being gone). Therefore, the only possible interpretation of the states is one in which they start when the event bringing them about has occurred. However, this does not mean that the superinterval property is cancelled. It means that the states of *being gone* cannot possibly obtain before their causing events in discourse. But once the states start obtaining, the property that they persist in time according to their typical duration is still part of their meanings (from the standpoint of the observer, the trees are gone for ever). Thus, the superinterval property is not cancelled. Rather, it surrounds the ET in a way compatible with the discourse (by extending into the future).
  If the superinterval of state does not really disappear but surrounds the ET of the sentence in a way compatible with the discourse context, the source of the superinterval property is the lexical meaning of the stative verb or phrase involved, rather than pragmatic knowledge. Pragmatic knowledge determines the ultimate location of the superinterval but not its existence. Contrast for example, *being crazy* to *being sad*, *knowing* to *believing*. Or consider the distinction

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[11] See Lascarides & Asher (1993) for a similar approach to discourse interpretations based on world knowledge assumptions.

between individual-level and stage-level predicates, which is taken to be lexical (cf. Kratzer 1989; Chierchia 1995). Lexical meanings convey prototypical information about their denotations (Rosch & Mervis 1975), and part of this information in verbs concerns the typical duration of events and states. When these lexical meanings combine into sentences, the sentence carries this information with it. Thus, rather than claiming that the superinterval implication is a pragmatic cancelable implication, I claim that it is an inference derived from the lexical meaning of verbs, and therefore, part of the computation of the meaning of the sentence.

3 TENSE MEANINGS AND TEMPORAL INTERPRETATIONS

3.1 *The interpretation of past tenses*

3.1.*1 Simple Past* Recall that past under past was problematic for a uniform theory because two readings were available and no postulated meaning of the simple past tense could account for both of them appropriately. In my approach, past tense has a single meaning, equal to $\lambda Q \lambda i_0[\exists i[i < i_0 \& Q(i)]]$, which requires the temporal property it modifies to be evaluated at a time prior to the evaluation time. Thus, past tense is treated as evaluation time sensitive. When past tense occurs in an independent sentence, the evaluation time will be the ST. When past tense is embedded under another tense, the past proposition should be evaluated relative to the local evaluation time representing the believer's now or attitude time. This is clear in the case of past embedded under future:

(36) Bill will tell you that Mary's exam went well.

The temporal interpretation of the embedded complement is in relation to Bill's future attitude time. The interval specified by the past tense is prior to the future attitude time but can be located either after, before or overlapping with the ST. The embedded past tense does not specify any relation relative to ST.

Consider now how the problematic temporal reading of past under past come about. The semantic composition of the sentence (37) (omitting the outermost world variable) first combines the tense meaning with a tenseless clause:

$\mathbf{past'(marybesick')} = \lambda Q_{\langle i,t \rangle} \lambda i_0 \exists i[i < i_0 \& Q(i)](\lambda i'[be\_sick'(m)(i')])$

to yield $\lambda i_0[\exists i[i < i_0 \& be\_sick'(m)(i)]]$. The embedding verb of type $\langle\langle w, \langle i, t\rangle\rangle, \langle e, \langle i, t\rangle\rangle\rangle$ takes as arguments a function from a world to a temporal abstract, an individual and an interval:

$$think'(^{\wedge}\lambda i_0[\exists i[i < i_0 \& be\_sick'(m)(i)]])$$
$$= \lambda x\lambda i'[think'(^{\wedge}\lambda i_0[\exists i[i < i_0 \& be\_sick'(m)(i)]])(x)(i')].$$

After combining with the subject **john'** and the matrix past tense, the result is the following:

(37) John thought that Mary was sick.
$$= \lambda i_1\exists i'[i' < i_1 \& think'(i', j, {}^{\wedge}\lambda i_0\exists i[i < i_0 \& be\_sick' (m)(i)])]^{st}$$
$$= \exists i'[i' < st \& think'(i', j, {}^{\wedge}\lambda i_0\exists i[i < i_0 \& be\_sick'(i, m)])]$$

At the last step of the derivation, the temporal abstract resulting from the sentential composition applies to the ST of the utterance context. The truth conditions say that (37) is true iff there is a past time i' at which John thinks, and for all his cognitive worlds and times $\langle w_0, i_0\rangle$ compatible with his beliefs at i', Mary is sick at a time earlier than i_0. Thus, if John's thinking time i' in (37) is part of the word-time pairs compatible with his cognitive state (as it is under normal circumstances), it follows that Mary is sick at a time earlier than John's thinking time i'. In other words, for some belief world-time pairs, $\langle w, i'\rangle$ would be included in $\{\langle w, i\rangle$ Mary is sick earlier than i in $w\}$. This is similar to Ogihara's (1996) account of the backward shifted reading.[12]

Now, given the superinterval property associated with states, i.e. that there is a superinterval i_s that contains i, and that for all instants within i_s, Mary is sick, it follows that both the interval of thinking and the interval of being sick can overlap. The superinterval of being sick can extend from an interval earlier than the thinking interval until the thinking interval itself, as in (26). This is indeed a possible reading and, in absence of adverbial modifications or contextual information, the most likely one.[13]

Note that the truth conditions themselves do not explicitly require the overlapping reading. Rather, they underdetermine the actual

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[12] In what follows, I will give truth conditions in a simplified manner, mostly referring at the temporal relations and omitting the complex definition of belief reports.

[13] This may be because there is a conversational implicature arising from the choice between simple past and past perfect. Past perfect is more informative because it only receives the backward shifted reading. If the speaker does not choose past perfect, he/she implicates that the backward shifted reading does not obtain. This makes the overlapping reading the default reading in absence of other temporal specifications.

temporal extension of the embedded state and its superinterval. The temporal operators only determine the relative location of the event intervals (the ETs). The possible duration of the embedded proposition depends on the typical duration of sickness, which is available to both speakers and interpreters. Thus the speaker not only attributes the thought that Mary was sick a while before the thinking time, but that she was and would continue to be sick for a while, given typical knowledge associated with *being sick*. The speaker's intended content includes the knowledge of the superinterval, the availability of which further specifies the truth conditional content.

However, the superinterval property associated with the state of being sick does not have to overlap with the thinking interval; this reading is only available. The backward shifted reading is in principle also possible. Whether one reading or the other obtains, i.e. the specific duration and location assigned to the embedded state, will depend on the temporal information available in the context. An obvious case of more specific temporal information is the occurrence of adverbs as in *Yesterday, John said that Mary was sick last year*. Another case in which contextual information constrains the temporal interpretation of the complement is by means of the RT in discourse:

(38) John went to a private school when he was a child. He said the school was awful ...

Since the events mentioned by John are located in John's childhood (the RT introduced by the *when*-clause), the state of the complement is accordingly located around this time and not around John's saying time. Note that the saying event is interpreted sequentially relative to the previous RT, i.e. later than the childhood events. This is consistent with the observations above regarding the behaviour of events in discourse. Also, under our definition of RT, *said* does not introduce a new RT for the embedded sentence. The RT of a sentence is either its temporal adverbs or the ET of the previous sentence in discourse. Thus, both the embedded state and the saying event are located relative to the interval of the previous sentence. In this respect, complement clauses behave as independent clauses, i.e. they tend to overlap with the RT from previous sentences in discourse. Thus, adverbials and contextual factors may constrain the interpretation of the superinterval (its past location and duration). The superinterval property only makes the overlapping reading available, while the actual reading depends on its compatibility with the context.

Next, consider a case in which an event complement is involved:

(39) John believed that Mary went to the party.
$\exists i [i < st \, \& \, believe'(i, j, \,^{\wedge}\lambda i_0 \exists i'[i' < i_0 \, \& \, go\_to\_the\_party'(i', m)])]$

Note that believing is a state and so it may be included in a superinterval, according to the superinterval property. It thus seems possible that the time of going to the party could be included within the interval of believing. However, this reading is not available because the entailment associated with states precludes this reading. The entailment of the *believe*-sentence is such that for all instants t within i, the believing interval, it is true that John believes p. Since the embedded complement is a past proposition that is believed at each instant t within i, the entailment of the entire sentence amounts to the following: for each instant t within the believing state, there is a prior interval in which Mary went to the party. In other words, the belief is that there was a single event of going to the party and this belief is true at all instant t within the believing interval i. Thus, the believed event of going to the party precedes all these instants. It follows that the interval of going to the party cannot overlap with the interval of believing.

The same type of reasoning applies to other aktionsart combinations of main and complement sentences. An event main sentence such as *John say p* will have to be contained within its interval of evaluation so that the event complement p will have to be true prior to the saying interval. No overlapping reading is possible. Episodic activities occurring with both stative and eventive matrix verbs will behave like telic events because they are true within their ETs and they do not have the superinterval property. Their intervals could be more or less large but they will be wholly located before the attitude time for similar reasons discussed in (39): For each instant within the believing state, there is a prior interval within which the activity took place. Note that this entailment of the believing state also obtains with stative complements: For each instant within the believing state, there is a prior interval (the ET) in which the embedded state is true. However, a stative complement could generate an overlapping reading due to the superinterval property surrounding the ET *of the complement*, as in (37). Thus, the aktionsart properties of the sentences involved determine the available temporal readings: Embedded states yield overlapping readings if context permits while embedded events yield sequential readings.

3.1.*2 Past progressive* Following Dowty's (1979) treatment of the progressive and tense and aspect composition, I assume that **prog** is

treated as a VP modifier of type $\langle e, \langle i, t \rangle \rangle$, $\langle e, \langle i, t \rangle \rangle$, rather than as a sentential operator. Its meaning applies to a VP-meaning, the subject argument and a temporal argument. $\mathbf{prog}(Q_{\langle e, \langle i,t \rangle \rangle})(x)(i)$ is true at w iff there is a superinterval i' containing i such that for all possible inertia continuations w', $[Q(x)(i')]$ is true at w'.[14] An important property of this composition is that the tense operator provides the local evaluation time for the aspectual operator. For example, in an expression such as $PAST'[\mathbf{prog}'\text{-}run'(j)]$, the aspectual operator $\mathbf{prog}$ is evaluated relative to the past interval of PAST.

The standard definition of progressive contains the key to explain its possible temporal interpretations. First, the definition satisfies the defining criterion of stative aktionsart: If $\mathbf{prog}[Q]$ is true at i, for any subinstant t of i, there is a superinterval containing t (and i) where Q is true, therefore, $\mathbf{prog}[Q]$ is also true at every subinstant of i. Thus, $\mathbf{prog}$ applies to any other aktionsart and returns a stative proposition. Second, the definition entails that there is a superinterval i' in which the modified proposition is true. As with other stative sentences, this property explains why progressive sentences usually generate overlapping readings relative to the local evaluation time. Consider some examples:

(40) John said that Mary was going to the party.
$\exists i [i < st \& say'(^{\wedge}\lambda i_0 \exists i'[i' < i_0 \& \mathbf{prog\_go\_party}'(m)(i')])(i)(j)] =$
$\exists i [i < st \& say'(i, j, {}^{\wedge}\lambda i_0 \exists i'[i' < i_0 \& \exists i_s [i' \subset i_s \& go\_party'(i_s, m)]])]$

(41) John said that he would tell his mother that they were having their last meal.
$\exists i [i < st \& say'(i, j, {}^{\wedge}\lambda i_0 \exists i'[i' > i_0 \& tell' (i', j, his\_mother', {}^{\wedge}\lambda i_1$
$\exists i''[i'' < i_1 \& \mathbf{prog\_have}(i'', meal', they')]])])]$

(40) is true iff John said in the past that there was another prior time surrounded by a superinterval in which Mary was in the process of going to the party. The overlapping reading obtains as in the case of a past state under past, i.e. the superinterval introduced by the truth requirements of $\mathbf{prog}$ can overlap with John's saying interval. Similarly for (41). The superinterval introduced around the past time i'' before the telling interval may overlap the telling.

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[14] More precisely, $\mathbf{prog}\,Q(x)(i)$ is true at a world w iff (a) there is an superinterval i' properly containing i, (b) i is not the final or initial subinterval of i', and (c) for all worlds w' in the inertia set of possible continuations of w at i, $Q(x)(i')$ is true in w'. Recall that Dowty (1986) argues that the possibility that i is the initial subinterval of i' should be excluded, although the definition of Dowty (1979) did not incorporate this restriction. This is because progressive sentences do not receive inceptive interpretations and their ETs are clearly understood in the middle of the event denoted (e.g. *At 5, I was sleeping*). In the text, I assume this restriction and omit consideration of the modal component of $\mathbf{prog}$.

Also, as with states in the simple past, the intervals introduced by **prog** do not necessarily overlap with the interval that happens to be the local evaluation time. Consider, for example:

(42) John said (today) that Mary was writing the paper yesterday.

(43) John said today that he would tell his friend tomorrow that we were having a good time yesterday.

Progressive thus allows backward shifted readings and, as other tenses, the available reading (the assigned location and duration) depends on contextual information:

(44) John was watching television when Mary came in. However, she said he was sleeping on the sofa.

The interval of sleeping overlaps with Mary's coming in, and not Mary's saying time. This is because the *when*-clause is the RT for the evaluation of following discourse. Thus, as with simple past, principles of discourse interpretation and general knowledge determine the most likely reading for past progressive.

3.1.*3   Independent and embedded past tenses*   Given that past statives in embedded constructions may overlap with the local evaluation time, the superinterval property also predicts that an overlapping reading should be possible when the local evaluation time is the ST. Although a sentence such as (45) below, for example, may still be true at the ST, it does not have the same obvious overlapping interpretation as past under past. This is because the overlapping reading is blocked by standard Gricean principles applied to grammatical elements.

(45) Karl was German.

If the speaker wanted to convey that the state of being German obtains at the ST, he would have used present tense, since the superinterval of states would guarantee its application to present and at least some past times (it would be more informative). If the speaker does not use present, the implication is that he/she does not know whether this piece of information obtains. Thus, the hearer is less inclined to infer that the state obtains at the ST, although this may in fact be true.

This implicature is clearly operative in (45). In absence of a discourse RT, the implication is that Karl is dead or changed his citizenship, in which case the sentence is a habitual state wholly located in the past.

The state does not overlap with the ST. Thus, independent past statives imply a superinterval in a way consistent with my proposal, but its duration may not overlap the ST due to a Gricean quantity maxim, hence the contrast with embedded past.

3.2   *The interpretation of indexical tenses*

Recall from the introduction that future and present tenses' interpretations cannot be uniformly accounted for in embedded sentences if their meanings are considered either simply indexical or evaluation time sensitive. The problem of these tenses is that most often they are interpreted as indexical, but, in some embedded contexts, they behave as evaluation time sensitive. Embedded present tense, for example, may receive either a double access reading or a purely simultaneous future interpretation. Only the former interpretation requires reference to the ST. I take this to mean, contrary to the approaches discussed earlier, that the future and the present tense have complex definitions that involve more than a reference to the ST. Specifically, I will argue on the basis of the distribution of all possible readings, that indexical tenses are interpreted relative to both the ST and the local evaluation time. These tenses are thus both indexical and evaluation time sensitive. They are indexical because they always involve a reference to the ST, and evaluation time sensitive because their interpretations depend on the local evaluation time in a way that is constrained by their indexicality.

3.2.1   Present tense   Consider again the interpretations available for embedded present:

(46) Hillary is smart.
(3)   The president believed that his party is furious.
(4)   The press will believe that the president is out of town.

Note that a present complement can be interpreted as uniquely overlapping the local evaluation time only if this time is future (or present). In a case such as (4), the reference to the ST is neither necessary nor implied. In contrast, if the evaluation time is past, the double access reading is the only possible one, as in (3), and the reference to the ST is required. This suggests that the denotation of present tense can either be a future interval or an interval overlapping with the ST, i.e. the tense in fact denotes any non-past interval. Note also that the interval denoted in every case overlaps with whichever happens to be the evaluation time (either the ST or the attitude

time). This indicates that the tense is evaluation time sensitive. Taking these properties together, the meaning of present tense thus requires the ET of the modified proposition to (a) overlap with the local evaluation time and (b) not to be wholly located before the ST, i.e. either be later or overlap with it. Formally, the definition of present is $\lambda Q \lambda i [\exists i'[i' \circ i \ \& \ \neg(i' < st) \ \& \ Q(i')]]$, where $\circ$ means *overlap with*. The tense is thus both evaluation time sensitive and indexical.

To see how the proposed meaning predicts the correct interpretations in both embedded and independent occurrences, consider first the case of present embedded under future or present:

(47) John thinks that Mary is smart.
$\lambda i_0 [\exists i [i \circ i_0 \ \& \ \neg(i < st) \ \& \ think'({}^{\wedge}\lambda i_1 \exists i'[i' \circ i_1 \ \& \ \neg(i' < st)$
$\& \ be\_smart'(m)(i')])(j)(i)]]^{st} =$
$\exists i [i \circ st \ \& \ think'(i, j, {}^{\wedge}\lambda i_1 \exists i'[i' \circ i_1 \ \& \ \neg(i' < st) \ \& \ be\_smart'(i', m)])]$

(48) John will say that Mary is his wife.
$\exists i_1 [i_1 > st \ \& \ say'(i_1, j, {}^{\wedge}\lambda i_0 \exists i_2 [i_2 \circ i_0 \ \& \ \neg(i_2 < st) \ \& \ be\_wife'(i_2, m)])]$

In the case of (47), which also exemplifies independent sentences evaluated relative to the ST, the sentence is true iff there is an interval i overlapping the ST at which John thinks that there is another interval i' overlapping his now and no earlier than the ST, at which Mary is smart. The embedded present simply overlaps with the local evaluation time, which in turn, overlaps with the ST. The restriction that the embedded ET be non-past is satisfied. Note that in (47), the outermost temporal quantifier need not specify the condition $\neg(i < st)$, thus reproducing the traditional definition of present tense. This is because, once the temporal abstract resulting from the tense composition is evaluated relative to the ST, the statement $i \circ st$ entails that i is not wholly located before the ST, and so it can be omitted for simplicity, although there is no harm leaving it in.

For the case of (48), the sentence could be true in the two following situations: when John says at a future time that Mary is John's wife at some interval overlapping with John's saying time, and when John says at a future time that Mary currently is and has been John's wife. In the former case, the ET of the present complement i_2 is a future interval overlapping with the future local evaluation time. In the latter case, this interval is extended enough to overlap with the ST and the future local evaluation time. Whether the embedded interval overlaps with the ST (i.e. the most likely size of this interval) will be determined by context and pragmatic considerations. This is clear in the following examples:

(49) (When John gets home), John will think that Mary is talking on the phone/is in the kitchen.

(50) John will announce tonight that Mary is writing a new book.

The ET of the embedded sentence in (49) most likely surrounds the future evaluation time. This is because the superinterval introduced by the progressive tends to be interpreted as surrounding its evaluation time[15] and events such as talking on the phone or states such as being in the kitchen do not tend to go on for long periods. Unless the distance between the ST and the future time is close enough, the overlap with the ST is not pragmatically plausible. This contrasts with (50) and (48), in which the overlap with the ST is pragmatically available.

Consider now the case of present under past sentences such as (7):

(7) Bill believed that Hillary is pregnant.
$$\exists i[i < st \ \& \ believe'(i, b, {}^{\wedge}\lambda i_0 \exists i'[i' \circ i_0 \ \& \ \neg(i' < st) \ \& \ be\_pregnant'(i', h)])]$$

This says that the sentence is true iff there is an interval i prior to the ST at which for all Bill's belief worlds, there is an interval i' such that (a) it overlaps Bill's believing time, (b) it is not an interval before the ST, and (c) Hillary is pregnant at i'. Note that by definition of the *before* and *after* relations, $\neg(i' < st)$ means that i' is not wholly located before the ST. Thus, an interval i' that overlaps with the past believing interval and is not wholly located before the ST, necessarily requires that i' overlaps with both the past believing interval i and the ST. Thus, the proposed definition of present tense accounts for all temporal readings available in both embedded and independent occurrences.

Several reasons suggest that the proposed definition of the present tense is a sensible one. First, it replicates the effects of the traditional definition (overlap with the ST), while expanding its explanatory adequacy to embedded domains in which the evaluation time is not the ST. Second, the definition follows from the minimal assumption of uniform interpretations in all contexts and from the actual distribution of possible readings. This contrasts with Ogihara's (1996) proposal, where each reading is explained by a different mechanism. The double access reading is explained by the temporal *de re* mechanism, while the future reading is obtained via the deletion rule (section 1.2).

In addition to simplicity and economy considerations, the meaning agrees in spirit with several proposals in which the temporal perspective of present is considered to be non-past (e.g. Kamp & Reyle 1993; Abusch 1997). In particular, Abusch (1988) proposes a definition of

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[15] The evaluation time is in the middle of the superinterval, i.e. it is not final or initial in it (see definition of progressive).

present tense similar to mine, in which the interval denoted overlaps with both the evaluation time and the ST. The novelty of my definition is that it imposes an indexical non-past condition that can be satisfied in different ways, depending on the local evaluation time.

Finally, there are generality considerations. Languages differ in the way lexical tense meanings are specified out of a set of universal possibilities such as evaluation-time sensitivity and indexicality. For example, English present tense is both evaluation time sensitive and indexical, while Japanese, which lacks a morphological future tense, has a non-past tense that is the non-indexical (evaluation time sensitive) formal counterpart of English present. This is what one would expect if the proposed lexical meaning had cross-linguistic validity (see Gennari 1999a for details).

3.2.2 *The semantics of present tense and the content-report mismatch*
In this section, I would like to briefly discuss the problem of the content-report mismatch, which has motivated the temporal *de re* analysis discussed before. The purpose of this section is not to offer a comprehensive analysis of the problem (for this, I refer the reader to Gennari 1999b), but to show how one might explain apparent inconsistencies between the account of the double access reading and the intuition of the content-report mismatch.

Note for example that it follows from the truth conditions of (7) that Bill believed that Hillary is pregnant during an interval overlapping with both Bill's now and the ST. The attributed embedded proposition seems to commit the believer to a belief about an interval overlapping with a future time, the ST from the perspective of the speaker.

(7) Bill believed that Hillary is pregnant.

However, Bill presumably had a belief about Hillary being pregnant at a past interval, and not necessarily at an interval extending into the future or including the ST (the content-report mismatch). To explain this puzzle, I have argued that the believer need not be committed to such specific temporal contents if the speaker's report is viewed as a report of an implicit attitude. Reports of implicit attitudes do not intend to represent the believer's literal belief (or the believer's ways of representation). They report a proposition that follows from the explicitly believed content plus other assumptions normally taken for granted.

In (7), for example, Bill did not actually have a belief about an interval extending into the future, but his belief *entailed* that the embedded state was true in the past and would be true in the future, given the speaker's addition of assumptions normally taken for granted.

The speaker attributes to Bill typical assumptions and knowledge of the world from which the implicit content reported logically follows. Thus, if Bill believed at a time before the ST that Hillary was pregnant, the speaker could infer that Bill believed that she was pregnant and would be pregnant for a while, given that Bill has rational beliefs and normal knowledge about pregnancy (e.g. typical assumptions about its duration). Before uttering the sentence in (7), the speaker goes through an inference schematically represented as follows:

(54) a. Bill believed that Hillary was pregnant at t.
   b. Bill's belief worlds are coherent.
   c. Bill believed that Hillary had a normal pregnancy.
   d. Bill knew that pregnancies typically last for an interval i including t.
   e. Bill knew that i includes a future time t' (the ST from the speaker's perspective).
   $\rightarrow$ Bill believed that Hillary is pregnant at i including t and t'.

From the speaker's perspective, the future time t' in Bill's worlds is the ST. Note that the embedded interval denoted by the present tense in (7) exists in the belief worlds, rather than in the actual world. The inference that Hillary's pregnancy obtains at a future time t' holds in the belief worlds. However, the actual belief may only be about a past interval (premise (a)). This is what the speaker would have reported if the inference was not possible in the current common ground. The speaker's inference concludes the pregnancy at the ST implicit in Bill's beliefs, given the attribution of normal assumptions and typical knowledge.[16]

Present under future sentences in their double access reading have similar characteristics to present under past ones. Consider, for example:

(55) The dean will believe that Bill's records are not good enough.

When the double access reading obtains, the speaker attributes an implicit future attitude based on an inference including common sense assumptions. The attributed future attitude is such that, given normal assumptions, it will entail something true about the past of the attitude

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[16] Note that premise (c) of (54) schematically represents other premises also implicitly assumed by the speaker. For example, Bill did not think at the time of the belief that Hillary was about to give birth, or Bill did not have any reason to think that Hillary would not have a normal and full term pregnancy. These are part of normal assumptions that the speaker takes for granted in the common ground and thus attributes to the believer. This correctly predicts that if the speaker knew that Bill thought that Hillary's situation was somewhat atypical (for example, that Hillary was sick and could loose the child), the present under past report in (7) would be infelicitous.

time (the ST), although the attitude holder may not know this at the ST. The difference with present under past reports is that what is entailed by the belief worlds looks backward instead of forward, i.e. once the believer acquires certain knowledge, his/her view of the past will change. For example, in (55), the dean will believe that Bill's records are bad at a future time t. But, since the dean will learn that Bill's records are generally bad at an interval i including t, and since i includes $t-1$ (the ST), it follows that the dean will believe that Bill's records are bad at an interval including $t-1$.

The notion of implicit report, traditionally acknowledged in philosophical literature (e.g. Stalnaker 1999) is further constrained here by the existence of a pragmatic inference, the premises of which (if any) should be taken for granted in the common ground. In particular, I have proposed (following Stalnaker's (1999) observations on implicit beliefs) that an implicit report such as that in (7) is felicitous, if there is an inference attainable in the common ground that allows the speaker to infer the attributed content. This is because, by the very nature of implicit attitudes, the speaker cannot assume *any* proposition as part of the belief worlds. Rather, he/she may assume those propositions that are normally taken for granted, i.e. those that constitute common knowledge and default assumptions. Consider, for example,

(56) Russell believed that Frege's ear lobe was smaller than Big Ben.

where Russell presumably did not have this explicit belief but it follows from the general pragmatic knowledge attributable to him. A belief attribution may thus take for granted beliefs that the believer is not aware of and does not represent in a linguistic form. This is the crucial difference that distinguishes report of implicit attitude from other types of reports.[17]

In sum, this account contrasts with current ones in that it only

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[17] Note incidentally, that the existence of implicit belief reports has important implications for the treatment of indexical tenses within intensional domains. The literature discussed so far assumes that all indexical tenses are interpreted *de re* (Ogihara 1996) and therefore, move outside the intensional domain. These assumptions follow from their very nature: Indexical tenses denote times in the utterance context, therefore, this cannot be part of the believer's worlds. However, while indexical tenses undoubtedly refer to the utterance context, it is not a necessary truth that they are always interpreted *de re* and moved outside the intensional domain. In particular, if indexical tenses occur in implicit reports, which are neither explicit *de dicto* nor *de re* reports, it follows that they are not *always* interpreted *de re*. Rather, they can be interpreted as denoting some attributed implicit content, and thus be interpreted in situ. That the speaker uses an indexical reference to report the believed content is no longer problematic because the report is not intended to represent an explicit belief, i.e. the way the believer would represent it or the referential expressions he/she would use. The speaker reports an implicit proposition with his/her referential expressions (perhaps, because of cooperation with the addressee, see Asher 1986). This proposition must be equivalent to the one implicitly believed (e.g. equivalent to the last line of (54)).

requires the standard semantic analysis of belief-reports, while the speaker is responsible for the use of the present tense via his/her own pragmatic inference. What creates the intuition that the speaker misrepresents the original belief is the inference process the speaker goes through in the report, which in most cases, attributes a stronger belief than the original content, given the premises added to the belief worlds. Thus, the content-report mismatch arises because reports containing indexical tenses involve an attribution of an implicit attitude. The choice of the present tense correlates with implicit reports but such reports are not restricted to indexical uses.

3.2.3 *Future tense* As with present tense, the future tense in embedded sentences is sensitive to the local evaluation time in a way that is constrained by its indexical reference to the ST. Consider again some examples from the introduction:

(5) In two days, an official will announce that the president will apologize (*tomorrow).

(6) A journalist said that the president will resign (*yesterday).

Note that there is a contrast between future embedded under past and future embedded under future. Sensitivity to the local evaluation time only appears in the later case, when the evaluation time is already located in the future. This suggests that future tense requires an interpretation relative to both the ST and the evaluation time if this time is later than the ST. Following this observation, I propose that the future tense specifies that the ET of the modified proposition is both later than the ST and later than the local evaluation time.[18] Formally, the meaning of future is $\lambda Q \lambda i [\exists i'[i' > i \,\&\, i' > st \,\&\, Q(i')]]$. This is a way to express that the temporal perspective from which Q is seen is always the ST and possibly the local evaluation time, if this time is later than the ST. When the local evaluation time is located before the ST or is equal to it, the first conjunct of the definition does not have any effect on the temporal interpretation.

To see this, consider first the case of future embedded under future:

(57) John will say that Mary will come.
$$\lambda i_0[\exists i_1[i_1 > i_0 \,\&\, i_1 > st \,\&\, say'(^\wedge\lambda i\exists i_2[i_2 > i \,\&\, i_2 > st$$
$$\&\, come'(m)(i_2)])(j)(i_1)]]^{st} =$$
$$\exists i_1[i_1 > st \,\&\, say'(i_1, j, ^\wedge\lambda i\exists i_2[i_2 > i \,\&\, i_2 > st \,\&\, come'(i_2, m)])]]]$$

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[18] Support for this idea can be found in Reichenbach's (1947) and Kamp & Reyle's (1993) analyses of simple future. According to them, simple future can have either the ST or another future time as RT or temporal perspective. If one thinks of this duality of point of reference in terms of evaluation times, my definition agrees with this observation.

(57) is true iff there is a time i_1 later than the ST at which John says that there is another future time i_2 later than his now and later than the ST at which Mary comes. The requirement that the ET of the embedded proposition be later than the local evaluation time captures the future interpretation relative to the attitude time and excludes the unattested reading suggested by the adverbial modification in (5). In addition, when the ST is the evaluation time, the requirement referring to the evaluation time in the meaning of the tense will turn out to be equivalent to that referring to the ST. This is clear in the case of the outermost quantifier of (57), once the future temporal abstract is applied to the ST (i.e. if $i_1 > i_0 \& i_1 > st$ and $i_0 = st$, then $i_1 > st \& i_1 > st$, which is equivalent to $i_1 > st$). This shows that the occurrence of future tense in independent sentences or when embedded under present is not problematic. In these cases, the local evaluation time is the ST. In such cases, the definition of $will$ is somewhat redundant but harmless.

Note incidentally, that the occurrence of a stative sentence in the complement of (57) would not receive an overlapping reading with the evaluation time, although the superinterval of states would make this reading possible. Consider for example, *John will think that Mary will be sad*. The overlapping reading does not obtain here because there is a quantity implicature. Present tense in this environment would be more informative than the use of future because by definition, it entails an overlapping reading with the evaluation time. If the speaker does not use present, it implies that the overlapping interpretation does not obtain. As with independent past sentences, implicatures triggered by grammatical elements lead to an interpretation in which the superinterval of states is not large enough to overlap the local evaluation time.

Consider now the case of future embedded under past:

(58) John said that Mary will come.
$\exists i_1[i_1 < st \& say'(i_1, j, {}^{\wedge}\lambda i_0 \exists i_2[i_2 > i_0 \& i_2 > st \& come'(i_2, m)])]]$

(58) is true iff there is an interval i_1 prior to ST in which John says that there is another interval i_2 later than the past attitude interval and later than the ST in which Mary comes. Note that the only possible reading is one in which the future time is located both after the ST and after the past attitude time. If the future interval was located after the past tense but not after the ST, the requirement that this interval be later than the ST would not be satisfied. This definition thus amounts to an interpretation of $will$ as indexical rather than evaluation time sensitive. Thus, our definition of the meaning of the future accounts for all the possible readings in both independent and embedded sentences.

4 CONCLUSIONS

This paper has shown that the problematic temporal readings of English complement clauses can be accounted for on the basis of uniform definitions of tense meanings. While English simple past tense is evaluation time sensitive, present and future tenses are both evaluation time sensitive and indexical. These tense meanings systematically interact with aktionsart properties, which further specify the temporal readings expected on the basis of the tense meanings alone. Overlapping readings are available with statives because this aktionsart class typically implies the truth of the sentence at a superinterval. In a subordinate construction, the superinterval associated with the embedded state is able to overlap with the time of the attitude, although the size and location of the superinterval ultimately depend on discourse considerations. In contrast, eventive sentences normally trigger sequential readings in both embedded and discourse contexts because they typically imply that they are maximally contained within their ETs. Thus, the interaction of appropriate tense meanings with aktionsart and discourse inferences predicts the intended readings for both independent and embedded sentences without any special syntactic mechanism.

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