On the interpretation of tense in temporal adverbial clauses

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Abstract Tenses in English temporal adjunct clauses seem to show properties of both matrix and embedded tenses. On the one hand, they are often argued to be interpreted with respect to the time of utterance (Stump 1985; Arregui & Kusumoto 1998; Kubota et al. 2011). On the other hand, they are more constrained than matrix tenses, claimed to be limited to past tense when the matrix tense is past, and present when the matrix tense is future. I present evidence from the English perfect that adjunct clauses are always interpreted relative to the nearest c-commanding temporal operator, which can in principle give rise to both types of behaviors: adjunct tenses are interpreted relative to some temporal operator if within the scope of matrix tense, or they are interpreted relative to the time of utterance if they are outside the scope of matrix tense. What decides between these possibilities in a given clause are syntactic and pragmatic conditions on adjunction and the resulting interaction between the presuppositions introduced by the adjunct clause and the meanings of the temporal connectives. The result is that when the matrix clause is a non-perfect, adjunct tenses are always interpreted relative to the utterance time. When the matrix clause contains a perfect, however, adjunct tenses may be interpreted relative to the matrix tense operator.

1 Introduction

The behavior of tense in temporal adjunct clauses poses an enduring problem for theories of tense because its profile within and across languages differs from that of complement clauses. In English, for example, adjunct tense morphology must be past in (1) and present in (2), irrespective of the temporal connective. Tenses in complement clauses, by contrast, are not so restricted.

(1) I adopt**ed** a cat before/after/when Katie **left**/*leaves/*will leave.
(compare *I believed that Katie liked/likes/will like her cat.*)

(2) I **will** adopt a cat before/after/when Katie **leaves**/*left/*will leave.
(compare *I will believe that Katie liked/likes/will like her cat.*)

Two central questions regarding the status of adjunct tense are as yet unresolved in the literature: (a) whether adjunct tenses are interpreted or vacuous, and (b) if adjunct tenses are interpreted, what evaluation parameter they are interpreted with respect to. This paper provides evidence from the English perfect that adjunct tenses are interpreted rather than vacuous, and shows that it is possible to derive the evaluation parameter of an adjunct tense in English from the meaning and adjunction position of the adjunct clause.

Much previous work considers two possibilities for adjunct tense interpretation in (1) and (2). Adjunct tenses are presumed to be either interpreted with respect to the time of utterance (e.g. Stump 1985; Arregui & Kusumoto 1998; Kubota et al. 2011), or relative to some other time introduced by the matrix clause (i.e. matrix event time) (e.g. Ogihara 1996; von Stechow & Grønn 2013). Each option is expected to make different predictions for each temporal connective. The meaning of *after*, for example, orders the adjunct event prior to the matrix event. In (1), an adjunct past tense evaluated with respect to either the matrix event time or the utterance time is therefore compatible with the truth conditions of *after* clauses. By contrast, the meaning of *before* is not compatible with an adjunct past tense that is interpreted relative to the matrix event time, because *before* requires the adjunct event to be in the future of the matrix event. Thus, the adjunct past in *before* clauses must be interpreted relative to the time of utterance.

To maintain a uniform analysis of adjunct tense in (1), we could stipulate that adjunct tenses are always interpreted relative to the time of utterance in English (see e.g. Kubota et al. 2011). This readily explains why adjunct past is always the choice in (1), despite the fact that each temporal connective asserts a different temporal ordering between the matrix and adjunct event times. A similar move also explains the uniform *absence* of adjunct past in (2), despite the fact that an adjunct past interpreted relative to the matrix event time is always compatible with the truth conditions of *after* clauses. If adjunct past is always interpreted with respect to the time of utterance, an adjunct event that occurs in the future should never be introduced with past morphology.

A problem for this approach is the availability of adjunct past in (3), which is used to introduce an adjunct event that is in the future. In (3), the past tense in the adjunct clause seems to be interpreted with respect to the future time introduced by *woll* rather than the utterance time (or the matrix event time).

(3) Context: Katie and her brother are young children planning their futures. They both want to get a PhD and complete their PhDs by the time Katie is 30. Additionally, they want Katie to get her PhD after/before/when her brother gets his.

> If all goes according to plan, by the time she is 30, Katie will have gotten her PhD after/before/when her brother **did**.

What is puzzling about the contrast between (2) and (3) is that the matrix clause in each example introduces a future time, relative to which an adjunct past can in principle be interpreted. However, adjunct past is only accepted if the matrix clause also contains the *perfect*, which cannot be explained by stipulating an evaluation parameter for English adjunct tenses.

On the basis of examples like (3), I will argue that adjunct tenses can in principle be interpreted relative to matrix temporal operators such as tense and aspect. I propose, however, that they are often interpreted with respect to the time of utterance due to conditions on redundant or contradictory meanings, which require adjunct tenses to be interpreted higher than their base adjunction positions. On the proposed theory, the apparently different evaluation times in (1) and (2) vs. (3) are not stipulated, but follow from the assumptions about adjunction, the meanings of the temporal connectives and tense operators, and the pragmatics of inferences associated with temporal adjunct clauses.

The result is that adjunct tenses in the context of matrix non-perfects (e.g. (1), (2)) are interpreted with respect to the time of utterance, because there are no adjunction positions within the scope of matrix tense that result in a meaningful interpretation of an adjunct tense. Conversely, adjunct tenses in matrix perfects (e.g. (3)) are interpreted relative to the matrix tense operator because the meaning of the perfect ameliorates the conditions blocking an adjunction position below matrix tense.

A summary of the proposal is as follows: the adjunct clause introduces the run-time of a presupposed event (Heinämäki 1974; Stump 1985; Beaver & Condoravdi 2003; Condoravdi 2010; Iatridou 2014, among others). When that run time is depends on where the clause is located at LF. Some choices will lead to redundancy or contradiction with the content of *before/after/when*. As we will see, an effort to avoid redundancy and contradiction guides the movement of the clause. The perfect expands the clausal spine, and makes room for a QR position below matrix tense that is not available in non-perfect matrix clauses.

The paper is organized as follows: Section 2 details the proposed framework for tense interpretation in matrix and adjunct clauses. Section 3 discusses the meanings and syntax of temporal connectives when they select for tensed clausal complements. Section 4 demonstrates how the proposal correctly predicts the distribution of adjunct past in future perfect and non-perfect contexts. Section 5 addresses the status of adjunct present tense and demonstrates how the proposal correctly predicts its distribution on the assumption that adjunct present is an underlying future. Lastly,

Section 6 argues against alternative proposals that treat English adjunct tenses as vacuous.

2 Interpreting matrix and adjunct tenses

I adopt a Priorean tense system (cf. von Stechow & Beck 2015) expressed with the indexation conventions outlined in von Fintel & Iatridou (2019). Like in Dowty (1982) this system makes use of an index on the right that is shifted, and one on the left that keeps track of the context. Each index represents a world-time pair: the right index (i) represents the evaluation world and time, and the left index (u) represents the utterance world and time. The rule in (5) sets the highest evaluation index as identical to the utterance world and time, thus ensuring that (unembedded) sentences are interpreted as claims about the context in which they are uttered. For example, given the interpretation in (4) and the rule in (5), an utterance of *Katie left* will situate Katie's leaving in the past relative to the time of utterance.

(4) ${}^{u}[\![\text{PAST Katie leave}]\!]^{i} = 1$ iff $\exists t$: Katie leaves in w_i at t and $t < t_i$

(5) **Utterance Rule**: An utterance of a sentence ϕ that is made in a world w at a time t counts as true iff ${}^{<w,t>}[\![\phi]\!]^{<w,t>} = 1$.

Following von Fintel & Iatridou (2019), who build off of insights by Iatridou et al. (2001), I assume the meanings in (6), (7), and (9) for English tense, aspect, and the perfect. These definitions take as an assumption the proposed description of tense and aspect advanced by Klein (1994). In this system, aspect locates the run time of an event with respect to an intermediate interval, which is related to the utterance time via tense. This is captured by the nature of this system – structurally lower temporal operators take as their evaluation index the output of the next highest operator (i.e. they are bound by the next highest operator). Since we will not be discussing worlds until Section 3, I will refer to the world-time index as just a time index in the meanwhile, representing the evaluation time of a constituent.

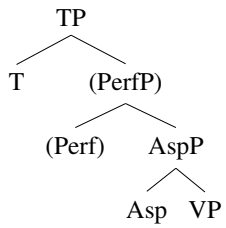


Figure 1: Proposed basic clause structure.

(6) Tense

a. ${}^{u}[\![\text{PRS } \phi]\!]^{t} = 1$ iff ${}^{u}[\![\phi]\!]^{t} = 1$
b. ${}^{u}[\![\text{PST } \phi]\!]^{t} = 1$ iff $\exists t' < t : {}^{u}[\![\phi]\!]^{t'} = 1$
c. ${}^{u}[\![\text{FUT } \phi]\!]^{t} = 1$ iff $\exists t' > t : {}^{u}[\![\phi]\!]^{t'} = 1$

(7) Aspect
a. ${}^{u}[\![\text{PFV } \phi]\!]^{t} = 1$ iff $\exists t' \subseteq t : {}^{u}[\![\phi]\!]^{t'} = 1$
b. ${}^{u}[\![\text{IPFV } \phi]\!]^{t} = 1$ iff $\exists t' \supseteq t : {}^{u}[\![\phi]\!]^{t'} = 1$

For the operators we will be discussing in this paper, the utterance time will often not need to be tracked throughout a derivation because the evaluation index will govern interpretation. However, I include it here for completeness because it is necessary for the interpretation of certain adverbs, e.g. *yesterday/tomorrow*. These so-called 'deictic' elements are defined thus because further embedding them appears not to shift their evaluation time in the same way as other embedded elements.[1]

(8) a. Katie will believe that her cat left yesterday.
Deictic *yesterday* means the day before UT, not the day before belief time
b. Katie will believe that her cat left the day before.
Non-deictic *day before* means before belief time

In Reichenbach (1947) terms, the evaluation index of a matrix tense corresponds to the utterance time (UT), the evaluation index of aspect corresponds to the reference time (R),[2] and the evaluation index of the VP corresponds to the event or situation time (E). Perfective and imperfective aspect respectively locate E within R and vice versa, and a matrix tense relates R to UT.

Following Iatridou et al. (2001) (and many others), I assume that the perfect is a separate maximal projection from tense and aspect, and structurally intervenes between them (as in Figure 1). This structure is evident from the order of auxiliary verbs in English, where the perfect auxiliary *have* both linearly precedes the imperfective auxiliary *be*, and also blocks *be* from moving to T (e.g. *Katie has not been leaving early* vs. **Katie is not having left early*). The perfect mediates between tense and aspect by introducing another interval (i.e. an *extended now* or a *perfect*

[1] It is worth noting that an embedded present tense also behaves partially like a deictic element. A sentence *Katie believed that her cat is angry* is only true if the cat is angry for an interval that includes both the belief time and some time at or after the utterance time, called the *double access reading*. This feature of the English present will not affect the main insights of this paper, but I will henceforth assume with Altshuler & Schwarzschild (2013) that the meaning of the English present makes use of the context parameter as well as the evaluation time.

[2] Klein (1994) uses the notion Topic Time instead of R in a proposed shift from points to intervals, but this distinction is not relevant for the present purposes.

time span), bounded on the right by the output of tense (here R = right boundary (RB) of perfect time span).

(9) ${}^{u}[\![\text{PRF } \phi]\!]^{t} = 1$ iff $\exists t' : t = RB(t') \wedge {}^{u}[\![\phi]\!]^{t'} = 1$

In the terms of this system, a present perfect introduces an interval whose right boundary is the utterance time because the evaluation index of the English present is assigned to its complement, namely the perfect. A past or future perfect shifts the right boundary of the perfect time span to a past or future time:

(10) a. Present perfect: —perfect time span—RB=UT
b. Past perfect: —perfect time span—RB<UT
c. Future perfect: —perfect time span—RB>UT

As described by Iatridou et al. (2001), whether the perfect has a perfective or imperfective complement gives rise to different readings, which are called the *existential perfect* (henceforth *E-perfect*) and *universal perfect* (henceforth *U-perfect*) respectively. When the perfect has a perfective complement, the matrix event is understood to be contained in the perfect time span. When the perfect has an imperfective complement, the matrix event is understood to be ongoing throughout the entire perfect time span.

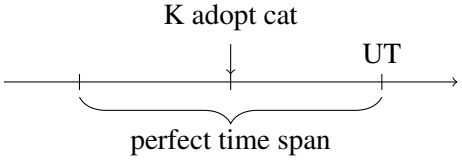
(11) Katie has adopted a cat since last Tuesday.
There is an adoption interval between now and last Tuesday.

(12) Katie has been living in France since last Tuesday.
Every sub-interval between now and last Tuesday is a time at which Katie lives in France.

According to the present framework, the difference between the so-called E-perfect and U-perfect is a natural consequence of the composition of aspect with the perfect. Aspect takes as its evaluation index the output of the perfect, namely the perfect time span. If the sister of the perfect is perfective aspect, the event time is contained inside the perfect time span. If the sister of the perfect is imperfective aspect, the event time contains the perfect time span, resulting in the two meanings in (13) and (14).

(13) *E-perfect*: Katie has adopted a cat.
$[\![\text{PRS PRF PFV Katie adopt a cat}]\!]^{UT} = 1$ iff...
a. $[\![\text{PRF PFV Katie adopt a cat}]\!]^{UT} = 1$ iff...
b. $\exists t : UT = RB(t) \wedge [\![\text{PFV Katie adopt a cat}]\!]^{t} = 1$ iff...
c. $\exists t : UT = RB(t) \wedge \exists t' \subseteq t \wedge [\![\text{Katie adopt a cat}]\!]^{t'} = 1$

d. In prose: There is some interval, bounded on the right by UT, which contains a time at which Katie adopts a cat.



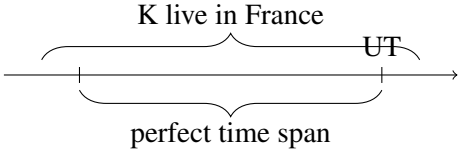
(14) *U-perfect*: Katie has been living in France.
$[\![$PRS PRF IPFV Katie live in France$]\!]^{UT} = 1$ iff...

a. $[\![$PRF IPFV Katie live in France$]\!]^{UT} = 1$ iff...

b. $\exists t : UT = RB(t) \wedge [\![$IPFV Katie live in France$]\!]^{t} = 1$ iff...

c. $\exists t : UT = RB(t) \wedge \exists t' \supseteq t \wedge [\![$Katie live in France$]\!]^{t'} = 1$

d. In prose: There is some interval, bounded on the right by UT, which is contained in an interval in which Katie lives in France.



Returning to adjunct clauses, adjunction position within the matrix clause is expected to affect the evaluation index of an adjunct, which is proposed to have consequences for tense interpretation inside the adjunct clause. Since tense shifts the evaluation index of its sister, an adjunct clause that adjoins to the sister of tense will be interpreted relative to the output of the tense operator. Similarly, an adjunct clause that adjoins to the sister of the perfect (i.e. to AspP) will be interpreted relative to the output of the perfect, and so on. If the adjunct clause adjoins to the TP itself, however, it will be interpreted outside the scope of tense, so its evaluation index will be determined by the utterance rule (unless the clause is embedded).

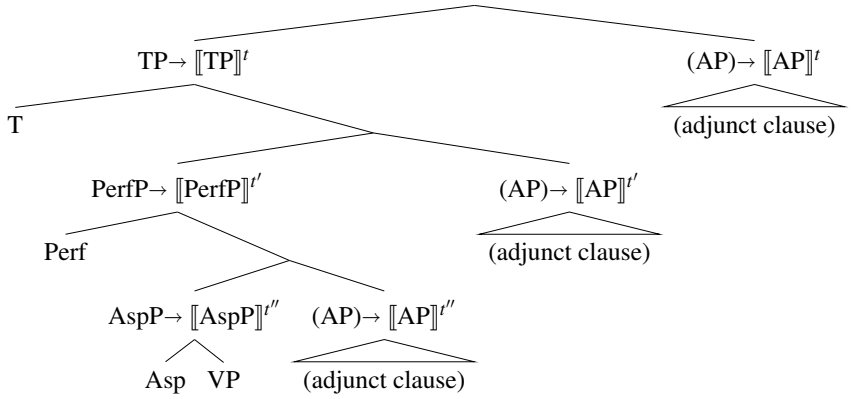


Figure 2: Adjuncts take the evaluation indices of their sisters.

Returning to the examples in (1) and (2) (repeated below), in the framework adopted here, we could imagine either of two hypotheses about the interpretation of adjunct tense. Either adjunct tenses are interpreted outside the scope of any matrix operator, and are thus interpreted with respect to (*w.r.t.*) the time of utterance, or they are interpreted within the scope of some matrix operator, and are thus relative to the output of that operator. On this approach, tenses are always interpreted relative to the parameter of evaluation, rather than the context index (i.e. they are not deictic), but can appear to refer to the time of utterance due to their position in the clause.

(1) Adverbial clauses within matrix past
   a. I adopt**ed** a cat when Katie **left**/*leaves/*will leave.
   b. I adopt**ed** a cat before Katie **left**/*leaves/*will leave.
   c. I adopt**ed** a cat after Katie **left**/*leaves/*will leave.

(2) Adverbial clauses within matrix future
   a. I **will** adopt a cat when Katie **leaves**/*left/*will leave.
   b. I **will** adopt a cat before Katie **leaves**/*left/*will leave.
   c. I **will** adopt a cat after Katie **leaves**/*left/*will leave.

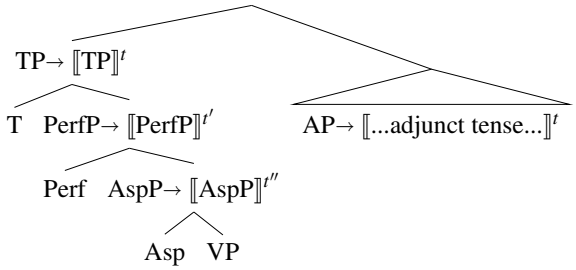


Figure 3: Hypothesis 1: adjunct tenses are interpreted w.r.t. UT.

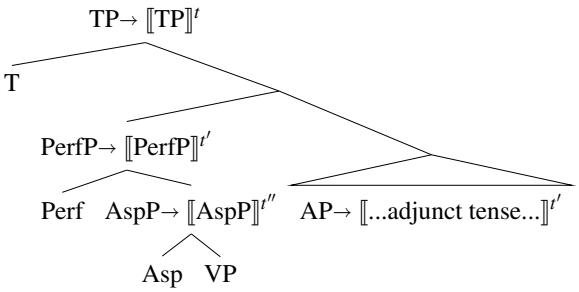


Figure 4: Hypothesis 2: adjunct tenses are interpreted relative to some other time, e.g. the output of tense.

I will argue, on the basis of evidence from the future perfect, that an LF like Figure 3 describes (1) and (2), while an LF like Figure 4 describes (3) (expanded in (15) with the full paradigm of adjunct tenses) and (16). Recall that when the matrix clause is future perfect, relative adjunct past becomes available. Not only is adjunct past available, but adjunct present is *not* always available – it depends on the temporal connective. In general, present perfect is preferred to present non-perfect in the adjunct clause.

(15) Context: Katie and her brother are young children planning their futures. They both want to get a PhD and complete their PhDs by the time Katie is 30. Additionally, they want Katie to get her PhD after/before/when her brother gets his.

a. If all goes according to plan, by the time she is 30, Katie will have gotten her PhD **after** her brother did/??does/has.

b. If all goes according to plan, by the time she is 30, Katie will have gotten her PhD **before** her brother did/does/has.

c. If all goes according to plan, by the time she is 30, Katie will have gotten her PhD **when** her brother did/?does/has.

(16) Context: my mom plans to visit me twice before the year is over, and her first visit is scheduled to follow my future purchase of a new bike.

a. By this time next year, mom will have visited twice **since** I bought/*buy my new bike.

b. %?By this time next year, mom will have visited twice since I've been riding my new bike.

Focusing on *since* clauses, which show the clearest contrast between adjunct past and present, observe that both (16a,b) are compatible with an interpretation in which I buy a bike and start riding it *after* the time of utterance. I propose that the tense inside the *since* clause must therefore be interpreted somewhere below matrix tense. A similar conclusion applies to *before/after/when* clauses. In (15), the context makes it clear that Katie's brother gets his PhD at a future time, even when the adjunct tense is past. The only difference between (15) and (16) is that adjunct present is also licensed for *before/when* clauses.

Sections 3 and 4 investigate the meanings of these temporal connectives in greater detail and demonstrate that Figure 5 is the LF that licenses adjunct past in future perfect contexts. In other words, relative adjunct past is always relative to the output of tense rather than the output of the perfect or aspect.

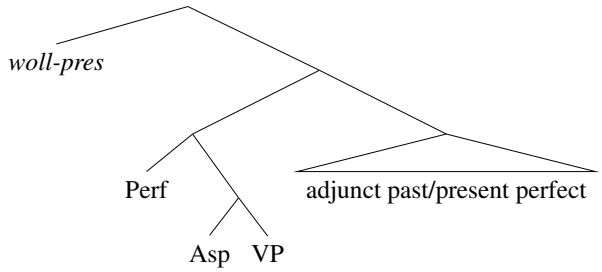


Figure 5: Proposed LF for (16).

This LF is intuitively correct if we reason about the contexts in which adjunct past vs. present perfect are used. If the event inside *since*, for example, strictly precedes the right boundary of the perfect time span, the adjunct tense is past (16a). If the event inside *since* is ongoing throughout the entire interval, present perfect is licensed (16b).[3] On this interpretation, adjunct tenses in (16a,b) show the profile of

[3] von Fintel & Iatridou (2019) discuss a problem with *since* clauses that contain U-perfects, which is that the meaning discussed for (16b) is never predicted. The perfect time span introduced by *since* is predicted to be the left boundary of the matrix perfect time span, rather than ongoing throughout it. They propose that such cases are explained if *since I have been riding my bike* is actually *since the time since which I have been riding my bike*, where the second instance of *since* is deleted. Their

relative tenses, relative to the output of tense (i.e. the right boundary of the perfect time span).

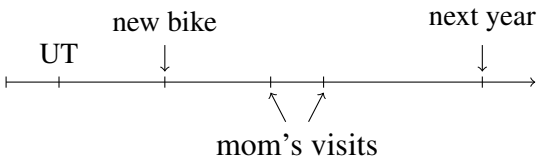


Figure 6: Past/*present inside *since* because the *since* event precedes the future time introduced by *woll*.

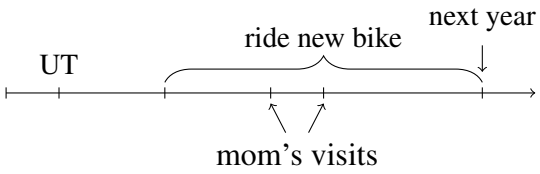


Figure 7: Adjunct present perfect licensed because *since* event now overlaps the future time introduced by *woll*.

We will additionally see that the meanings of the temporal connectives require the locus of adjunct tense interpretation to be different than the adjunction position of the temporal connective itself. This is achieved if clausal complements of temporal connectives QR out of the adjunct clause to a different domain of evaluation. The LF in Figure 5 therefore represents the location of the clausal *complement* of *since/before/after/when*, not the position of those connectives themselves.

3 Temporal connectives

3.1 The meanings of temporal connectives

In the coming sections, I motivate a view in which the evaluation indices of adjunct tense operators are bound by matrix temporal operators. This can be achieved if temporal connectives do not, themselves, bind the evaluation indices of their complements. Following von Fintel & Iatridou (2019), I will assume that English temporal connectives take as a complement the name of an interval. This is easiest

insights can be readily imported into the present analysis. What is crucial for my approach is that the present perfect inside the lower *since* clause is sensitive to the adjunction position of the higher *since* clause.

to see when they take non-clausal complements, with a possible denotation given in (17). For now, I will focus mostly on *since/before/after*; *when* will be revisited in Section 4.

In prose, *since* demarcates the left boundary (LB) of an interval, while *before/after* order their complements with respect to an interval.

(17) a. ${}^{u}[\![\text{since } 1990]\!]^{t} = 1$ iff ${}^{u}[\![1990]\!]^{t} = LB(t)$
b. ${}^{u}[\![\text{before } 1990]\!]^{t} = 1$ iff $t < {}^{u}[\![1990]\!]^{t}$
c. ${}^{u}[\![\text{after } 1990]\!]^{t} = 1$ iff $t > {}^{u}[\![1990]\!]^{t}$

A challenge for this approach is how to unify the meanings in (17) with those of temporal connectives when they take clausal complements, which are presumably predicates of times. A resolution to this issue, following Geis (1970), Larson (1984), Romero & von Stechow (2008), Iatridou (2014), von Fintel & Iatridou (2019), among others, is to treat temporal adjunct clauses as relative clauses with the semantics of a definite description (Iatridou 2014), i.e. like a free relative (Jacobson 1995).

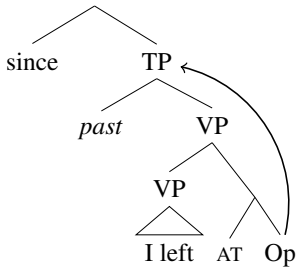


Figure 8: A tensed clausal complement of *since* is a relative clause.

On this view, *since I left* should mean something like *since the time at which I left*. A relative clause analysis of temporal connectives has been independently motivated on the basis of so-called *Geis ambiguities* (Geis 1970). The observation is that the adjunct clause in both (18) and (19) behaves as though wh-movement has taken place to its edge. Adding an embedded clause within the adjunct gives rise to an attachment ambiguity, suggesting that the quantity that the temporal connectives select for originates in a lower position in the adjunct clause.

(18) Max left before Katie told him to (leave).
Low reading: Max left before x, where x is the time he should have left according to Katie's instructions.
High reading: Max left before x, where x is the time at which Katie gave him leaving instructions.

(19) Max left before **the time at which** Katie told him to (leave). (similarly ambiguous)

If *before* clauses like (18) are relative clauses, the two readings that we observe correspond to the LFs in (20), where the base position of the operator is different for each reading.[4]

(20) a. [*before* [Op λ_3 Katie told him to leave at e_3]] (Low reading)

b. [*before* [Op λ_3 Katie told him at e_3 to leave]] (High reading)

Assuming that clausal complements of temporal connectives are relative clauses, we will now discuss the meaning of the operator. Iatridou (2014) provides evidence that a clausal complement of *since* is a definite description because it has a uniqueness presupposition. Evidence from projection tests shows that the complement of *since* is presupposed. The inference associated with *since*'s complement survives entailment cancelling operators like negation and questions. Likewise, while (22a) is a normal question to encounter on a car insurance questionaire, (22b) would be a surprise.

(21) a. He hasn't visited Cape Cod since his cat died. → the cat died
b. Has he visited Cape Cod since his cat died? → the cat died

(22) a. Have you been convicted of drunk driving in the last 10 years?
b. Has it been 10 years since you were convicted of drunk driving?

The uniqueness condition is evident in (23). It is infelicitous to say example (23) in a context where Max habitually insults Katie. We can rescue the sentence by adding something like *the first time he insulted her*.

(23) Katie has adopted a cat since Max #(first) insulted her.

On the basis of these tests, von Fintel & Iatridou (2019) assume that the operator is like a definite article, and returns the unique time at which some predicate is true (and presupposes that there is a unique such time). This is shown in (24) (though (24) doesn't explicitly state the presupposition).

[4] Additional motivation for this movement analysis is the fact that the different readings are island sensitive.

(i) Max left before Katie told him the story about her departure. (only high reading)
Max left before Katie's story.
*Max left before Katie's departure.

(24) $[\![\text{Op}]\!]^t = \lambda P_{i,t}$. the τ such that (s.t.) $P(\tau) = 1$

What they do not observe, however, is that interpreting a tensed clausal complement of *since* in situ is predicted to be contradictory on these assumptions. In prose, *since I left* evaluated at some time t asserts the time of departure to be the left boundary of t, but presupposes that the time of departure *precedes* t (because of the adjunct past).

(25) [since I left] = [since [Op_3 [λ_3 [PST PFV I leave at e_3]]]]

(26) ${}^u[\![\text{AT } \alpha]\!]^t = 1$ iff ${}^u[\![\alpha]\!]^t = t$

(27) $[\![$since [Op_3 [λ_3 [PST PFV I leave at e_3]]]$]\!]^{t,g} = 1$ iff ...

a. $[\![\text{Op}_3$ [λ_3 [PST PFV I leave at e_3]]$]\!]^{t,g} = LB(t)$

i. = the τ s.t. $\lambda i.[\![$ PST PFV I leave at $e_3]\!]^{t,g(3/i)}(\tau) = 1$

ii. = the τ s.t. $\exists t' < t : \exists t'' \subseteq t'.[\![$I leave at $e_3]\!]^{t'',g(3/\tau)} = 1$

iii. = the τ s.t. $\exists t' < t . \exists t'' \subseteq t'$. I leave at $\tau \wedge \tau = t''$

b. Result: $\tau < t$ (contribution of adjunct past) AND $\tau = LB(t)$ (contribution of *since*) ***contradiction***

Choosing a different adjunct tense doesn't resolve the problem (revisited in Section 5). To avoid a contradictory interpretation on this system, *since* must take a different evaluation index from its complement, which can be achieved if the relative clause quantifier-raises to a higher position. If the complement of *since* raises, I assume it leaves behind a trace that denotes an interval. This allows us to maintain the view that tense operators inside tensed adjunct clauses are sensitive to matrix operators, and makes specific predictions about what sorts of matrix operators can bind them.

Both the meaning and syntactic requirements of *since* heavily constrain where the base adjunction position of the adjunct is, and therefore constrain where the adjunct tense is interpreted. I assume with McCoard (1978), Mittwoch (1988), and von Fintel & Iatridou (2019) that *since*-adjuncts in English modify the left boundary of the perfect time span, which means that *since* must adjoin within the scope of the perfect. Its complement must therefore QR outside the scope of the perfect to get a meaningfully different evaluation index.

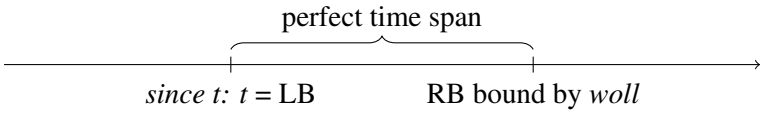


Figure 9: *Since* introduces the left boundary of the perfect time span.

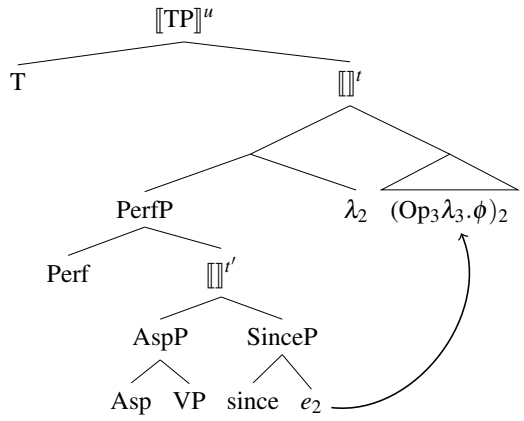


Figure 10: When *since* takes a clause, its complement is quantificational and raises to a higher position.

When the clause raises, the contradiction is avoided because *since* and the past inside it take different evaluation indices. The in situ *since* clause is evaluated with respect to the perfect time span, while the past inside it is evaluated with respect to the right boundary of the perfect time span.

(28) Max will have adopted a cat since Katie left.

a. $[\![\lambda_2$PRF PFV Max adopt cat since $e_2]\!]^{t,g}$ =
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'$. Max adopt cat at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} = LB(t')$

b. $[\![$Op$_3$ $[\lambda_3$ [PST PFV I leave at $e_3]]]\!]^{t,g}$ =
the τ s.t. $\exists i' < t$. $\exists i'' \subseteq i'$. Katie leave at $\tau \wedge \tau = i''$.

c. Applying (28b) to (28a)...

i. assertion: $\tau = LB(t')$

ii. presupposition: $\tau < t = RB(t')$ ***no contradiction!***

Importing this approach to *before/after*, we predict that, like *since*, trying to interpret a past clausal complement of *before* with respect to the same index as *before* results in a contradictory interpretation. *Before* requires the adjunct event to follow *before*'s evaluation index, but a past inside it would require the exact *opposite* ordering.

(29) $[\![$before [Op$_3$ $[\lambda i$ [PST PFV I leave at $e_3]]]\!]^{t,g}$ = 1 iff ...

a. $t <$ the τ s.t. $\exists t' < t . \exists t'' \subseteq t'$. I leave at $\tau \wedge \tau = t''$

b. $\tau < t$ (contribution of adjunct past) AND $\tau > t$ (contribution of *before*) ***contradiction***

I propose that the presuppositional nature of adjunct clauses makes them sensitive to the more general pragmatic condition in (30) (which is essentially what Schlenker (2009) has put forward, with roots and discussion in Stalnaker (1978), Singh (2007), Fox (2008), Chierchia (2009), Mayr & Romoli (2016), Mandelkern & Romoli (2017), among others). This condition renders an utterance infelicitous if the asserted content is either contradictory or redundant given its local context. This condition rules out an in situ adjunct past in a *since/before* clauses because the presuppositions introduced by *before/since* contradict their asserted content. It also rules out an in situ adjunct past in *after* clauses on account of redundancy – *after* both presupposes and asserts the same content.[5]

(30) S is infelicitous if, for any part E of S, ⟦E⟧ is entailed or contradicted by its local context.

(31) $[\![\text{after } [\text{Op}_3\ [\lambda i\ [\ \text{PST PFV I leave at } e_3]]]]]\!]^{t,g} = 1$ iff ...
   a. $t >$ the τ s.t. $\exists t' < t . \exists t'' \subseteq t'$. I leave at $\tau \wedge \tau = t''$
   b. $\tau < t$ (contribution of adjunct past) AND $\tau < t$ (contribution of *after*) ***redundant***

As was demonstrated for *since*, the contradictory and redundant interpretations in (29) and (31) can be avoided if the complements of *before/after/since* are interpreted with respect to a different evaluation index than their selecting heads. Before demonstrating this in Section 4, however, it is important to acknowledge that the pragmatic motivations for this analysis are based on the assumption that the complements of *before/after* are presupposed like the complements of *since* are. Since this is a debated assumption, we now address the motivation for treating *before/after* like *since*.

[5] Stump (1985) and Sharvit (2013) had a similar insight that such a condition must be responsible for the contrast in (iia,b). This will become an important part of the proposal in future non-perfect contexts.

(ii) (adapted from Smith 1975: 72; Stump 1985: 145)
   a. *Max will adopt a cat after Katie **left**.
   assertion: Max will adopt a cat ∧ adoption follows departure (entailed by the presupposition that Katie left)
   b. Max will adopt a cat after Katie **said** she would leave.
   assertion: Max will adopt a cat ∧ adoption follows departure (NOT entailed by the presupposition that Katie said she would leave)

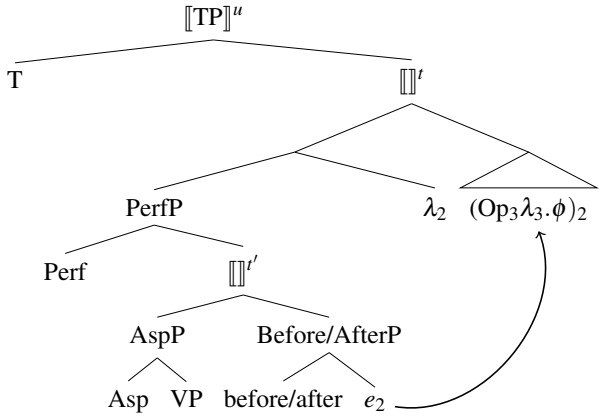


Figure 11: When *before/after* takes a clause, its complement is quantificational and raises to a higher position.

Firstly, like *since*, inferences associated with the complements of *before/after* pass canonical presupposition projection tests and are infelicitous when uniqueness is not met.[6] This is expected if temporal adjunct clauses are generally relative clauses whose relative operator is a definite article.

(32) a. He didn't get a new pet before/after his cat died. → the cat died
b. Did he get a new pet before/after his cat died? → the cat died

(33) (weird question to find on a car insurance questionnaire)
Did you have your license for at least 10 years before/after you were convicted of drunk driving?

(34) (Context: Katie has gone to Amsterdam three times.)
Max adopted a cat before/after Katie #(first) went to Amsterdam.

That said, the complement of *before* apparently need not be true in the actual world, which is puzzling on the present account. In (35a), the relative operator supposedly presupposes that there is some unique time at which Mozart finished his Requiem. However, this presupposition is apparently not satisfied because Mozart is asserted to have died before such a relevant time.

(35) a. Mozart died before he finished his Requiem. (Beaver & Condoravdi 2003: 48)
→ ¬ Mozart finished his Requiem.

[6] Beaver & Condoravdi (2003) build a notion of uniqueness into the meanings of *before/after*, and thus argue that (34) does not need an element like *first* to be felicitous. While I disagree with their judgment of examples like (34), the force of my proposal is compatible with their analysis, so I will largely ignore this difference.

b. The police defused the bomb before it exploded.
→ ¬ The bomb exploded.

These uses of *before* have been called counterfactual (e.g. Heinämäki 1974; Ogihara 1995) in the sense that the complement of *before* must be something that *would have* happened were it not for the matrix event. The complement of *before* cannot introduce just any false proposition.

(36) #Mozart died before the Spaghetti Monster took over the Earth.

Beaver & Condoravdi (2003) explain this feature of *before*, while keeping it within the purview of our treatment of *after* and *since*, by appealing to the future-referring nature of *before*. The worlds in which the adjunct event happens are future versions of the worlds in which the matrix event happens. The worlds of evaluation for the complement of *before* therefore need not be the actual world, but need to share a common history with the actual world up to a certain point.

Following Thomason (1984), they fix for every time t an equivalence relation $\simeq_t$ on the set of worlds. On this notion of equivalence, if $w \simeq_t w'$ and $t' < t$, $w \simeq_{t'} w'$, which means that for all $t' < t$, w and w' are indistinguishable. All worlds w' such that $w \simeq_t w'$ are called *historical alternatives* of w relative to time t, which are proposed to satisfy the following conditions.

(37) Beaver & Condoravdi (2003: 50)
Initial branch point condition: $alt(w,t) \subseteq \{w' | w \simeq_t w'\}$
Normality condition: $alt(w,t)$ contains only those historical alternatives of w at t which are reasonably probable given the course of events up to t.

Assuming that the adjunct clause has access to these alternative worlds of evaluation, the presupposition in (35a) is satisfied as long as Mozart finished his requiem in one of those worlds. The meaning of *before* then requires Mozart's death to precede any such time at which he would otherwise have finished his requiem.[7]

So far, I have proposed that past complement clauses of temporal connectives must move to some higher position than their base adjunction positions. We will now

[7] It's not immediately clear to me how this modality should be formally implemented into the theory. Beaver & Condoravdi (2003) propose a modal operator *earliest*, which they propose to be a part of the meanings of *before/after*. This particular implementation would not explain counterfactual *before* on my proposal because complements of *before/after* are proposed to be interpreted outside the scope of the earliest operator. I therefore leave it as a topic for future research to find the right formulation of counterfactual *before*. As an aside, whether *earliest* serves another function in the meanings of *before/after* is also an interesting domain for future research, but is orthogonal to the central claims of this paper. In particular, I have only considered adjunct predicates that are eventive so the trace of the relative clause is always a point. However, if we were to consider stative or imperfective adjunct predicates, the presence or absence of *earliest* makes particular predictions about the types of overlap that can occur between the adjunct and matrix event times that should be investigated in greater detail.

investigate the possible base adjunction positions of these adjuncts and the predicted meanings associated with them. The findings of this investigation will be used to predict the full typology of adjunct tenses in perfect and non-perfect contexts.

3.2 The syntax of temporal connectives

In this section, we observe that *since* adjuncts only have one adjunction position, namely the one in Figure 10, while *before/after* have at least two. Section 4 shows how these different base adjunction positions, combined with the requirement that complements of *before/after/since* must QR, make different predictions for each temporal connective regarding the availability of adjunct past in matrix future perfect and non-perfect contexts.

In prose, *since* means that its complement demarcates the left boundary of its evaluation time, while *before/after* order their complements with respect to their evaluation time. Though these meanings don't contain any intrinsic constraints on what sorts of intervals they can refer to, there are empirical differences in the distribution of these different adverbials.

In particular, *before/after* clauses appear to be ambiguous in English in a way that *since* clauses are not. While *before/after* clauses can appear in any tensed clause, *since* clauses appear to only modify the perfect. This is evidenced by the fact that English *since* cannot modify a clause that does not contain the perfect.

(38) a. They have known each other since 1990.
b. *They knew each other since 1990.

I therefore follow McCoard (1978), Dowty (1979), Iatridou et al. (2001) and many others in referring to *since* as a *perfect-level* adverbial (Iatridou et al. (2001)'s term). In our terms, perfect-level modification means adjunction within the immediate scope of the perfect. It may be a unique property of English *since* that it is an exclusively perfect-level modifier. Conversely, *before/after* can be both perfect-level and what Iatridou et al. (2001) call *eventuality-level* modifiers. Here, eventuality-level modification means adjunction to VP within the immediate scope of aspect.

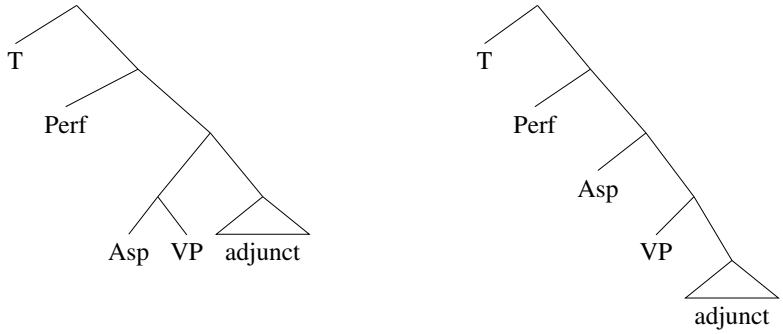


Figure 12: Perfect-level vs. eventuality-level modification.

We know that eventuality-level modification is possible for *before/after* because these adjuncts can modify non-perfects.[8] We can additionally show, with the help of adverb stacking, that in the presence of a matrix perfect, there is real attachment ambiguity for these adjuncts.

Iatridou et al. (2001), following observations by Dowty (1979) and Vlach (1993), show that *for*-adverbials can be a useful diagnostic for adjunction position given that their meaning is heavily influenced by word order. While a postverbal *for* clause can be either a perfect-level or eventuality-level modifier, a pre-posed *for* clause can only be a perfect level modifier. This is demonstrated in (39). The addition of the adverb *never* forces an interpretation in which the perfect time span is bounded on the right by the utterance time and extends backwards throughout the speaker's entire life. The modifier *for 5 days* does not contradict this interpretation if it modifies the matrix eventuality, but it is contradictory if it modifies the perfect time span.

(39) a. I have never ridden a bicycle for 5 days.
b. #For 5 days, I have never ridden a bicycle.

Stacking a *before* clause on a clause with a pre-posed *for* adverbial shows that a perfect-level reading is available to *before* clauses as well.

(40) For 5 days, the British had been fighting before reinforcements arrived. They helped end the fight.

[8] They can also be targeted by VP-ellipsis.

(iii) I adopted a cat before/after Katie left but Max didn't ~~adopt a cat before/after Katie left~~.

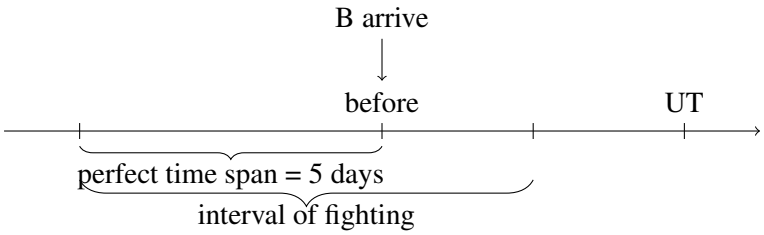


Figure 13: Schematic for interpretation of (40).

Because the example in (40) has a U-perfect, the period of fighting may be longer than the perfect time span. The *for* adverbial dictates the duration of the perfect time span but not necessarily the duration of the battle. There is an interpretation of (40) in which the *before* clause introduces a time after the 5-day period but before the battle ends. This interpretation suggests that the *before* clause adjoins just below the perfect, ordering the adjunct event with respect to the perfect time span, not the event time.

This is not only a possible interpretation of (40), but also the most natural one. Following (40) with (41) makes the speaker sound extremely unhelpful. If the Brits' arrival was understood to follow the battle rather than the perfect time span, (41) should be a reasonable utterance in the context of (40).

(41) #...they arrived a week after the fighting began.

Changing the U-perfect to an E-perfect, however, reveals an eventuality-level interpretation for the *before* clause. In (42), there is an interval of 5 days in which the Americans move their camp before the arrival of the British (and ambush them), which comes about if the *before* clause attaches to VP rather than aspect.

(42) During the last 5 days of August, the Americans had moved their camp before the British arrived, and ambushed them from the other side.

We therefore have evidence that *before* can be either a perfect-level or eventuality-level modifier. However, while it is easy to see that *after* can also have an eventuality-level interpretation (shown in (43)), it is less straightforward to show that it can have a distinct perfect-level interpretation.

(43) During the last 5 days of August, the Americans had beaten the British after moving their camp, and ended the war.

Trying to make (43) a U-perfect along the lines of (40) will not distinguish the adjunction position of the *after* clause. This is because it is very difficult, if not impossible, to construct a scenario in which the adjunct event precedes the perfect

time span but not the eventuality. The counterpart to (40), as in (44), could be ambiguous between a perfect-level and an eventuality-level interpretation with no consequences for the meaning.

(44) For 5 days, the Americans had been fighting after the British arrived. The British started the fight.

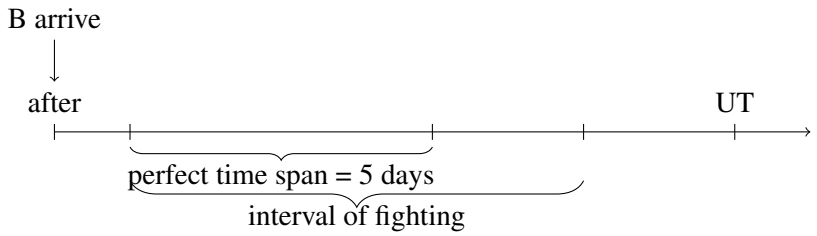


Figure 14: Schematic for interpretation of (44).

We will see that whether *after* can have a perfect-level interpretation ultimately does not affect the predictions of the theory. I will discuss the predictions for adjunct tense on the conservative assumption that *before/after* can be either perfect-level or eventuality-level modifiers. We will see, however, that only some adjunction distinctions are crucial.

To summarize, *since* clauses are unambiguously perfect-level modifiers. Past clausal complements of *since* cannot be interpreted in situ, so they must QR to a position where they can be interpreted, namely just below T. We will now investigate the predictions for *before/after* clauses on the assumption that they can be either perfect-level or eventuality-level modifiers. The base adjunction position of *before/after* clauses will affect whether there is a higher position that their clausal complements can move to and what the adjunct tense possibilities are for that position. We begin by looking at the places in the clausal spine where adjunct past is predicted to be meaningful.

4 Predicting the distribution of adjunct past

We will now investigate the predicted distribution of adjunct past in future perfect contexts, given the different base adjunction positions of *before/after* clauses. We will see that adjunct past is always predicted to be available for eventuality-level adjuncts because there is a QR landing site below tense that results in a meaningful interpretation of an adjunct past. By contrast, adjunct past is not uniformly available to perfect-level adjuncts: adjunct past is predicted to be licensed for *after* but not *before* clauses.

4.1 Before

Recalling the examples in (15), *before* is compatible with both adjunct past and present in future perfect contexts. We have also seen that *before* clauses are ambiguously eventuality-level or perfect-level modifiers. Here we see that only eventuality-level modification is predicted to license an adjunct past in *before* clauses, and this adjunct past is predicted to be interpreted relative to the output of matrix tense. Perfect-level *before* clauses have a meaning that contradicts an adjunct past interpreted anywhere.

(15) If all goes according to plan, by the time she is 30, Katie will have gotten her PhD before her brother did/does/has.

An eventuality-level *before* clause in (15) would order Katie's PhD (matrix event) before her brother's (adjunct event). This is schematized in the timeline on the right in Figure 15. The tree on the left in Figure 15 represents the only LF that licenses an adjunct past tense given the base adjunction position of the *before* clause.

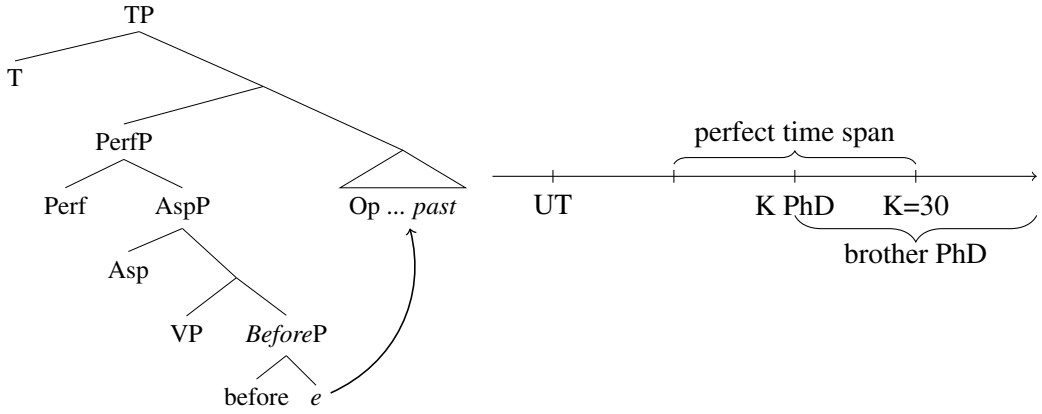


Figure 15: Eventuality-level *before*: adjunct past licensed if the adjunct clause raises to just below T.

As we saw in Section 3.1, a past tense inside the *before* clause results in a contradiction if interpreted in situ: a past tense interpreted in situ would situate Katie's brother's PhD before hers, which is the exact opposite of the meaning of *before*. Inspecting the timeline in Figure 15, we also see that the contradiction is not resolved if the adjunct past is interpreted with respect to either the entire perfect time span, or UT. However, if it is interpreted with respect to the *right boundary* of the perfect time span (i.e. Katie's 30th birthday), there is no contradiction. It is perfectly possible for Katie's brother to get his PhD after Katie gets hers but before she turns

30. Thus, an adjunct past can be interpreted with respect to the output of tense, but no other time. According to the predictions of the theory, this result corresponds to a derivation in which the complement of *before* raises to a position within the scope of *woll*.

If we consider a higher adjunction position for the *before* clause, i.e. perfect-level adjunction, Katie's brother's PhD should now be ordered with respect to the perfect time span that contains Katie's PhD, rather than the event time. This state of affairs is contradicted by an adjunct past interpreted anywhere. Katie's brother's PhD cannot be past with respect to the right boundary of the perfect time span, while strictly following the perfect time span.

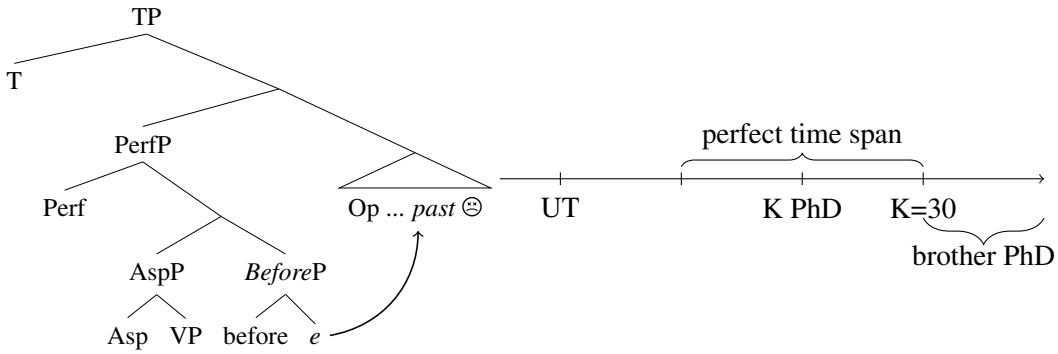


Figure 16: Perfect-level *before*: adjunct past is not licensed.

To summarize, a relative adjunct past is licensed for eventuality-level but not perfect-level *before* clauses. We will now demonstrate the predicted distribution of adjunct past in *after* clauses.

4.2 After

As we saw for *before*, if an *after* clause is an eventuality-level modifier, an adjunct past is predicted to be licensed, and must be interpreted relative to the right boundary of the perfect time span. The meanings of *after* clauses demand that Katie's brother's PhD precedes Katie's, which is in principle satisfied by an adjunct past interpreted anywhere (see the timeline in Figure 17). However, only an adjunct past interpreted just below tense satisfies the pragmatic condition in (30); all other possibilities are redundant.

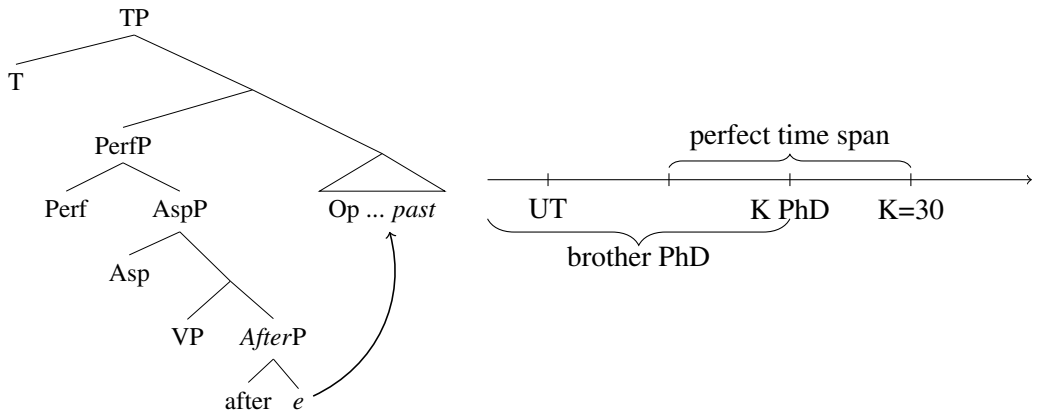


Figure 17: Eventuality-level *after*: adjunct past licensed if the adjunct clause raises to just below T.

(15) If all goes according to plan, by the time she is 30, Katie will have gotten her PhD after her brother did/??does.

a. If adjunct past is interpreted within the scope of the perfect, or outside the scope of tense

i. presupposition: Katie's brother's PhD is past w.r.t. Katie's PhD, the perfect time span that contains it, or UT

ii. assertion: Katie will have gotten a PhD by the time she is 30.

iii. assertion: Katie's brother's PhD will precede hers. (redundant given the presupposition in (i))

b. If adjunct past is interpreted above the perfect but below *woll*

i. presupposition: Katie's brother PhD is past w.r.t. the right boundary of the perfect time span

ii. assertion: Katie will have gotten a PhD by the time she is 30.

iii. assertion: Katie's brother's PhD will precede hers. (NOT redundant given the presupposition in (i))

Unlike *before*, however, an adjunct past is also licensed if the *after* clause adjoins as a perfect-level modifier. The condition in (30) rules out an adjunct past interpreted in situ, but not in a position just below matrix tense.

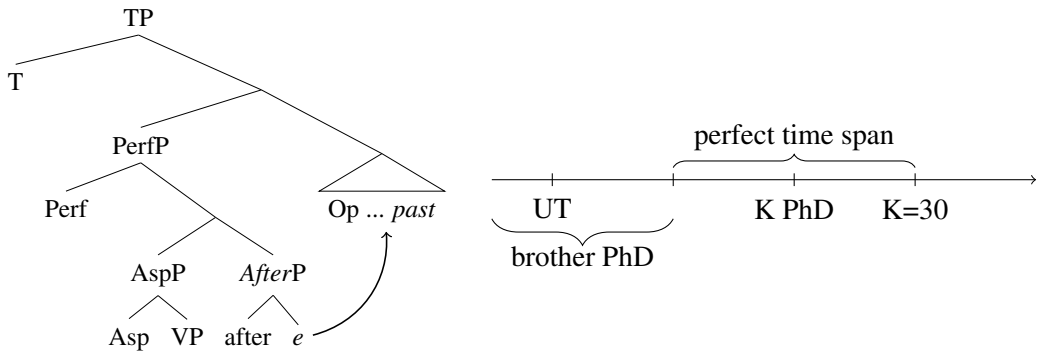


Figure 18: Perfect-level *after*: adjunct past licensed if the adjunct clause raises to just below T.

(15) If all goes according to plan, by the time she is 30, Katie will have gotten her PhD after her brother did/??does.

a. If adjunct past is interpreted above the perfect but below *woll*

i. presupposition: Katie's brother PhD is past w.r.t. the right boundary of the perfect time span.

ii. assertion: Katie will have gotten a PhD by the time she is 30.

iii. assertion: Katie's brother's PhD will precede the perfect time span in which Katie gets her PhD. (NOT redundant given the presupposition in (i))

We could also test for the availability of adjunct past in *before/after* clauses if they adjoined even higher, i.e. as tense-level modifiers. It is not obvious that *before/after* clauses ever adjoin that high, but if they did, no adjunct past would be licensed because the nearest QR position is outside the scope of matrix tense. Adjunct past would therefore have to be interpreted with respect to UT, which is contradictory for *before* clauses and redundant for *after* clauses.

In summary, adjunct past is licensed for some but not all adjunction positions of *before/after* clauses. Adjunct past is always licensed in eventuality-level *before/after* clauses, but never tense-level ones (a hypothetical but not empirically motivated possibility). Perfect-level *before/after* clauses show non-uniform behavior for adjunct past: adjunct past is licensed for perfect-level *after* clauses because being past with respect to the perfect time span is not entailed by being past relative to its right boundary. However, adjunct past is not licensed for perfect-level *before* clauses because a single time cannot both follow the perfect time span while preceding its right boundary.

The predicted distribution of adjunct past in matrix future perfect contexts is summarized in Table 1 (for a complete list of computations, see Appendix).

Combinations of base adjunction position and QR landing site that allow adjunct past are marked with ✓. Combinations that disallow adjunct past are marked with either **c* or **r* depending on whether they are ruled out due to a contradiction or a redundancy.

Table 1: The predicted distribution of adjunct past in *before/after* clauses for various adjunction positions and QR sites in future perfect contexts.

	Adj. site↓/QR site →	VP	AspP	PerfP	TP
Before	eventuality-level	*c	*c	✓	*c
	perfect-level	–	*c	*c	*c
	tense-level	–	–	*c	*c
After	eventuality-level	*r	*r	✓	*r
	perfect-level	–	*r	✓	*r
	tense-level	–	–	*r	*r

This approach therefore corroborates the intuition from Section 1 that the presence of the perfect in a sentence licenses relative adjunct past. We will now see that this relative past is normally ruled out in future non-perfect contexts.

4.3 Back to the future non-perfect

In the absence of the perfect, there is no perfect-level adjunction, so our domain of investigation only includes eventuality-level and tense-level adjunction sites. We have already shown that tense-level adjunction rules out a relative adjunct past: interpreting an in situ adjunct past is always contradictory or redundant, as is interpreting it relative to the time of utterance (the only available QR position). We now observe that in the absence of the perfect, the meanings of eventuality-level vs. tense-level *before/after* clauses are essentially indistinguishable, thus predicting a lack of adjunct past for eventuality-level *before/after* clauses as well.

An adjunct past in a *before* clause is contradictory no matter where it is interpreted in Figure 19: Katie's departure cannot be past with respect to the adoption, the *woll* time containing it or UT without contradicting the meaning of *before*. This prediction corresponds to the observation that adjunct past is ruled out in *before* clauses in future non-perfect contexts.

(45) *I will adopt a cat before Katie left.

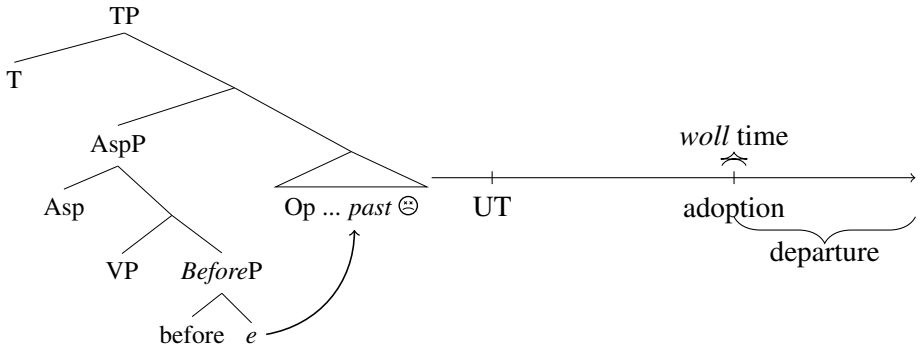


Figure 19: Eventuality-level *before*: no adjunct past.

Likewise, an adjunct past in an *after* clause is always ruled out by redundancy. Whether an adjunct past is interpreted in situ, below *woll*, or outside the scope of tense, it violates the condition on redundancy. This corresponds to the observed lack of adjunct past in (46).

(46) *I will adopt a cat after Katie left.

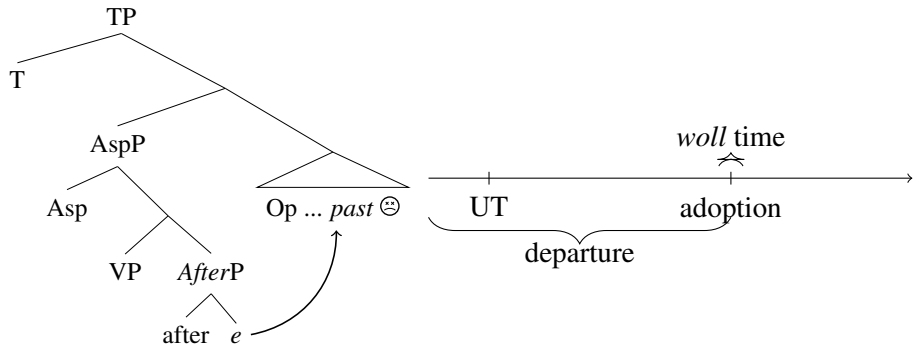


Figure 20: Eventuality-level *after*: no adjunct past.

Table 2 summarizes where an adjunct past is predicted to be licensed given different combinations of adjunction position and QR site. It shows that there are no combinations in which an adjunct past is licensed, thus correctly accounting for the absence of adjunct past in these future non-perfect contexts. As in Table 1, combinations that disallow adjunct past are marked with either **c* or **r* depending on whether they are ruled out due to a contradiction or a redundancy.

Table 2: The predicted distribution of adjunct past in *before/after* clauses for various adjunction positions and QR sites in future non-perfect contexts.

	Adj. site↓/QR site →	VP	AspP	TP
Before	eventuality-level	*c	*c	*c
	tense-level	–	*c	*c
After	eventuality-level	*r	*r	*r
	tense-level	–	*r	*r

We have seen that this system correctly rules out relative past in (45) and (46) and rules in relative past in future perfects. Now we turn our attention to the other side of the problem, which pertains to the distribution of adjunct present tense morphology in future contexts.

What is important to note here is that all of the examples so far contain eventive predicates, which normally reject the English simple present. Assuming that the conditions regulating matrix present tense are active in adjunct clauses as well, the adjunct present morphology observed in (2) is never predicted. However, there are a number of scenarios in which an adjunct *future* is predicted to be licensed. Section 5 shows that all of the scenarios in which adjunct future is predicted correspond to places where adjunct present is observed. I will therefore propose, following McCawley (1971), Comrie (1982) and Dancygier (1998), that adjunct future involves *woll*-deletion, stranding bare present morphology.

5 Adjunct present

The appearance of adjunct present in (2) is surprising because it has different properties than the regular English present. Matrix and embedded present is normally restricted to predicates with the subinterval property, or else it induces habitual or generic readings. However, adjunct present appears on non-statives and non-progressives, and does not correspond to a habitual or generic reading. English present also typically has a simultaneous interpretation, but the adjunct events are not necessarily interpreted as contemporaneous with UT or any other salient time. Adjunct present likewise does not show the properties of English futurate present, which requires a "plan" reading (Dowty 1979; Copley 2008; Kaufmann 2005).

I propose to relate this puzzle to another one, which has eluded every analysis of English adjunct tense that I know of, namely the absence of adjunct future in any context. Adjunct clauses appear to be a context in which English present and future are in complementary distribution.

(47) *I will adopt a cat before/after/when Katie will leave.

The adjunct present in examples like (2) behaves like a future in nearly every respect. It does not discriminate on the basis of aktionsart, it doesn't require a "plan" reading or a generic interpretation, and it introduces a time that is understood to follow UT. It is therefore conceivable that the LF that corresponds to adjunct present in (2) contains an adjunct *woll* + *pres* rather than a simple present operator. On this analysis, adjunct present in (2) is the output of an English-specific pronunciation rule that deletes adjunct instances of *woll*.

This proposal is based on analyses of English adjunct present morphology in conditionals. As Wekker (1977) and others discuss, temporal adverbial clauses appear to be part of a class of subordinative constructions in which *woll* is systematically unavailable. The addition of *woll* in a conditional clause is ill-formed unless there is an available reading with volitionality or inevitability. This extra reading is proposed to be unavailable to temporal adverbial clauses, thus accounting for the complete lack of *woll* in those contexts.

(48) a. If Max is left destitute, I'll change my will.
Uncertainty about whether Max will be left destitute. I will decide whether to change my will if/when such destitution is realized.

b. If Max will be left destitute, I'll change my will.
Relevant knowledge about Max's future destitution is available now, so my decision to change my will is in the immediate future.
(Wekker 1977: 66)

On the basis of minimal pairs like (48a,b), it has been argued that examples without *woll*, like (48a), have an underlying representation like that of (48b). The example is ultimately pronounced in (48a), however, due to a *woll*-deletion rule that applies unless *woll* contributes an additional reading beyond simple future reference (McCawley 1971; Comrie 1982; Dancygier 1998). I will assume a version of this pronunciation rule for temporal adverbial clauses as well.

Sharvit (2013), following Ogihara (1996), notes that there are a few exceptions to this rule, such as under ellipsis.

(49) Max will leave before Katie will. (Sharvit 2013: 24, fn. 10)

The availability of adjunct *woll* in a prosodically special context, such as ellipsis, corroborates the view that the lack of adjunct future is an effect of pronunciation rather than the semantics.

If we take for granted that adjunct present has the profile of a future tense, we can predict its distribution with the same reasoning that we used to predict the distribution of adjunct past. What we find is that adjunct future is always redundant or contradictory, except when it outscopes matrix tense. This result cross-cuts the perfect/non-perfect distinction in the matrix clause.

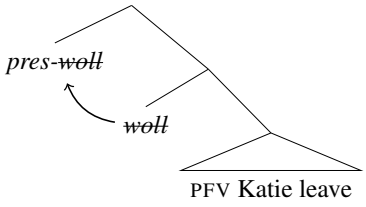


Figure 21: The future modal *woll*, which normally composes morphologically with tense, is deleted in subordinate contexts.

Starting with matrix future perfects, we can check each adjunction position of *before/after* clauses and subsequent QR sites for the availability of adjunct future. For *after* clauses, adjunct future is contradictory unless it is interpreted with respect to UT. This is true regardless of where the *after* clause adjoins.

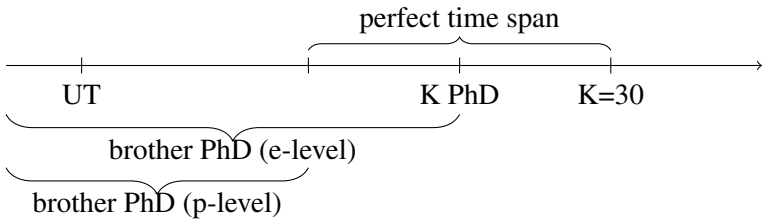


Figure 22: Whether *after* is an eventuality-level or a perfect-level modifier, adjunct future is contradictory unless interpreted w.r.t. UT.

Similarly, adjunct future in a *before* clause is always redundant unless it is interpreted with respect to UT.

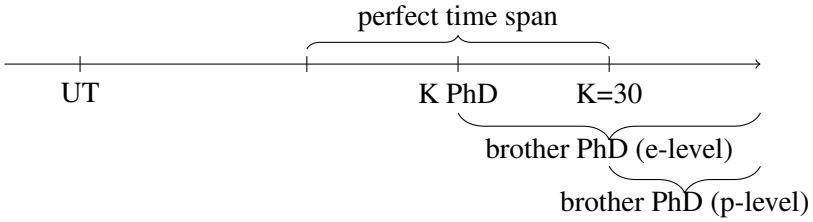


Figure 23: Whether *before* is an eventuality-level or a perfect-level modifier, adjunct future is redundant unless interpreted w.r.t. UT.

(50) By the time she is 30, Katie will have gotten her PhD before her brother *does*$^{kPhD,k=30}$.

a. presupposition: Katie's brother's PhD is future w.r.t. her PhD or the interval that contains it.

b. assertion: Katie will get a PhD.

c. assertion: Katie's PhD precedes her brother's. (redundant given (a))

(51) By the time she is 30, Katie will have gotten her PhD before her brother $does^{UT}$.

a. presupposition: Katie's brother's PhD is future w.r.t. UT.

b. assertion: Katie will get a PhD.

c. assertion: Katie's PhD precedes her brother's. (NOT redundant given (a))

In summary, adjunct future is only licensed if it is interpreted very high, outside the scope of any matrix temporal operators. This result is summarized in Table 3, which shows the full space of adjunction and QR positions (for a complete list of computations, see Appendix).

Table 3: A summary of adjunct future licensing in *before/after* clauses in matrix future perfect contexts (*c = * due to contradiction; *r = * due to redundancy).

	Adj. site↓/QR site →	VP	AspP	PerfP	TP
Before	eventuality-level	*r	*r	*r	✓
	perfect-level	–	*r	*r	✓
	tense-level	–	–	*r	✓
After	eventuality-level	*c	*c	*c	✓
	perfect-level	–	*c	*c	✓
	tense-level	–	–	*c	✓

By the same logic, removing the perfect from the matrix clause results in the same predicted distribution of adjunct future. In future non-perfect contexts, adjunct future is only licensed if it outscopes matrix tense.

Table 4: A summary of adjunct future licensing in *before/after* clauses in matrix future non-perfect contexts.

	Adj. site↓/QR site →	VP	AspP	TP
Before	eventuality-level	*r	*r	✓
	tense-level	–	*r	✓
After	eventuality-level	*c	*c	✓
	tense-level	–	*c	✓

We can now combine these results with the predicted distribution of adjunct past. In future non-perfect contexts, adjunct past was predicted never to be licensed,

while adjunct future was predicted to be licensed if the adjunct clause outscopes matrix tense. The theory therefore correctly predicts uniformity in future non-perfect contexts: we should always expect adjunct future in examples like (2), where the future is interpreted with respect to UT. I propose that we observe uniform present morphology in the adjunct clauses instead of uniform future tense due to a pronunciation rule that deletes *woll* in these contexts.

In future *perfect* contexts, however, adjunct future is not the only option. Some adjunction positions and temporal connectives license adjunct past as well. Adjunct past is always licensed in a position lower than adjunct future. I therefore propose that locality constrains the system, so the first viable QR site is the locus of adjunct tense interpretation. This predicts that scenarios in which an adjunct past is licensed always realize adjunct past, because there is no need to QR to a higher position.

This prediction is borne out by *since* clauses, which uniformly reject adjunct present non-perfect. *Since* clauses behave this way because the closest viable QR site licenses an adjunct past or a present perfect, but not a future. The predictions for *before/after* are shown in Table 5.

Table 5: Predicted adjunct tense for each adjunction position in future perfect contexts.

	Adj. site	Predicted adjunct tense
Before	e-level	past
	p-level	future
	t-level	future
After	e-level	past
	p-level	past
	t-level	future

If we assume that every instance of adjunct future is pronounced as a present tense, this analysis correctly predicts optionality between past/present for *before* clauses but not for *after* clauses (unless the *after* clause is used as a tense-level modifier, which is currently only a hypothetically possible reading). This is because the two diagnosable adjunction positions for *before/after* clauses correspond to different outcomes for the complement of *before* but not for *after*.

Generalizing these results, we expect the availability of a relative adjunct past to be insensitive to the value of matrix tense. Whether the matrix perfect is in the future or in the past does not affect whether the adjunct event can be past relative to the output of tense. Only when the adjunct tense is interpreted with respect to the time of utterance do we expect adjunct tense to be sensitive to the value of matrix tense. If the matrix event time is in the past, an adjunct future will always be contradictory

or redundant, but an adjunct past is always licensed; the opposite is true for matrix future.

5.1 When

Until now, I have put aside a demonstration of the predictions this theory makes for *when* clauses. This is because the meaning of *when* is less clear. Moens & Steedman (1988) show that *when* is compatible with a number of interpretations. In (52), the three different matrix clauses indicate a different temporal ordering between the *when* clause and the matrix event.

(52) When they built the 39th Street bridge... (Moens & Steedman 1988: 23)
  a. ...a local architect drew up the plans.
  b. ...they used the best materials.
  c. ...they solved most of their traffic problems.

In (52a), the matrix event is understood to precede the adjunct event because planning typically precedes a building project. In (52b), there is coincidence between the two events, and in (52c), the matrix event is understood to follow completion of the adjunct event. These three interpretations do not all follow straightforwardly from a uniform meaning of *when*, assuming *when* explicitly orders the adjunct event time with respect to the matrix event time.

A unified meaning of *when* is not crucial for our present purposes, however. What is important is that the observed tenses in *when* clauses are compatible with the various possible interpretations in (52). The present analysis has already covered *before/after* clauses, which could conceivably describe the scenarios in (52a,c). We will now demonstrate the predictions for a meaning for *when* that requires coincidence between the matrix and adjunct events. Recall that *when* clauses allow both past and present in future perfect contexts, but only present in future non-perfect contexts.

(15) If all goes according to plan, by the time she is 30, Katie will have gotten her PhD when her brother **did**/?does/has.

To investigate *when* clauses, we must additionally investigate the possible base adjunction positions of *when*. In (53), it appears that *when* can have either an eventuality-level or a tense-level interpretation, but not a perfect-level one. This is because the adjunct event cannot be understood to be *at* the entire perfect time span.

(53) For 5 days, I had been riding my bike when Katie arrived.
Eventuality-level reading: Each day for 5 days, I was riding my bike at the

time that Katie arrived. (*when* modifies event time)
Tense-level reading: At the end of a 5-day period of bike riding, Katie arrived. (*when* modifies right boundary of perfect time span)

Assuming that a *when* clause with an *at* interpretation can either adjoin low or high, we can compute the possible adjunct tenses for each. Because the adjunct clause is eventive, a regular present tense is never possible, so we are again looking for adjunct past or future. Notice that neither is licensed in situ because any in-situ tense will contradict a simultaneous interpretation of *when*.

(54) [when Katie left] = [at [Op_3 [λ_3 [PST PFV K leave at e_3]]]]

(55) $[\![$at [Op_3 [λ_3 [PST PFV K leave at e_3]]]$]\!]^{t,g}$ = 1 iff ...

a. $t = [\![\text{Op}_3\ [\lambda_3\ [\ \text{PST PFV K leave at } e_3]]]\!]^{t,g}$ =
the τ s.t. $\exists t' < t . \exists t'' \subseteq t'$. K leave at $\tau \wedge \tau = t''$

b. Result: $\tau < t$ (contribution of adjunct past) AND $\tau = t$ (contribution of *at*) ***contradiction***

(56) If adjunct tense were future instead of past:
Result: $\tau > t$ (contribution of adjunct past) AND $\tau = t$ (contribution of *at*) ***contradiction***

The complement of *when* must therefore QR to some higher position in any case. In the case of high adjunction, the only place to move is above tense, in which case we expect adjunct future interpreted with respect to UT (pronounced as present). If the *when* clause adjoins low, and the matrix clause is a future perfect, there is a position below T that the adjunct clause can QR to, which licenses a relative past. We thus correctly predict both adjunct past and present (underlyingly future) to be licensed for *when* clauses, where each choice corresponds to a different adjunction position.

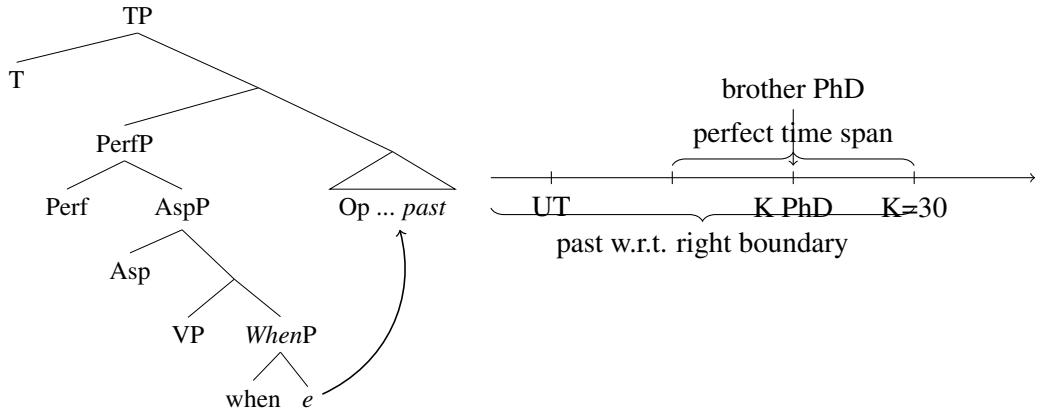


Figure 24: Eventuality-level *when*: licenses adjunct past interpreted just below matrix T.

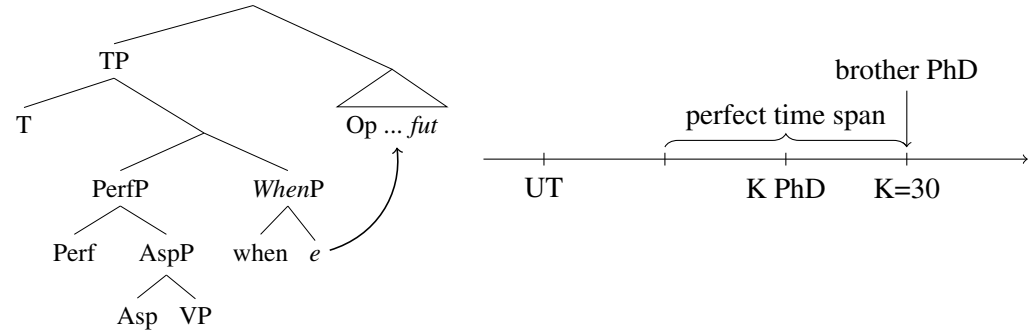


Figure 25: Tense-level *when*: licenses adjunct future outside the scope of matrix T.

Removing the perfect makes any relative adjunct tense contradictory because the matrix event time is contained in the *woll*-time. If an adjunct past/future interpreted relative to the event time is contradictory, it will stay contradictory if interpreted relative to the *woll*-time. Therefore, the only possible adjunct tense is a future evaluated with respect to UT, which is pronounced as a present.

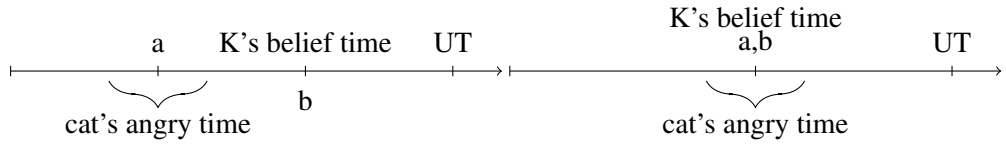
We have seen that a relative adjunct past is correctly predicted to be licensed for *before/after/when/since* clauses when the matrix clause is a perfect but not a future non-perfect, and that adjunct present (underlying future) is always predicted to be interpreted with respect to UT. This conclusion stands in contrast with analyses that propose adjunct present morphology to be a Sequence of Tense (SOT) phenomenon. We will now visit analyses of these sort and show why they are less successful than the present approach.

6 SOT analyses of adjunct present

I have advanced a theory that treats adjunct tenses in English at face value, so to speak. Adjunct past is observed when the adjunct event is interpreted as past with respect to some time. Adjunct future (pronounced as present) is observed when adjunct past is not licensed and the adjunct event is interpreted as future with respect to UT. This stands in contrast with approaches that treat adjunct tenses as vacuous tense morphology, licensed by an SOT mechanism.

SOT describes configurations of subordinate past within the context of a matrix past that are ambiguous between two interpretations. This is demonstrated in (57), which is ambiguous between the so-called *backshifted* and *simultaneous* readings. On the backshifted interpretation, the embedded past is interpreted as a "real" past operator and requires the embedded interval to strictly precede Katie's belief time. On the simultaneous reading, the embedded past is interpreted like a relative present tense, which induces overlap between the embedded interval and the belief time.

(57) Katie believed that her cat was angry.



(a) Backshifted reading: a $<$ b (b) Simultaneous reading: a $\circ$ b

The simultaneous interpretation is assumed to correspond to an LF that does not contain a regular embedded past operator. Instead, this LF contains either a vacuous tense or an embedded present (these might be the same thing depending on the theory), but bears past morphology because of a grammatical process that assigns the morphology of the matrix tense to the embedded clause.

(57) Katie believed that her cat was angry.
LF1: [*past* Katie believe [that *past* her cat be angry]] (back-shifted reading)
LF2: [*past* Katie believe [that ?? her cat be angry]] (simultaneous reading)

Assuming that this grammatical process can also transmit matrix tense morphology to adjunct clauses, there is an interpretation of adjunct past in (1) in which the past morphology is *not* indicative of a past interpretation, but is rather parasitically licensed by the matrix past. By extension, adjunct present might be observed when the matrix tense is future because the English future is assumed to be composed of a present tense and a modal (i.e. *woll* + *pres*). The present tense operator that attaches to the future modal is proposed to be able to "license" present morphology

on a lower clause in the same way that past does. On this approach, Ogihara (1996) suggests we must imagine that the LFs that correspond to (1) and (2) are like Figure 26, in which the adjunct clause scopes below the matrix tense operator, contrary to what I have proposed. This is because a matrix tense can only transmit its features to elements in its c-command domain.

(1) I adopt**ed** a cat after Katie **left**.
[*past* I adopt a cat [after ?? Katie leave]]

(2) I **will** adopt a cat after Katie **leaves**.
[*woll-pres* I adopt a cat [after ?? Katie leave]]

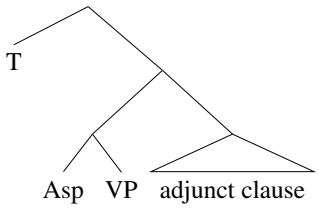


Figure 26: An LF in which SOT accounts for the observed adjunct tenses in (1) and (2).

Ogihara notes, however, that this type of approach faces serious difficulty: treating adjunct tenses as morphologically licensed by a matrix tense fails to explain key contrasts between the adjunct present in (2) and other subordinate clauses. While some authors have worked to address some of these problems, I will argue that no approach of this type can easily explain both the future non-perfect and the future perfect examples.

There are two different formalisms of SOT that I know of, both of which have been explored for adjunct tenses and which make different predictions. One approach, adopted by von Stechow & Grønn (2013), is called the *feature transmission view* of SOT, in which the embedded past in (57) is a present tense operator concealed by past morphology. The past feature observed in the subordinate clause is transmitted through binding by the higher past operator.

Another approach, adopted by Sharvit (2013), is called the *deletion view* of SOT, in which the embedded past in (57) is a deleted past operator, licensed by a c-commanding past. Deletion of a past operator amounts to deleting its evaluation index, making it vacuous like the English present. The evaluation indices of lower operators in the embedded clause are thus bound as though there were no tense head, thus resulting in a simultaneous interpretation. On the deletion view, the

simultaneous reading is a feature of the SOT mechanism, while on the feature transmission view, it is a by-product of the fact that the only possible concealed tense in this context is a present.

(57) Katie believed that her cat was angry. (simultaneous version)

a. [*past* I tell Max [that *pres* cat be angry]] (SOT = feature transmission)

b. [*past* I tell Max [that ~~*past*~~ cat be angry]] (SOT = tense deletion)

The first problem that these approaches face is the apparent non-optionality of SOT in temporal adverbial clauses. In other subordinate adjunct clauses such as relative clauses, ambiguity afforded by the SOT theory in past contexts is realized as separate adjunct tenses in future contexts. If SOT applies, it apparently does so optionally, since (a) (58a) is ambiguous, and (b) morphological uniformity between the matrix and adjunct clause is not enforced in (58b).

(58) a. I gave Katie the cat that she liked. (ambiguous)
SOT applies: Katie likes the cat at the time of giving
SOT does not apply: Katie liked the cat before the time of giving

b. I will give Katie the cat that she likes/liked.

Since SOT is not generally enforced in independent contexts, something needs to be added to the theory to explain why adjunct tenses in (1) and (2) are uniformly determined by matrix tense. In particular, why can't we pronounce adjunct past in a future context, as in (46), as we can in (58b)? According to the LF in Figure 26, the adjunct past should be interpreted with respect to a future time, which is compatible with the truth conditions of *after* clauses.

(46) *I will adopt a cat after Katie left.

The puzzle that (46) poses is different for each type of SOT approach. On the feature transmission view, either present or past morphology should be licensed in future *after* clauses, where the choice does not affect interpretation. Due to the fact that the adjunct predicate is eventive, and there are no "deleted" present tenses on this view, the only LF that is compatible with the truth conditions of *after* clauses contains a relative adjunct past. Whether this past tense is concealed by present morphology should be optional if feature transmission is an optional process, thus failing to predict the ill-formedness of (46).

(59) LF for future *after* clauses: [I will adopt a cat [after PST Katie leave]]
SOT applies (2): "I will adopt a cat after Katie leaves."
SOT does not apply (46): "I will adopt a cat after Katie left."

Adopting the condition on redundancy proposed in this paper would not resolve this issue because it would rule out the only viable LF on this theory. In order for a feature transmission SOT approach to work, it would therefore need an additional condition on pronunciation to rule out adjunct past in (46) compared to (58b).[9]

On a deletion view, (46) is puzzling for a different reason. On this theory, two LFs are in principle available for an *after* clause in a future context, one with a relative adjunct past and one with a relative adjunct present. The LF that contains adjunct present corresponds to (2) and requires SOT to apply because an interpreted adjunct present shouldn't be available for an eventive predicate (assume for the sake of argument that a deleted present can integrate into the meaning of *after* clauses without a simultaneous interpretation).

(60) Two LFs for future *after* clauses:
   a. [I will adopt a cat [after ~~PRS~~ Katie leave]]
   SOT applies (2): "I will adopt a cat after Katie leaves."
   b. [I will adopt a cat [after PST Katie leave]]
   SOT does not apply (46): "I will adopt a cat after Katie left."

However, this theory says nothing about the LF that contains an adjunct past because the structural description for SOT is not met in that case. Sharvit (2013) therefore proposes that a condition on redundancy rules out (46), leaving deleted present as the only possible realization of tense in the adjunct clause.

The crucial problem for both of these approaches is that adjunct past *is* available in future perfect contexts. As we saw in Section 2, adjunct past and present perfect in (16) behave as though they are interpreted with respect to the output of tense, i.e. as though they are interpreted according to the LF in Figure 27.

(16) Context: my mom plans to visit me twice before the year is over, and her first visit is scheduled to follow my future purchase of a new bike.
   a. By this time next year, mom will have visited twice since I bought/*buy my new bike.
   b. ?By this time next year, mom will have visited twice since I've been riding my new bike.

[9] It is also not obvious to me that the present morphology on *likes* in (58b) is ambiguous in the way that the theory predicts. If SOT can't be independently observed in future contexts outside of examples like (2), this poses another problem for the SOT approach.

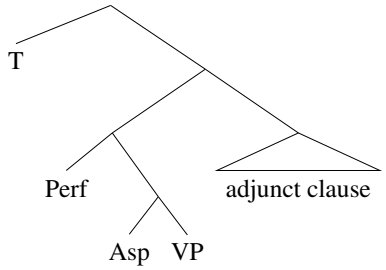


Figure 27: An LF that accounts for the interpretation of past/present perfect in (16).

If the LF in Figure 27 is right, it poses an immediate problem for SOT approaches because this is supposed to be the *same* LF that licenses SOT present in the adjunct clause. Despite this, simple present morphology is patently ruled out in (16), which therefore falsifies the predictions of the theory.

One could try to argue against the LF in Figure 27. For example, one could propose that the adjunct clause in (16) is interpreted below the perfect. On this amendment to the theory, the adjunct past and present perfect couldn't be interpreted or else the result would be either contradictory or simply the wrong meaning. This problem could be rectifiable, however, if the adjunct past and present perfect were also vacuous tenses licensed by an SOT rule. The perfect has been shown to license a vacuous past in embedded clauses.

(61) a. John believes Mary to have claimed that she was in the wrong. (Ogihara 1996: 131)
Simultaneous reading: Mary's claim is "I am in the wrong".

b. John has often believed/thought/said that he was unhappy. (Stowell 2007: 15)
Simultaneous reading: John's utterance is "I am unhappy".

While the perfect may license a vacuous past (via an SOT rule), it doesn't seem to license simultaneous interpretations of embedded present perfect. The fact that adjunct tense shows signature properties of relative tenses in future perfect contexts therefore presents a serious challenge to SOT analyses of adjunct tense in English.

(62) a. John believes Mary to have claimed that she has been in the wrong. (doesn't mean Mary claimed "I am in the wrong")

b. John has often believed/thought/said that he has been unhappy. (doesn't mean John has said "I am unhappy")

7 Conclusion

This paper began with an empirical enrichment to the study of English temporal adjunct tenses. Previous literature proposed analyses of English temporal adjunct tenses on the basis of examples like (1) and (2), which suggest that adjunct tense is always past when the matrix tense is past, and present when the matrix tense is future. However, we observed that this generalization only holds in matrix *non-perfect* contexts. In matrix future perfect contexts, adjunct past *is* available, and has a relative interpretation.

Based on the profile of temporal adjunct tenses in future perfect contexts, I have argued that English adjunct tense is in principle sensitive to matrix temporal operators for interpretation; however, temporal adjunct tenses are often interpreted with respect to the utterance time due to the meanings of temporal adverbials, which require their complements to be interpreted in a higher structural position than their base adjunction site.

When the matrix clause is a non-perfect, the number of possible adjunction positions between an adjunct's base position and the highest temporal operator is fewer than that in a corresponding perfect clause. The result is that there are *no meaningful adjunction sites* below matrix tense where an adjunct tense can be interpreted in examples like (1) and (2), thus resulting in adjunct tenses that are necessarily interpreted with respect to the utterance time.

When the matrix clause contains a perfect, however, an adjunction position is made available below matrix tense, where a relative adjunct past can be interpreted, even if the adjunct event occurs in the future. This prediction is borne out by the occurance of adjunct past in (3) and (16), which is interpreted relative to the output of tense.

The proposal relied on the assumption that adjunct clauses presuppose the truth of their clausal complements. The acceptability of a particular adjunct tense was therefore proposed to depend on a pragmatic condition that rules out contradictory or redundant interpretations. This pragmatic condition, combined with the distributional restrictions inherent to the temporal connectives themselves, heavily constrains the possible LFs associated with examples like (1), (2), (3), and (16).

With these assumptions, I demonstrated the full space of predicted adjunct tenses in perfect and non-perfect contexts for different temporal connectives and adjunction positions.[10] For future perfect contexts, relative adjunct past was available for some combinations but not others, thus correctly predicting the fact that some temporal

[10] I have not demonstrated the predictions for matrix present contexts, but they should be the same as for matrix future contexts. Adjunct past is contradictory or redundant in present non-perfect contexts, but not in present perfect contexts.

(iv) a. I'm washing the dishes after we have/*had/*will have lunch.

connectives seem to require adjunct past while others do not. Likewise, adjunct past was uniformly ruled out in the corresponding future non-perfects, thus correctly accounting for its absence in (2). In all the contexts where present (non-perfect) morphology is observed, adjunct future was predicted to be licensed, corroborating views of subordinative present as an underlying future tense (McCawley 1971; Comrie 1982; Dancygier 1998).

Lastly, this analysis was shown to be empirically more successful than SOT analyses of English adjunct tenses (e.g. Ogihara 1996; Sharvit 2013; von Stechow & Grønn 2013). An SOT analysis of English adjunct tense would have required adjunct clauses to be interpreted within the scope of matrix T in examples like (1) and (2), which fails to capture the relevance of the perfect in the matrix clause.

To situate this proposal into a broader discussion on adjunct tense interpretation, what makes temporal adverbial clauses special is that they contain the following ingredients: they're governed by an expression that encodes temporal ordering and is presuppositional, and they have the syntax of a clausal adjunct. Other adjunct clauses (e.g. relative clauses, *because* clauses, etc.) lack some of these ingredients and may have others that are missing in temporal adverbial clauses, and thus show a different profile with respect to adjunct tense interpretation. The syntax and morphology suggests that all of these adjunct clauses are built from the same set of tense and aspect morphemes, so the semantics of those morphemes should be the same throughout. The different profiles of adjunct tenses must therefore be a product of the different syntactic configurations between adjunct and matrix clauses as well as the meanings of those clauses.

While this analysis has offered a unified account of temporal adjunct tenses in English, a reviewer notes that it raises puzzles for the cross-linguistic picture. In particular, temporal adjunct tenses in Japanese have been argued to behave more transparently like relative tenses, i.e. permitting adjunct past in future non-perfect *after* clauses, which was argued to be redundant (see Ogihara 1996; Sharvit 2013; von Stechow & Grønn 2013 for discussion). It is unclear what accounts for this difference between English and Japanese without further investigation, but the following avenues of investigation are raised by the present theory. Recall that the analysis of English was based on a particular set of assumptions about the meanings of tense operators in English, combined with the conjecture that complements of temporal connectives can QR if they violate the pragmatic condition on redundancy/contradiction in situ. If in another language, the meanings of tense operators were different, or the complements of temporal connectives couldn't

b. (My hands are wet because) I'm washing the dishes before we have/*had/*will have lunch.

c. I have been washing the dishes since I had/*have lunch.

move for some reason, or the language offered a different strategy for ameliorating violations of this pragmatic condition, the picture would be different.

In sum, this paper has argued that temporal adjunct tenses in English are interpreted instead of vacuous, and constrained by the meanings of temporal connectives. The English perfect provided a testing ground in which to detect this behavior. Future research should investigate the cross-linguistic picture by finding analogous constructions to the English perfect in other languages and studying the behavior of temporal adjunct tenses in those contexts.

Abbreviations

FUT = future; IPFV = imperfective; LB = left boundary; PFV = perfective; PRF = perfect; PRS = present; PST = past; RB = right boundary; SOT = sequence of tense; UT = utterance time

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Competing Interests

The author has no competing interests to declare.

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A A list of computations

This appendix contains all of the computations for *before* and *after* whose results are summarized in Tables 1 and 3.

A.1 *Before*

Summary of proposal: the complement of *before* must QR to some higher position for the adjunct tense to be non-contradictory/non-redundant. Here are the computations for each base position, landing site, and choice of adjunct past or future.

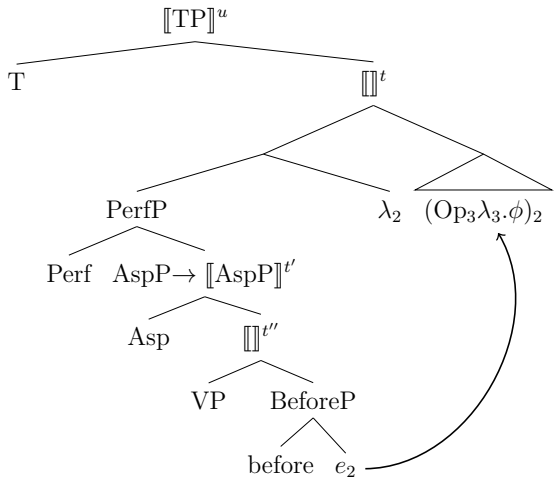

Figure 1: Schematic of proposal: complement of *before* raises to some higher position, e.g. PerfP

Assuming T's sister is evaluated wrt t, the perfect's sister is evaluated wrt t', and aspect's sister is evaluated wrt t'', the meanings of *before* for each adjunction position are in (1).

(1) a. Eventuality-level *before*: $[\![e_2]\!]^{t'',g(2/i)} > t''$
b. Perfect-level *before*: $[\![e_2]\!]^{t',g(2/i)} > t'$

The complement of *before* interpreted with adjunct past in different positions is in (3).

(2) a. QR to AspP: $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}$ K's brother get PhD at $e_3]]]\!]^{t',g}$
the τ s.t. $\exists i' < t'.\ \exists i'' \subseteq i'.$ K's brother get PhD at $\tau \wedge \tau = i''$
b. QR to PerfP: $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}$ K's brother get PhD at $e_3]]]\!]^{t,g}$
the τ s.t. $\exists i' < t.\ \exists i'' \subseteq i'.$ K's brother get PhD at $\tau \wedge \tau = i''$
c. QR to TP: $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}$ K's brother get PhD at $e_3]]]\!]^{u,g}$
the τ s.t. $\exists i' < u.\ \exists i'' \subseteq i'.$ K's brother get PhD at $\tau \wedge \tau = i''$

The complement of *before* interpreted with adjunct future in different positions is in (3).

(3) a. QR to AspP: $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{fut pfv}$ K's brother get PhD at $e_3]]]\!]^{t',g}$
the τ s.t. $\exists i' > t'.\ \exists i'' \subseteq i'.$ K's brother get PhD at $\tau \wedge \tau = i''$

b. QR to PerfP: $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{fut pfv}$ K's brother get PhD at $e_3]]]\!]^{t,g}$
the τ s.t. $\exists i' > t.\ \exists i'' \subseteq i'.$ K's brother get PhD at $\tau \wedge \tau = i''$

c. QR to TP: $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{fut pfv}$ K's brother get PhD at $e_3]]]\!]^{u,g}$
the τ s.t. $\exists i' > u.\ \exists i'' \subseteq i'.$ K's brother get PhD at $\tau \wedge \tau = i''$

The English sentences:

(4) If all goes according to plan, by the time she is 30, Katie will have gotten her PhD before her brother did/does.

Putting them together, starting with adjunct past:

(5) E-level *before*+QR to AspP: *adjunct past

a. $[\![\lambda_2 \textsc{pfv}$ Katie get PhD before $e_2]\!]^{t',g} =$
$\lambda i.\exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} > t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}$ I leave at $e_3]]]\!]^{t',g} =$
the τ s.t. $\exists i' < t'.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t''$

ii. presupposition: $\tau < t'$ **contradiction!**

(6) E-level *before*+QR to PerfP: ✓adjunct past

a. $[\![\lambda_2 \textsc{Perf pfv}$ Katie get PhD before $e_2]\!]^{t,g} =$
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} > t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}$ I leave at $e_3]]]\!]^{t,g} =$
the τ s.t. $\exists i' < t.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t''$

ii. presupposition: $\tau < t = RB(t')$ **no contradiction!**

(7) E-level *before*+QR to TP: *adjunct past

a. $[\![\lambda_2 \textsc{Fut perf pfv}$ Katie get PhD before $e_2]\!]^{u,g} =$
$\lambda i.\exists t > u \wedge \exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} > t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}$ I leave at $e_3]]]\!]^{u,g} =$
the τ s.t. $\exists i' < u.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t''$

ii. presupposition: $\tau < u$ **contradiction!**

(8) P-level *before*+QR to PerfP: *adjunct past

a. $[\![\lambda_2 \textsc{Perf pfv}$ Katie get PhD before $e_2]\!]^{t,g} =$
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} > t'$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}$ I leave at $e_3]]]\!]^{t,g} =$
the τ s.t. $\exists i' < t.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t'$

ii. presupposition: $\tau < t = RB(t')$ **contradiction!**

(9) P-level *before*+QR to TP: *adjunct past

a. $[\![\lambda_2$FUT PERF PFV Katie get PhD before $e_2]\!]^{u,g} =$
$\lambda i.\exists t > u \wedge \exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'$. Katie get PhD at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} > t'$

b. $[\![\text{Op}_3\ [\lambda_3\ [$ PAST PFV I leave at $e_3]]]\!]^{u,g} =$
the τ s.t. $\exists i' < u.\ \exists i'' \subseteq i'$. K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t'$

ii. presupposition: $\tau < u$ **contradiction!**

And now for adjunct future:

(10) E-level *before*+QR to AspP: *adjunct future

a. $[\![\lambda_2$PFV Katie get PhD before $e_2]\!]^{t',g} =$
$\lambda i.\exists t'' : t'' \subseteq t'$. Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} > t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [$ FUT PFV I leave at $e_3]]]\!]^{t',g} =$
the τ s.t. $\exists i' > t'.\ \exists i'' \subseteq i'$. K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t''$

ii. presupposition: $\tau > t'$ *entails the assertion:* **redundant!**

(11) E-level *before*+QR to PerfP: *adjunct future

a. $[\![\lambda_2$PERF PFV Katie get PhD before $e_2]\!]^{t,g} =$
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'$. Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} > t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [$ FUT PFV I leave at $e_3]]]\!]^{t,g} =$
the τ s.t. $\exists i' > t.\ \exists i'' \subseteq i'$. K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t''$

ii. presupposition: $\tau > t = RB(t')$ *entails the assertion:* **redundant!**

(12) E-level *before*+QR to TP: ✓adjunct future

a. $[\![\lambda_2$FUT PERF PFV Katie get PhD before $e_2]\!]^{u,g} =$
$\lambda i.\exists t > u \wedge \exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'$. Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} > t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [$ FUT PFV I leave at $e_3]]]\!]^{u,g} =$
the τ s.t. $\exists i' < u.\ \exists i'' \subseteq i'$. K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t''$

ii. presupposition: $\tau > u$ *does not entail the assertion:* **not redundant!**

(13) P-level *before*+QR to PerfP: *adjunct future

a. $[\![\lambda_2$PERF PFV Katie get PhD before $e_2]\!]^{t,g} =$
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'$. Katie get PhD at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} > t'$

b. $[\![\text{Op}_3\ [\lambda_3\ [$ FUT PFV I leave at $e_3]]]\!]^{t,g} =$
the τ s.t. $\exists i' > t.\ \exists i'' \subseteq i'$. K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t'$

ii. presupposition: $\tau > t = RB(t')$ *entails the assertion:* **redundant!**

(14) P-level *before*+QR to TP: ✓adjunct future

a. $[\![\lambda_2$FUT PERF PFV Katie get PhD before $e_2]\!]^{u,g} =$
$\lambda i.\exists t > u \wedge \exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'$. Katie get PhD at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} > t'$

b. $[\![\text{Op}_3\ [\lambda_3\ [$ FUT PFV I leave at $e_3]]]\!]^{u,g} =$
the τ s.t. $\exists i' > u.\ \exists i'' \subseteq i'$. K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau > t'$

ii. presupposition: $\tau > u$ *does not entail the assertion:* **not redundant!**

A.2 *After*

Everything is the same except for the asserted content.

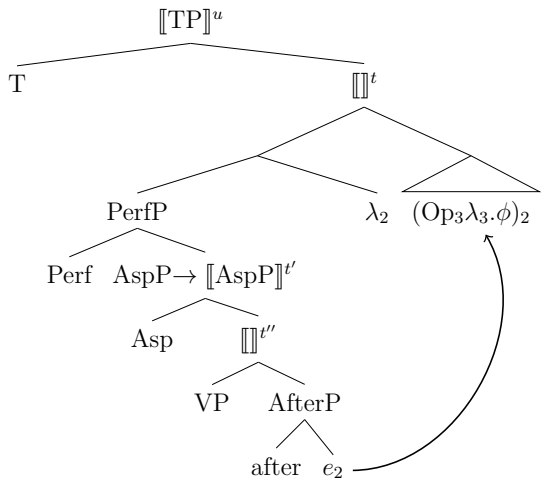

Figure 2: Schematic of proposal: complement of *after* raises to some higher position, e.g. PerfP

Assuming T's sister is evaluated wrt t, the perfect's sister is evaluated wrt t', and aspect's sister is evaluated wrt t'', the meanings of *after* for each adjunction position are in (15).

(15) a. Eventuality-level *after*: $[\![e_2]\!]^{t'',g(2/i)} < t''$

b. Perfect-level *after*: $[\![e_2]\!]^{t',g(2/i)} < t'$

The English sentences:

(16) If all goes according to plan, by the time she is 30, Katie will have gotten her PhD after her brother did/??does.

Putting them together, starting with adjunct past:

(17) E-level *after*+QR to AspP: *adjunct past

a. $[\![\lambda_2$PFV Katie get PhD after $e_2]\!]^{t',g} =$
$\lambda i.\exists t'' : t'' \subseteq t'$. Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} < t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}\ \text{I leave at}\ e_3]]]\!]^{t',g} =$
the τ s.t. $\exists i' < t'.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t''$

ii. presupposition: $\tau < t'$ *entails the assertion:* **redundant!**

(18) E-level *after*+QR to PerfP: ✓adjunct past

a. $[\![\lambda_2 \textsc{Perf pfv}\ \text{Katie get PhD after}\ e_2]\!]^{t,g} =$
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} < t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}\ \text{I leave at}\ e_3]]]\!]^{t,g} =$
the τ s.t. $\exists i' < t.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t''$

ii. presupposition: $\tau < t = RB(t')$ *does not entail the assertion:* **not redundant!**

(19) E-level *after*+QR to TP: *adjunct past

a. $[\![\lambda_2 \textsc{Fut perf pfv}\ \text{Katie get PhD after}\ e_2]\!]^{u,g} =$
$\lambda i.\exists t > u \wedge \exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} < t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}\ \text{I leave at}\ e_3]]]\!]^{u,g} =$
the τ s.t. $\exists i' < u.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t''$

ii. presupposition: $\tau < u$ *entails the assertion:* **redundant!**

(20) P-level *after*+QR to PerfP: ✓adjunct past

a. $[\![\lambda_2 \textsc{Perf pfv}\ \text{Katie get PhD after}\ e_2]\!]^{t,g} =$
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} < t'$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}\ \text{I leave at}\ e_3]]]\!]^{t,g} =$
the τ s.t. $\exists i' < t.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t'$

ii. presupposition: $\tau < t = RB(t')$ *does not entail the assertion:* **not redundant!**

(21) P-level *after*+QR to TP: *adjunct past

a. $[\![\lambda_2 \textsc{Fut perf pfv}\ \text{Katie get PhD after}\ e_2]\!]^{u,g} =$
$\lambda i.\exists t > u \wedge \exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} < t'$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{past pfv}\ \text{I leave at}\ e_3]]]\!]^{u,g} =$
the τ s.t. $\exists i' < u.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t'$

ii. presupposition: $\tau < u$ *entails the assertion:* **redundant!**

And now for adjunct future:

(22) E-level *after*+QR to AspP: *adjunct future

a. $[\![\lambda_2 \textsc{pfv}\ \text{Katie get PhD after}\ e_2]\!]^{t',g} =$
$\lambda i.\exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} < t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{fut pfv}\ \text{I leave at } e_3]]]\!]^{t',g} =$
the τ s.t. $\exists i' > t'.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t''$

ii. presupposition: $\tau > t'$ **contradiction!**

(23) E-level *after*+QR to PerfP: *adjunct future

a. $[\![\lambda_2 \textsc{Perf pfv}\ \text{Katie get PhD after } e_2]\!]^{t,g} =$
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} < t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{fut pfv}\ \text{I leave at } e_3]]]\!]^{t,g} =$
the τ s.t. $\exists i' > t.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t''$

ii. presupposition: $\tau > t = RB(t')$ **contradiction!**

(24) E-level *after*+QR to TP: ✓adjunct future

a. $[\![\lambda_2 \textsc{Fut perf pfv}\ \text{Katie get PhD after } e_2]\!]^{u,g} =$
$\lambda i.\exists t > u \wedge \exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t'',g(2/i)} < t''$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{fut pfv}\ \text{I leave at } e_3]]]\!]^{u,g} =$
the τ s.t. $\exists i' < u.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t''$

ii. presupposition: $\tau > u$ **no contradiction!**

(25) P-level *after*+QR to PerfP: *adjunct future

a. $[\![\lambda_2 \textsc{Perf pfv}\ \text{Katie get PhD after } e_2]\!]^{t,g} =$
$\lambda i.\exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} < t'$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{fut pfv}\ \text{I leave at } e_3]]]\!]^{t,g} =$
the τ s.t. $\exists i' > t.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t'$

ii. presupposition: $\tau > t = RB(t')$ **contradiction!**

(26) P-level *after*+QR to TP: ✓adjunct future

a. $[\![\lambda_2 \textsc{Fut perf pfv}\ \text{Katie get PhD after } e_2]\!]^{u,g} =$
$\lambda i.\exists t > u \wedge \exists t' : t = RB(t') \wedge \exists t'' : t'' \subseteq t'.$ Katie get PhD at $t'' \wedge [\![e_2]\!]^{t',g(2/i)} < t'$

b. $[\![\text{Op}_3\ [\lambda_3\ [\ \textsc{fut pfv}\ \text{I leave at } e_3]]]\!]^{u,g} =$
the τ s.t. $\exists i' > u.\ \exists i'' \subseteq i'.$ K's brother <get PhD> at $\tau \wedge \tau = i''$.

c. i. assertion: $\tau < t'$

ii. presupposition: $\tau > u$ **no contradiction!**