Cross-linguistic variation in temporal adjunct clauses

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1 Introduction

A particular meaning can be realized by morphosyntactically distinct expressions across languages. One of the challenges in cross-linguistic research is to account for convergence in meaning in light of morphosyntactic variation. Analyses of the variation can principally be of a purely semantic, a purely syntactic or of a mixed syntactic-semantic nature. This paper examines cross-linguistic variation in the distribution and interpretation of tense in temporal adjunct clauses (cf. the English sentences *John crossed the street before/after he fell*). The languages we consider are English, Japanese and Russian. Temporal adjunct clauses (TACs) in these three languages exhibit a pattern of variation that has received analyses that rely on syntax to varying degrees (Ogihara 1994, 1996, Arregui and Kusumoto 1998). After introducing the pattern in §2, we develop a semantic analysis in §3 that accounts for the variation solely on the basis of the meaning of the tenses and the temporal connectives realized in these constructions. A comparison of our analysis to the previous ones in §4 identifies both empirical and theoretical advantages. §5 concludes the paper.

2 Tenses in temporal adjunct clauses

Before examining the distribution and interpretation of tenses in TACs, we illustrate the past and non-past tenses of English, Japanese and Russian in the examples in (1) to (3): the a.-examples feature the past tenses (glossed PAST in the Japanese and Russian examples), the b.-examples the non-past tenses (glossed NPST).[1]

[1] # indicates that the example is syntactically well-formed but odd on semantic grounds. Glosses used in the paper are FEM = feminine gender, GEN = genitive case, IMPF =

(1) a. Ken was at home yesterday/#now/#tomorrow.
b. Ken is at home #yesterday/now/tomorrow.

(2) Japanese:
a. Ken-wa kinoo/#ima/#asita ie-ni i-ta.
Ken-TOP yesterday/now/tomorrow home-at be-PAST
'Ken was at home yesterday/#now/#tomorrow.'
b. Ken-wa #kinoo/ima/asita ie-ni i-ru.
Ken-TOP yesterday/now/tomorrow home-at be-NPST
'Ken is/will be at home #yesterday/now/tomorrow.'

(3) Russian:
a. Ken pe-l včera/#sejčas/#zavtra.
Ken sing.IMPF-PAST yesterday/now/tomorrow
'Ken sang yesterday/#now/#tomorrow.'
b. Ken poj-ot #včera/sejčas/zavtra.
Ken sing.IMPF-NPST yesterday/now/tomorrow
'Ken is singing #yesterday/now/tomorrow.'

In matrix clauses, the past tense of each language locates the eventuality denoted by the verb in the past of the speech time, as illustrated by the compatibility with the past time denoting adverb *yesterday* (and its Japanese and Russian equivalents). We uniformly refer to the tense illustrated in the b.-examples as the 'non-past' tense of the three languages since this tense is principally compatible with both present and future time reference. Language-specific constraints pertaining to e.g. aspect and modality result in the non-past tenses not always being compatible with both present and future time reference (cf. e.g. Copley 2002; Kaufmann 2005).

As observed by Ogihara (1996), among others, the tense form acceptable in Japanese TACs is determined by the temporal connective rather than the temporal location of the eventuality denoted by the embedded clause with respect to the speech time. In TACs with the temporal connective *mae* 'before', only the non-past tense is acceptable whereas with *ato* 'after', only the past tense is acceptable. This is illustrated in (4) and (5), respectively (with the TAC in square brackets); in the a.-examples, the matrix clause is in the past tense, in the b.-examples it is in the non-past tense.

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imperfective aspect, INSTR = instrumental case, NOM = nominative case, NPST = non-past tense, PAST = past tense, PERF = perfective aspect, TOP = topic.

(4) a. [Ken-ga #ki-ta/ku-ru mae-ni] Anna-ga
Ken-NOM arrive-PAST/arrive-NPST before-at Anna-NOM
kaet-ta.
leave-PAST
'Anna left before Ken arrived.'

b. [Ken-ga #ki-ta/ku-ru mae-ni] Anna-ga
Ken-NOM arrive-PAST/arrive-NPST before-at Anna-NOM
kae-ru.
leave-NPST
'Anna will leave before Ken arrives.'

(5) a. [Ken-ga ki-ta/#ku-ru ato-ni] Anna-ga
Ken-NOM arrive-PAST/arrive-NPST after-at Anna-NOM
kaet-ta.
leave-PAST
'Anna left after Ken arrived.'

b. [Ken-ga ki-ta/#ku-ru ato-ni] Anna-ga
Ken-NOM arrive-PAST/arrive-NPST after-at Anna-NOM
kae-ru.
leave-NPST
'Anna will leave after Ken arrives.'

The distribution of the Japanese past and non-past tenses in these two constructions reveals that the tense of the TAC is interpreted with respect to the matrix clause event time rather than the speech time. (We use the term 'event time' to refer to the time at which the eventuality denoted by a clause is temporally located.) Compare, for example, (4a) and (5a): in both examples, the eventuality denoted by the TAC is temporally located prior to the speech time, yet the TAC in (4a) must have the non-past tense, while that of (5a) must have the past tense. The crucial difference between the two examples is that in (4a) the temporal connective *mae* 'before' locates the eventuality denoted by the TAC after the time of the eventuality denoted by the matrix clause (hence the non-past tense TAC) while *ato* 'after' in (5a) locates the eventuality denoted by the TAC prior to that of the matrix clause (hence the past tense TAC).

Traditionally, a tense that is interpreted with respect to the matrix event time is called a RELATIVE tense (Comrie 1985). This is in contrast to an ABSOLUTE tense, which is interpreted with respect to the speech time. Thus, the distribution of tenses in Japanese TACs might lead one to characterize

them as being relative tenses.[2] We return to this classification in §4.1.

Considering the data in (6) to (9), we see that tenses in English and Russian TACs are not interpreted relative to the matrix event time: e.g. English and Russian *before*-clauses, for example, realize the past tense if the matrix clause is in the past tense, but the non-past tense if the matrix clause has non-past temporal reference (cf. (6a,b) and (8a,b)).

(6) a. Anna left [before Ken arrived/#arrives].
b. Anna will leave [before Ken #arrived/arrives].

(7) a. Anna left [after Ken arrived/#arrives].
b. Anna will leave [after Ken #arrived/arrives].

(8) a. Anna u-exa-l-a [pered tem, kak Ken
Anna PERF-leave-PAST-FEM before that.INSTR as Ken
pri-exa-l/#pri-ede-t].
PERF-arrive-PAST/PERF-arrive-NPST
'Anna left before Ken arrived.'

b. Anna u-ede-t [pered tem, kak Ken
Anna PERF-leave-NPST before that.INSTR as Ken
#pri-exa-l/pri-ede-t].
PERF-arrive-PAST/PERF-arrive-NPST
'Anna will leave before Ken arrives.'

(9) a. Anna u-exa-l-a [posle togo, kak Ken
Anna PERF-leave-PAST-FEM after that.GEN as Ken
pri-exa-l/#pri-ede-t].
PERF-arrive-PAST/PERF-arrive-NPST
'Anna left after Ken arrived.'

b. Anna u-ede-t [posle togo, kak Ken
Anna PERF-leave-NPST after that.GEN as Ken
#pri-exa-l/pri-ede-t].
PERF-arrive-PAST/PERF-arrive-NPST
'Anna will leave after Ken arrives.'

[2]However, as pointed out by Ogihara (1999), this is not true of all embedded environments in Japanese. In (i), which Ogihara attributes to Soga (1983) and Kudo (1995), the past tense in the embedded *toki* 'when' clause is interpreted relative to the speech time:

(i) Taro-wa [Tokyo-ni i-ta toki], apaato-ni sundei-ta.
Taro-TOP Tokyo-at be-PAST when apartment-at live-PAST
'When Taro was in Tokyo, he lived in an apartment.'

Data like these indicate that the tenses embedded in English and Russian TACs are interpreted with respect to the speech time, i.e. that they are absolute tenses according to Comrie (1985). Compare, for example, (8a) and (9a): the eventuality denoted by the TAC in each of these examples is temporally located prior to the speech time, and both TACs are realized with the past tense, regardless of the location of the eventuality denoted by the TAC with respect to that denoted by the matrix clause.

3 A formal semantic analysis of the variation

TACs are unique among embedding constructions in that the embedding construction itself contributes information about the relative temporal order between the eventualities denoted by the matrix and the embedded clauses. (Compare them e.g. with propositional attitude complements and relative clauses.) Ogihara (1994, 1996) shows that a compositional analysis of Japanese TACs is available that accounts for the distribution and interpretation of tenses on the basis of the meaning of the temporal connectives and the tenses. We argue that a semantic analysis of the cross-linguistic variation is desirable, and show in §3.2 that Ogihara's semantic analysis of Japanese can be extended to account for English and Russian.

3.1 Basic assumptions about temporal interpretation

Our analysis is couched in a system in which natural language expressions are translated into a logical translation language (cf. Montague's (1973) Intensional Logic) and these translations receive model-theoretic interpretations.[3] We follow Dowty (1979), Stump (1985) and Yoon (1996) in assuming that the interpretation of a simple sentence like (10) is obtained by applying the meaning of (here, past) tense to that of the untensed sentence *Ken arrive* (which we call 'sentence radical').

(10) Ken arrived.

A sentence radical denotes a set of times at which the eventuality described by the sentence holds. A sentence radical is of type $\langle i, t\rangle$, where i is the type for times, and t is the type of truth values. The translation of the sentence radical of (10) is as follows ('$\Rightarrow$' stands for 'translates as'):

[3] We provide translations since they are a convenient way of representing the interpretations of natural language utterances. The translations are, however, dispensable, unlike e.g. Logical Form in semantic theories like that presented in Heim and Kratzer (1998).

(11) $\textsf{Ken arrive} \Rightarrow \lambda t[\mathrm{AT}(t, arrive'(k))]$

The translation of the sentence radical is interpreted as the set of times t such that Ken arrives at t. As defined in (12), the first argument of the AT predicate specifies the evaluation time for the second argument of the predicate:

(12) $[\![\mathrm{AT}(\zeta, P)]\!]^{M,i,g} = 1$ iff $[\![P]\!]^{M,i',g} = 1$ where $i' = [\![\zeta]\!]^{M,i,g}$

The AT predicate shifts the evaluation time of its second argument P: rather than being interpreted at the temporal parameter i at which the AT predicate is interpreted, P is interpreted relative to the denotation of the first argument ζ.

Tenses are temporal modifiers of type $\langle\langle i,t\rangle, \langle i,t\rangle\rangle$. They introduce restrictions on the location of the times at which the eventuality holds.[4] For example, the past tense constrains the set of times at which the eventuality is located in the past with respect to the *local evaluation time*; this is the speech time for matrix clauses and a time introduced by the embedding construction for embedded clauses (details are given below). Past tense translates as follows:

(13) $\textsf{PAST} \Rightarrow \lambda P_{\langle i,t\rangle}\lambda t[P(t) \wedge \mathbf{past}(t)]$

The translation says that times at which the eventuality holds are times of which the predicate **past** holds. As defined in (14), these times are past with respect to the temporal parameter i, the local evaluation time of **past**:

(14) $[\![\mathbf{past}(\zeta)]\!]^{M,i,g} = 1$ iff $[\![\zeta]\!]^{M,i,g} < i$

$\mathbf{past}(\zeta)$ is true just in case the time that the expression ζ denotes is prior to the temporal parameter i.

The translation of the tensed sentence (10) is derived by applying the translation of the past tense (13) to that of the sentence radical (11):

(15) $\textsf{PAST}(\textsf{Ken arrive}) \Rightarrow \lambda P_{\langle i,t\rangle}\lambda t[P(t) \wedge \mathbf{past}(t)](\lambda t[\mathrm{AT}(t, arrive'(k))])$
$\equiv \lambda t[\mathrm{AT}(t, arrive'(k)) \wedge \mathbf{past}(t)]$

[4]Since the formal system of this paper does not deal with issues involving aspect or discourse, we simply treat sentence radicals as denoting sets of times and tenses as relating the speech time and the event time. We anticipate that, in a fuller analysis in which the role of aspect is taken into account, it will be necessary to model the meanings of sentence radicals as sets of temporal intervals (rather than as sets of times) and to define the meaning of tenses using Reichenbach's (1947) notion of a reference time, whose location is contextually constrained. So far as we are aware, there is no inherent obstacles to enriching our analysis this way.

Tensed sentences are again temporal abstracts (i.e. sets of times). We assume that existential closure applies when sentences are interpreted in discourse. Applying existential closure to (15), we obtain (16):

(16) $\exists t[\mathrm{AT}(t, arrive'(k)) \wedge \mathbf{past}(t)]$

We interpret (16) relative to a model M, the speech time s^* and an assignment function g:

(17) $[\![\exists t[\mathrm{AT}(t, arrive'(k)) \wedge \mathbf{past}(t)]]\!]^{M,s^*,g} = 1$ iff there is some time t which is prior to the speech time s^* and Ken arrives at t.

Since the local evaluation time for matrix clause tenses is the speech time, the past tense here locates the event time prior to the speech time. In TACs, the local evaluation time of an embedded tense can but need not be the speech time, as we now show.

3.2 Tense interpretation in temporal adjunct clauses

Recall from section 2 that only the non-past tense occurs in Japanese *mae* 'before' TACs while only the past tense occurs in *ato* 'after' clauses. Ogihara (1994, 1996) derives this from the meanings of tenses and temporal connectives; here, we illustrate how his analysis of *mae* 'before' clauses can be formulated in our system. Consider (18):

(18) [Ken-ga ku-ru mae-ni] Anna-ga kaet-ta.
Ken-NOM arrive-NPST before-at Anna-NOM leave-PAST
'Anna left before Ken arrived.'

We account for the fact that the non-past tense embedded in the TAC is interpreted with respect to the matrix event time by assigning the following translation to the temporal connective *mae* 'before':

(19) mae 'before' $\Rightarrow \lambda P \lambda Q \lambda t[Q(t) \wedge \mathrm{AT}(t, \exists t_1[P(t_1) \wedge t < t_1])]$

The temporal connective requires the time t at which the matrix clause Q is interpreted to precede the time t_1 at which the embedded clause P is interpreted ($t < t_1$). The local evaluation time of the embedded clause P is the matrix clause event time t, the first argument of the AT predicate. The interaction of the interpretation of the temporal connective with the tenses embedded in the matrix and the embedded clause is spelled out in (20). The translation of the matrix clause (20a) and that of the embedded clause (20b) are temporal abstracts; they are the arguments of the temporal connective. The result of applying the meaning of the temporal connective

to the temporal abstracts, several beta-reductions and existential closure is given in (20c).

(20) a. Anna leave-**PAST** $\Rightarrow \lambda t[\mathrm{AT}(t, leave'(a)) \wedge \mathbf{past}(t)]$
b. Ken arrive-**NPST** $\Rightarrow \lambda t[\mathrm{AT}(t, arrive'(k)) \wedge \mathbf{npst}(t)]$
c. $\exists t[\mathbf{past}(t) \wedge \mathrm{AT}(t, leave'(a)) \wedge \mathrm{AT}(t, \exists t_1[\mathbf{npst}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1])]$

The matrix clause past tense (translated as **past**) is interpreted relative to the speech time s^* and hence locates the time t_1 of Anna's leaving prior to the speech time. The embedded non-past tense (translated as **npst**), however, is interpreted relative to t, and hence locates the time t_1 of Ken's arrival at or in the future of the time t of Anna's leaving:

(21) $[\![\mathbf{npst}(\zeta)]\!]^{M,i,g} = 1$ iff $i \leq [\![\zeta]\!]^{M,i,g}$

Since the temporal connective requires t to precede t_1, it is correctly predicted that (18) means that Anna left before Ken arrived. (The complete model-theoretic interpretation of (20c) is spelled out in the Appendix.)[5]

Ogihara's analysis also predicts that the past tense is unacceptable in Japanese *mae* 'before' clauses:

(22) #[Ken-ga ki-ta mae-ni] Anna-ga kaet-ta.
Ken-NOM arrive-PAST before-at Anna-NOM leave-PAST
(Intended: 'Anna left before Ken arrived.')

In such examples, a conflict arises between the interpretation of the embedded past tense and the interpretation of the temporal connective, as illustrated by the translation of (22) in (23):

(23) $\exists t[\mathbf{past}(t) \wedge \mathrm{AT}(t, leave'(a)) \wedge \mathrm{AT}(t, \exists t_1[\mathbf{past}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1])]$

The embedded past tense locates the time t_1 of the embedded clause prior to its local evaluation time t, the matrix event time. Since the temporal connective requires that t precede t_1, (23) is contradictory, thus correctly predicting that (22) is infelicitous.

The lexical entry for *ato* 'after' is given in (24):

[5]Since our analysis is not concerned with modality, it incorrectly predicts that the eventuality denoted clauses embedded by *before* (and its Japanese and Russian equivalents) is realized. We assume that our analysis could be adapted along the lines of Beaver and Condoravdi (2003) to account for the non-veridical readings of *before*-TACs.

(24) ato 'after' $\Rightarrow \lambda P \lambda Q \lambda t[Q(t) \wedge \mathrm{AT}(t, \exists t_1[P(t_1) \wedge t_1 < t])]$

Since here t is constrained to follow t_1, Ogihara's analysis predicts that only the past tense is available in Japanese TACs with *ato* 'after'.

English and Russian differ from Japanese in that past tense is acceptable in *before*-clauses (cf. section 2). To account for this difference, we propose that the meaning of the temporal connectives in English and Russian differs from that of Japanese: English *before* and Russian *pered* 'before', just like Japanese *mae* 'before', require the time t of the matrix clause to precede the time t_1 of the embedded clause ($t < t_1$), but the local evaluation time of the embedded clause P is now the speech time. This is achieved by the following translations:[6]

(25) English before/Russian pered 'before'
$\Rightarrow \lambda P \lambda Q \lambda t[\exists t_1(Q(t) \wedge P(t_1) \wedge t < t_1)]$

The difference between (25) and the lexical entry of Japanese 'before' in (19) is that, here, the denotation of the embedded clause (again, represented by the variable P) is not embedded under an AT predicate. Thus, the local evaluation time of the embedded clause is the local evaluation time of the matrix clause, namely the speech time.

We illustrate our analysis for English in (26):

(26) Anna left before Ken arrived.
a. Anna leave-PAST $\Rightarrow \lambda t[\mathrm{AT}(t, leave'(a)) \wedge \mathbf{past}(t)]$
b. Ken arrive-PAST $\Rightarrow \lambda t[\mathrm{AT}(t, arrive'(k)) \wedge \mathbf{past}(t)]$
c. $\exists t \exists t_1[\mathbf{past}(t) \wedge \mathrm{AT}(t, leave'(a)) \wedge \mathbf{past}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1]$

The temporal abstracts in (26a) and (26b) are the translations of the matrix clause and the embedded clause, respectively. After applying the translation of *before* to these arguments and applying existential closure, the translation of the whole sentence is (26c). Since the meaning contribution $\mathbf{past}(t_1)$ of the embedded past tense is not embedded under an AT predicate, it is interpreted with respect to the speech time, yielding the temporal order $t_1 < s^*$. The temporal connective contributes the information that t temporally

[6] The lexical entry for English *after* and Russian *posle* 'after' is as follows:

(i) English after/Russian posle 'after'
$\Rightarrow \lambda P \lambda Q \lambda t[\exists t_1(Q(t) \wedge P(t_1) \wedge t > t_1)]$

precedes t_1, which is not in conflict with $t_1 < s^*$, thus, correctly predicting the interpretation of past tense *before*-TACs in English and Russian.

To sum up, this semantic analysis of the cross-linguistic variation in the distribution and interpretation of tenses in TACs is a synthesis (and modest extension) of Ogihara's (1994, 1996) relative tense analysis of Japanese TACs and Stump's (1985) absolute tense analysis of English TACs. In both analyses, the distribution of tenses in TACs is accounted for compositionally in terms of an interaction of the meanings of the temporal connectives and the embedded tenses. Our synthesis of the two analyses shows that a unified semantic treatment of the variation is possible if we allow the time a temporal connective specifies as the local evaluation time of the embedded clause to vary from language to language.

3.3 Ogihara's (1994, 1996) objections to Stump (1985)

Ogihara (1994, 1996) considers but rejects an analysis of English TACs where the embedded tense is interpreted relative to the speech time (cf. our analysis in §3.2 and that of Stump (1985)). Ogihara's first objection is that such an analysis predicts that TACs with embedded future tenses, such as (27), are acceptable, contrary to fact:

(27) #John will call Mary when he will finish his book.

We argue that the fact that Stump's and our analyses does not rule out such examples on semantic grounds is not a problem, but rather desirable in light of completely acceptable examples like (28). (These were noted in Smith (1975:73) and Ogihara (1994:footnote 7).)

(28) John will leave when Mary will.

We currently have no explanation for why (28) but not (27) is acceptable.

Ogihara's second objection (Ogihara 1994:255, Ogihara 1996:184f.) is that the analysis predicts interpretations that are not available. Consider the examples in (29), where the embedded non-past tense can only be interpreted as having future time reference.

(29) Ogihara (1994:225)
   a. John will call Mary after he finishes his assignment.
   b. John will call Mary before he finishes his assignment.

Ogihara holds that since the non-past TAC is interpreted relative to the speech time in Stump's and our analyses, it is predicted that the embedded clause could be interpreted at the speech time, contrary to fact.

We argue that this problem does not arise if the effect of Aktionsart on the temporal interpretation of clauses with non-past tense is taken into consideration. As noted at the beginning of §2, the English non-past tense is not compatible with present and future time references in all of its occurrences; in particular, event-denoting verbs realized in the (simple) non-past tense have present time reference if interpreted habitually (30a) and receive a (scheduled) future time interpretation if episodic (30b).

(30) a. Anna sings.
b. Anna sings tomorrow.

Since the TACs in (29) receive only an episodic interpretation, it is predicted that John's finishing of the assignment is located in the future of the speech time.

The following examples further suggest that only episodically interpreted TACs are possible. Both (31a) and (32a) are stative; if realized as a TAC, they are either coerced to an inceptive interpretation (31b), which is a kind of episodic interpretation, or highly marginal (32b).

(31) a. John believes Mary.
b. John will be happy after he believes Mary.

(32) a. John knows Mary.
b. ??John will be happy after he knows Mary.

We conclude that Ogihara's objections to the kind of analysis of English and Russian TACs developed in this section (and in Stump (1985) for English) do not hold up.

3.4 A pragmatic restriction on the interpretation of TACs

A more serious problem for our analysis as it currently stands (and for other analyses of TACs, too, including e.g. Ogihara (1996:186), Arregui and Kusumoto (1998), Kusumoto (1999:260-262), Beaver and Condoravdi (2003)) is that the truth-conditional meanings assigned to certain examples do not suffice to rule them out. We illustrate this for English; the corresponding Russian examples have exactly the same problem. Consider the non-past variants of (6a) and the past variants of (7b), repeated in (33a)

and (33b), respectively, along with the truth-conditional meanings assigned to them by our analysis (assuming that English *will*-futures are translated by **fut**, which is interpreted as $[\![\mathbf{fut}(\zeta)]\!]^{M,i,g} = 1$ iff $[\![\zeta]\!]^{M,i,g} > i$).

(33) a#Anna left [before Ken arrives].
$\exists t \exists t_1 [\mathbf{past}(t) \wedge \mathrm{AT}(t, leave'(a)) \wedge \mathbf{npst}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1]$

b#Anna will leave [after Ken arrived].
$\exists t \exists t_1 [\mathbf{fut}(t) \wedge \mathrm{AT}(t, leave'(a)) \wedge \mathbf{past}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t > t_1]$

The truth-conditional meanings assigned to these examples by our analysis predict them to be acceptable since the constraints introduced by the tenses do not contradict those introduced by the temporal connectives.

Stump (1985:146) proposes that such examples are ruled out on pragmatic grounds (cf. also Kusumoto 1999): he invokes Grice's maxims (specifically "a principle of conversational economy" (p.146)) to argue that examples like *#John will leave after Mary arrived* are pragmatically odd because the same information can be conveyed by a simpler assertion (namely, *Mary arrived. John will leave*). Stump relies on the assumption that "[w]hen a speaker uses a sentence of the form ϕ **after** ψ, ϕ **before** ψ, s/he normally pragmatically presupposes the truth of ψ" (p.146). However, as was pointed out by Heinämäki (1974) and others, the truth of ψ cannot always be presupposed: in (34), for example, truth of the hand count being completed cannot be presupposed since the hand count was not completed.

(34) On Dec. 9, the U.S. Supreme Court stopped the hand count before it was completed. (Beaver and Condoravdi 2003)

We agree with Stump in that examples like (33) are ruled out on pragmatic grounds but we propose that the meaning of the tenses in discourse underlies the pragmatic restriction. It is well-known that temporal modifiers such as *yesterday, at that time* or *in the afternoon* constrain the reference time of the clause they modify (cf. e.g. Dowty 1982; Hinrichs 1986). We assume that TACs (which are complex temporal modifiers) have a similar function:

(35) The TAC constraint:
The temporal reference of the TAC constrains the reference time of the matrix clause.

We argue that examples like (33) are infelicitous because they violate the TAC constraint: in (33a), the matrix past tense requires the reference time to

be in the past of the speech time but the non-past TAC is not able to further constrain this reference time; likewise, in (33b), the matrix clause requires a future reference time, which the past tense TAC cannot further constrain. This accounts for the observation (cf. Stump 1985:144) that English (and Russian) TACs are temporally interpreted in the past (future) if the matrix clause is interpreted in the past (future). The TAC constraint accounts for this pattern on the basis of independently-motivated assumptions about how the reference time is restricted.

There is evidence that this pattern should be accounted for pragmatically rather than semantically (e.g. by a semantic constraint along the lines of "A *before/after*-TAC is temporally interpreted in the past of the speech time if the matrix clause is interpreted in the past of the speech time, and in the future if the matrix clause is in the future"). The evidence comes from Japanese:

(36) a. [Ken-ga ku-ru mae-ni] Anna-ga kaet-ta.
Ken-NOM arrive-NPST before-at Anna-NOM leave-PAST
'Anna left before Ken arrived.' (out-of-the-blue interpretation)

b. $\exists t[\mathbf{past}(t) \wedge \mathrm{AT}(t, leave'(a)) \wedge \mathrm{AT}(t, \exists t_1[\mathbf{npst}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1])]$

Recall that our semantics predicts only that the time of Ken's arrival is non-past with respect to the past time of Anna's leaving (36b), thus not constraining the location of the time of Ken's arrival with respect to the speech time. Out of the blue, the most natural interpretation of (36a) is that Ken's arrival precedes the speech time. This is predicted by the TAC constraint in (35): if the TAC is interpreted with past time reference, it can constrain the location of the matrix clause (past) reference time. The TAC constraint also correctly predicts that (36a) is infelicitous in a context where the speaker knows that Ken's arrival is in the future of the speech time. In this case, the temporal location of the (veridical) TAC cannot constrain the matrix clause reference time; in such a context (36a) is infelicitous for exactly the same reason that the English examples in (33) and its Russian equivalents are ruled out.

However, as pointed out in Kaufmann and Miyachi (2008), certain Japanese TACs are felicitous even if the TAC is not interpreted with past (future) temporal reference when the matrix clause is interpreted with past (future) reference. (36a), for example, is felicitous in a context where the time of Ken's arrival might be in the future of the speech time and, crucially, the speaker does not know whether Ken has already arrived at the speech

time (i.e. the TAC receives a non-committal non-veridical interpretation, cf. Beaver and Condoravdi (2003)). The sentence becomes especially natural in a context where the fact that Ken's arrival has not yet happened at the time of Anna's departure is significant in some way for the realization of the latter. Imagine, for example, that Anna and Ken are office mates but are on extremely bad terms with each other. One day, Anna decides to leave the office earlier than usual to avoid encountering Ken, who is expected to come in around the time she usually leaves. If Anna's friend Karina leaves the office with Anna, she can later felicitously utter (36a) to express that Anna's leaving preceded Ken's arrival (whenever that may be). What is crucial for the felicity is that Ken was not at the office at the time of Anna and Karina's departure; Ken may or may not have come to the office by the time of Karina's utterance. In this context, the realization (and hence temporal location) of the eventuality denoted by the TAC is unknown, and Ken may arrive at the office after the speech time. If there was a semantic requirement for TACs to be interpreted in the past (future) when the matrix clause is interpreted in the past (future), we would not expect (36a) to be able to receive this interpretation. As a pragmatic constraint, however, we expect that the TAC constraint can be violated in certain contexts. Our discussion above suggests that one such context is where the speaker does not know whether the eventuality denoted by the TAC is realized. We leave for future research the question of which other kinds of contexts can override the TAC constraint in languages like Japanese.

4 Comparison with previous analyses

In this section we compare our analysis of the variation to the analyses proposed in Ogihara (1994, 1996) and Arregui and Kusumoto (1998). A key difference between our analyses and these is that, in the latter, the variation is not accounted for semantically but as differences in the syntax-semantics interface or the syntax of the languages, respectively. After presenting the two analyses in sections 4.1 and 4.2, we argue in section 4.3 that the semantic approach has both empirical and theoretical advantages.

4.1 Ogihara (1994, 1996)

As discussed in §3.3, Ogihara explicitly rejects the assumption that tenses in English TACs are interpreted relative to the speech time. Ogihara instead proposes that tenses in English TACs, just like those of Japanese TACs, are interpreted relative to the matrix event time, and that the Sequence-of-Tense

(SOT) rule obligatorily deletes embedded tenses at Logical Form (LF) under identity with a c-commanding tense in the matrix clause. Motivation for the existence of the SOT rule in English comes from Propositional Attitude Complements (PACs), as in (37):

(37) Ken said that Anna was sick.

(37) has two interpretations: a BACK-SHIFTED one according to which Anna was sick at a time prior to Ken's saying and an OVERLAPPING one according to which Anna was sick at the time of Ken's saying. If the past tense embedded in the PAC is interpreted with respect to the matrix event time, the back-shifted interpretation is predicted since the embedded past tense locates the time of Anna's being sick prior to the matrix event time. The overlapping reading, however, is not predicted. Ogihara's SOT rule optionally applies at LF and deletes the embedded past tense (under identity with the past tense in the matrix clause). In (38), ~~PAST~~ indicates that the past tense has been deleted:

(38) LF of (37) after application of the SOT rule:
Ken say-PAST [that Anna be-~~PAST~~ sick]

This LF results in the overlapping interpretation of (37) since the embedded clause is now located in the past by the same past tense that locates the matrix eventuality in the past.[7]

Ogihara proposes that the SOT rule obligatorily applies to embedded tenses in TACs. As a result, examples like (39a) are predicted to be grammatical: the embedded past tense is deleted at LF (39b), and the resulting expression receives an interpretation according to which the time of Ken's arrival is prior to the speech time (contribution of the matrix clause tense) and Anna's leaving is prior to Ken's arrival (contribution of the temporal connective):

(39) a. Anna left before Ken arrived.
b. LF of (39a):
Anna leave-PAST [before Ken arrive-~~PAST~~]

Ogihara's SOT-based analysis of English and Japanese TACs captures the contrast in how tenses are distributed in TACs in the two languages. But it faces both empirical and theoretical objections. First, since the SOT

[7]See Gennari (2003) for a critical assessment of the SOT-based analysis of PACs and an alternative semantic approach to the interpretation of tense in PACs.

rule applies at the level of Logical Form, the analysis can only be couched in theories that have a syntactic level of representation at which deletion operations are permissible. Second, Ogihara's analysis stipulates that the SOT rule obligatorily applies in TACs but only optionally applies in PACs; this begs for a more principled account of the difference between tense interpretation in TACs and PACs (cf. Kubota et al. (2009) for discussion). Third, it is unclear whether Ogihara's analysis extends to a wider set of languages. As pointed out in Arregui and Kusumoto (1998), tenses in Polish TACs are distributed like those of English in that e.g. the past tense is permitted in *before*-clauses with a past matrix clause (cf. (6a)). But unlike English PACs, Polish PACs do not motivate that Polish has the SOT rule. We illustrate this for Russian, which behaves like Polish in all relevant respects. The Russian example in (40) only has the back-shifted interpretation where Anna was sick at a time prior to Ken's saying:

(40) Ken skaza-l [čto Anna by-l-a bol'n-a].
Ken say-PAST that Anna be-PAST-FEM sick-FEM
'Ken said that Anna had been sick.'

Since (40) does not have an overlapping interpretation, Russian PACs do not motivate that Russian has the SOT rule. If one assumes (as Arregui and Kusumoto (1998) seem to do) that a language either has the SOT rule or does not have it, Ogihara's analysis of English and Japanese TACs cannot account for Polish and Russian TACs.

One could, of course, try to save Ogihara's analysis by assuming that the availability of the SOT rule in a particular language is not determined on the basis of PACs but on a construction-by-construction basis. For example, one might say that the SOT rule obligatorily applies in Russian and Polish TACs and does not apply in Russian and Polish PACs (cf. Kondrashova's (2005) discussion of Russian as a 'split-SOT' language). This would, however, make the undesirable typological prediction that there are many more language types than actually attested (namely nine, depending on whether the SOT rule applies obligatorily, applies optionally or does not apply in TACs or PACs). Since only three language types are actually attested such a move does not seem plausible from a typological perspective.

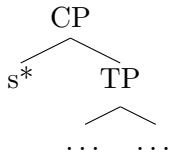
More generally, analyzing the variation observed in English and Japanese TACs as a (two-way) distinction in whether the SOT rule is available or not has the same problem as the (two-way) typological classification of tenses as absolute or relative (cf. §2). As discussed in more detail in Kubota et al. (2009), English, Russian and Polish tenses cannot be classified as one or the other, thereby breaking down the classification and rendering problem-

atic any analysis based on a binary distinction. Instead, we argue, there are language- and construction-specific constraints on the temporal interpretation of embedded tenses; these constraints determine what the local evaluation time for a particular tense is.

4.2 Arregui and Kusumoto (1998)

Arregui and Kusumoto (1998) analyze variation in the distribution and interpretation of tenses in English, Polish and Japanese. They propose that the variation is due to a syntactic difference between English and Polish on the one hand and Japanese on the other. In particular, they propose that the temporal connectives of English and Polish TACs select CPs whereas those of Japanese TACs select TPs. This syntactic difference has semantic repercussions since, according to Arregui and Kusumoto (1998), the speech time occurs in the head of CP:

(41)



Since English and Polish temporal connectives select a CP, the tense embedded in the TAC is interpreted relative to the speech time. The tense embedded in Japanese TACs, however, is interpreted relative to the matrix event time since the Japanese connectives select TPs. This predicts that the past tense is acceptable in *before*-TACs with matrix past tense clauses in English and Polish whereas the non-past tense (which Arregui and Kusumoto (1998) call the 'present' tense) is acceptable in Japanese *mae* 'before' TACs. We illustrate this for English in (42) and for Japanese in (43):

(42) a. Anna left before [$_{\mathbf{CP}}$ Ken arrived].
b. *before:* $\lambda P \lambda t \forall t'[P(t') \rightarrow t < t']$
c. $\exists t[t < s^* \wedge leave'(a)(t) \wedge \forall t'[(t' < s^* \wedge arrive'(k)(t')) \rightarrow t < t']]$

English TACs consist of CPs (42a). Arregui and Kusumoto (1998) follow Heinämäki (1974) in assuming (42b) as the meaning of *before*. Consequently, both the matrix clause tense and the tense of the *before*-clause of (42a) are interpreted relative to the speech time, resulting in the interpretation in (42c).

In Japanese, temporal connectives select TPs, as illustrated in (43a):

(43) a. [**TP**Ken-ga **ku-ru**] mae-ni Anna-ga kaet-ta.
Ken-NOM arrive-NPST before-at Anna-NOM leave-PAST
'Anna left before Ken arrived.'

b. *mae* 'before': $\lambda P \lambda t \forall t'[P(t') \rightarrow t < t']$

c. $\exists t[t < s^* \wedge leave'(a)(t) \wedge \forall t'[arrive'(k)(t') \rightarrow t < t']]$

Given the meaning of *mae* 'before', the Japanese TAC is interpreted relative to the matrix event time, thus locating Ken's arriving in the non-past of Anna's leaving. The temporal connective locates the time of Ken's arrival in the future the time of Anna's leaving.

The assumption that English and Polish (or Russian) connectives select CPs while those of Japanese select TPs does not yet suffice, however, to account for the distribution of tenses in TACs in the three languages. In particular, it does not yet account for the unavailability of past tenses in Japanese TACs such as (44a):

(44) a#[**TP**Ken-ga ki-ta] mae-ni Anna-ga kaet-ta.
Ken-NOM arrive-PAST before-at Anna-NOM leave-PAST
(Intended: Anna left before Ken arrived.)

b. $\exists t[\underline{t < s^*} \wedge leave'(a)(t) \wedge \forall t'[\exists t''[\underline{t'' < t'} \wedge arrive'(k)(t'')] \rightarrow t < t']])$

The problem is that the semantics of *mae* 'before' and the tenses assigns an interpretable translation to (44a): (44b) is true if and only if there is a time t prior to the speech time at which Anna leaves and all times t' are such that if there is a time t'' that precedes t' and at which Ken arrives, then t, the time at which Anna leaves, precedes t'. This is true, for example, if (44b) was uttered at 6pm in a situation in which Anna left at 3pm (t) and Ken arrived at 4pm (t''): in this case, Anna's leaving would be before the speech time s^*, and all times t' are such that if there is a time t'' before t' and Ken leaves at t'', then t precedes t'.

In order to exclude examples like (44a), Arregui and Kusumoto (1998) stipulate that Japanese *mae* 'before' bears a binder index (but not *ato* 'after'): since the non-past tense in Arregui and Kusumoto's (1998) analysis is a variable, *mae* 'before' can combine with non-past TPs but not with past TPs (past tense is not a variable but translates as $\lambda P \lambda t \exists t'[t' < t \wedge P(t')]$). The resulting analysis of the cross-linguistic variation observed in English, Japanese and Polish (and Russian) TACs thus relies on a non-uniform syntax/semantics of the temporal connectives in Japanese, as well as a non-uniform syntax/semantics of the past and non-past tenses of the three languages.

4.3 Discussion

The analysis we developed in section 3 is based entirely on the semantic contributions of the tenses and the temporal connectives. The analyses we reviewed in this section are syntactic to different degrees: Ogihara (1994, 1996) provides a semantic analysis of Japanese TACs but assumes a deletion mechanism at LF to account for English TACs; Arregui and Kusumoto (1998) posit different structures for English and Russian/Polish TACs on the one hand and Japanese TACs on the other, and make recourse to syntactic differences between Japanese *mae* 'before' and *ato* 'after' to account for the Japanese data.

As with all cross-linguistic phenomena that involve both the semantic and the syntactic components of grammar, here, too, the question arises as to which kind of analysis is most suitable to account for the observed variation. We have shown that a purely semantic analysis is possible and is a viable alternative to the previous analyses which rely on syntax to varying degrees.

We find at least two arguments in favor of our semantic analysis. First, it is undeniable that tenses and TACs have semantic/pragmatic functions, namely to locate eventualities in time and in relation to others. We advocate a semantic analysis of the cross-linguistic variation observed in the distribution and interpretation of tenses in TACs, since it builds on these semantic/pragmatic functions. Second, the semantic analysis is preferable since, all other things being equal, it only relies on the semantics of the tenses and temporal connectives; by contrast, Ogihara's analysis additionally requires a deletion operation at a theory-internal, syntactic level of representation, and Arregui and Kusumoto (1998) additionally need to make several language- and construction-particular stipulations.

5 Conclusion

This paper developed a formal semantic analysis of cross-linguistic variation in the interpretation of tenses in English, Japanese and Russian temporal adjunct clauses. Taken as a case study of examining the range of possible analyses of variation that involves convergence of meaning in light of different morphosyntactic means, we have argued that a semantic analysis is favorable at least to account for tense variation in temporal adjunct clauses. Variation in other empirical domains can also be subjected to this line of inquiry: Kubota et al. (2009), for example, extend the empirical domain to include tenses embedded in propositional attitude complements.

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Appendix

This appendix spells out the model-theoretic interpretation of the translation of the Japanese example (18) given in (20c), and repeated in (45).

(45) $\exists t[\mathbf{past}(t) \wedge \mathrm{AT}(t, leave'(a)) \wedge \mathbf{AT}(t, \exists t_1[\mathbf{npst}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1])]$

(46) $[\![(45b)]\!]^{M,s^*,g} = 1$ iff there is some g' such that $g' = g$ (except possibly that $g'(t) \neq g(t)$) and $[\![\mathbf{past}(t) \wedge \mathrm{AT}(t, leave'(a)) \wedge \underline{\mathrm{AT}(t, \exists t_1[\mathbf{npst}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1])}]\!]^{M,s^*,g'} = 1$

The underlined part of (46) is analyzed as follows:

(47) $[\![\mathrm{AT}(t, \exists t_1[\mathbf{npst}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1])]\!]^{M,s^*,g'} = 1$
iff $[\![\exists t_1[\mathbf{npst}(t_1) \wedge \mathrm{AT}(t_1, arrive'(k)) \wedge t < t_1]]\!]^{M,w,i,g'} = 1$ (where $i = [\![t]\!]^{M,s^*,g'} = g'(t)$)
iff there is some g'' such that $g'' = g'$ (except possibly that $g''(t_1) \neq g'(t_1)$) and

a. $[\![\mathbf{npst}(t_1)]\!]^{M,w,i,g''} = 1$ and
b. $[\![\mathrm{AT}(t, arrive'(k))]\!]^{M,w,i,g''} = 1$ and
c. $[\![t]\!]^{M,w,i,g''} = [\![t_1]\!]^{M,w,i,g''}$

(48) a. $[\![\mathbf{npst}(t_1)]\!]^{M,w,i,g''} = 1$ iff $i \leq [\![t_1]\!]^{M,w,i,g''}$ iff $g'(t) \leq g''(t_1)$ (since $i = g'(t)$ and $[\![t_1]\!]^{M,w,i,g''} = g''(t_1)$)

b. $[\![\mathrm{AT}(t, arrive'(k))]\!]^{M,w,i,g''} = 1$ iff $[\![arrive'(k)]\!]^{M,w,i',g''} = 1$ iff $[\![arrive'(k)]\!]^{M,w,i'} = 1$ (where $i' = [\![t_1]\!]^{M,w,i,g''} = g''(t_1)$)

c. $[\![t]\!]^{M,w,i,g''} < [\![t_1]\!]^{M,w,i,g''}$ iff $g'(t) < g''(t_1)$ (since $[\![t]\!]^{M,w,i,g''} = g''(t) = g'(t)$ and $[\![t_1]\!]^{M,w,i,g''} = g''(t_1)$)

Thus, (47a–c) are true iff

(49) a. $g'(t) < g''(t_1)$ (from (47a,c) = (48a,c)) and
b. $[\![arrive'(k)]\!]^{M,w,i'} = 1$ (where $i' = g''(t_1)$) (from (47b) = (48b))

Thus, (47) is true iff there is some g'' such that $g'' = g'$ (except possibly that $g''(t_1) \neq g'(t_1)$) and

(50) a. $g'(t) < g''(t_1)$ and
b. $[\![arrive'(k)]\!]^{M,w,i'} = 1$ (where $i' = g''(t_1)$)

In other words, (47) is true iff there is some time i' such that:

(51) a. $g'(t) \leq i'$ and
b. $[\![arrive'(k)]\!]^{M,w,i'} = 1$

Thus,

(52) $[\![(45\mathrm{b})]\!]^{M,s^*,g} = 1$ iff there is some g' such that $g' = g$ (except possibly that $g'(t) \neq g(t)$) and

a. $g'(t) < s^*$ and
b. $[\![leave'(a)]\!]^{M,w,i,g'} = 1$ (where $i = g'(t)$) and
c. (47)

In other words, $[\![(45\mathrm{b})]\!]^{M,s^*,g} = 1$ iff there are some times i $(= g'(t))$ and i' $(= g''(t_1))$ such that $i < s^*$ and $i \leq i'$ and $[\![leave'(a)]\!]^{M,w,i} = 1$ and $[\![arrive'(k)]\!]^{M,w,i'} = 1$.