Relative Tense without Existential Quantification and *Before*

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Abstract

This article discusses the semantics of tense morphemes in Japanese in temporal adverbial clauses as well as in relative clauses. We claim that they are non-pronominal higher order entities but do not carry existential quantifier meanings on their own. Specifically, we argue against the view that Japanese past tense sentences are necessarily existentially quantifying and that this is the reason why they cannot occur as *mae* 'before' clauses. This view is incompatible with the fact that Japanese *ato* 'after' clauses must occur in the past tense. By contrast, our own proposal about Japanese tense morphemes is based on the idea that the inherent meaning of 'before' (or 'after') agrees with the "relative" meaning of the tense morpheme in the temporal adverbial clause. That is, a 'before' clause must be in the future tense (conveyed by the non-past tense form) because it describes a situation that follows the matrix predication time, whereas an 'after' clause must be in the past tense because it describes a situation that precedes the matrix predication time. Choosing the wrong tense form would then result in a contradiction. We will make two separate compositional proposals within two major accounts of 'before' and 'after': Beaver and Condoravdi's and Anscombe's. This enables us to show that correct empirical predictions can be made about 'before' and 'after' clauses, including non-veridical 'before' clauses, regardless of which account of temporal connectives turns out to be optimal. Our proposal also covers 'when' clauses and (nominal) relative clauses. Japanese tense morphemes are higher order entities and are "quantifier-raised" to yield "simultaneous readings" for present tense relative clauses. From the viewpoint of natural language semantic theory, this article establishes that non-pronominal relative tense morphemes are not always existentially quantifying. When an existential quantifier interpretation is needed, it is supplied through independent means. This is a promising approach to the semantics of relative-tense languages

such as Japanese.

Keywords

relative tense, *before* and *after*, quantification tense, referential tense

1. Introduction

This article argues that even though Japanese is a "relative tense" language, its tense morphemes are not inherently existentially quantifying. Specifically, we will discuss the semantics of Japanese and English tense morphemes in 'before' and 'after' clauses (including non-veridical 'before' clauses) and show that a correct analysis of Japanese tense morphemes must say that they are relative tense morphemes but do not induce existential quantification.[1] It is often assumed or suggested in the literature that an absolute tense is referential and non-quantificational, whereas a relative tense morpheme is necessarily existentially quantifying. For example, von Stechow (1995) encodes relative tense in terms of existential quantification, though he considers two possibilities (referential vs. quantificational) for absolute tense. Kratzer (1998) encodes (absolute) tense in terms of the idea that tense morphemes are like pronouns, thereby endorsing the idea that they are referential expressions (unless bound by an external operator).[2] Given this background, it is theoretically important to establish that a relative tense

[1] In this article, we use 'before' and 'after' (single quotes) in the main text to indicate expressions in any language that correspond in meaning to these quoted English expressions (Japanese expressions *-mae-ni* or *-ato-ni* in most cases), whereas *before* and *after* indicate the actual English expressions *before* and *after*.

[2] See also Partee (1973, 1984).

morpheme is not necessarily existentially quantifying.[3,4] Our proposal still presupposes Ogihara and Sharvit's (2012) conclusion about the typological distinction between English-type and Japanese-type languages regarding the temporal interpretation of relative clauses. That is, non-pronominal Japanese tense morphemes can be "scoped out" to "bind" tense morphemes in relative clauses, thereby enabling simultaneous readings, whereas English tense morphemes cannot be.[5]

In this article, we will use two important technical terms both of which contain the word *relative*: "relative tense" and "relative clause." Let us clarify the use of these two terms here. The term "relative tense" is used to designate a tense morpheme (or a clause that contains this tense morpheme) interpreted in relation to the predication time of the immediately higher clause, rather than in relation to the utterance time. The term "relative clause" is used to refer to a gapped relative clause, which involves a movement from a position within a clause to an operator position to create a "predicate."[6]

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[3] The proposal made by Kaufmann and Miyachi (2011) has similar properties: Japanese tense morphemes are relative and do not involve existential quantification.

[4] See Ogihara (1996) and Abusch (1997), among many others, for a comprehensive discussion of the presence or absence of the sequence-of-tense phenomenon and absolute vs. relative tense languages.

[5] In our account, Japanese tense morphemes are higher order entities (of type $<it,<i,it>>$) with no built-in existential quantifier import. We shall show that this expression can be "quantifier-raised" to bring about desired semantic consequences in relative clauses (as well as in temporal adverbial clauses).

[6] There are a couple of more caveats to be added here. In Section 7, we will argue that a *toki* 'when/time' clause can be a relative clause in that it involves a syntactic movement that creates a variable-binding configuration. We might also mention that Japanese has "internally headed relative clauses (IHRC)" which arguably lack "gaps" associated with regular relative clauses

Let us discuss some concrete examples. When a temporal adverbial clause situation is located in the past of the utterance time, English requires a past tense clause. This is shown in (1a, b). For example, if there was exactly one event of Bill's arriving, then it is easy to see that the past tense in each temporal adverbial clause indicates anteriority in relation to the utterance time, and *before* and *after* add information about the temporal order between the two situations in question.[7] More specifically, in (1a) the time of Bill's arrival was before the utterance time, and the time of Mary's leaving was before the time of Bill's arrival. The case of *after* in (1b) is similar except that the order of the two events is reversed.

(1) a. Mary left before Bill arrived.
b. Mary left after Bill arrived.

This means that using indexical tense morphemes in temporal adverbial clauses is perfectly acceptable for the purpose of semantics. However, this is not the only strategy that natural language adopts.

We argue with Ogihara (1994, 1996), Kaufmann and Miyachi (2011) and others that the tense morphemes in *mae* 'before' and *ato* 'after' clauses in Japanese are instances of relative tense and are not existentially quantifying. Being relative tense morphemes, they are interpreted in relation to the matrix clause predication time.[8] This has the consequence of yielding "semantic harmony" between the temporal connectives and tense morphemes. Consider the examples (2a, b).

(Shimoyama 1999).

[7] As we shall discuss below, non-veridical (or non-factual) *before* cases make it difficult to justify the use of past tense in some *before* clauses, but since our task in our article is not to discuss the English data, we will not pursue this issue further.

[8] See also Takubo (2012).

(2) a. [Naoki-ga **kuru**] **mae** -ni Hanako-ga kaet-ta.[9]
Naoki-NOM **arrive.FUT before** at Hanako-NOM leave-PAST
'Hanako left before Naoki arrived.'

b. [Naoki-ga **ki-ta**] **ato** -ni Hanako-ga kaet-ta.
Naoki-NOM **arrive-PAST after** at Hanako-NOM leave-PAST
'Hanako left after Naoki arrived.'

As the bold-faced expressions (and their glosses) show, non-past tense forms occur in 'before' clauses, and past tense forms occur in 'after' clauses. Crucially, changing the tense in the 'before' or 'after' clause would result in ungrammaticality. This is consistent with the claim that tense morphemes in 'before' and 'after' clauses are instances of relative tense because an 'after' clause event is located in the past of the matrix clause event, whereas a 'before' clause event is located in the future of the matrix clause event.[10]

Japanese does not have an overt future tense, and a sentence with no overt past tense marking can refer to either the time of the higher predicate (relative present) or a time later than that (relative future). Ogihara (1996) contends that this is an instance of ambiguity, rather than vagueness. In other words, Japanese has both present and future tenses despite the lack of morphological marking for this semantic distinction. Ogihara (1996: 4) considers the example given here as (3).[11]

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[9] *Kuru* literally means 'come', but using *arrive* (rather than *come*) yields a better translation in English.

[10] Assuming the ambiguity analysis of the non-past tense marking of Japanese verbs, we will provide appropriate glosses for non-past verb forms.

[11] See Ogihara (1996) for more examples.

(3) Taroo-ga koko-ni i-masu.
Taro-NOM here-at be-PRES/FUT
'Taro is here (now).' OR 'Taro will be here.'

(3) can mean 'Taro is here' or 'Taro will be here' depending upon the context. Crucially, however, it lacks the interpretation in which the time in question is any non-past time. This leads us to conclude that there is a semantic distinction between present and future even though there is no overt morphological distinction between them. This underlying distinction between present and future in Japanese enables Ogihara (1994, 1996) and Kaufmann and Miyachi (2011) to support the view that Japanese 'before' clauses contain future tense.

Kaufmann and Miyachi (2011) analyze Japanese tense morphemes in *mae* 'before' and *ato* 'after' clauses as instances of relative tense as in Ogihara (1994) but add a caveat to the effect that *mae* 'before' and *ato* 'after' clauses are generally restricted to event sentences.[12] The same empirical claim had been made earlier by Kusumoto (1999). There are more complications, however. Both Kusumoto (1999) and Kaufmann and Miyachi (2011) also note that some predicates that are otherwise considered stative occur felicitously in 'before' and 'after' clauses. Some relevant examples are given in (4).

(4) a. Hanako-wa Osaka-ni (san-nen) i-ta ato-ni Tokyo-ni utut-ta.
Hanako-TOP Osaka-to (three-years) be-PAST after-at Tokyo-to move-PAST
'Hanako moved to Tokyo after having been in Osaka (for three years).'
b. Hanako-wa sinkansen-ni not-ta toki
Hanako-TOP bullet.train-DAT take-PAST when/time

[12] Thanks are due to a reviewer who suggests that the discussion of aspectual classes in relation to the semantics of *mae*/*ato* clauses should be included in this article.

Fuji-san-ga mieru mae-ni ne-te simat-ta.

Mt. Fuji-NOM see.can.FUT before-at fall.asleep end.up-PAST

'When Hanako took the bullet train, she fell asleep before Mt. Fuji came into her view.' [Literal translation: 'She fell asleep before Mt. Fuji can be seen.']

c. Hanako-wa koko-ni iru mae-ni betu-no heya-ni i-ta.

Hanako-TOP here-at be.FUT before-at another-gen room-at be-PAST

'Hanako was in a different room before coming here.'

[Literal translation: 'Hanako was in another room before she is here.']

Kaufmann and Miyachi (2011) contend that these are cases in which stative predicates are reinterpreted as event predicates via an aspectual shifting operation. This could be a good explanation of the above data. Kaufmann and Miyachi (2011) also present unacceptable examples like (5) and argue that aspectual shift is a coercion operation that can only occur as a last resort in a limited number of cases.

(5) *Hanako-wa byookidat-ta ato-de ronbun-o kaki-oe-ta.

Hanako-TOP be.sick-PAST after-at paper-ACC write-finish-PAST

[Lit.] 'Hanako finished writing her paper after she was ill.'

This complication pertaining to aspectual properties of predicates is clearly an important issue that must be taken into account. However, it is fair to say that the difference in acceptability judgments is very subtle, and the factors that determine the acceptability of data involving stative 'before' and 'after' sentences are not well understood. For example, *byooki-da* 'be-sick' could occur in a sentence like (6) with an appropriate adverbial *nagai aida* 'for a long time'.[13]

[13] Note also that the 'after' clause in (6) is not followed by any postposition, whereas the corresponding 'after' clause in (5) is followed by the postposition *-de*. Replacing *-de* with *-ni*

(6) Hanako-wa nagai aida byookidat-ta ato
Hanako-TOP long time be.sick-PAST after
migoto ni hukkatu-si kinmedaru-o tot-ta
wonderfully recover-and gold medal-ACC get-PAST
'It is wonderful that Hanako recovered and got a gold medal after having been sick for a long time.'

English allows for other uses of statives in examples like (7a) and (7b) (Anscombe 1964: 3), which appear to refer to proper temporal parts of relevant maximal stative eventualities, rather than maximal ones.[14]

(7) a. The Parthenon was there before St. Peter's was there.
b. St. Peter's was there after the Parthenon was there.
c. # Sento Piitaazu-ga aru mae-ni Parutenon-ga at-ta.
St. Peter's-NOM be.FUT before-at the.Parthenon-NOM be-PAST
[Intended] 'The Parthenon was there before St. Peter's was there.'
d. # Parutenon-ga at-ta ato-ni Sento Piitaazu-ga at-ta.
the.Parthenon-NOM be-PAST after-at St. Peter's-NOM be-PAST
[Intended] 'St. Peter's was there after the Parthenon was there.'

We have just seen that 'before'/'after' clauses in Japanese do not always occur with stative predicates. However, it is not clear what restrictions should be imposed on their occurrences. It is arguable that stative sentences that refer to the entire eventuality can occur in 'before' or 'after'

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might make the sentence sound better. It is not clear what determines the felicity of Japanese 'when' clauses with a stative predicate. This is a topic for future research.

[14] These examples are also discussed in Ogihara (1995).

clauses. If so, Kaufmann and Miyachi's (2011) idea that Japanese 'before' and 'after' clauses can only work with events is on the right track. However, even when entire eventualities are referred to, some stative sentences are excluded from them as shown in (7c, d).[15] Thus, for the purpose of this article, we will not make a special arrangement to exclude states from *mae* 'before' or *ato* 'after' clauses except to caution that some stative predicates do not occur in these constructions. Our formal proposal does not make reference to events or states since this allows us to keep the overall structure of our proposal relatively simple.[16]

Let us now turn briefly to the discussion of a proper formalization of tense in natural language. Ogihara and Sharvit (2012) analyze tense morphemes in matrix and complement clauses using a formal system in which tense morphemes are complex pronominals involving

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[15] Worse still, we find an example like (i) in which a proper part of a stative eventuality *sonzai-suru* 'exist' could be referred to in a 'before' clause. We believe (i) is acceptable on a reading in which the Parthenon was built before St. Peter's was.

(i) Sento Piitaazu-ga sonzai-suru mae-ni (sude-ni) Parutenon-ga sonzai-si-tei-ta.
St. Peters-NOM exist-do.FUT before-at already Parthenon-NOM exist-do-PROG-PAST

This example suggests that it is premature for us to say anything definitive about the behavior of stative sentences in 'before' or 'after' clauses.

[16] An anonymous reviewer suggests that statives like *mieru* 'can see' generally do not occur for future interpretations. We can easily construct "future tense" examples of *mieru* 'can see' as in (i):

(i) Asita-wa tenki-ga ii kara, kitto Fuji-san ga mieru yo.
tomorrow-TOP weather-NOM good because surely Mt. Fuji-NOM see.can ENDING
'Because the weather is good tomorrow, (we) can surely see Mt. Fuji (then).'

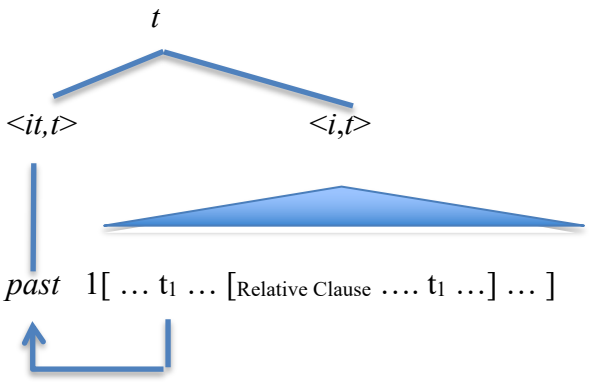
two temporal entities and a relation that orders them. They are pronominal tense morphemes and may or may not be bound by a quantifier (such as an existential and a universal), which is introduced independently of such pronominal tense morphemes, if necessary. This allows us to set up a system in which different tense systems can be encoded and cross-linguistic comparison is enabled. However, regarding tense morphemes in relative clauses, Ogihara and Sharvit (2012) propose a typological distinction between languages with both pronominal and quantificational tense morphemes and those with just pronominal ones. Specifically, "simultaneous readings" in relative clauses, as exemplified by (8), are accounted for in terms of quantifier raising (QR) being available for true quantificational tense morphemes (type <*it*,*t*>) in languages like Japanese.

(8) Hanako-wa [nai-te iru kodomo]-o mi-ta.
Hanako-TOP cry-PROG.PRES child-ACC see-PAST
'Hanako saw a child who was crying (at that time).'

This accounts for a simultaneous reading as indicated by the English gloss for (8). By contrast, English tense morphemes are all pronoun-like and they cannot be quantifier-raised.[17] This hypothesis presupposes that QR becomes obligatory when there is a type mismatch. (9) shows what happens when quantificational tense morphemes are quantifier-raised in Ogihara and Sharvit's (2012) account. Following Ogihara and Sharvit's (2012) notation, the quantificational past is indicated by *past* in (9).

[17] This has to be a syntactic constraint since there is no semantic problem with QR-ing a pronominal expression to create a binder.

(9)



In the rest of this article, we shall pursue a different account in which Japanese tense morphemes denote higher type entities of type <*it*,<*i,it*>> but do not have an existential quantifier meaning. This account still allows tense morphemes to QR and can yield simultaneous readings for present tense relative clauses.[18]

This analysis successfully accounts for the semantics of *mae* 'before' and *ato* 'after' clauses under Beaver and Condoravdi's (henceforth B&C) (2003) and Anscombe's (1964) systems. In addition, it provides an empirically accurate result in other constructions such as relative clauses. This means that the lexical meaning of a relative tense morpheme does not need to involve existential quantifier force, which is a major theoretical point that needs to be stressed when considering the typology of different tense systems.

One caveat needs to be inserted here. Whichever proposal we adopt, we need to assume that the entire sentence containing a temporal adverbial clause is evaluated in relation to a contextually salient interval. Consider examples like (10a, b).

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[18] For example, the past tense morpheme *-ta* denotes the function shown in (i). After combining with a "temporal abstract," which corresponds to the propositional meaning of the sentence skeleton in question, the tensed clause denotes a "temporal relation" of type <*i,it*>. This will be discussed in detail in Section 4.

(i) $[\![\text{-ta 'PAST'}]\!] = \lambda f_{<i,t>} . \lambda t_1 . \lambda t_2 [t_2 < t_1 \,\&\, f(t_2) = 1]$

(10) a. John brushed his teeth before he went to bed.

b. Mary always called Bill before she visited him.

It is unreasonable to conclude that (10a) is false just because John brushed his teeth at 10 p.m. yesterday and he went to bed at 11 p.m. the day before yesterday. Intuitively, we will need to restrict our attention to a contextually salient evening of a particular day to evaluate it. This type of contextual restriction is even more pronounced when an adverb of quantification like *always* is superimposed on the entire sentence. (10b) clearly requires that the context provide a set of relevant time intervals within which the sentence skeleton is evaluated. Each event of Mary's phone call must be paired with a relevant (potential) event of her visiting Bill. This type of restriction must be assumed for B&C (2003) or Anscombe (1964). Therefore, we will not explicitly encode it in our description or formalization in this article.[19]

2. Sharvit's analysis of Japanese PAST and Beaver and Condoravdi's analysis of *before*

We now turn to a detailed discussion of Sharvit's (2014) proposal about Japanese tense morphemes in 'before' clauses. Based on Ogihara and Sharvit's (2012) analysis of Japanese tense, which allows the quantificational variant of past tense to scope out and bind time variables in relative clauses, Sharvit (2014) goes one step further and claims that the Japanese past tense morpheme *-ta* always receives an existential quantifier interpretation. According to this account, Japanese has no pronominal past tense. Sharvit's proposal about the Japanese past tense morpheme is given in (11a).[20] Given the LF of the sentence in (11b), we obtain the truth conditions in (11c).[21]

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[19] This is discussed by Ogihara (1995) and is incorporated in Sharvit's (2014) proposal discussed in Section 2.

[20] This is based on (31b) in Sharvit (2014: 274).

[21] One important ingredient of past tense (or any past tense sentence) that is missing in this

(11) a. For any K, $t \in D_i$, $[\![\text{-ta}]\!]^{K,g}(p)(t)$ is defined only if $K < t$ and there is a $t' \in D_i$ such that $t' \subseteq K$ and $p(t')$ is defined. When defined, $[\![\text{-ta}]\!]^{K,g}(p)(t)$:= True iff there is a $t' \in \{t'' \subseteq K \mid p(t'') \text{ is defined}\}$ such that $p(t')$ = True.

b. Hanako-ga kaet-ta.

Hanako-NOM leave-PAST

'Hanako left.'

➔ LF: [t_0 [[1 Hanako-ga kaet t_1] -ta]][22]

c. $[\![t_0$ [1 Hanako-ga kaet t_1] -ta$]\!]^{K,g} = [\![\text{-ta}]\!]^{K,g}(\lambda t$. Hanako leaves at $t)(c_T)$[23]

Hanako-NOM leave PAST

This is defined only if $K < c_T$ (the time of the context = the utterance time) and there is a time $t_2 \subseteq K$ such that **[λt . Hanako leaves at t](t_2)** is defined. When defined, $[\![\text{-ta}]\!]^{K,g}(\lambda t$. Hanako leaves at $t)(c_T) = 1$ iff there is a time t_3 such that **λt . Hanako leaves at t (t_3)** is defined such and Hanako leaves at t_3.

(11c) says that (11b) is true when the context supplies a past interval K, and there is a time t within K such that Hanako leaves at t. This encodes the assumption that the past tense morpheme *-ta* in Japanese has an existential quantifier interpretation (with the necessary, context-supplied past time interval K serving as a restriction on the quantificational force of the existential).

Sharvit (2014) adopts this analysis of Japanese past tense and B&C's (2003) account of

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formalization is the contextually salient past interval, which could be supplied by temporal adverbials of the right sort (e.g., *yesterday*, *last week*, etc.). The presence of this type of adverbial (covert or overt) may be the presupposition that past tense in any language requires. This article will not touch on this issue, and the point being made is not affected by it.

[22] t_0 is a designated temporal variable denoting the utterance time/context time (denoted by c_T, mnemonic for 'context time', in this article).

[23] K is an interval supplied by the context.

before clauses. B&C's account espouses the assumption that *before* and *after* are lexical converses and claims that Anscombe's (1964) analysis, which goes against this assumption, needs to be corrected.[24] B&C's account, which is intensional, is given in (12a, b).[25]

(12) a. 'p before q' is true in w iff $(\exists t: \langle w,t\rangle \in p)\ t < earliest_{alt(w,t)}.q$

b. 'p after q' is true in w iff $(\exists t: \langle w,t\rangle \in p)\ t > earliest_{alt(w,t)}.q$

In this symbolization, p and q represent propositions (i.e., sets of world-time pairs), but this proposal abstracts away from the semantic contribution of tense morphemes. For example, if we wish to discuss the semantics of (13a), then the proposition provided by the main clause is understood to be (13b), and the proposition contributed by the *before* clause is (13c).

(13) a. Mary left before Bill arrived.

b. $\{\langle w_1, t_1\rangle \mid$ Mary leaves in w_1 at $t_1\}$ (corresponding to p in (12a))

c. $\{\langle w_1, t_1\rangle \mid$ Bill arrives in w_1 at $t_1\}$ (corresponding to q in (12a))

Given (12a), (13a) means that Mary leaves at some time t in the actual world such that the earliest time of Bill's arrival in any "alternative world" (defined in a rather complex manner as shown in (12a)) is later than t. If the *before* clause is veridical, then Bill's (earliest) arrival time must be located in the past as well. However, if it is a non-veridical *before*, then the earliest *before* clause time is only found in some of the alternative possible worlds specified by ***alt***. Consider (14), which exemplifies an instance of non-veridical *before*.

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[24] We shall discuss Anscombe's (1964) account in Sections 5 and 6 in detail.

[25] Beaver and Condoravdi (2003) define *earliest* the following way: $earliest_W\ .\ X =$ earliest.$\lambda t.(\exists w \in W)$ X.$\langle w,t\rangle$. Here, X corresponds to the proposition given by q in (12a), and W is a set of worlds.

(14) John died before he saw his grandchildren.

The function ***alt*** applies to a world-time pair, which is for our purposes the actual world w_0 and the chosen time *t* at which John died, and yields a set of worlds that are identical up to *t* and develop in ways that are reasonably probable given the course of events up to *t*. In the case of (14), those are some of the worlds in which John continued to live. The idea in question is very similar to that of inertia worlds proposed by Dowty (1979) in connection with the semantics of the English progressive. The function ***earliest*** then takes the set of worlds specified by ***alt*(*w*,*t*)** and yields the earliest time at which *q* holds in any of the ***alt*(*w*,*t*)** worlds. Again, regarding (14), this is the earliest time at which John might have seen his grandchildren had he not died. The claim made by the sentence, then, is that this time is later than the actual time of John's death. This accounts for non-veridical instances of *before* clauses as well as veridical ones. If we adopt this account, we have to determine how the relational meaning of a tensed clause can be embedded within it to predict the correct empirical results.

Based on B&C's proposal, Sharvit (2014) encodes the semantic contribution of tense morphemes explicitly. She argues that if Japanese past tense is a quantificational tense with an existential quantifier meaning, adopting B&C's account produces a presupposition failure when a *mae* 'before' clause is in the past tense. More specifically, the definite description "the earliest time *t* at which *q* holds" is undefined. Here's how this conclusion is derived in Sharvit's account. Sharvit assumes that the Japanese past tense morpheme *-ta* is an expression of type <*it*,*it*> with a meaning specified in (11a).[26] As mentioned above, this results in an existential quantifier meaning for the past tense sentence (11b) as shown in (11c).

The Japanese sentence in (15) contains a *mae* 'before'-clause in the past tense and is

[26] For ease of parsing, we will systematically simplify semantic types of type <*α*,*β*> for any atomic type *α*, *β*, as *αβ* (Heim and Kratzer, 1998) if it occurs as part of a more complex type. For example, <<*e*,*t*>,*t*> is abbreviated as <*et*,*t*> and <*i*,<*i*,*t*>> is simplified as <*i*,*it*>.

ungrammatical and uninterpretable. According to Sharvit's account, (15) is syntactically analyzed as in (16) and is semantically interpreted as in (17). To simplify our discussion, we will examine veridical 'before' cases. We then show that the same argumentation applies to non-veridical cases as well. As shown in (17), the connective *mae-ni* 'before-at' is of type <*it*,<*it*,*t*>>, a function that takes two temporal abstracts as arguments and yields a truth value.

(15) *Bill-ga ki-ta mae-ni Mary-wa/ga kaet-ta.
Bill-NOM arrive-PAST before-at Mary-TOP/NOM leave-PAST
This is anomalous and cannot mean 'Mary left before Bill arrived.'

(16) [t_0 [PAST [[λ_1 [Mary leave-t_1]][before [PAST [λ_2 [Bill arrive-t_2]]]]]]]

(17) **Lexical information**

⟦'leaves'⟧ = λx . λt . x leaves at t

⟦'arrive'⟧ = λx . λt . x arrives at t

⟦*-ta* 'past'⟧ = $\lambda f_{<i,t>}$. λt . $\exists t_1$ [$t_1 < t$ & $f(t_1) = 1$][27]

⟦*mae* 'before'⟧ = $\lambda f_{<i,t>}$. λt . $t <$ the earliest time t_1 such that $f(t_1) = 1$.

Compositional Semantic Calculations

1. ⟦[λ_1 [Mary leave-t_1]]⟧ = λt . Mary leaves at t
2. ⟦[λ_2 Bill arrive t_2]]⟧ = λt . Bill arrives at t
3. ⟦PAST [λ_2 Bill arrive t_2]]⟧ = λt_1 . $\exists t_2$ [$t_2 < t_1$ & Bill arrives at t_2]
4. ⟦before [PAST [λ_2 Bill arrive t_2]]⟧ = λt . $t <$ the earliest time t_1 such that $\exists t_2$ [$t_2 < t_1$ & Bill arrives at t_2]
5. ⟦[λ_1 Mary leave-t_1] [before [PAST [λ_2 Bill arrive t_2]]]⟧ =
(combined via predicate modification)

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[27] This is a simplified version of Sharvit's (2014) original account presented in (11a), which pays careful attention to presuppositions and contextual restriction to a specific interval. For our purposes, this simplified presentation will do the job.

λt . Mary leaves at t & $t <$ the earliest time t_1 such that $\exists t_2$ [$t_2 < t_1$ & Bill arrives at t_2]

6. $[\![[t_0[\text{PAST}[[\lambda_1$ Mary leave-$t_1]$ [before [PAST [λ_2 Bill arrive $t_2]]]]]]]\!] = 1$ iff
   there is a time $t < c_T$ (within a contextually salient interval) such that Mary leaves at t and t is earlier than the earliest time t_1 such that $\exists t_2$ [$t_2 < t_1$ & Bill arrives at t_2]

What is crucial for our purposes is that the relative nature of past tense *-ta* is not used here to order the main clause event (Mary's arrival) and the 'before' clause event (Bill's arrival). Rather, the time of Bill's arrival (indicated by t_2) is understood to be earlier than t_1, which is bound by the 'earliest' operator. In other words, t_1 is not the time of Mary's leaving. According to the calculation in (17) of the truth conditions of the sentence (15), the sentence fails to denote a truth value because **[the earliest time t_1 such that $\exists t_2$ [$t_2 < t_1$ & Bill arrives at t_2]]** in the final line in (17) is never defined if time is dense.[28] To clarify the point Sharvit (2014) makes, let us assume for our discussion that Mary left at 9 p.m., Bill arrived at 9:10 p.m., and there was no other past event of Mary's leaving or Bill's arriving. Applying the truth conditions given by Sharvit's proposal to this particular case, this amounts to the following definite description assuming that Bill arrived exactly once and did so at 9:10 p.m.

(18) the earliest time t such that 9:10 p.m. $< t$

Assuming that time is dense, we find no earliest time later than 9:10 p.m. This results in a presupposition failure in that the definite description fails to denote.

The above example assumes that the *mae* 'before' clause receives a veridical interpretation. However, even if we assume that the 'before' clause receives a non-veridical interpretation, we reach the same conclusion. For example, let us suppose that among the

[28] Given the set of instants T, T is a dense structure of times iff for any t_1 and $t_2 \in T$ such that $t_1 < t_2$, there is always a third time t_3 such that $t_1 < t_3 < t_2$.

alternative worlds, there is a possible world w_1 in which Bill arrived at 9:10 p.m. and there is no other world w_2 (within the restricted set, needless to say) in which Bill arrived at an earlier time. If so, the definite description associated with *before* is again (18). We come to the same conclusion: this results in a presupposition failure because (18) fails to denote. This means that under B&C's account of *before* clauses and the existential quantifier analysis of *-ta* 'past,' a *mae* 'before' clause in the past tense results in a presupposition failure regardless of whether it is veridical or not.

Sharvit contends that a *mae* 'before' clause in the non-past tense form (assuming that it is like a tenseless form) has no existential quantifier meaning and can occur in *mae* 'before' clauses to yield a coherent interpretation. This assumption is crucial for her proposal. One example is given here in (19).

(19) Bill-ga kuru mae-ni Mary-wa/ga kaet-ta.
Bill-NOM arrive.FUT before-at Mary-TOP/NOM leave-PAST
'Mary left before Bill arrived.'

A major challenge for Sharvit's account is that Japanese 'after' clauses in the past tense are also predicted to be anomalous within B&C's framework. This issue is acknowledged by Sharvit (2014: 307) herself, and there is no easy solution. B&C's proposal about *after* clauses is based on the same definite-description-based analysis because B&C's position is that *before* and *after* are lexical converses; they should be treated in a parallel fashion. Thus, we are let to the prediction that non-past verb forms are acceptable but past tense verb forms are not in *ato* 'after' clauses as well. However, this is just the opposite of native speakers' intuitions. Note the examples in (20a, b) and their predicted interpretations in (20c, d).

(20) a. Bill-ga ki-ta ato-ni Mary-ga kaet-ta.
Bill-NOM arrive-PAST after-at Mary-NOM leave-PAST
'Mary left after Bill arrived.'

b. *Bill-ga kuru ato-ni Mary-ga kaet-ta.
Bill-NOM arrive.FUT after-at Mary-NOM leave-PAST
[Intended] 'Mary left after Bill arrived.'

c. There is a past time t at which Mary leaves and the earliest t_2 such that there is a $t_3 < t_2$ and Bill arrives at t_3 is earlier than t.

d. There is a past time t at which Mary leaves and the earliest t_2 such that Bill arrives at t_2 is earlier than t.

(20a) is perfectly acceptable and receives an interpretation analogous to *Mary left after Bill arrived* in English. By contrast, (20b) is ungrammatical/anomalous. Despite this fact, Sharvit's proposal predicts that (20a) is anomalous, and (20b) is acceptable since the non-past tense form *kuru* 'leave' is understood to be tenseless, which produces no existential quantification. The prediction is that (20a) receives the truth conditions in (20c), which are never satisfied because the underlined definite description is not defined. For the sake of concreteness, let us assume that Bill arrived at 8 p.m. and Mary left at 8:30 p.m. and that there were no other arrivals of Bill or departures of Mary. Then the key question is whether "the earliest t such that 8 p.m. $< t$" is defined. Clearly, it is not defined, and this should mean that past tense *ato* 'after' clauses are ruled out just like past tense *mae* 'before' clauses. By contrast, (20b) should be interpreted as in (20d) since non-past tense is like a tenseless clause and does not induce existential quantification, which would yield a coherent reading. Unfortunately, these predictions are just the opposite of what the native speaker's intuitions require. Japanese 'after' clauses only occur in the past tense, but the above analysis predicts that only non-past 'after' clauses are acceptable. This clearly shows that existential quantification cannot be the source of the anomaly of past tense *mae* 'before' clauses in Japanese. Kaufmann (2020) independently developed a similar

criticism of Sharvit's analysis of Japanese tense morphemes in 'before' and 'after'.[29]

Sharvit (2014: 307) suggests the possibility that the semantics of *after* clauses requires an analysis not involving the ***earliest*** operator. However, this would go against B&C's idea that 'before' and 'after' are lexical converses of each other. We believe that adopting B&C's analysis of 'before' but modifying their analysis of 'after' needs independent justification. In the rest of this article, we shall not try to decide between the two major approaches to the semantics of 'before' and 'after,' namely, Anscombe's (1964) and B&C's (2003). We shall embed our relational and non-quantificational approach to Japanese tensed clauses within each proposal and show that the approach is empirically justified either way.

3. A sketch of our proposal within B&C's proposal

In this section, we will present an alternative analysis of Japanese tense morphemes that correctly accounts for their behavior in both *mae* 'before' and *ato* 'after' clauses within B&C's (2003) system. The key idea to be incorporated into our proposal is that Japanese tense morphemes in *mae* 'before' and *ato* 'after' clauses measure their semantic contributions in relation to the matrix predication time. In particular, the "non-past" tense that occurs in a 'before' clause is understood to receive a relative future interpretation. This means that tense morphemes in Japanese 'before' and 'after' clauses specify temporal relations that harmonize with what *mae* 'before' and *ato* 'after' encode. This idea was executed by Ogihara (1994, 1996) and Kaufmann and Miyachi (2011) in a simplified system in which each temporal adverbial clause receives an existential quantifier interpretation. These previous accounts do not discuss non-veridical *mae* 'before' cases, however. Such cases must be included in a more comprehensive proposal.

As mentioned earlier, the interpretation of the "relativity" of temporal adverbial clauses as formalized in Sharvit's account only deals with *-ta* 'past' as a tense morpheme. Moreover, the

[29] We thank a reviewer for drawing our attention to this publication.

lexical semantics of *-ta* 'past' does not restrict the temporal order between the time of the eventuality described in the *mae* 'before' clause and the matrix clause predication time. The non-past verb form in Japanese is regarded as tenseless (or relative present) and is treated as such in its semantic interpretation. For Sharvit, it is very important that the non-past tense form does not induce existential quantification. Unlike Sharvit, we regard 'before' clauses in Japanese to be in the future tense. To address these differences as well as the empirical issue discussed in Section 2, we need to make sure that the revised proposal will encode the intuition about "relative tense" within B&C's (2003) framework. We can think of the two possibilities given in (21b, c) for (21a). To simplify our discussion, let us assume that the *mae* 'before' clause is veridical.

(21) a. Naoki-ga kuru mae -ni Hanako-ga kaet-ta.
Naoki-NOM arrive.FUT before -at Hanako-NOM leave-PAST
'Hanako left before Naoki arrived.'

b. $\exists t$ [t < now & Hanako leaves at t & t < [the earliest t_1. Naoki arrives at t_1 & $t < t_1$]]

c. $\exists t$ [t < now & Hanako leaves at t & $\underline{t < [\text{the earliest time } t_1 \text{ . such that Naoki arrives at } t_1]}$ & $\underline{\underline{t < [\text{the earliest time } t_1 \text{ . such that Naoki arrives at } t_1]}}$

For now, let us concentrate on whether they provide the right truth conditions, rather than how they are obtained compositionally. Note that the second half of (21b) says '*t* is earlier than the earliest t_1 at which Naoki arrives and is later than *t*'. This condition necessarily holds if the definite description is defined. This is undesirable because (21b) is verified even if there was another event of Naoki's arrival before Hanako's departure within the contextually specified interval. Intuitively, the sentence ought to be false in such a case. By contrast, (21c) provides the desired truth conditions. Note that the order between the earliest time of Naoki's arrival and *t* is specified twice (once with a single underline, another time with a double underline), which is redundant. However, this embodies the semantic harmony idea. The same order is imposed by the semantics of *mae* 'before' and by the future tense (indicated by the non-past tense form) in

the *mae* 'before' clause. This is important because we can then explain why *mae* 'before' clauses must be in the future tense, and *ato* 'after' clauses must be in the past tense.

To make the point clearer, let us present the two possible proposals using *ato* 'after' examples as well here.

(22) a. Hanako-ga kaet-ta ato-ni Naoki-ga ki-ta.

b. $\exists t$ [t < now & Naoki arrives at t & [the_earliest t_1. Hanako leaves at t_1 & $t_1 < t$] < t]

c. $\exists t$ [t < now & Naoki arrives at t & [the earliest time t_1 . such that Hanako leaves at t_1] < t & [the earliest time t_1 . such that Hanako leaves at t_1] < t

The second half of (22b) says that the earliest time at which Hanako leaves and which is earlier than t, is earlier than t. This condition is automatically satisfied if the definite description is defined. However, when the definite description is not defined, (22a) is predicted to be anomalous. This prediction is incorrect if Hanako left after Naoki arrived (rather than before). Intuitively, (22a) is simply false in that case. Thus, we cannot adopt (22b) as our analysis. By contrast, (22c) is empirically and theoretically satisfactory as long as the redundant statements are understood to represent the semantic contributions of the temporal connective and the tense, respectively. When the 'after' clause occurs in the correct tense form (i.e., past tense), this morpheme makes a redundant claim without producing a contradiction. If it occurs in the future tense, which is overtly unmarked, the tense imposes a condition that is just the opposite of what 'after' requires. Thus, this will result in an 'after' clause that never satisfies its semantic requirements. This is the correct empirical prediction.

The above discussion shows that B&C's account allows us to adopt an analysis of Japanese tense forms in 'before'/'after' clauses that conforms to the native speaker's intuitions about the semantic contributions of tense forms in these clauses. In the next section, we shall work out a compositional semantic analysis of the rough sketches represented in (21c) and (22c).

4. A Compositional Re-analysis of *mae* 'before' and *ato* 'after' clauses within B&C's framework

In the previous section, we discussed how B&C might accommodate the idea that Japanese employs relative tense morphemes in 'before' and 'after' clauses. In this section, we shall propose a compositional semantic analysis of this idea. We will encode the semantic contribution of Japanese tense morphemes while preserving B&C's intuitions underlying their proposal.

We shall consider the case of (23) regarding 'before'.

(23) Naoki-ga kuru mae-ni Hanako-ga kaet-ta.
Naoki-nom arrive.FUT before-at Hanako-NOM leave-PAST
'Hanako left before Naoki arrived.'

We will show how the sentence is analyzed compositionally. In this demonstration, we shall show that this proposal can handle both veridical and non-veridical cases. The details of the lexical semantic definitions are given in (24). Note here that the lexical semantics of *mae* 'before' encodes two temporal requirements simultaneously. This involves some technical maneuvers. The calculation of T (the earliest 'before'-clause time in some alternative worlds) is done without referring to the second temporal argument of f. Thus, it is bound by an existential quantifier showing that any time will do. By contrast, the semantic contribution of tense crucially involves the ordering of the main clause and 'before' clause situations. This is shown by the formula $\exists w_2[f(w_2)(T)(t_2) = 1]$, in which t_2 corresponds to the matrix clause predication time.

(24) **Lexicon**

Truth definition: $[\![S]\!]^{w, c}$ is true iff there is a time t such that $[\![S]\!]^{w, c}(t)(c_T) = 1$

$[\![\text{-ta}]\!]^{w, c} = \lambda f_{<i,t>} . \lambda t_2 . \lambda t_3 . f(t_2) = 1 \ \& \ t_2 < t_3$

$[\![\text{-}\varnothing \text{ (FUT)}]\!]^{w, c} = \lambda f_{<i,t>} . \lambda t_2 . \lambda t_3 . f(t_2) = 1 \ \& \ t_3 < t_2$

[[Naoki-ga kuru 'Naoki arrive' (sentence skeleton)]]$^{w, c} = \lambda t$. Naoki arrives at t

[[mae-ni 'before-at']]$^{w, c} = \lambda f_{<s,<i,it>>} . \lambda g_{<i,t>} . \ \lambda t_2 . [g(t_2) = 1 \ \& \ t_2 < T \ \& \ \exists w_2[f(w_2)(T)(t_2) = 1]]$, where T = the earliest $t_1 . \exists t_4 . \exists w_1 \in alt(w, t_2) [f(w_1)(t_1)(t_4)]$[30]

[[Hanako-ga kaeru 'Hanako leave' (sentence skeleton)]]$^{w, c} = \lambda t$. Hanako leaves at t

On the basis of (24), the truth conditions of (23) are calculated using the compositional structure in (25).[31]

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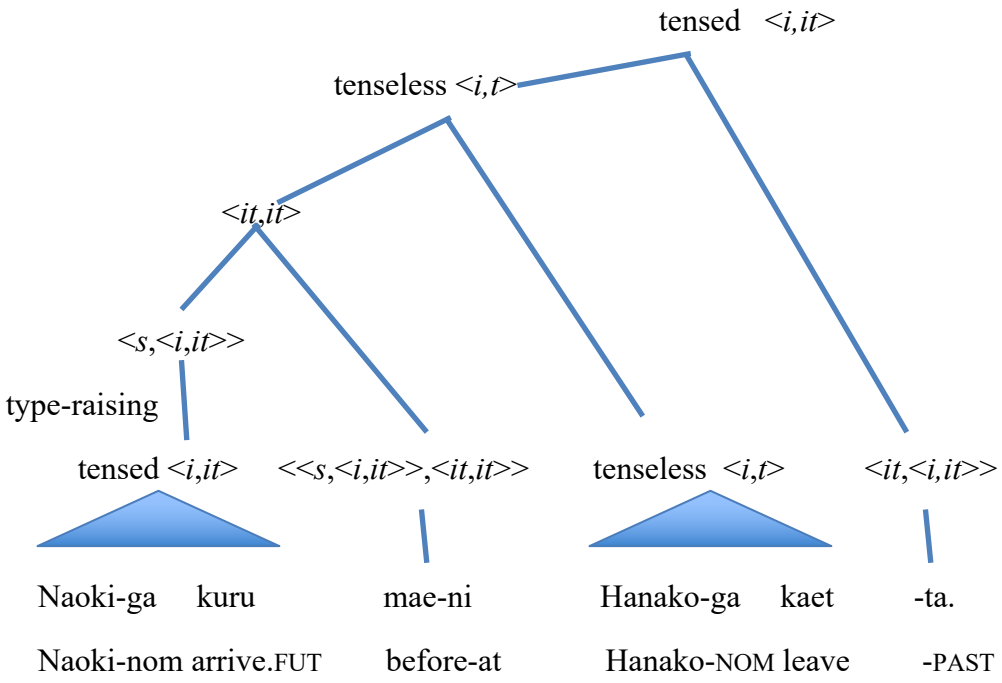
[30] The semantics of *mae* 'before' contains the condition $\exists w_2[f(w_2)(T)(t_2) = 1]$, which is very weak as far as the existence of w_2 is concerned. However, this is good enough for our purposes since this clause is used to make sure that t_1 and t_2 stand in the right temporal order. Existence of a relevant world is already established when the "earliest time" is defined in the earlier part of the lexical definition. This account assumes that the temporal order between instants and intervals is established independently of worlds. Thanks are due to the editor, Cleo Condoravdi, for suggesting this presentation of our proposal. By representing the earliest possible 'before' clause time by T, we understand the role of the tense accurately and clearly. This also facilitates the comparison of the two separate presentations of our proposal (one under B&C's and the other under Anscombe's).

[31] The type s indicates worlds, which is based on the type system adopted by Heim and Kratzer (1998).

(25)



What is crucial for our purposes is that *mae-ni* 'before-at' and the tense in the subordinate clause (i.e., the 'before' clause) must make the same semantic contribution. This is shown in (26).

(26) $[\![$Naoki-ga kuru mae-ni 'before Naoki arrives (FUT)'$]\!]^{w_0, c} =$

$\lambda g_{<i,t>}$. λt_2 . $g(t_2) = 1$ & $\underline{t_2 < T}$ & Naoki arrives at T in some world & $\underline{t_2 < T}$, where T = the earliest time at which Naoki arrives in any accessible world defined relative to w_0 and t_2

Note that the condition $t_2 < T$ (underlined in (26)) occurs twice; one is contributed by *mae-ni* 'before-at,' and the other is what the "future tense" requires. The condition on the time of Naoki coming also occurs twice, and the one associated with the role of the tense morpheme is redundant for the purpose of semantics. The truth conditions for the entire structure are given as in (27) after removing the redundancies. The detailed compositional calculations are provided in the Appendix.

(27) $\exists t_2$ [$t_2 < c_T$ & Hanako leaves at t_2 & t_2 < the earliest time at which Naoki arrives in an accessible world]

(27) says that Hanako left at a past time earlier than the earliest time at which Naoki arrived in an accessible possible world. This is desirable in that it takes care of both veridical and non-veridical cases of 'before' cases.

To appreciate the semantic role of tense morphemes in 'before' clauses more clearly, we should turn to an ungrammatical (and anomalous) *mae* 'before' clause example. Let us analyze the ungrammatical sentence (28) in terms of our proposal. (29) shows the interpretation of the 'before' clause.[32]

(28) *Naoki-ga ki-ta mae-ni Hanako-ga kaet-ta.
Naoki-NOM arrive-PAST before-at Hanako-NOM leave-PAST
[Intended] 'Hanako left before Naoki arrived.'

(29) $[\![$Naoki-ga ki-ta mae-ni 'before Naoki arrived (past)'$]\!]^{w_0, c}$ =
$\lambda g_{<i,t>}$. λt_2 . $g(t_2) = 1$ & $\underline{t_2 < T}$ & Naoki arrives at T in some world & $\underline{T < t_2}$, where T = the earliest time at which Naoki arrives in any accessible world defined relative to w_0 and t_2

The two underlined conditions in (29) are mutually contradictory. We can never find t_2 that can have both properties simultaneously, given a particular T. As a consequence, the entire sentence that contains a *mae* 'before' clause in the past tense can never be true. This shows that *mae* 'before' clauses in Japanese must occur in the future tense (i.e., the future interpretation of the non-past verb form).

The case of *ato* 'after' clauses is a mirror image of the *mae* 'before' case; they have to occur in the past tense form to avoid a contradictory requirement. Let us now sketch how this

[32] More computational details are given in the Appendix.

works. Consider (30).

(30) Hanako-ga kaet-ta ato-ni Naoki-ga ki-ta.
Hanako-NOM leave-PAST after-at Naoki-NOM arrive-PAST
'Naoki arrived after Hanako left.'

(31) shows the lexical meaning of *ato* 'after' and the interpretation of the entire *ato*-clause.

(31) $[\![\text{ato-ni 'after-at'}]\!]^{w,c} = \lambda f_{<i,it>} . \lambda g_{<i,t>} . \lambda t_2 . [g(t_2) = 1 \ \& \ T < t_2 \ \& \ \exists w_2[f(w_2)(T)(t_2) = 1]]$,
where T = the earliest $t_1 . \exists t_4 . \exists w_1 \in alt(w, t_2) [f(w_1)(t_1)(t_4)]$
$[\![\text{Hanako-ga kaet-ta ato-ni 'after Hanako left (PAST)'}]\!]^{w_0, c} =$
$\lambda g_{<i,t>} . \lambda t_2 . g(t_2) = 1 \ \& \ \underline{T < t_2}$ & Naoki arrives at T in some world & $\underline{T < t_2}$, where T = the earliest time at which Naoki arrives in any accessible world defined relative to w_0 and t_2[33]

The last line in (31) shows the same temporal relation twice (underlined), just as in the case of *mae-ni* 'before-at'. This shows that an *ato* 'after' clause must contain a sentence in the past tense, which is empirically correct. If the sentence contains a "future tense," that would result in a contradictory condition. The anomaly of such a sentence is thus explained.

In this section, we showed how the desired empirical results are predicted by our proposal about Japanese tense morphemes within B&C's account of 'before' and 'after,' as assumed by Sharvit's proposal. In the next section, we will turn to an alternative analysis, which is due to Anscombe (1964).

[33] As mentioned earlier when we discussed (23), the last condition, i.e., Hanako leaves at t_1, is needed for technical reasons and is redundant.

5. Anscombe's Analysis of *before*

Let us turn to Anscombe's (1964) analysis of *before* and *after*, which predates B&C's (2003) proposal by almost forty years. (32) shows Anscombe's analysis as adopted by Landman (1991: 143).[34] Anscombe's analysis is designed for the English connectives *before* and *after*. However, if we are willing to adjust the tense form differences, this proposal successfully accounts for the behavior of *mae* 'before' and *ato* 'after' in Japanese as well.

(32) a. $[\![\text{p before q}]\!]^{t_0} = 1$ iff $\exists t_1 < t_0 [p(t_1) = 1 \ \& \ \forall t_2 [[t_2 < t_0 \ \& \ q(t_2) = 1] \rightarrow t_1 < t_2]]$

b. $[\![\text{p after q}]\!]^{t_0} = 1$ iff $\exists t_1 < t_0 [p(t_1) = 1 \ \& \ \exists t_2 < t_1 [q(t_2) = 1]]$

Note that (32a) covers non-veridical *before* cases such as (33), which was discussed above as (14) in connection with B&C's account, as well as veridical cases. (33) is non-veridical in that the entire sentence can be true without there having been a past time when the *before* clause was true.[35] (33) receives the interpretation in (34) under Anscombe's analysis in (32a).

(33) Bill died before he saw his grandchildren.

(34) $\exists t_1 [t_1 < \text{now} \ \& \ \text{Bill dies at } t_1 \ \& \ \underline{\forall t_2 [\text{Bill sees his grandchildren at } t_2 \rightarrow t_1 < t_2]}]$

(34) is satisfied because the underlined universal statement receives a non-presuppositional interpretation. Since there will be no event of Bill's seeing his grandchildren after his death, the condition given in the underlined condition in (34) is vacuously satisfied if Bill died at some past

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[34] (32) represents one possible analysis of *before* and *after* which Anscombe (1964: 10-11) presents and then denies.

[35] In fact, (33) is an instance in which the truth of the entire sentence entails the falsity of the *before* clause. There are so-called "non-committal" examples in which the *before* clause could be true or false depending on the situation (Heinämäki, 1974).

time. This corresponds to the non-veridical reading of the *before* clause in (33). It is important to note that exactly the same non-veridical reading is obtained in Japanese, though the *mae* 'before' clause in this example is in the future tense, which is not marked overtly. (35) is grammatical and meaningful.

(35) Naoki-wa [hatu-mago-no kao-o miru mae-ni] nakunat-ta.
Naoki-TOP first-grandchild-GEN face-ACC see.FUT before-at die-PAST
'Naoki died before he saw his first grandchild.'
[Literal translation: 'Naoki died before he would see his first grandchild's face.'][36]

By contrast, *ato* 'after' clauses do not produce non-veridical interpretations. For example, (36) can only mean that Naoki died and then saw his grandchildren; the *ato* 'after' clause is necessarily veridical. This can only receive a pragmatically impossible reading. [37]

(36) # Naoki-wa nakunat-ta ato-ni hatu-mago-no kao-o mi-ta.
Naoki-TOP die-PAST after-at first-grandchild-GEN face-ACC see-PAST
'Naoki saw his first grandchild after he died.'

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[36] The word selection in this example slightly deviates from the English "original" but makes the sentence more natural. Regardless, the point made is exactly the same as the corresponding English sentence.

[37] A different way of capturing the generalization offered by Anscombe's analysis of 'before' is to say that there is no subordinate clause event that precedes or overlaps the matrix clause event. Excluding the simultaneous event possibility, this amounts to the claim that *before S* is a negative counterpart of *after S*. This perspective is presented in Ogihara (1995) and Krifka (2010).

In Section 6, we will propose a compositional account of the Japanese tense morphemes within Anscombe's (1964) analysis of 'before' and 'after'.

6. A Compositional Analysis of *mae* and *ato* within Anscombe's proposal for *before*

This section will show that the relative tense analysis of Japanese temporal adverbial clauses under discussion is also feasible under Anscombe's extensional analysis of *before*. For the purpose of this article, we simply assume that Anscombe's extensional account supplemented by a pragmatic principle may be a viable alternative to B&C's account. The reader is referred to Heinämäki (1974), Landman (1991), Ogihara (1995), Beaver and Condoravdi (2003), Condoravdi (2010), and Krifka (2010) for relevant discussion. A more thorough comparison of the two proposals requires a separate article.

Let us analyze the sentence (21a) (repeated here as (37)).

(37) Naoki-ga kuru mae -ni Hanako-ga kaet-ta.
Naoki-NOM arrive.FUT before -at Hanako-NOM leave-PAST
'Hanako left before Naoki arrived.'

(38) shows the lexical semantics of *mae-ni* 'before-at' based on Anscombe's proposal, and the denotation of the entire sentence prior to the application of the truth definition to it. Note that in the lexical meaning of *mae-ni* 'before-at', there is an existential quantifier within the scope of the universal quantifier binding t_7 in $\forall t_8[\exists t_7[f(t_8)(t_7) = 1] \rightarrow [t_6 < t_8 \,\&\, f(t_8)(t_6) = 1]]$. This existential quantifier is needed to "pull out" just the event times of the 'before'-clause situation since the 'before' clause itself denotes a relation of type $\langle i,it\rangle$. The condition regarding the relative order between the matrix event and the 'before'-clause event is specified twice in the "consequent" of the universal formula. The first condition $t_6 < t_8$ comes from the inherent meaning of 'before', and the second condition tests the temporal order imposed by the tense morpheme in the 'before' clause. If the 'before'-clause is in the future tense, we can obtain a coherent interpretation given

in (38) for ‘Hanako left before Naoki arrive.FUT’.

(38) **Lexicon**

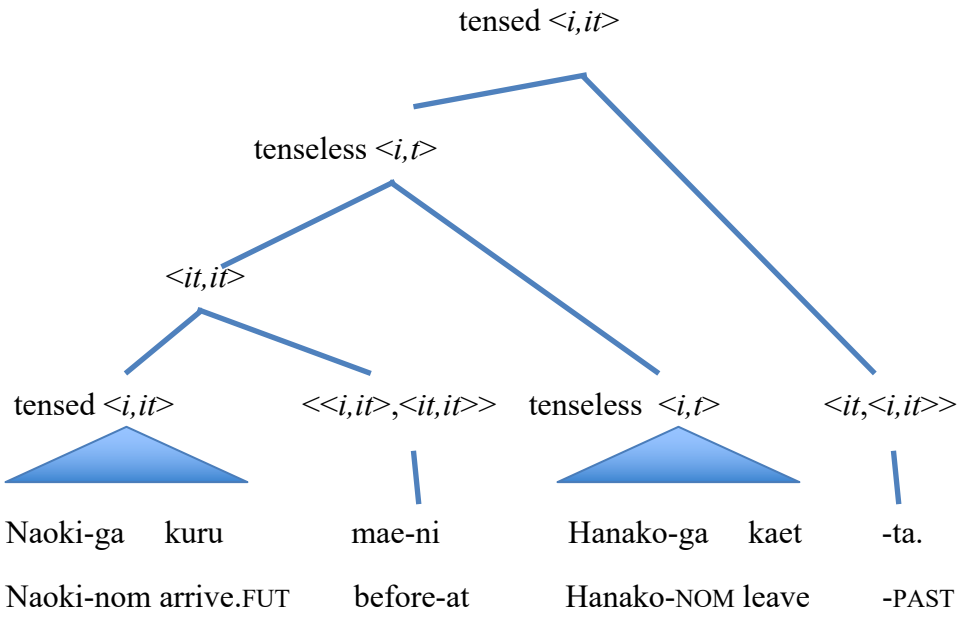
[[mae-ni ‘before-at’]] = $\lambda f_{<i,it>} . \lambda g_{<i,t>}. \lambda t_6[g(t_6) = 1 \ \& \ \forall t_8[\exists t_7[f(t_8)(t_7) = 1] \rightarrow [t_6 < t_8 \ \& \ f(t_8)(t_6) = 1]]]$

Compositional Semantic Calculations

[[Naoki-ga kuru mae-ni Hanako-ga kaet-ta ‘Hanako left before Naoki arrive.FUT’]] = $\lambda t_6 . \lambda t_5$ [[Hanako leaves at t_6 & $t_6 < t_5$] & $\forall t_8$ [Naoki arrives at t_8 $\rightarrow$ [$\underline{t_6 < t_8}$ & [Naoki arrives at t_8 & $\underline{t_6 < t_8}$]]]]

The compositional structure we use here is shown in (39) and is the same as (21) except that the semantics we adopt is extensional.

(39)



To indicate the essential point of Anscombe’s proposal and to clarify the semantic contribution of the future tense variant of the tenseless form any predicate in Japanese, the interpretation of the clausal complement of ‘before,’ represented by the function variable *f*, must occur twice in

the lexical meaning of *mae* 'before' in (38). The *f* that occurs in the "antecedent" is used to obtain the times at which the event or state obtains. Thus, the "evaluation time" — the second argument of *f* — is existentially quantified with no restriction and does not have a substantive semantic role.[38] The *f* that occurs in the "consequent" is used to express the "relative tense" property of Japanese tense morphemes; it requires a specific temporal order between the matrix tense situation and the *mae* 'before' clause situation. Thus, we end up with a formula with the same temporal relation specified twice if we choose the right tense morpheme. For example, the final result in (38) contains two occurrences of the condition "$t_6 < t_8$." The final line in (38) is reduced to (40) after the redundancy is removed and the truth definition is applied.[39]

(40) $\exists t$[Hanako leaves at t & $t < c_T$ & $\forall t_8$[Naoki arrives at $t_8 \rightarrow t < t_8$]])

If we replace the "future tense" in the 'before' clause in (37) with the past tense morpheme *-ta* as in (41) in the *before* clause to interpret the same sentence (36), we arrive at a contradiction as shown in (42).

(41) *Bill-ga ki-ta mae-ni Mary-ga kaet-ta.
Bill-NOM arrive-past before-at Mary-NOM leave-PAST
[Intended] 'Mary left before Bill arrived.'

(42) ⟦Bill-ga ki-ta mae-ni Mary-ga kaet-ta 'Mary left before Bill arrived'⟧ =
$\lambda t_6 . \lambda t_5$ [[Mary leaves at t_6 & $t_6 < t_5$] & $\forall t_8$ [Bill arrives at $t_8 \rightarrow$ [$\underline{t_6 < t_8}$ & $\underline{t_8 < t_6}$]]

[38] Since *f* corresponds to a temporal abstract given the 'before' clause, its "propositional content" occurs twice as well. The first one is crucial for identifying the 'before' clause event times. The second one is redundant but innocuous. This is similar to the case of B&C's account.

[39] For a detailed compositional calculation of the truth conditions, the reader is referred to the Appendix.

In (41) the past tense and 'before' impose mutually contradictory requirements, which are underlined in (42): $t_6 < t_8$ and $t_8 < t_6$. We contend that this is the reason that past tense sentences cannot occur as Japanese 'before' clauses. Conversely, using "future" tense (i.e., the non-past tense form of any predicate that has a future meaning) in 'before' clauses allows us to provide the right semantics as we saw in (38).[40]

Regarding Japanese 'after' clauses, we can also appeal to the same "semantic harmony" idea. The case of 'after' is simpler than the case of 'before' because 'after' clauses do not involve non-veridical instances. We will skip this discussion to save space. (43) provides the lexical semantics of *ato* 'after' within Anscombe's proposal.

(43) $[\![$ato-ni 'after-at'$]\!] = \lambda f_{<i,it>} . \lambda g_{<i,t>} . \lambda t_6 \, [g(t_6) = 1 \ \& \ \exists t_7[f(t_7)(t_6) = 1 \ \& \ t_7 < t_6 \,]]$

$[\![$Bill-ga ki-ta 'Bill arrived' (tensed)$]\!] = \lambda t_3 . \lambda t_4$ [Bill arrives at t_3 & $t_3 < t_4$]

$[\![$Mary-ga kaeru 'Mary leave' (tenseless)$]\!] = \lambda t_1 .$ [Mary leaves at t_1]

What is given in (43) makes sure that the sentence in (44) receives the right interpretation. The final interpretation of (44) is given in (45).

(44) Bill-ga ki-ta ato-ni Mary-ga kaeru.
Bill-NOM arrive-PAST after-at Mary-NOM leave.FUT
'Mary will leave after Bill arrives.'

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[40] One quirky issue here is that when (41) receives a non-veridical reading in that Mary left but Bill never arrived (though expected), then the contradictory condition in (42) is not a problem since there was no time of Bill's arriving in the first place. In other words, (42) renders (41) true after the truth definition is applied. We contend that this option should not be adopted since this choice of tense is not a good one for veridical cases, and choosing the future tense always gives us the right empirical result.

(45) $\exists t_5$ [[Mary leaves at t_5 & $c_T < t_5$] & $\exists t_7$[Bill arrives at t_7 & $\underline{t_7 < t_5}$ & $\underline{t_7 < t_5}$]]

The redundancy of the temporal relation specification $\underline{t_7 < t_5}$ (underlined) is left intact to show the effect of having two morphemes indicating the same meaning, i.e., the connective *ato* 'after' and the past tense *-ta* in the 'after' clause. For purely semantic purposes, one of them can be safely dropped. If we choose the wrong tense form in the 'before' clause, it never satisfies the specified truth conditions and is rendered anomalous.

In this section, we have shown how our proposal can be incorporated into Anscombe's analysis of *before* and *after*. Combined with the results obtained in Section 4, we can now conclude that our idea of encoding the semantics of Japanese tense morphemes in terms of higher order functions can be embedded in the two major analyses of 'before' and 'after.' In Section 7, we turn to *toki* 'when/time' clauses in Japanese.

7. *Toki* 'when/time' clauses

So far, we concentrated on the semantics of 'before' and 'after' clauses and proposed a compositional analysis for them that can be embedded in B&C's proposal or Anscombe's. By contrast, tense morphemes in *toki* 'when/time' clauses do not always behave like relative tense (Arregui and Kusumoto, 1998; Kusumoto, 1999; Kaufmann and Miyachi, 2011), and this fact deserves serious attention in view of our claim that Japanese tense morphemes are instances of relative tense. We shall adopt Kusumoto's idea that (nominal) relative clauses allow the utterance time to be the "evaluation time," and *toki* 'when/time' clauses can also be evaluated in relation to the utterance time when they are relative clauses in that they involve syntactic movements creating variable binding configurations.[41], [42]

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[41] For a more detailed recent study of *toki*-clauses and its critique, the reader is referred to Oshima (2011) and Kaufmann (2020).

[42] It is important to distinguish between nominal relative clauses that target nominal expressions

In Japanese, tense morphemes in (nominal) relative clauses can receive "relative" interpretations as in (46a): at the past time of Naoki's meeting the person, this person lived in the same city as he did. However, the same interpretation can be obtained when the relative clause is in the past tense as in (46b). This means that tense morphemes in relative clauses *can* be interpreted in relation to the utterance time (see Ogihara, 1996; Arregui and Kusumoto, 1998; and many others) as well as in relation to higher predication times.[43]

(46) a. Naoki-wa [onazi mati-ni sun -de i-ru hito] -ni at-ta.
Naoki-TOP same city-DAT live-TEIRU.PRES person]-DAT meet-PAST

b. Naoki-wa [onazi mati-ni sun -de i -ta hito] -ni at-ta.
Naoki-TOP same city-DAT live-TEIRU-PAST person]-DAT meet-PAST
'Naoki met a person who lived in the same town.' (both (46a) and (46b))

In the past, this phenomenon received at least two different analyses. One is due to Ogihara (1996), in which the relativized NP is subject to scoping at LF, which produces a higher position of the NP for interpretive purposes. This structure is then responsible for "absolute" interpretations. Arregui and Kusumoto (1998) and Kusumoto (1999) argue against the LF movement analysis and offer an alternative proposal in which a distinguished variable *t** is posited, which denotes the utterance time when it is free.[44] A relative clause is then interpreted in relation to the utterance time because this variable *t** serves as the "evaluation time" for the

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as *who Mary met* and putative "temporal relative clauses" that target temporal expressions such as *when Mary met Sue*.

[43] The relative clause in (46a) could also receive an "independent interpretation" in which the time of the person's living in the same city is the utterance time. But this reading normally requires some additional temporal adverbials and is not the most natural reading.

[44] It may be bound in an intensional context in Kusumoto's (1999:124) system.

relative clause tense. The basic intuition is that in Japanese the content of a relative clause can be evaluated from the viewpoint of the utterance context. Our system to be presented in Section 8 is slightly different in technical details, but we could replicate Kusumoto's system by letting the denotation of *-ta* 'PAST' apply to the utterance time in relative clauses.

Let us now discuss the behavior of tense morphemes in *toki* 'when/time' clauses. Consider the examples in (47).

(47) a. Osaka-ni iru toki ni kekkonsi -ta. [*toki* clause: relative tense]
Osaka-at be.PRES time at get.married-PAST
'(I) got married when I was in Osaka.'
[Lit.] 'When (I) am in Osaka, (I) got married.'

b. Osaka-ni i-ta toki-ni kekkonsi -ta. [*toki* clause: absolute tense]
Osaka-at be-PAST time at get.married-PAST
'(I) got married when I was in Osaka'

c. Ie-o tateru toki torakku-o kat-ta. [*toki* clause: relative tense]
house-ACC build.PRES time truck-ACC buy-PAST
'When (I) built the house, (I) bought a truck.'
[Lit.] 'I bought a truck when I build the house.'

d. Ie-o tate-ta toki torakku-o kat-ta. [*toki* clause: relative/absolute]
house-ACC build-PAST time truck-ACC buy-PAST
'When (I) built the house, (I) bought a truck.'

(47a) and (47b) contain a stative predicate in each *-toki* clause and are synonymous with each other; they both mean that the speaker got married within the time frame set by his/her/their being in Osaka. The past tense morpheme in the *-toki* 'when/time' clause in (47b) behaves like an instance of absolute tense, whereas the present tense in (47a) is understood to be an instance of relative tense. The *toki* clause in (47b) must be interpreted in relation to the utterance time

since there is no sense in which the *toki* clause situation is prior to the time of getting married. (47c, d) contain event predicates (*ie-o tateru* 'build a house') in *toki* phrases, which can receive relative tense interpretations. That is, (47c) is understood to mean that when the speaker built a house, they bought a truck beforehand, and (47d) can mean that the house building preceded the truck buying. However, (47d) arguably can also receive an absolute tense-like interpretation. That is, it can mean that the purchasing of a truck took place during the house building (or even before the house building *per se* as long as the purchasing was for the house building), rather than after the house building was complete.

To account for the above data, Kusumoto (1999) argues that *toki* clauses can be relative clauses, and this allows the tense in the *toki* clause to be evaluated in relation to the utterance time. The evidence for this view comes from the availability of Geis ambiguity (Geis, 1970; Larson, 1990) in *toki* clause examples and its absence in *mae* 'before' or *ato* 'after' clause examples. This is shown in the examples in (48) (Kusumoto 1999: 276).[45]

(48) Watasi-wa [Junko-ga [Satoshi-ga tuku to] it-ta] toki-ni
I-TOP Junko-NOM Satoshi-NOM arrive-PRES that say-PAST time at
eki-de kare-o mat-tei -ta.
station-at he-ACC wait-TEIRU-PAST
'I was waiting for Satoshi at the station when Junko said that he would arrive'. (Two interpretations are possible.)

By contrast, *mae* 'before' and *ato* 'after' clauses do not exhibit the same Geis ambiguity. An example with *mae* 'before' is given in (49). This sentence only has the "higher" interpretation: it talks about the time of Junko's utterance and not the time at which Satoshi was claimed to arrive.

[45] See also Kusumoto (2017).

(49) Watasi-wa [Junko-ga [Satoshi-ga kuru to] iu] mae-ni kare-ni
I-TOP Junko-NOM Satoshi-NOM arrive.FUT that say.PRES before-at he-to
denwasi-ta.
telephone-PAST
'I called Satoshi before the time of Junko's utterance to the effect that he (i.e., Satoshi) would arrive.' (Only one interpretation is available.)

Kusumoto's argument is that since *toki* 'when/time' clauses can be relative clauses, they have the ability to be interpreted in relation to the utterance time.

Kaufmann and Miyachi (2011) adopt a slightly different technique but their conclusion is very similar to that of Kusumoto (1999) since they claim that the source of the ambiguity in *toki* 'when/time' clauses is the lexical semantics of *toki*; they posit two interpretations for *toki*, $toki_{rel}$ (relative *toki*) and $toki_{abs}$ (absolute *toki*), and their differences are responsible for the ambiguity of the entire clause. By contrast, *mae* 'before' and *ato* 'after' are unambiguous and yield only one interpretation. Therefore, we conclude that Kaufmann and Miyachi (2011) are essentially in agreement with Kusumoto regarding the semantics of *toki* 'when/time'. We agree with Kusumoto that the fact that *toki* 'when/time' clauses can be relative clauses, but *mae* 'before' and *ato* 'after' clauses cannot be, is responsible for the difference in the temporal interpretation in question.[46] Having said that, we will not discuss *toki* 'when/time' clauses in any formal detail. A sample derivation involving a *toki* 'when/time' clause in which a tense behaves like absolute tense is given in the Appendix. Detailed examination of *toki* should require a separate article.

To summarize the discussion in this section, the explanation of why *toki* clauses (or the

[46] See Endo (2012) and Oda (2015) for more detailed discussion of the syntactic and semantic differences among 'before', 'after', and 'when' clauses in Japanese. The generalization that Kusumoto reached is valid as long as we restrict our attention to those that are headed by the postposition *-ni* 'at'.

tense morphemes that occur in them) can be interpreted in relation to the utterance time is that they can be relative clauses, and relative clause tense morphemes are known to have the ability to be interpreted independently (i.e., in relation to the utterance time). This is Kusumoto's (1999) argument, and we think this is the right explanation. Informally speaking, this means that the speaker's perspective could be represented in relative clauses. Stated semi-formally, the utterance time could be supplied as the "evaluation time" for the relative clause tense, which causes the relative tense to behave like an absolute tense. This still allows Japanese tense morphemes to have constant higher order denotations representing relative tense. Note also that the indexical behavior of tense morphemes in *toki* clauses is optional as in regular (i.e., nominal) relative clause tense morphemes. We believe that this is sufficient to show that the semantics of Japanese tense morphemes is uniform, and the apparent peculiarity of *toki* 'when/time' clauses can be explained through the syntactic difference between *mae*/*ato* 'before'/'after' clauses and *toki* 'when/time' clauses.

8. Nominal Relative Clauses

So far, we have discussed the behavior of Japanese tensed clauses in temporal adverbial clauses. We motivated an analysis of the Japanese tensed clauses in which they denote temporal relations of type $\langle i,it\rangle$ with no built-in existential quantificational force. Tense morphemes themselves denote higher order entities of type $\langle it,\langle i,it\rangle\rangle$. In this section, we shall see that this analysis of Japanese tense provides an empirically accurate account of the behavior of tense morphemes in (nominal) relative clauses. What is particularly important is the possibility that Japanese relative clauses are interpreted in relation to the matrix predication time. This is crucial since the analysis of Japanese presented in Ogihara and Sharvit (2012) accounts for this fact by assuming that Japanese past can be a quantificational tense. Their claim is that the matrix tense is a generalized quantifier with an existential quantifier meaning and QRs to a position from which it binds the time variable associated with the tense in the relative clause. This was shown earlier in (9). The lexical meaning of the quantificational *-ta* 'past' in this system is given as in (50), ignoring

presuppositions. This makes *-ta* completely parallel to *someone* or *something* in the nominal domain.

(50) $\lambda f_{<i,t>} \,.\, \exists t[t < c_T \,\&\, f(t) = 1]$

Ogihara and Sharvit (2012) propose that Japanese has both pronominal tense (an instance of which is in the relative clause) and quantificational tense (an instance of which is in the matrix clause and is QR-ed).

The proposal defended in this article assumes that Japanese tense morphemes always denote complex functions of type <*it*,<*i,it*>> with no inherent quantificational force. When they occur in the matrix clause, they scope over tense morphemes in relative clauses, if any.

In this section, we shall show that the "relative tense" interpretation of relative clauses (interpretations in which relative clause tense morphemes are interpreted in relation to the matrix predication time) is a natural consequence of a compositional account. We shall make the quantifier raising of the relativized DP syntactically overt. However, regarding the matrix tense morpheme, we simply generate it at the top S level and is interpreted in situ. We adopt this route to avoid further technical complication. We will consider the example sentence in (51).

(51) Hanako-ga [nai-te iru kodomo]-o mi-ta.
Hanako-NOM cry-PROG.PRES child-ACC see-past
'Hanako saw a child who was crying (at that time).'

This is a sentence in the past tense that contains a relative clause in the present tense. As shown in the English gloss, the relative clause can receive a simultaneous reading in that the time of the child's crying is simultaneous with the time of Hanako's seeing, which is located in the past. The basic ingredients needed for a compositional semantic calculation are given in (52).

(52) **Lexicon**

$[\![$kodomo 'child'$]\!] = \lambda x.\ \lambda t_1\ [x$ is a child at $t_1]$

$[\![$miru 'see'$]\!] = \lambda y.\ \lambda x.\ \lambda t_1\ [x$ sees y at $t_1]$

$[\![$naku 'cry'$]\!] = \lambda x.\ \lambda t_1\ [x$ cries at $t_1]$

$[\![$-ta 'PAST'$]\!] = \lambda f_{<i,t>}\ .\ \lambda t_1\ .\ \lambda t_2\ [t_1 < t_2\ \&\ f(t_1) = 1]$

$[\![$-∅ 'PRES'$]\!] = \lambda f_{<i,t>}\ .\ \lambda t_1\ .\ \lambda t_2\ [t_1 = t_2\ \&\ f(t_1) = 1]$

$[\![\exists_{\text{temporal}}]\!] = [\lambda f_{<i,it>}\ .\ \lambda t_5.\ \exists t[f(t)(t_5) = 1]]$

$[\![(\text{'some'})]\!] = \lambda f_{<e,it>}\ .\ \lambda g_{<e,it>}\ .\ \lambda t\ .\ \exists v[f(v)(t) = g(v)(t) = 1]$[47]

Syntactic operations

QR and its semantic calculation[48]

[… DP ….] ➔ DP 1,e [… $e_{1,e}$ …]

$[\![[\text{DP } [1\ \ [\ \ldots\ e_1\ \ldots]]]]\!]^g = [\![\text{DP}]\!]^g\ (\lambda x\ .\ \ [\![[\ \ldots\ e_1\ \ldots]]]\!]^{g[1 \to x]})$

Given the above apparatus, the semantic calculation will be performed on the basis of the LF structure in (53). The entire sentence is still of a relational type (i.e., <*i*,*it*>), but this is reduced to a sentence type *t* via the truth definition.

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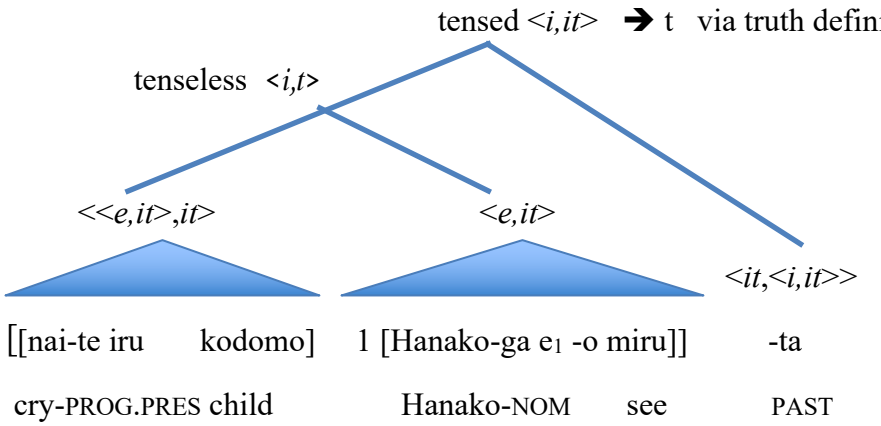
[47] For simplicity and convenience, a phantom determiner 'some' is introduced for an indefinite interpretation of a relativized nominal such as *nai-te iru kodomo* '(a/some) child that is crying' in (51).

[48] See, for example, Heim and Kratzer (1998) for the required syntax-semantics interface conditions.

(53)



Given the structure in (53), we obtain the truth conditions given in (54) compositionally. The details of the compositional calculations are found in the Appendix.

(54) $\exists t_2$ [$t_2 < c_T$ & $\exists v$[v is crying at t_2 & v is a child at t_7 & Hanako sees v at t_2]]

(54) shows that Hanako's seeing the child and the child's crying are contemporaneous. This is the default interpretation of (51), and it is predicted by our account correctly. This outcome supports the view that a relational account of Japanese tense morphemes (with no overt existential quantificational force) can deal with the simultaneous reading of relative clauses as a natural consequence. The desired result was obtained within our "relative tense" analysis of Japanese tense morphemes. [49]

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[49] There are many possible technical executions for the "relative tense" characteristics associated with Japanese tense morphemes. A reviewer suggests that a pronominal approach can accomplish all we want. We agree that there are many other routes to obtain the desired empirical results. However, we preserve the typological distinction proposed by Ogihara and Sharvit (2012) and Sharvit (2014), which is that the simultaneous reading of present tense relative clauses in Japanese in the present tense is guaranteed by the QR of the matrix tense, and this is not possible in English. This idea is preserved in our proposal of positing a higher order

There is one important additional point to make about relative clauses. We mentioned in Section 7 that relative clauses can be interpreted in relation to the utterance time. This means that the relative clause in (51) could also be interpreted "independently." This option is usually not salient but is enabled by some appropriate adverbials such as *ima* 'now.' We follow Kusumoto's proposal of adopting the designated variable *t** but slightly alter its semantic execution in order to derive the right result. The central idea remains the same: relative clauses allow the utterance time to be adopted as the time of reference. For example, (55a) is rendered as in (55b) thanks to the idea of the special variable *t**. (55a) is like (51) except that some appropriate adverbials have been added to obtain an "independent reading" of the relative clause tense.

(55) a. Hanako-ga [asoko-de ima nai-te iru kodomo]-o
Hanako-NOM over.there-at now cry-PROG.PRES child-ACC
kinoo eki-de mi-ta.
yesterday station-at see-PAST
'Yesterday at the station, Hanako saw the child who is now crying over there.'

b. $\exists t_2[t_2 < c_T \,\&\, \exists v[v \text{ is crying at } c_T \,\&\, v \text{ is a child at } c_T \,\&\, \text{Hanako sees } v \text{ at } t_2]]$

See the Appendix for the details of compositional calculations.

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tense morphemes in Japanese, rather than pronominal ones. Note that the matrix tense does not behave like a quantifier-raised DP that binds a pronoun that it c-commands since no pronominal tense is posited for Japanese in our system. If so desired, we could posit both pronominal and higher order tense morphemes for Japanese and obtain a simultaneous interpretation for a present tense in a relative clause through a pronominal tense in the relative clause; our main theoretical point would remain the same.

9. Conclusion

In this article, we have shown that characterizing Japanese as a relative tense language does not necessarily lead to the conclusion that its tense morphemes are existentially quantifying. Specifically, we have demonstrated that the semantic properties of Japanese tensed sentences can be faithfully represented as temporal relations that do not include existential quantification. We have further demonstrated that the relational analysis of Japanese tensed temporal adverbial clauses ('before' and 'after' clauses) provides the correct empirical consequences regardless of whether we adopt Anscombe's (1964) analysis or B&C's (2003). The semantics of Japanese tense morphemes that is of higher order but does not involve an existential quantifier is satisfactory in other constructions as well. Tense in Japanese (nominal) relative clauses can be interpreted in relation to the matrix predication time, and this is accounted for straightforwardly in our proposal. The "simultaneous interpretation" of *toki* 'when' clauses is explained in a similar fashion. We also discussed "independent" interpretations of tense in nominal relative clauses and *toki* 'when/time' clauses. Our conclusion is that these facts are related to each other: *toki* clauses can be analyzed as relative clauses in that the time expression can undergo movement just as in nominal relative clauses, and (nominal and temporal) relative clauses are interpretable in relation to the utterance time thanks to the designated variable t^* (Kusumoto, 1999; 2017). This allows Japanese tense morphemes to be unambiguously "relative." From the viewpoint of linguistic theory, this article shows that it is important to sever existential quantification from shiftable (i.e., relative) tense morphemes: relative tense morphemes can be non-existentially quantifying at least at the lexical level.

Acknowledgement

I am indebted to Yael Sharvit for our coauthored work (2012) and her single authored article (2014). Her research on tense has inspired me to work on this article. Earlier versions of this article were presented in various forms and venues: Northwest Linguistics Conference (April 2016), Semantic Workshop in Tokai (August 2016), Theoretical East Asian Linguistics 11 (June

2017), Tokyo University Colloquium (June 2017), and NINJAL colloquium (June 2017). The audiences of these meetings greatly contributed to the content of this work. Thanks are due to Amie DeJong, Edith Aldridge, Barbara Citko, Kyoko Sano, Bryan Thompson, Ajda Gokcen, Raymond Gagne, Koji Kawahara, David Oshima, Osamu Sawada, Jowang Lin, Satoshi Tomioka, Ken Hiraiwa, Hironobu Hosoi, Tsuneko Nakazawa, Kei Yoshimoto, and Yukinori Takubo. I also thank the anonymous reviewers for Journal of Semantics and the editor, Cleo Condoravdi, for their comments, suggestions, and encouragement. All remaining errors are of course mine.

Appendix

The main text only contains the bare essence of compositional calculations for readability. More details are found here for those who are interested in examining the details. First, the detailed calculations for (23) are given here as (1). This is a grammatical and acceptable example involving *mae* 'before', and it is analyzed within B&C's system. We assume that each sentence is evaluated with respect to a world w_0 (generally the world of the context), g_c (an assignment function furnished by the context c), and the context c.

An example containing 'before' that is well-formed and meaningful and analyzed within B&C's account of 'before'

(1)

1. $[\![$Naoki-ga kuru 'Naoki arrives (FUT)'$]\!]^{w_0,g_c,c} = \lambda t$. $\lambda t'$. Naoki arrives at t & $t' < t$
2. $[\![$Hanako-ga kaeru 'Hanako leave' (sentence skeleton)$]\!]^{w_0,g_c,c} = \lambda t$. Hanako leaves at t
3. '**Before' clause**: $[\![$Naoki-ga kuru mae 'Naoki arrives (FUT)'$]\!]^{w_0,g_c,c} =$ $[\lambda f_{<s,<i,it>>}$. $\lambda g_{<i,t>}$. λt_2 . $[g(t_2) = 1$ & $t_2 < T$ & $\exists w_2[f(w_2)(T)(t_2) = 1]]$, where T = the earliest t_1 . $\exists t_4$. $\exists w_1 \in alt(w, t_2)$ $[f(w_1)(t_1)(t_4)]]$ (λw . λt . $\lambda t'$. Naoki arrives at t in w & $t' < t$)
   [We need the intensional meaning of the tensed clause that combines with *mae* 'before.']
4. $\lambda g_{<i,t>}$. λt_2 . $[g(t_2) = 1$ & $t_2 < T$ & $\exists w_2$[Naoki arrives at T in w_2 & $t_2 < T$], where T =

the earliest t_1 . $\exists t_4$. $\exists w_1 \in alt(w, t_2)$ [Naoki arrives at t_1 in w_1 & $t_4 < t_1$]]

[The condition "$t_2 < t_1$" appears twice because the same condition is imposed by 'before' and the future tense in the 'before' clause. Note also that the condition "Naoki arrives at t_1" occurs twice. This is a technical consequence of our analysis, but has no adverse effect. *T* is defined as a time at which Naoki arrives. So "saying that again" makes no semantic difference. Note these redundancies are important to ensure that correct tense forms are used in 'before' clauses. Having said this, we will simplify the above condition for readability.]

5. $\lambda g_{<i,t>}$. λt_2 . [[$g(t_2) = 1$ & $t_2 < T$], where T = the earliest t_1 . $\exists w_1 \in alt(w, t_2)$ [Naoki arrives at t_1 in w_1]]
6. $\lambda g_{<i,t>}$. λt_2 . [$g(t_2) = 1$ & $t_2 <$ [the earliest t_1 . $\exists w_1 \in alt(w, t_2)$ [Naoki arrives at t_1 in w_1]]]
7. **Entire sentence without matrix tense**: [[Naoki-ga kuru mae-ni Hanako-ga kaeru 'Hanako leave (tenseless) before Naoki arrives (FUT)']]$^{w_0, g_c, c}$ = $\lambda g_{<i,t>}$. λt_2 . [$g(t_2) = 1$ & $t_2 <$ [the earliest t_1 . $\exists w_1 \in alt(w, t_2)$ [Naoki arrives at t_1 in w_1]]] (λt . Hanako leaves at t)
8. λt_2 . Hanako leaves at t_2 & $t_2 <$ the earliest time at which Naoki arrives in some accessible world
9. **Entire sentence with matrix tense**: [[Naoki-ga kuru mae-ni Hanako-ga kaet-ta 'Hanako left (PAST) before Naoki arrives (FUT)']]$^{w_0, g_c, c}$ = λt_2 . λt_1 . $t_2 < t_1$ & Hanako leaves at t_2 & $t_2 <$ the earliest time at which Naoki arrives in some accessible world
10. **Truth definition**: $\exists t_2$ [$t_2 < c_T$ & Hanako leaves at t_2 & $t_2 <$ the earliest time at which Naoki arrives in some accessible world]

We then showed what would go wrong if the wrong tense form was chosen for *mae* 'before' clauses. (28) is one such example, and its detailed analysis is shown in (2).

An example containing 'before' that is never true and is anomalous, which is analyzed within B&C's account of 'before'

(2) 1. $[\![$Naoki-ga ki-ta 'Naoki arrived (PAST)'$]\!]^{w_0,g_c,c}$ = λt . $\lambda t'$. Naoki arrives at t & $t < t'$

2. **'Before' clause**: $[\![$Naoki-ga ki-ta mae 'before Naoki arrived (PAST)'$]\!]^{w_0,g_c,c}$ = [$\lambda f_{<s,<i,it>>}$. $\lambda g_{<i,t>}$. λt_2 . [$g(t_2) = 1$ & $t_2 < T$ & $\exists w_2[f(w_2)(T)(t_2) = 1]$]], where T = the earliest t_1 . $\exists t_4$. $\exists w_1 \in alt(w, t_2)$ [$f(w_1)(t_1)(t_4)$]] (λw . λt . $\lambda t'$. Naoki arrives at t in w & $t < t'$)

   [We need the intensional meaning of the clause that combines with *mae* 'before.']

4. [$\lambda g_{<i,t>}$. λt_2 . [$g(t_2) = 1$ & $t_2 < T$ & $\exists w_2$[Naoki arrives at T in w_2 & $T < t_2$]], where T = the earliest t_1 . $\exists t_4$. $\exists w_1 \in alt(w, t_2)$ [Naoki arrives at t_1 in w_1 & $t_1 < t_4$]]

   [We can now simplify the description of the denotation by removing redundancies.]

5. [$\lambda g_{<i,t>}$. λt_2 . [$g(t_2) = 1$ & $\underline{t_2 < T}$ & $\underline{T < t_2}$]], where T = the earliest t_1 . $\exists w_1 \in alt(w, t_2)$ [Naoki arrives at t_1 in w_1]]

The two underlined conditions are mutually contradictory; T must be after t_2 and before t_2 at the same time, which is impossible. This demonstrates the importance of choosing the right tense form for *mae* 'before' clauses. The same goes for *ato* 'after' clauses.

In the main text, we then turned to Anscombe's system, and showed that our relational analysis of Japanese tensed clauses produces the right result here as well. The compositional calculations for (37) are shown in (3).

An example containing 'before' that is well-formed and meaningful and is analyzed within Anscombe's account of 'before'

(3) 1. $[\![$Naoki-ga kuru 'Naoki arrive.FUT'$]\!]^{w_0,g_c,c}$ = λt_3 . λt_4 [Naoki arrives at t_3 & $t_4 < t_3$]

2. $[\![$Hanako-ga kaeru 'Hanako left' (tenseless)$]\!]^{w_0,g_c,c}$ = λt_1 [Hanako leaves at t_1]

3. **Entire sentence without matrix tense**: $[\![$Naoki-ga kuru mae-ni Hanako-ga kaeru 'Hanako leave before Naoki arrive.FUT)'$]\!]^{w_0,g_c,c}$ =

$= \lambda f_{<i,it>} . \lambda g_{<i,t>}. \lambda t_6 . [g(t_6) = 1 \ \& \ \forall t_8 [\exists t_7[f(t_8)(t_7) = 1] \rightarrow [t_6 < t_8 \ \& \ f(t_8)(t_6) = 1]]]$

$(\lambda t_3 . \lambda t_4$ [Naoki arrives at t_3 & $t_4 < t_3$])$(\lambda t_1$ [Hanako leaves at t_1])

4. λt_6 [[Hanako leaves at t_6] & $\forall t_8$ [$\exists t_7$[Naoki arrives at t_8 & $t_7 < t_8$] $\rightarrow$ [$t_6 < t_8$ & [Naoki arrives at t_8 & $t_6 < t_8$]]]]

   [Since the existence of t_7 is guaranteed by the infinity of time on both ends, we can simply the denotation of this sentence, and the past tense meaning is added to the matrix clause.]

5. **Entire sentence (before truth definition)**: $\lambda t_6 . \lambda t_5$ [[Hanako leaves at t_6 & $t_6 < t_5$] & $\forall t_8$ [Naoki arrives at t_8 $\rightarrow$ [$\underline{t_6 < t_8}$ & [Naoki arrives at t_8 & $\underline{t_6 < t_8}$]]]]
6. $\lambda t_6 . \lambda t_5$ [[Hanako leaves at t_6 & $t_6 < t_5$] & $\forall t_8$ [Naoki arrives at t_8 $\rightarrow$ $t_6 < t_8$]]
7. **Truth definition**: $\exists t$[Hanako leaves at t & $t < c_T$ & $\forall t_8$[Naoki arrives at $t_8 \rightarrow t < t_8$]])

The final line in (3) makes the right prediction regarding the meaning of (33).

Just like in the case of B&C's system, we demonstrated why tense mismatches result in anomalous sentences by examining (41), which produces a sentence that is never true. Its compositional calculations are shown in (4).

An example containing 'before' that is never true and is analyzed within Anscombe's account of 'before'

(4)

1. $[\![$Naoki-ga ki-ta 'Naoki arrived' (PAST)$]\!]^{w_0,g_c,c} = \lambda t_3 . \lambda t_4$ [Naoki arrives at t_3 & $t_3 < t_4$]
2. **Entire sentence with matrix tense**: $[\![$Naoki-ga ki-ta mae-ni Hanako-ga kaet-ta 'Hanako left before Naoki arrived'$]\!]^{w_0,g_c,c} =$

   $\lambda f_{<i,it>} . \lambda g_{<i,it>}. \lambda t_6 . \lambda t_5 [g(t_6)(t_5) = 1 \ \& \ \forall t_8 [\exists t_7[f(t_8)(t_7) = 1] \rightarrow [t_6 < t_8 \ \& \ f(t_8)(t_6) = 1]]]$

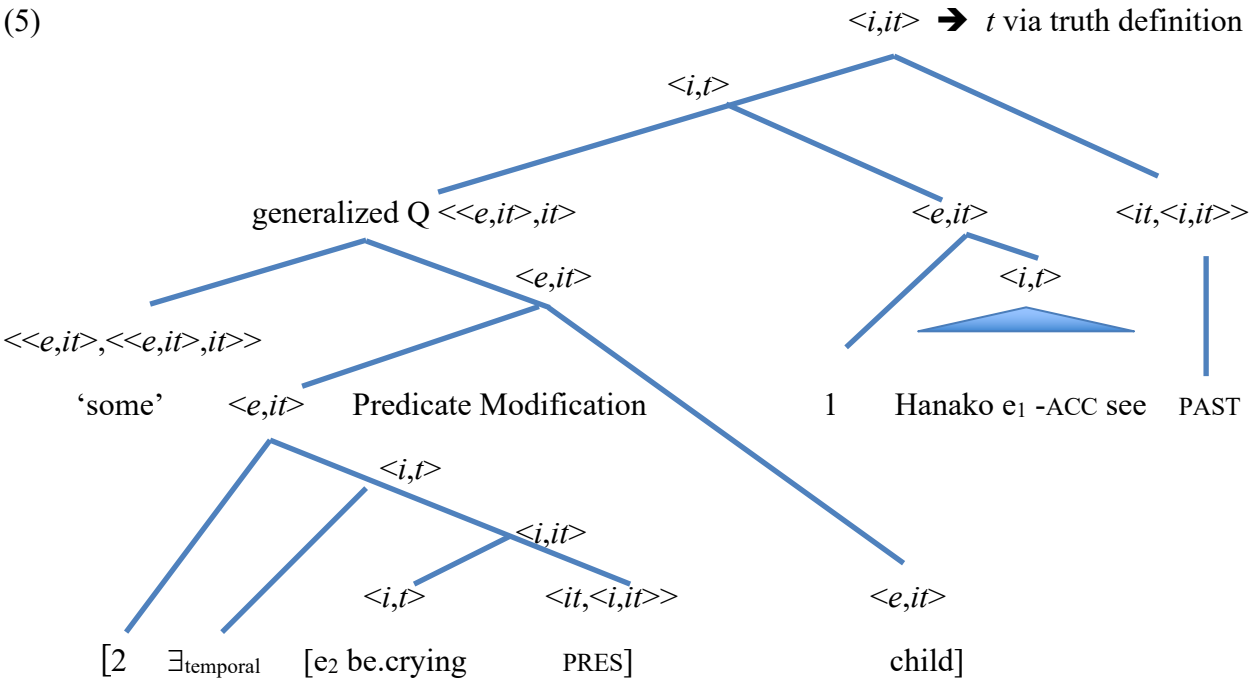
   $(\lambda t_3 . \lambda t_4$ [Naoki arrives at t_3 & $t_3 < t_4$])$(\lambda t_1 . \lambda t_2$ [Hanako leaves at t_1 & $t_1 < t_2$])
3. $\lambda t_6 . \lambda t_5$ [[Hanako leaves at t_6 & $t_6 < t_5$] & $\forall t_8$ [$\exists t_7$[[Naoki arrives at t_8 & $t_8 < t_7$] $\rightarrow$ [$t_6 < t_8$ & [Naoki arrives at t_8 & $t_8 < t_6$]]
4. $\lambda t_6 . \lambda t_5$ [[Hanako leaves at t_6 & $t_6 < t_5$] & $\forall t_8$ [Naoki arrives at t_8 $\rightarrow$ [$\underline{t_6 < t_8}$ & $\underline{t_8 < t_6}$]]

The final line in (4) contains two mutually contradictory requirements, which are underlined. Since they cannot be satisfied simultaneously, a matrix sentence that contains a *mae* 'before' clause in the past tense can never be true. This is the right empirical prediction.

We now turn to some relative clause facts. First, we will show the details of how to account for simultaneous readings of Japanese relative clauses in the "present" tense that is embedded under a past tense matrix predicate. (47) is the example sentence that is analyzed in detail here. Refer to the compositional structure in (5) and the actual calculations in (6).

An example of a relative clause in the present tense that receives a simultaneous reading under past tense in the matrix clause

(5)



(6) 1. **Relative clause**: $[\![\exists_{\text{temporal}}\ [[\text{e}_3\text{-ga nai-te iru}]\ \text{PRES}]]\!]^{w_0,g_c,c}$

2. $[\![\exists_{\text{temporal}}]\!]^{w_0,g_c,c}\ ([\lambda f_{<i,t>}\ .\ \lambda t_1\ .\ \lambda t_2\ [t_2 = t_1\ \&\ f(t_1) = 1]](\ [\![\text{e}_3\text{-ga nai-te iru}]\!]^{w_0,g_c,c}\ ))$

3. $[\![\exists_{\text{temporal}}]\!]^{w_0,g_c,c}\ (\lambda t_1\ .\ \lambda t_2\ [t_2 = t_1\ \&\ [\![\text{e}_3\text{-ga nai-te iru}]\!]^{w_0,g_c,c}\ (t_1) = 1)$

4. $[\lambda f_{<\text{i,it}>}\ .\ \lambda t_5.\ \exists t[f(t)(t_5) = 1]]\ (\lambda t_1\ .\ \lambda t_2\ [t_2 = t_1\ \&\ [\![\text{e}_3\text{-ga nai-te iru}]\!]^{w_0,g_c,c}\ (t_1) = 1)$

5. $\lambda t_5.\ \exists t[t_5 = t\ \&\ [\![\text{e}_3\text{-ga nai-te iru}]\!]^{w_0,g_c,c}\ (t) = 1]$

6. **Relative clause with a binder index**: $[\![3\ [\exists_{\text{temporal}}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\!]^{w_0,g_c,c}$ = $\lambda x\ .\ [\![\exists_{\text{temporal}}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]\!]^{w_0,g_c[3 \rightarrow x],c}$

7. $[\lambda x\ .\ \lambda t_5.\ \exists t[t_5 = t\ \&\ x \text{ is crying at } t]]$

   [The "event time" argument of the relative clause must be somehow saturated. We therefore need a covert existential quantifier here. $\exists_{\text{temporal}}$ is used for that purpose.]

8. **Head noun**: $[\![\text{kodomo 'child'}]\!] = \lambda x.\ \lambda t.\ x$ is a child at t [type $<e,it>$, from the lexicon]

9. **Temporal Predicate Modification**: $[\![[[3\ [\exists_{\text{temporal}}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\ \text{kodomo}]]\!]^{w_0,g_c,c}$ =

   $\lambda x.\ \lambda t.\ [[\![[3\ [\exists_{\text{temporal}}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]]\!](x)(t) = [\![\text{kodomo}]\!](x)(t) = 1] = 1$

10. $\lambda x.\ \lambda t.\ [\exists t_7[t = t_7\ \&\ x \text{ is crying at } t_7]\ \&\ x \text{ is a child at } t]$

11. **Relativized DP (with a covert determiner):** $[\![(\text{'some'})\ [[3,e\ [\exists_{\text{temporal}}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\ \text{kodomo}]]\!]^{w_0,g_c,c}$ = $[\lambda f_{<e,it>}\ .\ \lambda g_{<e,it>}\ .\ \lambda t\ .\ \exists v[f(v)(t) = g(v)(t) = 1]]\ (\lambda x.\ \lambda t.\ [\exists t_7[t = t_7\ \&\ \text{x is crying at } t_7]\ \&\ \text{x is a child at } t])$ [Covert Determiner Instantiation]

12. $\lambda g_{<e,it>}\ .\ \lambda t\ .\ \exists v[\lambda x.\ \lambda t.\ [\exists t_7[t = t_7\ \&\ x \text{ is crying at } t_7]\ \&\ x \text{ is a child at } t](v)(t)\ \&\ g(v)(t) = 1$

13. $\lambda g_{<e,it>}\ .\ \lambda t\ .\ \exists v[[\exists t_7[t = t_7\ \&\ v \text{ is crying at } t_7]\ \&\ v \text{ is a child at } t]\ \&\ g(v)(t) = 1]$

14. **S with a binder index**: $[\![1,e\ [\text{Hanako-ga } e_{1,e}\text{ -o miru}]]\!]^{w_0,g_c,c}$ = $\lambda z\ .\ [\![\text{Hanako-ga } e_{1,e}\text{ -o miru}]]\!]^{w_0,g[1 \rightarrow z],c} = \lambda z\ .\ \lambda t.$ Hanako sees z at t [Temporal PA]

15. **Entire sentence without tense**: $[\![(\text{'some'})\ [[3\ [\exists_{\text{temporal}}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\ \text{kodomo}][1,e\ [\text{Hanako-ga } e_{1,e}\text{ -o miru}]]]\!]^{w_0,g_c,c}$ =

    $\lambda g_{<e,it>}\ .\ \lambda t\ .\ \exists v[[\exists t_7[t = t_7\ \&\ \text{v is crying at } t_7]\ \&\ v \text{ is a child at } t]\ \&\ g(v)(t) = 1]$ $(\lambda z\ .\ \lambda t.$ Hanako sees z at $t)$

16. $\lambda t\ .\ \exists v[[\exists t_7[t = t_7\ \&\ v \text{ is crying at } t_7]\ \&\ x \text{ is a child at } t]\ \&$ Hanako sees v at $t]$

17. **Entire sentence**: $[\![(\text{'some'})\ [[3\ [\exists_{\text{temporal}}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\ \text{kodomo}][1,e\ [\text{Hanako-ga } e_{1,e}\text{ -o miru}]]\ \text{-ta}]\!]^{w_0,g_c,c}$ = $[\lambda f_{<i,t>}\ .\ \lambda t_1\ .\ \lambda t_2\ [t_1 < t_2\ \&\ f(t_2) = 1]](\lambda t\ .\ \exists v[[\exists t_7[t = t_7\ \&\ v \text{ is crying at } t_7]\ \&\ v \text{ is a child at } t]\ \&$ Hanako sees v at $t])$ [Matrix

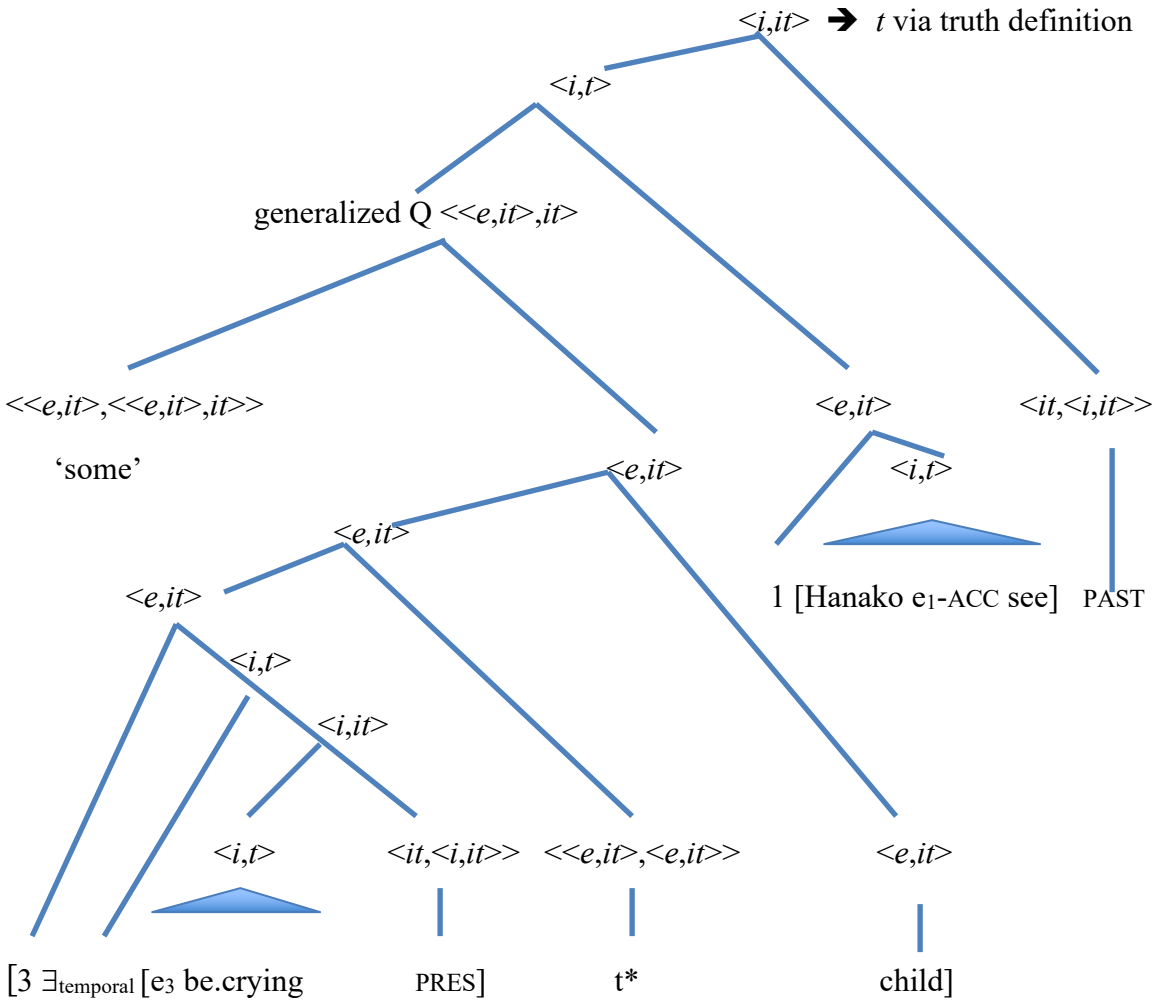
tense is added]

18. $\lambda t_1 . \lambda t_2$ [$t_1 < t_2$ & $\exists v$[[$\exists t_7$[$t_2 = t_7$ & v is crying at t_7] & v is a child at t_7] & Hanako sees v at t_2]]
19. **Truth definition added**: $\exists t_2$ [$t_2 < c_T$ & $\exists v$[[$\exists t_7$[$t_2 = t_7$ & v is crying at t_7] & v is a child at t_7] & Hanako sees v at t_2]]

The final line says that the time of *v*'s crying contains the time of Hanako's seeing *v*. This predicts the simultaneous reading. The time of the common noun *kodomo* 'child' is presumably freer, but in this instance, the prediction is satisfactory because this account says that *v* was a child when she cried.

As mentioned in Section 8.1, (55a) receives the interpretation given in (55b) in which the present tense in the relative clause is interpreted like an indexical. This interpretive possibility is encoded in terms of Kusumoto's idea of inserting the designated variable *t**, which is encoded here as a context-dependent operator as shown in the computation in (8). The compositional semantic structure is given in (7). The semantic contribution of the adverbials is ignored for the sake of brevity.

(7)



t* ensures PRES behaves like "indexical PRES"

(8) 1. **Relative clause with a binder index**: $[\![3\ [\exists_{temporal}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\!]^{w_0,g_c,c}$ = $[\lambda x\ .\ \lambda t_5.\ \exists t[t_5 = t\ \&\ x \text{ is crying at } t]]$ (See (7) for the calculations up to this point.)

2. $[\![\text{t*}]\!]^{w_0,g_c,c} = \lambda f_{<e,it>}\ .\ \lambda z\ .\ \lambda t_1\ .\ f(z)(c_T) = 1$

3. **Designated index *t* is added:** $[\![[[3\ [\exists_{temporal}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\ \text{t*}]]\!]^{w_0,g_c,c}$ = $[\lambda z\ .\ \lambda t_5.\ \exists t[c_T = t\ \&\ z \text{ is crying at } t]]$

4. **Temporal Predicate Modification**: $[\![[[3\ [\exists_{temporal}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\ \text{t*}]\ \text{child}]\!]^{w_0,g_c,c}$ = $[\lambda z\ .\ \lambda t_5.\ \exists t[c_T = t\ \&\ z \text{ is crying at } t]\ \&\ z \text{ is a child at } t_5]$

5. **Relativized DP (with a covert D)**: $[\![\text{'some'}\ [[[3\ [\exists_{temporal}\ [[e_3\text{-ga nai-te iru}]\ \text{PRES}]]]\ \text{t*}]\ \text{child}]]\!]^{w_0,g_c,c}$ =

$\lambda g_{<e,it>}$. λt_5. $\exists v$[[$\exists t$[$c_T = t$ & v is crying at t] & v is a child at t_5] = $g(v)(t_5)$ = 1]

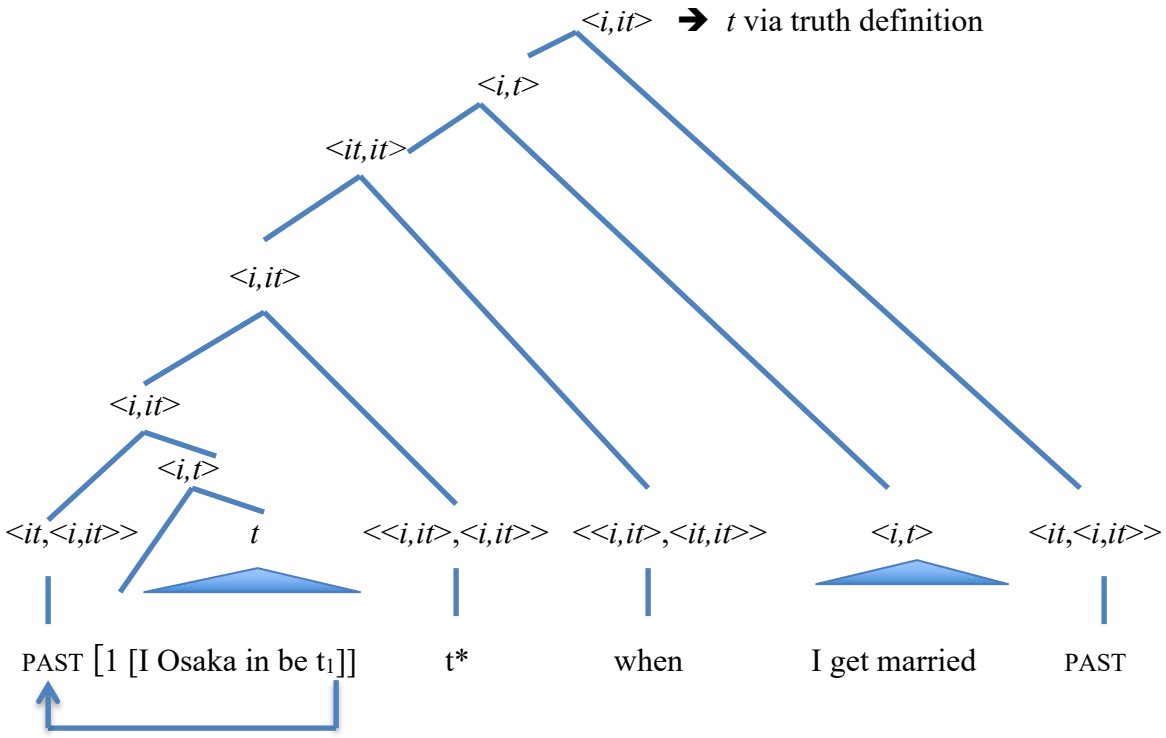
6. **Entire sentence without (matrix) tense**: [[['some' [[[3 [$\exists_{temporal}$ [[e_3-ga nai-te iru] PRES]]] t*] child]] [1 [Hanako e_1 -o see]]]^{w_0,g_c,c} = λt_5. $\exists v$[[$\exists t$[$c_T = t$ & v is crying at t] & v is a child at t_5]
7. **Entire sentence with (matrix) tense**: [[['some' [[[3 [$\exists_{temporal}$ [[e_3-ga nai-te iru] PRES]]] t*] child]] [1 [Hanako e_1 -o see]]] PAST]]^{w_0,g_c,c} = λt_1 . λt_2 [$t_1 < t_2$ & $\exists v$[[$\exists t_7$[$c_T = t_7$ & v is crying at t_7] & v is a child at t_7] & Hanako sees v at t_2]]
8. **Truth definition**: $\exists t_2$ [$t_2 < c_T$ & $\exists v$[[$\exists t_7$[$c_T = t_7$ & v is crying at t_7] & v is a child at t_7] & Hanako sees v at t_2]]

The final line says that at some past time Hanako saw some *v* that is a child and is crying at the utterance time.

Finally, we shall present an account of a tense morpheme in a *toki* 'when/time' clause when it behaves like an indexical. As mentioned in Section 7, *toki* clauses in Japanese can be relative clauses in that a covert temporal *wh*-expression undergoes a movement. This allows the designated index *t** to be inserted, and this allows the *toki* clause to specify its semantic contribution in relation to the utterance time. Let us sketch a formal analysis of an example presented in the main text, i.e., (47b) here to show the main point of our discussion. The example is repeated here as (9). The compositional structure is given in (10), and the computational details are provided in (11).

(9) Osaka-ni i-ta toki ni kekkonsi -ta. [*toki* clause: absolute tense]
Osaka-at be-PAST time at get.married-PAST
'(I) got married when I was in Osaka'

(10)



t* ensures that the embedded PAST behaves like "indexical PAST"

(11) 1. $[\![\text{I Osaka in be}]\!]^{w_0,g_c,c} = \lambda t$. I be in Osaka at t

2. $[\![\text{PAST [1 [I Osaka in be } t_1]]]\!]^{w_0,g_c,c} = \lambda t_1 . \lambda t_2 . t_1 < t_2$ & I be in Osaka at t_1

3. $[\![\text{t*}]\!]^{w_0,g_c,c} = \lambda f_{<i,it>} . \lambda t_1 . \lambda t_2 . f(t_1)(c_T) = 1$

   [This is a temporal version of the variable, and its denotation is different from the one used in (8) above for a "nominal relative clause."]

4. $[\![[\text{PAST [1 [I Osaka in be } t_1]]]\text{ t*}]\!]^{w_0,g_c,c} = \lambda t_1 . \lambda t_2 . t_1 < c_T$ & I be in Osaka at t_1

5. $[\![\text{when}]\!] = \lambda f_{<i,it>} . \lambda g_{<i,t>} . \lambda t_7 . \exists t\, [f(t_7)(t) = 1 \,\&\, g(t_7) = 1]$[50]

6. **'when/time' clause (including 'when/time')**: $[\![[[\text{PAST [1 [I Osaka in be } t_1]]]\text{ t*}]\text{ when}]\!]^{w_0,g_c,c} = \lambda g_{<i,t>} . \lambda t_7 . [t_7 < c_T$ & I be in Osaka at t_7 & $g(t_7) = 1]$

---

[50] This semantics posited for *toki ni* 'when/time' may not be sufficiently refined to take care of all cases. However, it should be regarded as a preliminary proposal for accounting an "independent reading" of this type of construction in Japanese.

[The existential quantifier is semantically vacuous, and we can safely delete it.]

7. $[\![\text{I get married}]\!]^{w_0,g_c,c} = \lambda t$. I get married at t
8. $[\![[[[\text{PAST}\ [1\ [\text{I Osaka in be}\ t_1]]]\ \text{t*}]\ \text{when}][\text{I get married}]]\!]^{w_0,g_c,c}$ =

   λt_7 . [$t_7 < c_T$ & I be in Osaka at t_7 & I get married at t_7]
9. **Matrix past tense is added**: $[\![[[[[\text{PAST}\ [1\ [\text{I Osaka in be}\ t_1]]]\ \text{t*}]\ \text{when}][\text{I get married}]]\ \text{PAST}]\!]^{w_0,g_c,c}$ =

   λt_7 . λt_8 . $t_7 < t_8$ & $\exists$t [$t_7 < c_T$ & I be in Osaka at t_7 & I get married at t_7]
10. **Truth definition**: $\exists t_7$. $t_7 < c_T$ & $t_7 < c_T$ & I be in Osaka at t_7 & I get married at t_7
11. **Removing redundancies**: $\exists t_7$. $t_7 < c_T$ & I be in Osaka at t_7 & I get married at t_7

The final line correctly accounts for the reading in which the *toki* 'when/time' clause appears to receive an "indexical" interpretation. Although this is hardly the whole story about Japanese *toki* 'when/time' clauses, this we hope provides an important step toward the right approach to their complex behavior. Note that the apparent indexical character is attributed to the intervention of the designated variable *t**, and this is enabled by the fact that the *toki* 'when/time' clause is a temporal relative clause (Kusumoto, 1999; 2017).

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