

On the Proper Treatment of Tense in English*

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In this paper, I argue against the two major approaches to the semantics of tense: the quantificational approach and the referential approach. The difference between them lies in the fact that the former is in favor of the indefinite view of tense, whereas the latter the definite view of tense. Tenses are characterized by the variability in the sense that they can be interpreted as being indefinite in some context or definite in other context. The difficulty the two approaches are faced with is that neither takes an appropriate account of the variability of tense. To provide a proper semantic treatment of tense, I propose in this paper a treatment of tense which incorporates choice functions. The choice functions, which apply to a non-empty set of intervals, pick the most salient time the speaker might have in mind at the utterance time. This might assist in capturing the variability of tense. (Mean-Young Song, Dongguk University)

Key words: tense, definite tense, indefinite tense, the quantification approach, the referential approach, choice functions, presuppositions, temporal predicates

1. Introduction

This paper is mainly concerned with exploring a proper semantic treatment of tense in English. The difficulty we frequently encounter in dealing with tense is that tense shows the variability in meaning, depending on the context of use. To put it differently, in some context, the eventuality under the scope of tense is interpreted as being true at *any* time denoted by that tense, and in other context, on the other hand, the even-

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tuality picked by the tense in question is interpreted as being true at a particular time supplied by the context. The former is referred to as an indefinite tense or indeterminacy of tense, while the latter a definite tense or determinacy of tense. To illustrate this, consider the following sentences:

- (1) a. John Baird invented television.
 b. Mary went to school yesterday.

Suppose that the speaker of a sentence like (1a) does not know the exact time when John Baird invented television, and that he or she simply knows who invented television. One should notice that a sentence like (1a) certainly makes sense even in this situation. Given this, (1a) is interpreted to mean that there exists a past time at which John Baird invented television, which is certainly indefinite. In contrast, a sentence like (1b) carries the meaning that Mary went to school at a time which is included in the day before the utterance time. Since temporal adverbials like *yesterday* refers to a specific time, the past tense in (1b) makes reference to a definite time. As was seen sentences like (1a) and (1b), thus, the interpretation of tenses might be different from context to context.

There are two major approaches to the meaning of tense in the semantic treatment of tense: the quantificational and the referential approach. The quantificational approach makes a point in favor of the indefinite view of tense, while the referential approach the definite view of tense. As sentences like (1a) and (1b) indicate, however, neither of the two approaches is sufficient to handle tense in a proper way. This is mainly due to the variability of tense. Instead of providing an analysis which can capture the semantic variability of tense, the two theories only account for one part of the readings available in temporal expressions.

As a device to capture the variability, this paper will propose a proper semantic treatment of tense by incorporating choice functions. The choice functions for tense apply to a non-empty set of intervals denoted by temporal predicates like *past*, *present*, and *future* and select the most salient interval at the time of utterance of a sentence. The interval picked by the choice functions might be definite or indefinite, depending upon the context of use. By doing so, we would be able to present a unified semantic treatment of tense.

This paper is structured as follows: Section 2 includes the discussion of what the quantificational theory is like, along with the problems with

the theory. In section 3, I will account for the properties of the referential theory of tense and its problems. Section 4 is devoted to the discussion of the motivation of choice functions, along with the basic ideas of choice functions. The main purpose in section 5 is to extend the choice functions to the treatment of tenses. The choice functions cannot apply to empty sets. Section 6 is mainly concerned with what might happen to the choice function analysis of tense, when the choice functions apply to an empty set.

2. The Quantification Theory of Tense

The classical formal semantics (Prior (1967, 1968), Montague (1973), Dowty (1979), and Stump (1985) among others) adopts the view that tense is interpreted to be indefinite. According to this, the eventualities under the scope of the tense operator is true or false at *any* past or future time. This kind of treatment of tense is characterized by existential quantification over intervals, as illustrated in (2a) and (2b), and hence it is often referred to as the quantificational theory of tense.

- (2) a. $P\phi$ is true iff $\exists t' : t' < t$ and ϕ is true at t'
 b. $F\phi$ is true iff $\exists t' : t < t'$ and ϕ is true at t'

(2a) says the formula $P\phi$ is true iff there is a past time at which ϕ is obtained. (2a) and (2b) show that P and F are implicit existential quantifiers over past times and future times respectively. Let us take the following sentence for instance:

- (3) a. John went to school
 b. $P(\text{john-went-to-school})$

A sentence like (3a) is translated into (3b). According to (2a), (3b) is true at a time t iff there is some time t' prior to t and *John goes to school* is true at t' . This kind of interpretation suggests that tense is treated as indefinite. As we saw in (2a) and (2b), the above treatment of tense is mainly characterized by existential quantification over times in the metalanguage and the fact that tense is taken to be a sentential operator.

Dowty (1979) shows different positions from what we discussed in

(2a-b) in the sense that an explicit existential quantifier over intervals is involved in the interpretation of tense, along with the introduction of the AT operator, as illustrated in (4).

- (4) $\exists t[\text{tense}(t) \ \& \ \text{AT}(t, \phi)]$,¹⁾ where tense is a one-place predicate and ϕ is a formula.

According to (4), (3a) translates as (5):

- (5) $\exists t[\text{past}(t) \ \& \ \text{AT}(t, \text{john-goes-to school})]$

(5) roughly says that there is a past time t and at t John went to school. Thus, (5) is semantically equivalent to (3b), which indicates the past tense in (5) is indefinite. However, the difference between (3b) and (5) is that in (3b), the existential quantifier occurs in the meta-language, while it occurs in the object language in (5). Thus, the former and the latter are referred to as a metalanguage analysis and an object-language analysis, respectively.

As was mentioned above, the quantificational theory of tense is characterized by the treatment of tense as indefinite. Given this, one might argue that the treatment of tense as indefinite is semantically equivalent to that of the present perfect in the sense that the latter refers to an indefinite point of time. For example, the indefinite past tense is interpreted in the same way as the present perfect. We can witness this view in Montague (1973), Reichenbach (1947), and Stump (1985). Montague treats the English present perfect as the indefinite past. However, this view has some problems, which will be elaborated upon in what follows.²⁾

A piece of evidence against the view is that it cannot account for the acceptability of (6a) in which the past tense occurs with a past time adverb like *yesterday* and the unacceptability of a sentence like (6b) where the present perfect takes place.

- (6) a. John went on a picnic with Mary yesterday
 b. *John has gone on a picnic with Mary yesterday

1) In this formula, tense refers to a temporal predicate.

2) I will give brief arguments which are against this view to save space. The reader can refer to Song (1999) and Song (2000), where I have presented a more detailed discussion of the problems with the indefinite past approach to the present perfect.

- (7) a. ??John went on a picnic with Mary several times
 b. John has gone on a picnic with Mary several times before

Given that the past tense is interpreted in the same way as the present perfect in the sense that they both refer to an indefinite time, we would have to expect that (6a) would be no more grammatical than (6b) is, contrary to fact. It is worth noticing that unlike the present perfect, the past tense may refer to a definite time (i.e. a particular time the speaker has in mind). Thus, the past tense is compatible with past time adverbs like *yesterday* denoting a specific time, as in (6a), while this is not the case with the present perfect, as in (6b). The same argument holds for sentences like (7a-b). That is, adverbs like *several times* and *before* describe that the event under the scope of the perfect has repeated several times without presenting a specific time. Thus, the view that the interpretation of the past tense is equivalent to that of the perfect would have to expect that like (7b), (7a) is grammatical, contrary to fact.

The following sentences also make a point against the view that the past tense is semantically equivalent to the present perfect.

- (8) a. *John left now
 b. John has left now

According to this view, a sentence like (8a) is truth-conditionally equivalent to (8b). However, the past tense in (8a) is incompatible with a speech-time-oriented adverb like *now*, whereas this is not the case with the present perfect in (8b). The key distinction between the past tense and the present perfect lies in the fact that the former subsumes events which took place in a period of time which is wholly past, whereas the latter establishes the present relevance of an eventuality which took place in the past. Thus, the past tense cannot occur with a speech-time-oriented adverb like *now*, as illustrated in (8a). In contrast, the present perfect is compatible with *now*.

2.1. Problems with the Quantificational Theory³⁾

Partee (1973) argues that the quantificational theory of tense is in-

3) Notice that Partee's (1973) and Enç's (1986) arguments against the quantificational theory of tense which will be discussed below in this section serve as pieces of evidence in favor of the referential theory.

appropriate for the tenses in natural language. She provides the following example as a piece of evidence against the theory:

(9) I didn't turn off the stove.

A sentence like (9) shows the deictic use of the past tense. In other words, when (9) is uttered, the past tense is used to refer to a specific time, given the situation where the speaker uttered (9) while driving halfway down the turnpike. However, the quantificational theory fails to capture the right interpretation of (9). The Priorian analysis of tense would have to predict that (9) can be represented as in (10a) and (10b).

- (10) a. $\neg P(\text{I-turn-off-the-stove})$
 b. $P\neg(\text{I-turn-off-the-stove})$

In (10a), the negation takes wider scope than the past tense operator, while the scopal relation is reversed in (10b). (10a) says that there is a past time such that I didn't turn off the stove, which is too weak, given the circumstance mentioned above, and on the other hand, (10b) says that it is not the case that I ever turned off the stove, which is too strong. Hence, neither (10a) nor (10b) are appropriate for the intended meaning conveyed by the sentence in (9).

Enç (1986) also argues that the quantificational theory of tense fails to provide a proper treatment of tense. She presents the following sentence which serves as a counter-example to the quantificational theory:

(11) Every member of our investment club will buy a house

A sentence like (11) can be represented as (12a) and (12b) in terms of the quantificational theory:

- (12) a. $F(\forall x[\text{m-of-c}(x) \rightarrow \text{buy}(x, \text{a-house})])$ ⁴
 b. $\forall x[\text{m-of-c}(x) \rightarrow F(\text{buy}(x, \text{a-house}))]$

(12a), in which the future tense operator take wide scope over the universal quantifier, says that there will be a future time at which every

4) In this representation, "m-of-c" is short for "member of our investment club." I also ignore the translation of the indefinite article for simplicity.

member of our investment club buys a house. On the other hand, (12b), in which the scopal relation between the tense operator and the universal quantifier is reversed, says that for every member of our investment club, there will be a future time at which he or she buys a house. According to En (1986), (11) is interpreted to mean that every-current-and-future member will buy a house. Hence, she claims that neither of the two represents the right reading of (11). That is, (12a) only refers to every future member of our investment club, whereas (12b) every current member. Thus, (12a) and (12b) cannot capture the right reading of (11).

This kind of argument basically assumes the meaning of the expression *member of our investment club* in the following way: the extension of *member of our investment club* denotes the set of members of our investment club at time *t*. Thus, as we saw in (12a-b), if the NP is under the scope of the tense operator *F*, then the evaluation time for the time *t* will be shifted into the future time, and, in consequence, this will pick only the future members from the domain of the set. If the NP is outside the scope of the tense operator *F*, on the other hand, then the evaluation time will be the present, or the utterance time, and the NP only refers to current members.

However, one should notice that the range of quantifiers may be different from context to context. To illustrate this, consider the following sentence:

(13) Every boy loves Susan

A sentence like (13) does not imply that every boy in the world loves Susan. Instead, it means that every boy relevant to the discourse loves Susan. Likewise, when the speaker utters a sentence like (11), he or she intends to imply that every member who is relevant at the utterance time who is picked from the domain of the set denoted by *every* will buy a house. Thus, the extension of a quantified NP like *every member of our investment club* at a time *t* may be independent of the time or times at which the proposition under the scope of tense is evaluated. This suggests that Enç's arguments bear no relation to the issue of whether tense is treated as an operator since the domain of a quantified NP seems to be context-dependently determined without respect to tense operators.⁵⁾

5) There are various ways to incorporate the fact about the context dependency of the quan-

The quantificational theory also has difficulty dealing with the following sentences:

- (14) a. John did not die in New York.
 b. John did not lose his head.

Let us consider (14a) first. According to the quantificational theory, the IL translation of a sentence like (14a) can be represented as (15a) and (15b):

- (15) a. $\neg P[\text{die-in-New-York}'(j)]$
 b. $P\neg[\text{die-in-New-York}'(j)]$

What (15a) says is that John never died in New York at *any* past time, while (15b) says that there was some past time at which John did not die in New York. Suppose that John actually died in Boston. Given this, (15a) is the correct reading for (14a), whereas (15b) is not. This is because what the past sentence in (14a) says is that there was no past time whatsoever at which John died in New York. Thus, (15b) is inappropriate for the meaning of (14a) since it is too weak. The same argument goes for a sentence like (14b).

3. The Referential Theory of Tense

The referential theory of tense that adopts the determinacy of tense treats temporal expressions in analogy to the treatment of nominal expressions without positing an existential quantification over times.^{6,7} According to this approach, the reference time is determined by the context of use. That is, the most salient local evaluation time is contextually supplied. As a device to capture this, the referential theory assumes that

tified NPs into the semantic interpretation. One possible way would be to interpret member of our investment club as denoting the set of all past-present-future members, and then allow the context to pick some subset of this. I will not go into the details of this since this is beyond the present study.

6) We can see this kind of approach in the discourse representation theory.

7) Reichenbach (1947) contains the first attempt to treat tense as being definite within the framework of formal semantics, even though he does not explicitly address that tense is determinate. I had already pointed this out in Song (2005). To save space, I will not go into details of this. The reader can refer to it.

tense bears an index just like nominal expressions such as pronouns, as in *John PAST₂ leave Seoul* (see Partee (1984), Enç (1987), and Abusch (1997) among others). Thus, the sentence *John PAST₂ leave Seoul* would be true if for some function g from free variables to appropriate referents, $g(t)$ precedes the utterance time and $g(t)$ is a time at which Mary leaves Seoul.

Given this, we can define the semantics of each tense as follows under the referential theory:

- (16) a. $PRES_i$ is defined with respect to u and g iff $g(i)$ overlaps u .
When defined, $\|PRES_i\|^{u,g} = g(i)$
- b. $PAST_i$ is defined with respect to u and g iff $g(i) < u$.
When defined, $\|PAST_i\|^{u,g} = g(i)$
- c. FUT_i is defined with respect to u and g iff $u < g(i)$.
When defined, $\|FUT_i\|^{u,g} = g(i)$

In (16a-c), g is a function which assigns indices to appropriate referents (or times) and u is the utterance time. For example, the value of $PAST_2$ in the above sentence is determined by the function g applied to the index 2, i.e. $g(2)$, and $g(2)$ precedes the utterance time since the sentence in question is in the past. Recall that $g(2)$ refers to the most salient time picked out by the sentence.

Let us take the following sentence for instance and see how the referential analysis fits in.

(17) Mary won the race

A sentence like (17) would have an LF representation like (18) in terms of the referential view:

(18) Mary $PAST_2$ won the race

The resulting translation of (18) would be something like (19).⁸⁾

8) The translation is a result from the application of the following semantics of the simple tenses, the present, the past, and the future, as in (ia-c) respectively:

- (i) a. $PRES_i$ translates as $\lambda P[PRES(t_i) \ \& \ P(t_i)]$
b. $PAST_i$ translates as $\lambda P[PAST(t_i) \ \& \ P(t_i)]$

(19) PAST(t_2) & won' (m, the-race, t_2)⁹⁾

The translation in (19) is characterized by the fact that no quantification over times is involved in this translation and that a free variable (i.e. t_2) occurs. The value of the free variable t_2 is anchored by the most salient time in the context. This contrasts with the translation of tense adopted by the quantificational theory in which a variable denoting times is bound by the existential quantifier. When a formula contains free variables, it is evaluated with respect to a certain value assignment to the free variables which are determined not by semantics, but by the context of use, i.e. pragmatics. The free variables are felicitous if the context provides enough information to evaluate them. Otherwise, they are not felicitous.

Given the presuppositions in (16a-c), the truth conditions for (19) can be stated as follows. The past sentence (17) presupposes that $\|PAST_2\|^{M, w, g, u}$ is defined iff for some function g from indices to appropriate referents, $g(2)$ precedes u . When this presupposition is felicitous, $\|PAST(t_2) \& won'(m, the-race, t_2)\|^{M, w, g, u}$ is true iff t_2 is prior to u , and Mary wins the race at t_2 . One should notice that in this truth condition, t_2 is the value of the function g applied to the index 2, i.e. $g(2) = t_2$. So far, we have seen how the referential theory of tense deals with tense within formal semantics.¹⁰⁾ However, the theory is not sufficient to account for the distributions of tense in natural language. This will be elaborated upon in the next section.

3.1. Problems with the Referential Theory

This sub-section is devoted to pointing out some problems with the referential theory. In many utterances, the speaker might use tenses, whether it is in the past or future tense, without making any reference

c. FUT_i translates as $\lambda P[FUT(t_i) \& P(t_i)]$

In the translation (ia-c), P is a variable of type $\langle s, \langle i, t \rangle \rangle$ with the denotation of properties of intervals. The reader can consult with Song (2005) for more details.

9) In (19), I simply translate the definite NP *the race* as *the-race* for convenience' sake.

10) Note that the referential theory of tense has been more frequently incorporated into the Discourse Representation Theory (DRT) than into the formal framework discussed here in this paper. DRT is mainly concerned with understanding temporal sequencing in discourse, as in *John walked in. He sat down*, in much the same way as it treats a sequence of referential NPs like names and pronouns in discourse.

to a specific time picked out by the sentence in question. This is in favor of the quantification theory of tense which takes tense to be indefinite. For illustration, consider the following sentences:

- (20) a. Dinosaurs disappeared from the earth
 b. Einstein proposed the theory of the relativity

Neither of the sentences in (20a) and (20b) makes reference to a specific interval in the past. In other words, we can say such sentences without referring to or presupposing any particular date and time in the past when those events described in (20a) and (20b) took place. Instead, they simply describe that those events occurred in the past. For example, (20a) is understood to mean that there was a past time at which dinosaurs disappeared from the earth. This sentence makes sense even when the speaker does not have any particular time in his or her mind in uttering it. This indicates that the treatment of the past tense as definite is not sufficient to account for the semantics of the past tense.

The following sentences serve as examples that are against both the referential theory and the quantificational theory:

- (21) a. John did not lose his head
 b. John did not die in New York

On the assumption that the negation is an operator, the meaning of (21a) can be represented as follows in terms of the operational analysis or the quantificational treatment of tense.

- (22) a. $\neg P[\text{lose}'(j, \text{his-head})]$
 b. $*P\neg[\text{lose}'(j, \text{his-head})]$

The semantic representations in (22a-b) are based on the scope relation between the past tense operator and the negation. What (22a) says is that John never lost his head at *any* past time, while (22b) says that there was some time in the past at which John did not lose his head. Notice that (22a) is the correct reading for (21a), whereas (22b) is not. This is because what the past sentence in (21a) says that there was no past time whatsoever at which John lost his head, and hence, (22b) is too weak a meaning of (21a). The same argument goes for a sentence

like (21b). Thus, sentences like (21a-b) are another set of examples which indicate that the Priorian treatment of tense (or the operational analysis) is not appropriate for dealing with tense in natural language.

It is, however, worth noticing that the past event described in (21a) – i.e. the event of John losing his head – does not make reference to a particular time, either. Suppose John is alive when (21a) is uttered. Then (21a) is understood to mean that he never lost his head at *any* past time, which implies that the past tense in (21a) is completely indefinite. This kind of explanation holds for a sentence like (21b), too. Thus, the referential theory does not take proper account of sentences like (21a-b). We have discussed neither of the two theories of tense is sufficient to provide a proper treatment of tenses in natural language. In what follows, I will elaborate on a more plausible way to deal with tense.

4. Definition of Choice Functions

Choice functions are employed in formal semantics as a possible solution to the violation of island constraints at the level of LF caused by indefinite NPs. Consider the following sentence:

- (23) a. The professor knows the fact that a student of mine joined the peace corps.
 b. For some *x*, *x* a student of mine, the professor knows the fact that *x* joined the peace corps.

A sentence like (23a) contains an indefinite NP *a student of mine* within the complex NP construction which constitutes an island. (23b) is the interpretation of (23a) with wide scope of the indefinite NP. As illustrated in (23b), the indefinite NP *a student of mine* takes scope over the whole matrix sentence. This indicates that the indefinite NP moves out of the island at LF. This kind of LF movement is illegal since it violates the island constraints according to which no elements can be extracted out of islands.

To remedy this, some linguists like Reinhart (1977) attempt to incorporate choice functions into the wide-scope interpretation of indefinites. The basic idea of this approach is that the wide-scope interpretation of an indefinite NP might be obtainable without moving it out of the is-

lands, in which case there is no such thing as the violation of island constraints in the first place, and that if the indefinite NP remains in situ, then it can be taken to be an argument, rather than a generalized quantifier. The choice function applies to the indefinite NP which is to be interpreted as having wide-scope.

The wide-scope interpretation of (23a) can be represented roughly as follows in terms of the choice function:

- (24) $\exists f$ [CH(f) & the professor knows the fact that f (student of mine) joined the peace corps]

(24) involves existential quantification over choice functions. One should also note that the indefinite NP remains in situ, instead of moving out to take wide scope over the whole matrix clause, as illustrated in (24). This means that the indefinite NP is interpreted as an argument of the verb and the interpretation in (24) definitely respects the island constraints on movement since as was mentioned earlier, the indefinite NP stayed in situ. (24) says that there exists a choice function such that the professor knows the fact that the student picked out by this function joined the peace corps. Notice that in (24), f is a function that ranges over functions that select one individual from the set of possible denotations of “student of mine.” The value of f is fixed by the context. In other words, f is the function that applies to the set of “student of mine” to return a particular individual that the speaker has in mind at the utterance time of (24).

Given the interpretation of the choice function laid out in the previous paragraph, we can define the choice function as follows:

- (25) Definition of Choice Functions

A function variable f is a choice function iff for any $\alpha \in A$, $f(A) = \alpha$.

(N. B. A is a non-empty set)

(25) says that f is a function that applies to a non-empty set to return a particular individual from that set. Recall that the value of f is determined by the context of use. What about the predicate CH (for the choice function) in (25)? We need to define it for clear presentation of what the choice functions are like. Recall that the choice function varia-

ble f is of type $\langle\langle e, t \rangle, e \rangle$. The predicate CH is of type $\langle\langle\langle e, t \rangle, e \rangle, t \rangle$ with the denotation of the functions from the functions from the sets of individuals to individuals to truth values, since it takes the function variable f to be its argument. Given this, the definition of CH can be stated as follows:

(26) $CH = \lambda f \forall P [P \neq \emptyset \rightarrow P (f (P))]$, where P is a variable of type $\langle e, t \rangle$.

(26) says that if for every one-place predicate it is a non-empty set, the predicate applies to the individual that the function variable f picks from that non-empty predicate – i.e. the individual f picks from the non-empty predicate is in the extension of that non-empty predicate. Since we have discussed the definition of the choice functions, we are now in a position to see how the choice function is applicable to the analysis of tense. This will be elaborated upon in what follows.

5. Choice Functions and Temporal Interpretation

This section mainly contains the discussion of the way I prefer to go with respect to the more appropriate treatment of the tenses in natural language, whether they are interpretable as definite or indefinite, by incorporating choice functions. As a first step toward the treatment, we need to define temporal predicates like past, present (henceforth PRES), and future (henceforth FUT). I assume that the temporal predicates are taken to be a set of intervals, as illustrated in (27a-c):

- (27) a. $\llbracket \text{past} \rrbracket^u =$ that function $h \in D_{\langle i, t \rangle}$ such that for any $i \in I$, $h(i) = 1$ iff i precedes u .¹¹⁾
 b. $\llbracket \text{PRES} \rrbracket^u =$ that function $h \in D_{\langle i, t \rangle}$ such that for any $i \in I$, $h(i) = 1$ iff i coincides with u .
 c. $\llbracket \text{FUT} \rrbracket^u =$ that function $h \in D_{\langle i, t \rangle}$ such that for any $i \in I$, $h(i) = 1$ iff i follows u .

As was mentioned above, the temporal predicates in the semantics (27a-c) denote a set of intervals, and thus, they are of type $\langle i, t \rangle$ with

11) In (27a-c), u refers to the utterance time, and i an interval.

the denotation of the functions from intervals to truth values. They are also assumed to be partial functions. One should notice that the local evaluation time for the temporal predicates is the utterance time, which is provided in the context of use.

Given this, we are ready to go through the main discussion. The basic idea that I have regarding the application of the choice functions to the temporal interpretation would be something like this: the choice function for temporal interpretation applies to the set of intervals denoted by each of the temporal predicates to yield an appropriate interval of that set of intervals. This can be represented as (28):

- (28) a. $f(\text{past})$: f applies to the set of intervals preceding u to return an appropriate interval of the set “past.”
 b. $f(\text{PRES})$: f applies to the set of intervals simultaneous with u to return an appropriate interval of the set “PRES.”
 c. $f(\text{FUT})$: f applies to the set of intervals following u to return an appropriate interval of the set “FUT.”

Recall that the temporal predicates like *past*, *PRES*, and *FUT* denote a set of intervals, and hence, they are of type $\langle i, t \rangle$. As was mentioned in (28a-c), the function variable f takes the temporal predicates as its arguments and the value of the function is an appropriate interval, and thus f is of type $\langle \langle i, t \rangle, i \rangle$ with the denotation of a function from sets of intervals to an interval. The appropriate interval, which is a value of the application of the choice function, is obtained from the context of utterance. How does the choice function possibly get its value from the context of utterance? The answer to this question that I came across is something like this: we need to come up with choice function variables in such a way that they assign to every temporal predicate an interval among those which are members of the set denoted by that temporal predicate at which the eventuality picked out by the sentence in question occurs.

The next thing we should do is to define the choice function f that applies to the temporal predicates to make clear how the new system fits in. More precisely, we need to define the predicate *CH* over choice functions to make the function variable f appropriate for temporal interpretation. The definition of choice functions for temporal interpretation I will explore in this paper is in analogy to that concerning in-

definite NPs. Hence, in conjunction with (25) and (26), we can define the choice functions for tense as below:

(29) Definition of choice functions for tense

$CH = \lambda f \forall I [I \neq \emptyset \rightarrow I (f(I))]$, where f is a variable of type $\langle\langle i, t \rangle, i \rangle$ and I is a variable of type $\langle i, t \rangle$ with the denotation of sets of intervals.

Notice that in (29), the predicate CH is of type $\langle\langle\langle i, t \rangle, i \rangle, t \rangle$ with the denotation of a function from the function variable f to truth values. (29) says that a function variable f is a choice function for tense (i.e. $CH(f)$ holds) if and only if for every temporal predicate I which is a non-empty set of intervals,¹²⁾ $f(I)$ is in the extension of I . To put it differently, the temporal predicate applies to an interval picked by the choice function variable f . It is worth noticing that the interval f picks is a member of the set to which that interval belongs.

Armed with what we have discussed so far, let us consider some examples to see how the analysis proposed in this paper works. The examples we will see below mainly contain those which are not properly accounted for in terms not only of the quantificational theory but also of the referential theory. Before launching into the discussion of how to deal with more complicated tensed sentences, consider a sentence like (30a) to which we can give a straightforward choice function analysis:

- (30) a. John arrived in Seoul
 b. $\exists f [CH(f) \ \& \ \text{arrive-in-Seoul}'(j, f(\text{past}))]$

In what follows, I will give a brief discussion of the characteristics the above analysis might have. A sentence like (30a) would translate into (30b) in terms of the choice function. One should note that in (30a), the predicate takes as its argument the temporal expression which is a domain of the choice function. This suggests that the predicates need one extra argument position which is reserved for temporal expressions. That is, the intransitive predicates require two arguments – one is an external one (i.e. the subject) and the other a temporal one (i.e. tense). The transitive predicates, on the other hand, need three arguments – the subject,

12) Remember that the domain of the choice function should be a non-empty set.

the object, and tense. The proposal in which the temporal expressions serve to be arguments of the predicates implies an in-situ analysis – i.e. tenses remain in-situ with no movement at all. Hence, in this kind of treatment, there will be no such problem whatsoever as scope relations that may be caused by LF movement. This may be one advantage of the choice function analysis over the quantification theory. I will get back to this later in this section.

In (30b), a choice function applies to a set of intervals. As was mentioned above, $f(\text{past})$ is an argument of the predicate *arrive-in-Seoul*, and it assigns the most salient interval as the value of the function f . Recall that the most salient interval is provided by the context of use. The translation in (30b) says that there exists a choice function f such that John arrived in Seoul at the interval that function picks. The interval the choice function f picks in (30b) counts as the most salient time or the given time at the utterance time of (30a). The truth condition for (30) can be stated roughly as below:

- (31) (30b) is true at t with respect to $M, w, g,$ and u iff there is a value assignment function $g' \langle h/f \rangle g^{13,14}$ such that $g'(h)$ is a choice function and John arrives in Seoul at $g'(h)(\text{past})$.

In the truth condition (31), $g'(h)(\text{past})$ makes reference to the interval the choice function picks, and it should be contained in the set of intervals denoted by *John arrives in Seoul* for the sentence (30a) to be true. It should be remembered that as was mentioned briefly above, the predicate like *arrive* is treated as a two-place predicate in our framework, hence it is of type $\langle e, \langle i, t \rangle \rangle$. The predicate *arrive in Seoul* combines with the subject *John*, which is base-generated in [SPEC, VP], and this leads *John arrives in Seoul* to be of type $\langle i, t \rangle$ with the denotation of a set of intervals. After that, *John arrives in Seoul* applies to the temporal predicate to which the choice function f has applied, and the resulting expression is reduced to the type i .

Now let us get back to Enç's (1986) example¹⁵) which she claims to be

13) One should recall that f and h denote a function of type $\langle \langle i, t \rangle, i \rangle$, rather than an individual of type e or i .

14) The notation $g' \langle h/f \rangle g$ means g' is a value assignment function just like g except that it possibly assigns h to f .

a problem with the quantification analysis and see how the framework proposed in this paper will present a possible solution to Enç's problem. Consider the sentence in (11), which is repeated below as (32) for convenience' sake:

(32) Every member of our investment club will buy a house

A sentence like (32) translates into (30) in terms of the choice function analysis:

(33) $\exists f [CH(f) \ \& \ \forall x[m.o.i.c(x) \rightarrow \text{buy}'(x, \text{a-house}', f \text{ (FUT)})]]$

(33) is understood to assert that there exists a choice function f such that for every member of our investment club, he or she buys a house at the interval selected by that choice function. Notice that in (33), the interval the choice function picks from the predicate denoting FUT is the most salient interval posterior to the utterance time u . Thus, the eventuality described by (33) is located into the future, indicating that every member of our investment club will buy a house at the given time in the future.

Let us get back to Enç's problem. One should recall that Enç (1986) argues that a sentence like (32) makes a point against the quantificational approach to tense. According to her, (32) carries the meaning that every-current-and-future member of our investment club will buy a house. However, the quantificational approach fails to capture the meaning of (32). The choice function treatment of tense is an in-situ analysis, as was mentioned above. Thus, the choice function analysis establishes no scopal relation whatsoever between the universal quantifier and tense, which contrasts with the quantificational view of tense. This suggests that the problem with the Priorian treatment Enç (1986) points out does not exist in the first place. Depending on the context of the utterance of (31), the universal quantifier binding the variable x in (33) might denote every-current-and-future member of our investment club. This is a de-

15) Recall that I have argued Enç's arguments against the quantificational analysis may be somewhat weak because her main point against it is not so much directly relevant to the way it treats tense as closely related to the context-dependent characteristics of the domain of quantificational NPs.

sired consequence on Enç's part.

Finally, let us get back to the example which neither the quantificational theory nor the referential theory takes an appropriate account of and see how the choice function analysis of tense deals with it. Consider the sentence (14a), which is repeated below as (34):

(34) John did not die in New York

As we discussed in sub-section 2.1, the past tense in (34) might be interpreted to be definite or indefinite, depending on the context of use. Let us consider two scenarios to make this clear. Scenario #1: suppose John actually died in Boston. In this situation, a sentence like (34) carries the meaning that John never died in New York at *any* past time. This is an indefinite interpretation of the past tense. Scenario #2: suppose John visited New York and he was hit by a car, but fortunately he did not die at that time. In this situation, the past tense in (34) is interpreted to make reference to a definite past time – i.e. the time John was hit by a car when he visited New York. Recall that the past tense in scenario #1 makes a point against the referential theory, while the past tense in scenario #2 the quantificational theory. In what follows, I will discuss how the framework proposed in this paper provides a proper treatment of a sentence like (34).

A sentence like (34) translates into (35) in terms of the choice function analysis.

(35) $\exists f [CH(f) \ \& \ \neg \text{die-in-NY}'(j, f(\text{past}))]$

(35) is understood to assert that there exists a choice function f such that John does not die at the given interval this choice function selects. In this case, the interval picked by the choice function is the most salient interval preceding the utterance time. The eventuality picked out by (34) is shifted into a past time, and hence (35) says that John did not die in New York at the given past time. In case of scenario #1, the interval selected by the choice function (i.e. $f(\text{past})$) is tantamount to the whole interval of John's life. Consequently, (35) is semantically equivalent to (36) which is represented in terms of the quantificational treatment, implicating that it's not the case that John died in New York at *any* past time during his whole life:

(36) $\neg P(\text{die-in-NY}'(j))$

Thus, the choice function analysis successfully captures the meaning of the indefinite past arising from scenario #1. In scenario #2, on the other hand, $f(\text{past})$ in (35) selects the interval when John went to New York and was hit by a car. Thus, (35) implicates that John did not die in New York at a given past interval when he was hit by a car in New York. This is how the choice function analysis captures the definite past arising from scenario #2.¹⁶⁾

I'd like to mention one thing before closing this section. The interpretation of tense in natural language is completely context-dependent. It may make reference to a particular time in some context, whereas this is not the case in other context. As we saw above, the choice function analysis takes a proper account of the semantic interpretation of tense that is context-dependent – that is, it can be interpreted as being definite or indefinite. This might be made possible because the choice function itself is characterized by the contextually supplied interpretation. For example, as we saw in the two scenarios, the past interval picked by the choice function is John's whole life time in scenario #1, and it is, on the other hand, one specific time in scenario #2. The fact that the choice function analysis of tense can capture the (in)definite interpretation of tense gives it one advantage over the two traditional rivals.¹⁷⁾ It can pro-

16) An anonymous referee pointed out to me that the IL translation in (35) might not be the right way to represent the semantics of an ambiguous sentence like (34), since the two readings of (34) are represented in terms of one single IL translation (35), which appears to depart from the so-called semantic principle that if a sentence allows n -many readings, then we need n -many semantic representations. However, (35) is not deviant from the principle. Recall that the interval picked out by the choice function is completely dependent upon the use of context. Suppose that John read a book at 3:15, then $f(\text{past}) = 3:15$, and John slept at 2 a. m., then $f(\text{past}) = 2$ a. m. Similarly, the interval picked out by the choice function in (35) is different, depending on whether (34) was uttered in scenario #1 or in scenario #2. The choice function analysis is not the only one that the interpretation of intervals is context-dependent. We can witness this parallelism in the extended now theory which is meant to treat the semantics of the perfect. That is, the interval picked out by the extended now predicate XN , as in $XN(t)$, is also different from context to context.

17) One anonymous referee says that the specific use of indefinites is different from definite NPs in that the only the latter presupposes both the speaker and the hearer identify the referent of the linguistic form in question. For this reason, it is unclear how choice functions can be applied to the use of definite NPs, so it is unclear how they can be applied to the definite use of tense. The difference between the specific indefiniteness and definiteness the anonymous referee mentioned does not always hold. In the semantic literature, the specific reading of the indefinite NPs (or the referential use of the indefinites in the sense of Fodor and Sag (1982)) is semantically nearly close (Heim (1982) and Enç

vide a unified way to treat tense in natural language.

6. Choice Functions and Empty Sets

So far, we have explored a more plausible alternative way to deal with tense, no matter whether it is marked as being definite or indefinite, by incorporating choice functions. As was mentioned above, what is important concerning the choice functions is that the choice functions must apply to a non-empty set. Otherwise, the semantic derivation would be crushed since the choice function might pick nothing out of the set. As a result, we would fail to calculate the meaning of a sentence. In this section, I will investigate a possible way out when the choice function applies to an empty set, as exemplified in (37a) and its logical translation (37b).

- (37) a. Martians attacked the earth
 b. $\exists f$ [CH(f) & attack'(m, the-earth, f (past))]

(37b) says that there exists a choice function such that Martian attacked the earth at a certain time in the past the choice function picks. In the world we live, there was no past time whatsoever at which Martians attacked the earth. In other words, the set of intervals at which Martian attacked the earth is an empty set. Therefore, there is no interval available for the choice function to pick, since in (37b), the domain of the choice function is an empty set. Given that the choice functions apply to an empty set, the following question will arise: How can we calculate the truth value of a sentence like (37a)? The answer to this question will be elaborated upon in what follows.

The strategy I will adopt in this paper to deal with this situation is along the lines of that of what I call the presuppositional treatment of

(1991)), or identical (Partee (1972)) to the meaning of definite NPs. Given this, the choice functions can be applied to the semantics of definite NPs. This has already been elaborated in Song (2004). Furthermore, just as indefinite NPs are ambiguous between specific (or referential) and non-specific reading, so are definite NPs. In case of definite NPs, the former and the latter are equivalent to as 'referential' and 'attributive', respectively in the sense of Donellan (1966). The attributive reading of the definite NPs does not have to require the presupposition that the hearer identifies their referent (cf. Partee (1972)). Besides, Stalnaker (1974) argues that presuppositions are established on the speaker's part, rather than on the hearer's part.

definite descriptions discussed in Heim and Kratzer (1998) and Song (2004).¹⁸⁾ According to the presuppositional treatment, if the presupposition induced by a certain expression were satisfied, then we would be able to calculate the semantics of the sentence, and if not, on the other hand, the sentence would be uninterpretable – i.e. no truth values would be able to be assigned to the sentence.¹⁹⁾ To illustrate this, consider the following sentence:

(38) The president of our social club knows something about semantics

The definite description *the president of our social club* in a sentence like (38) presupposes that there exists a president in our social club. The presuppositional treatment would say something about calculating the meaning of (38) like this. If the presupposition triggered by the definite description is felicitous, then the function denoted by *president of our social club* would be in the domain of the function denoted by the definite article *the*, which is assumed to be a partial function. If that is the case, we can apply the function *the* to the expression *president of our social club*, and in consequence, it would be able to pick one unique entity that is a president of our social club. In contrast, the function denoted by *president of our social club* would not be in the domain of *the*, when the presupposition failure takes place. What we thus end up would be that we are unable to continue calculating the meaning.²⁰⁾

Let us get back to the main line of discussion. I will make a similar argument regarding the case where the choice functions apply to an empty set. Like the definite descriptions, tenses trigger presuppositions as well. For instance, the past tense presupposes that the time of the eventuality picked out by the sentence in question precedes the utterance time, and the present tense presupposes that the time of an eventuality coincides with the utterance time, and so on. Given this, a sentence like

18) Following Frege, Heim and Kratzer (1998) claim that the definite descriptions like *the* need to be treated as being presuppositional in the sense that if the presupposition triggered by them are not satisfied, then the sentence will not be able to be assigned a meaning. Song (2004) extends this idea into the application of the choice functions to the semantics of the definite descriptions.

19) It is worth noting that the presuppositional analysis departs from the classical treatment like the Russellian and the Montagovian analysis.

20) One should note that this is something different from saying that a sentence like (55) is false if the presupposition is infelicitous.

(37a) presupposes that the event of Martians attacking the earth occurred prior to the utterance time. As we saw above in the presuppositional treatment of the definite descriptions, if the presupposition triggered by the past tense in (37a) is felicitous, then the function denoted by the temporal predicate *past*²¹⁾ would be in the domain of the choice function, which is a partial function. If so, we would be able to apply the choice function to the temporal predicate (i.e. $f(\text{past})$ holds) and it would be able to pick the most salient interval. As a result, we would be able to assign a meaning to (37a). On the contrary, what if the presupposition in (37a) were infelicitous? In this case, the function denoted by the temporal predicate *past* would not be in the domain of the choice function-i.e. the domain of the choice function is empty. Thus, the choice function would not be able to apply to the function denoted by the temporal predicate *past*. Consequently, a sentence like (37a) would not be able to be assigned a meaning, which amounts to saying that (37a) is pragmatically anomalous because of the presupposition failure.²²⁾

7. Conclusion

Tense in natural language is frequently interpreted as being definite in some context, and indefinite in other context. This paper has argued that neither the quantificational approach nor the referential approach is sufficient to provide a proper semantic treatment of tense since they

21) Remember that the temporal predicates are of type $\langle i, t \rangle$ with the denotation of functions from intervals to truth values.

22) One anonymous reviewer argues that this claim is strong in the sense that it leads us to say we don't know the truth values of a sentence, even when that sentence is false. However, one should recall that what this paper argues is that a sentence like (37) is assigned no semantic value since we can't calculate a semantics of a sentence like (37). This view, first proposed by Frege, is accepted by semanticists like Heim and Kratzer (1998) and Stalnaker (1974) among others. Let's get back to (37). Once we are aware that Martians never attacked the earth, as was mentioned above, it is hard to say which interval a sentence like (37) makes reference to. The most plausible answer is that (37) does not denote any interval at all. This means that (37) has no semantic value. That is, there is no such thing as the interval picked out by (37). This is because the function denoted by the temporal predicate PAST is not in the domain of the choice function. If it is not in the domain, then the choice function cannot apply to it, which suggests that we cannot apply functional application to calculate a semantics for (37). Given this, we can say that the choice function is a partial function. Inasmuch as there is no past time whatsoever at which Martians attacked the earth, it is reasonable to say (37) picks out no appropriate interval. This suggests that the semantic interpretation of a sentence like (37) crashes because no further semantic calculation is allowed. Thus, (37) is semantically and pragmatically anomalous.

both fail to capture the variability of tense. In order to treat tense in a more proper way by capturing its variability, I have proposed the choice function analysis of tense in this paper. The choice functions are characterized by the fact that they apply to a non-empty set to yield a particular entity from that set. The choice function analysis proposed here is meant to account for the semantics of tense by extending the basic notion of the choice function to the treatment of tense. That is, the choice function for tense applies to a non-empty set of intervals and picks from the set a certain interval the speaker has in mind at the utterance time. Depending on the context of use, the interval selected by the choice function might be definite or indefinite. This is how the choice function analysis captures the variability of tense which has not been well accounted for in terms of the two traditional rivals. Besides, this approach has one advantage over the two traditional approaches since it can provide a unified way to treat the semantics of tense. To my knowledge, what has been proposed in this paper is a first attempt, and further research is definitely needed to evaluate this.

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