

# Section A

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## The Semantic Content of Tensed Sentences



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# Outline for a Truth-Conditional Semantics for Tense

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## 1.1 Introduction

The use of verbs inflected or modified for tense, and temporal adverbs, indexicals, and quantifiers, pervades everyday speech. Getting clearer about their semantics not only promises to help us to understand how we understand each other, but is also a step toward clarifying the nature of time and temporally located thoughts. The goal of this chapter is to investigate, from the standpoint of *truth-theoretic semantics*, English tense, temporal designators and quantifiers, and other expressions we use to relate ourselves and other things to the temporal order. Truth-theoretic semantics provides a particularly illuminating standpoint from which to discuss issues about the semantics of tense and their relation to thoughts at, and about, times. Tense, and temporal modifiers, contribute systematically to conditions under which sentences we utter are true or false. A Tarski-style truth-theoretic semantics, by requiring explicitly represented truth conditions, helps to sharpen questions about the function of tense and to deepen our insight into the contribution the tenses and temporal modifiers make to what we say by using them.

We are interested in a semantic, rather than syntactic, phenomenon. Although tense is identified traditionally with verb inflection, our concern is with linguistic devices used for indicating a time interval, relative to or in which a state or activity is to be understood to occur or obtain. For ease of exposition, we will press ‘tense’ into use to cover any verb form used to indicate time intervals in which the event or state expressed by a verb is to occur or obtain. In English, verb inflection, such as adding ‘-ed’ to a bare infinitive, is one such device. But the phenomenon occurs

even in languages like Chinese that lack inflection for tense. Though we will be concerned solely with tense in English, we are interested in it as an example of a semantic phenomenon common to natural language. The structure of a semantic phenomenon may be expected to reflect underlying facts about the structure of thoughts about contingent particulars. We expect that all languages share basic expressive resources, even when they are realized by diverse syntactic devices.<sup>1</sup>

Our basic approach, which goes back to Frege (1977) and Russell (1903), treats tense as an indexical device for referring to times or time intervals at which events take place or states obtain. Where the time interval picked out is not the present, tense involves what we will call *indexically restricted quantifiers*. The indexical element functions to pick out a time of utterance as a reference point for indicating quantificationally the relative location of temporally bound states and events. While the central idea is intuitively appealing, it has not been systematically explored within a truth-theoretic framework. It turns out to be particularly powerful in its application to systematizing the often puzzling interaction of tense with other temporal devices. Treating tense as quantificational will make it possible to give a uniform account of tense and temporal modifiers and quantifiers in English, and it can be shown to complement in a compelling way the standard event/state analyses of adverbial modification. If the basic account is correct, in our most ordinary remarks we reveal a commitment to the existence of time intervals. Hence, time is real, or virtually everything we say is false.

We begin in section 1.2 with an overview of how to deploy a truth theory as a compositional meaning theory. We show that the requirement that the theory be *interpersonal* precludes a semantics for tense that employs tense operators. In section 1.3, we present an account of the simple tenses (present, past, future) and of the present progressive, and we discuss several methodological points about tense and semantics. In section 1.4, we give an account of deictic and structured temporal referring expressions. In section 1.5, we consider how our basic account interacts with temporal adverbials, and in section 1.6, how it interacts with ‘before’ and ‘after’, used as sentential connectives. In section 1.7, we examine how tense interacts with temporal quantifiers. In section 1.8, we treat so-called habitual sentences. In section 1.9, we examine how our

account of tense interacts with the event analysis of adverbial modification. In section 1.10, we consider the interaction of tense in main and complement clauses of indirect discourse reports and attitude sentences. In section 1.11, we apply applies the account to issues in the philosophy of time, and we discuss the limitations of semantics in metaphysics. Section 1.12 is a summary and conclusion. In the appendix, we show how the account extends smoothly to a truth-conditional semantics for the perfect tenses.

## 1.2 Truth-Theoretic Semantics

A compositional meaning theory for a natural language  $L$  should provide

- (R) from a specification of the meanings of finitely many primitive expressions and rules, a specification of the meaning of an utterance of any of the infinitely many sentences of  $L$ .

We confine our attention to declaratives.<sup>2</sup> A compositional meaning theory for a context-insensitive language  $L$ —that is, a language without elements whose semantic contribution depends on context of use—would issue in theorems of the form

- (M)  $s$  in  $L$  means that  $p$ ,

where ‘ $s$ ’ is replaced by a structural description of a sentence  $\varphi$  of  $L$ , and ‘ $p$ ’ is replaced by a metalanguage sentence that translates it.

For context-insensitive languages, the connection between a theory meeting Tarski’s famous Convention  $T$  and a compositional meaning theory is straightforward: a truth theory meets that convention only if it entails every instance of  $(T)$ ,

- (T)  $s$  is true in  $L$  iff  $p$ ,

where ‘ $s$ ’ is replaced by a structural description of a sentence  $\varphi$  of  $L$ , and ‘ $p$ ’ is replaced by a metalanguage sentence synonymous with  $\varphi$ . We shall call such instances of  $(T)$  *T-sentences*. The relation between a structural description that replaces ‘ $s$ ’ and a metalanguage sentence that replaces ‘ $p$ ’ in a  $T$ -sentence is the same as that between suitable substitution pairs in  $(M)$ . Therefore, every instance of  $(S)$  is true when what replaces ‘ $p$ ’ translates the sentence denoted by what replaces ‘ $s$ ’.

(S) If  $s$  is true in  $L$  iff  $p$ , then  $s$  in  $L$  means that  $p$ .

Given a  $T$ -sentence for  $s$ , (S) enables us to specify its meaning. An advantage of a truth-theoretic approach (over one trying to generate instances of (M) more directly) is its ability to provide the recursions needed to generate meaning specifications for object language sentences from a finite base with no more ontological or logical resources than required for a theory of reference.

In natural languages, many (arguably all) sentences lack truth values independently of use. 'I am tired' is not true or false *simpliciter*, but only as used. This requires discarding the simple accounts above of the forms of theories of meaning and truth. Theories issuing in instances of (M) and (T) for 'I am tired' would yield (1) and (2).

- (1) 'I am tired' in  $L$  means that I am tired.
- (2) 'I am tired' in  $L$  is true iff I am tired.

But (1) and (2) express nothing unless relativized to a context of utterance, and what they express in a context depends on who utters them and the time of utterance. This creates two related difficulties. First, theorists employing identical adequacy criteria will arrive at nonequivalent theories, since they will express different propositions by the sentences they use. Second, no one will give the correct account of the meanings or truth conditions of sentences with context-sensitive elements. Were we each to assert (1), one of us would assert that 'I am tired' means that Ludwig is tired at such and such a time, while the other would assert that it means that Lepore is tired at such and such a time. But 'I am tired' means neither.

A semantics for a language should be couched in a context-insensitive metalanguage. We want theories that any inquirer can reach by meeting generally agreed upon theoretical constraints and that can be used to express the same thing in every context. This requires metalanguage expressions, including semantic predicates, to be untensed. This requirement shows why tense operators cannot be employed to give a semantics for English. An operator like 'it was the case that' is *itself* tensed and hence is unsuitable for use in our metalanguage. Tense logics do not provide a semantics for tense expressions in natural languages; rather,

they represent a regimentation of them, which itself stands in need of a semantics couched in a context-insensitive metalanguage.

In modifying a compositional meaning theory to accommodate context sensitivity, and a truth theory that serves as its recursive engine, a theorist must choose between two options. The first retains the basic form of the meaning specification, ‘ $x$  means in language  $y$  that  $p$ ’, and correspondingly retains within the truth theory a two-place predicate relating a truth bearer and a language. The second adds an argument place to each semantic predicate in the theory for every contextual parameter required to fix a context-sensitive element’s contribution when used. Both approaches require metalanguage semantic predicates to be untensed. For concreteness, we will suppose that the fundamental contextual parameters are utterer and time of utterance.<sup>3</sup> On the first option, which adds no argument places to its semantic predicates, a theory must take utterances as the bearers of meaning and truth and will yield theorems of the forms (M1) and (T1).

(M1) For any speaker  $s$ , time  $t$ , sentence  $\varphi$  of  $L$ , utterance  $u$  of  $\varphi$  by  $s$  at  $t$ ,  $u$  means in  $L$  that  $p$ .

(T1) For any speaker  $s$ , time  $t$ , sentence  $\varphi$  of  $L$ , utterance  $u$  of  $\varphi$  by  $s$  at  $t$ ,  $u$  is true in  $L$  iff  $p$ .

Since different utterances of the same sentence may take different truth values and express different propositions, what replaces ‘ $p$ ’ can be an open sentence with variables bound by the initial quantifiers. The second option adds argument places to semantic predicates, which issues in instances of (M2) and (T2).

(M2) For any speaker  $s$ , time  $t$ , sentence  $\varphi$  of  $L$ ,  $\varphi$  means<sub>[ $s,t,L$ ]</sub> that  $p$ .

(T2) For any speaker  $s$ , time  $t$ , sentence  $\varphi$  of  $L$ ,  $\varphi$  is true<sub>[ $s,t,L$ ]</sub> iff  $p$ .

As a first gloss, we might try to treat ‘means<sub>[ $s,t,L$ ]</sub>’ and ‘is true<sub>[ $s,t,L$ ]</sub>’ as equivalent to ‘means as potentially spoken by  $s$  at  $t$  in  $L$ ’ and ‘is true as potentially spoken by  $s$  at  $t$  in  $L$ ’. However, as Evans (1985, pp. 359–60) points out, we cannot read these as ‘if  $\varphi$  were used by  $s$  at  $t$  in  $L$ , then  $\varphi$  would be true iff/mean that’, since, aside from worries about how to evaluate counterfactuals, these interpretations would assign sentences such as ‘I am silent’ false  $T$ -theorems. What we need are the readings

‘if  $\varphi$  were used by  $s$  at  $t$  in  $L$ , as things actually stand  $\varphi$  would be true iff/mean that’ or, alternatively, ‘ $\varphi$  understood as it would be in  $L$  if spoken by  $s$  at  $t$  is true iff/means that’. Mutatis mutandis for other semantic predicates.

If either option issues in an adequate meaning theory, so does the other. Both treat actual uses of sentences as fundamental in understanding truth and propositional meaning. We adopt the second because it issues in theorems more directly informative about *sentence* meaning, which is our stated subject. We therefore replace adequacy criterion (R) with (R’).

(R’) A compositional meaning theory for a natural language  $L$  should entail, from a specification of the meanings of primitive expressions of  $L$ , all true sentences of form (M2).

The analogue of Tarski’s Convention  $T$  for recursive truth theories for natural languages we shall call Davidson’s Convention  $D$ .

(D) An adequate truth theory for a natural language  $L$  must entail every instance of (T2) such that corresponding instances of (M2) are true.

A truth theory for  $L$  meeting (D) with axioms that interpret primitive expressions of  $L$  (henceforth ‘an interpretive truth theory’) provides the resources to meet (R’). (For a further discussion of the framework for truth-theoretic semantics, see Lepore and Ludwig 2003, pts. I and IV.)

### 1.3 The Simple Tenses

In this section, we consider the semantics of simple tenses, beginning with state verbs in section 1.3.1 and proceeding to event verbs in section 1.3.2. In section 1.3.3, we will argue that the tradition that treats the progressive as a tense is poorly conceived from the standpoint of truth-theoretic semantics.

#### 1.3.1 Indexicality of Tense for State Verbs

The most salient feature of tense is that its contribution to the meaning of utterances is sensitive to the time of utterance. Each of (3)–(5), in the

present, past, and future tense,<sup>4</sup> respectively, may be true when uttered by a speaker at some times but not at others.

- (3) Mary loves Bill.
- (4) Mary loved Bill.
- (5) Mary will love Bill.<sup>5</sup>

This indicates that (3)–(5) each contain a deictic element, either an indexical or a demonstrative device (we will use ‘deictic’ as generic for context sensitivity). From the standpoint of truth-theoretic semantics, a sentence contains a deictic element if and only if its *T*-sentence has variables on its right-hand side bound by quantifiers that bind contextual parameters in its truth predicate. If the values of the minimal set of contextual parameters alone suffice for understanding what the semantic value of a deictic element is, it is an indexical device; otherwise, it is (in part at least) a demonstrative device.

With (3)–(5), in which tense is the only deictic element, knowing the time of utterance suffices for understanding the contributions of their deictic elements. So the simple tenses are indexicals. This requires that the propositions (3)–(5) express in a context involve direct reference to the time of utterance, since the variable bound by the temporal quantifier in whose scope the biconditional falls is a directly referring term. On the assumption that the proposition expressed by an utterance provides the content of the speaker’s belief, every thought expressed using the present, past, and future tense is singular, since it directly refers to the time of utterance.

The case for regarding at least some tenses as quantifying over times is straightforward. When asserting (3), a speaker intends to say that Mary loves Bill then. When using (4), he intends to say that *at some time prior to his utterance* Mary loved Bill. Similarly, when using (5), he intends to say that *at some time after the time of his utterance* Mary will love Bill. In the latter two, clearly, the thoughts expressed quantify, respectively, over past and future times.

Unfortunately, in stating this, we reused the tenses we intend to explain. Even if untensed verbs are used in English, they cannot grammatically replace simple tensed ones.<sup>6</sup> This has an important consequence for

the semantics of English: namely, *its semantic theory is unspecifiable in English*. For reasons provided in section 1.2, interpretive truth theories cannot use deictic elements in specifying truth conditions of object language expressions, on pain of being uninterpretable. So providing an adequate interpersonal interpretive truth theory for English requires enriching the metalanguage with tenseless verbs that express relations between objects or events and times. For this purpose, we will use the present tense form, adding a variable in parentheses for the temporal argument place; for example, ‘loves(*t*)’ is the tenseless verb in the metalanguage corresponding to ‘loves’ in English.

Treating past and future tenses as indexical quantifiers introduces a second difficulty: namely, the object language lacks explicit markers for temporal variables. Natural language syntax, from the perspective of semantics, is understated. In trying to gain an explicit understanding of how languages work, we inevitably are drawn to paraphrases that yield more explicit syntactic representations of the semantic structures of expressions we study. This is familiar from the study of (other) quantifier phrases in natural languages, whose resources for indicating binding relations show all the marks of having been cobbled together on an as-needed basis. Tense makes this particularly vivid, since, in contrast to the case of more general quantifiers, here even familiar devices of pronominal cross-reference are missing, and binding relations are indicated more subtly.

For present purposes, we will simply specify satisfaction conditions for an extension of English in what we will call *English\**. *English\** includes the usual apparatus for regimenting restricted quantification, as well as tenseless verbs that homophonically translate the tenseless verbs required in the metalanguage to provide tenseless truth conditions. *English\** also includes a referring term ‘*t\**’ with the following reference axiom (stipulated to be interpretive): For any speaker *s*, time *t*,  $\text{ref}_{[s,t]}('t^*') = t$ .<sup>7</sup> (While this may seem also to be a natural axiom for ‘now’, we introduce ‘*t\**’ because it is unclear whether they are synonymous (see section 1.4).)

With this as background, leaving implicit the relativization of semantic predicates to *English\**, we can present satisfaction conditions for (3)–(5) in (6)–(8), respectively.<sup>8</sup>

- (6) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies $_{[s,t]}$  ‘Mary loves Bill’ iff  $f$  satisfies $_{[s,t]}$  ‘Mary loves( $t^*$ ) Bill’.
- (7) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies $_{[s,t]}$  ‘Mary loved Bill’ iff  $f$  satisfies $_{[s,t]}$  ‘[There is a time  $t_1 : t_1 < t^*$ ](Mary loves( $t_1$ ) Bill)’.
- (8) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies $_{[s,t]}$  ‘Mary will love Bill’ iff  $f$  satisfies $_{[s,t]}$  ‘[There is a time  $t_1 : t_1 > t^*$ ](Mary loves( $t_1$ ) Bill)’.

(‘ $x < y$ ’ and ‘ $x > y$ ’ mean ‘ $x$  is earlier than  $y$ ’ and ‘ $x$  is later than  $y$ ’.) Given the reference clause for ‘ $t^*$ ’, it is clear that each of (6)–(8) indexes to utterance time. Appropriate reference axioms applied to (6) yield (9), which in turn yields the  $T$ -sentence (10). Similarly, (8) yields (11).

- (9) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies $_{[s,t]}$  ‘Mary loves Bill’ iff Mary loves( $t$ ) Bill.
- (10) For any speaker  $s$ , time  $t$ , ‘Mary loves Bill’ is true $_{[s,t]}$  iff Mary loves( $t$ ) Bill.
- (11) For any speaker  $s$ , time  $t$ , ‘Mary will love Bill’ is true $_{[s,t]}$  iff [there is a  $t_1 : t_1 > t$ ](Mary loves( $t_1$ ) Bill).

Satisfaction clauses for English tensed and corresponding English\* untensed sentences are the same. Since satisfaction conditions for English\* sentences present no special difficulty,<sup>9</sup> where appropriate, we will use English\* to represent satisfaction conditions of English sentences.

Satisfaction conditions (6)–(8) treat the present tense differently from the past and future tenses. The past and future tenses function as restricted indexical quantifiers, whereas the present tense functions as a simple indexical. We might try to treat the present tense as requiring restricted quantification, as in (12).

- (12) [There is a time  $t_1 : t_1 = t^*$ ](Mary loves( $t_1$ ) Bill).

But in addition to its being superfluous, considerations about how simple tenses embed in complex expressions provide reasons against the quantification in (12) (see section 1.5).

(7) and (8) reveal that the past and future tenses are, from the perspective of truth-theoretic semantics, restricted indexical existential quantifiers. Existential quantification is required, since utterances in

these tenses reveal only that some event occurred in the past or will occur in the future *at some time or other*. They are *indexical* quantifier expressions because the predicate restrictions on the quantifier in their English\* translations contain an indexical.

One important consequence of this treatment is that we can never reexpress in English what we express on a given occasion using a tensed sentence. (This has important consequences for the semantics of indirect discourse and attitude sentences. See section 1.7.) If someone were to assert, ‘Mary loves Bill’, at  $t$ , he would express a proposition directly about  $t$ . To reexpress that same proposition later, it would not do to use the present tense, since any new utterance would be about a *different* time. But using the past tense, even with an adverbial modifier, would still involve direct reference to the time of utterance, which would be later than  $t$ . Suppose someone were to utter, ‘Mary loved Bill at  $t'$ ’. Since ‘at  $t'$ ’ determines a time earlier than *the time of utterance* at which Mary is asserted to have loved Bill, the speaker still refers to the utterance time and hence fails to express the original. There is nothing conceptually incoherent about reexpressing a proposition; English\* allows us to do so. But this feature of natural languages is surely no accident. Our access to time in thought involves reference to the present time. We step into the river of time only at that point on the bank at which we stand, the perpetual present, and we locate other times fundamentally by reference to that standpoint. Reexpressing the same proposition twice in English\* would involve using a directly referring term to pick the time out rigidly. But we would secure the referent of a directly referring term in thought only by describing its relation to the present time.<sup>10</sup>

As we represent tense, the future and past tenses involve quantification. However, unlike explicit quantification, quantification in tense, because it is lexically internal, takes narrow scope with respect to explicit quantifiers.<sup>11</sup> Sentences with explicit quantifiers receive recursive clauses in the truth theory, as in (13) (treating ‘everyone’ and ‘someone’ as unrestricted quantifiers for present purposes).

- (13) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies<sub>[ $s, t$ ]</sub> ‘Everyone( $x$ ) met someone( $y$ )’ iff every ‘ $x$ ’-variant  $f'$  of  $f$  satisfies<sub>[ $s, t$ ]</sub> ‘ $x$  met someone( $y$ )’.

In the standard sort of truth theory we are envisaging, both explicit quantifiers in ‘Everyone met someone’ would be unpacked before the axiom for its verb could be invoked, forcing the quantifier involved in tense always to take narrow scope, as in (14) and (15).

- (14) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies $_{[s,t]}$  ‘Everyone( $x$ ) met someone( $y$ )’ iff every ‘ $x$ ’-variant  $f'$  of  $f$  is such that some ‘ $y$ ’-variant  $f''$  of  $f'$  satisfies $_{[s,t]}$  ‘ $x$  met  $y$ ’.
- (15) For all speakers  $s$ , times  $t$ , functions  $f$ ,  $f$  satisfies $_{[s,t]}$  ‘Everyone( $x$ ) met someone( $y$ )’ iff every ‘ $x$ ’-variant  $f'$  of  $f$  is such that some ‘ $y$ ’-variant  $f''$  of  $f'$  is such that  $f''$  satisfies $_{[s,t]}$  ‘[There is a time  $t_1 : t_1 < t^*$ ]( $x$  meets( $t_1$ )  $y$ )’.<sup>12,13</sup>

### 1.3.2 Event Verbs

In contrast to state verbs, event verbs apply to an object at a time only if it is undergoing some change. Neither ‘Bill loved Mary’ nor ‘Bill weighed 145 lbs.’ implies that Bill has undergone change; but ‘Bill left’ implies that Bill underwent a change, minimally, of position. Also, event verbs, in contrast to most state verbs, take a progressive form by concatenating ‘is’ with the present participle morpheme. Corresponding to ‘leave’ is ‘is leaving’. The same operation on state verbs is generally ill formed; no form ‘is knowing’ corresponds to ‘know’. (This is not uniform, as is shown by ‘block’, ‘stand’, and ‘occupy’. But these have uses as event verbs as well.)

It is natural to suppose that the simple tenses function uniformly independently of the semantic category of a verb. If so, we should be able to provide a uniform treatment for state and event verbs. While this works smoothly for the past and future tenses of event verbs, it doesn’t for the present tense. Compare (16) with (17) and (18).

- (16) Mary loves Bill.
- (17) Mary leaves.
- (18) Mary opens the door.

An utterance of (16) is true if Mary loves Bill at the time of utterance. But it is difficult to find circumstances under which we comfortably assert (17) or (18) unembedded or unmodified (in contrast to, e.g., ‘If Mary

leaves, I will too' or 'Mary leaves on the 23rd of this month').<sup>14</sup> Even though events typically require more time to complete than utterances of sentences with present-tensed event verbs, this hardly explains the data. (17) is no less odd when said slowly enough for Mary to leave during its utterance. Moreover, many events require no more time than would an assertion that they were occurring (e.g., 'Bill speaks'), but their present tense utterances are no less odd. (We will consider sentences like 'Bill works for a living' in section 1.8. These typically express generality.) We know of no adequate explanation of this aspect of present tense event verbs.

There doesn't seem to be anything conceptually incoherent about a semantics for present tense event verbs that parallels our semantics for present tense state verbs. Moreover, not all natural languages share the awkwardness of present tense event verb sentences with English. This suggests that it is an idiosyncrasy of English and has nothing to do with the fact that these are event verbs *per se*.

If we are right, present tense event verbs do not index to the time of utterance. Yet from our treatment of past and future tenses, which parallels that for state verbs, it is clear that event verbs express a relation between one or more things and a time. If the implicit argument places for time in present tense event verbs were bound by a quantifier in sentences containing them, there would not be a puzzle about the truth value of their utterances. We suggest, then, that the argument place for time in present tense event verbs is unbound in unembedded and unmodified uses, and that the oddity in uttering (17) and (18) is due to their being open sentences and thereby truth-valueless. If we are right, (17) will receive (19) as its satisfaction clause, where '*t*' is a free variable. Satisfaction conditions for past and future tenses for 'leaves', in contrast, are given by (20) and (21).

(19) For any speaker *s*, time *t*, function *f*, *f* satisfies<sub>[*s*,*t*]</sub> 'Mary leaves'  
iff *f* satisfies<sub>[*s*,*t*]</sub> 'Mary leaves(*t*)'.

(20) [There is a *t*<sub>1</sub> : *t*<sub>1</sub> < *t*<sup>\*</sup>](Mary leaves(*t*<sub>1</sub>)).

(21) [There is a *t*<sub>1</sub> : *t*<sub>1</sub> > *t*<sup>\*</sup>](Mary leaves(*t*<sub>1</sub>)).

(20) and (21) represent past and future tenses with an indexical reference to the time of utterance because of the indexical '*t*<sup>\*</sup>' in the restriction on

their quantifiers. The asymmetry in treatments of past and future tenses of event verbs, on the one hand, and present tense, on the other, might be regarded as a defect. But it explains the oddity of utterances of (17) and (18), which an account treating them as parallel to state verbs would fail to do. Whether the proposal is satisfactory depends on how well it integrates into an account of how present tense event verbs interact with temporal adverbials and quantifiers, and on whether a simpler account of the data can be given. While we cannot show that no simpler account is available, we will show in sections 1.4 and 1.5 how to integrate our treatment with one for temporal adverbials and quantifiers.

### 1.3.3 The Progressive

The progressive is formed by adding ‘-ing’ to (the truncation of) the infinitive of an event verb. The concatenation of ‘is’ with a gerund has traditionally been treated as a tense. From our perspective, however, classifying the progressive as a tense is a mistake.<sup>15</sup> While ‘is leaving’ is tensed, since it indexes to time of utterance, its treatment in a truth-theoretic semantics should not distinguish it from the present tense state verbs. The contribution of tense to ‘is leaving’ (the dimension of variation among ‘is leaving’, ‘was leaving’, and ‘will be leaving’) is represented by the tenseless English\* (22).

(22) Bill is leaving( $t^*$ ).

So represented, the present progressive picks out the time of utterance relative to which an implicit argument in the verb is evaluated, just like present tense state verbs. (However, progressives behave like event verbs in their interaction with future-looking or neutral adverbials, like ‘noon’ or ‘on Tuesday’; this appears to be because of the pull of the analogy of form with the future formed from ‘to be’ + ‘going’ + the infinitive.)

Treating ‘is leaving’ as a tense of ‘leave’ requires exhibiting its satisfaction conditions as derived from those for the untensed verb ‘leaves( $t$ )’ in English\*. This may seem intuitively the right thing to do, since ‘is leaving’ is clearly related to the infinitive ‘to leave’. But this is insufficient to settle whether the connection is conceptual or structural. A virtue of the truth-theoretic approach is that it provides a precise way of distinguishing conceptual from structural connections.

When two verbs are *structurally* related, the same (or a synonymous) metalanguage verb is used in their satisfaction conditions, and the only variation between the satisfaction conditions will be variations in the quantificational apparatus invoked by tense. If the connection is not structural, distinct metalanguage verbs will be used in giving satisfaction conditions.

In light of this, (22) represents appropriate satisfaction conditions for ‘is leaving’ only if the relation expressed by ‘is leaving’ (‘was leaving’, ‘will be leaving’) is distinct from what is expressed by ‘leaves’ (‘left’, ‘will leave’). That they are distinct is shown by the fact that someone can be leaving, and not leave, or will be leaving, and never leave. While anyone who leaves the room was leaving, his leaving doesn’t require that he left or ever will: he might collapse halfway out the door. He was leaving, even though he never left. The point is even more transparent with other event verbs: someone may be *writing* a book, but never *write* it. These examples help clarify the relation between ‘was leaving’ and ‘left’: the former relates an agent to a time interval in which he is *engaged* in an activity that may lead to the kind of event the latter relates an agent to.

If correct, this dissolves the so-called imperfective paradox.<sup>16</sup> This paradox arises on the assumption that the progressive of an accomplishment verb like ‘leaves’ is a tense. ‘Leaves(*t*)’ applies to an object *x* at a time *t* only if after *t* ‘*x* left’ applies to it. If ‘is leaving’ were a tense of ‘leave’, then ‘is leaving’ would apply at *t* to something only if after *t* ‘left’ applied to it. This is obviously incorrect. But the pressure to accept the paradoxical result dissipates once we deny that the progressive form of ‘is leaving’ is a tense of ‘leaves’.

Progressives are neither state verbs nor event verbs. They express the occurrence at a time of a portion of a process that, if completed, constitutes an event of the type expressed by the verbs from which they are lexically derived. We shall, following common sense and an earlier tradition, call them *process verbs*.<sup>17</sup>

#### 1.4 Temporal Designators

Temporal designators divide into deictic designators, such as ‘now’ and ‘tonight’, and structured designators, such as ‘December 7, 1942’.

We begin with ‘now’ and ‘then’. It is natural to treat ‘now’ as parallel to ‘I’, and ‘then’ as parallel to ‘that’. Whereas ‘I’ is used to pick out the speaker of an utterance, ‘now’ is used to pick out its time. ‘That’ functions as a demonstrative, and ‘then’ as a demonstrative restricted to times. A standard reference clause for ‘I’ is (23); a reference clause modeled on it for ‘now’ is (24). Likewise, a reference clause for ‘that’ is (25), and a parallel reference clause for ‘then’ is (26).

(23) For any speaker  $s$ , time  $t$ ,  $\text{ref}_{[s,t]}(\text{'I'}) = s$ .

(24) For any speaker  $s$ , time  $t$ ,  $\text{ref}_{[s,t]}(\text{'now'}) = t$ .

(25) For any speaker  $s$ , time  $t$ , item  $x$ , if  $s$  demonstrates  $x$  at  $t$  with ‘that’,  $\text{ref}_{[s,t]}(\text{'that'}) = x$ .<sup>18</sup>

(26) For any speaker  $s$ , times  $t, t_1$ , if  $s$  demonstrates  $t_1$  at  $t$  with ‘then’,  $\text{ref}_{[s,t]}(\text{'then'}) = t_1$ .<sup>19</sup>

(25) and (26) assign a referent only if a speaker demonstrates something using the demonstrative expression. This is because even relative to a speaker and a time, a demonstrative sentence has a truth value only if the speaker performs an act of demonstration. In this way, demonstratives differ from indexicals, whose referents are completely determined by contextual parameters.

Treating ‘now’ as indexing the time of utterance is standard, but inadequate for many of its uses—for example, in issuing commands like ‘Do it now, not later’, or in sentences like ‘Now I have a lot more time to do what I am interested in’. Speakers using such sentences would not intend to be interpreted as referring only to the time of their utterances. Someone who says, ‘Do it now, not later’, would not be thought to have commanded the impossible. We *may* be able to treat these uses as creating conversational implicatures, but they are so routine that we are inclined to suggest that ‘now’ has a demonstrative as well as an indexical element. While a use of ‘now’ refers to a time that includes the utterance time, it can also refer to time extending beyond, and perhaps before, it. To accommodate these uses, we can modify (24) as in (27).

(27) For any speaker  $s$ , times  $t, t_1$ , if  $t_1$  is the interval including  $t$  referred to by  $s$  at  $t$  using ‘now’,  $\text{ref}_{[s,t]}(\text{'now'}) = t_1$ .

(This could be modified to require that the referent be the utterance time where the speaker lacks appropriate referential intentions.) Natural lan-

guages provide an array of descriptive indexical devices for referring to times or time intervals related specifically to the present—for example, in English, ‘today’, ‘tomorrow’, ‘tonight’, ‘yesterday’, ‘last year’, ‘next year’. A general treatment for descriptive indexical devices is illustrated in (28) and (29).

(28) For any speaker  $s$ , times  $t, t_1$ , such that  $t_1 =$  the night of  $t$ ,  
 $\text{ref}_{[s,t]}(\text{‘tonight’}) = t_1$ .

(29) For any speaker  $s$ , times  $t, t_1$ , such that  $t_1 =$  the day before  $t$ ,  
 $\text{ref}_{[s,t]}(\text{‘yesterday’}) = t_1$ .

Temporal indexicals directly refer.<sup>20</sup> In  $T$ -sentences derived from axioms like (28) and (29), the descriptive material does not contribute to truth conditions. The  $T$ -sentence for ‘Tonight is the night’, instantiated to speaker  $s'$  and time  $t'$ , would be (30).

(30) ‘Tonight is the night’ is true $_{[s',t']}$  iff  $t'$  is the night.

Treating descriptive indexicals as directly referring terms is required because coreferring descriptive indexicals can be interchanged *salva veritate*. We can report your assertion *yesterday* of ‘Today is Sunday’ by saying *today* that you said that yesterday was Sunday (note the shift in tense: we will discuss tense sequencing in complement clauses in section 1.10).<sup>21</sup>

We might try to treat structured temporal designators such as ‘January 1, 2001’ either as semantically equivalent to definite descriptions (e.g., ‘the first day of January of the 2,000th year after  $\varphi$ ’, where ‘ $\varphi$ ’ is replaced by a term that picks out an anchor year for the date system—(1 A.D. for the Gregorian calendar) or as having their referents merely fixed by a definite description. We opt for the latter approach. The first approach fails in modal contexts if we substitute for ‘ $\varphi$ ’ a description of an anchor year, such as ‘the year of the birth of Christ’ (or, more accurately, ‘the year thought to be the year of Christ’s birth by Dionysius Exiguus’, four or five years after the birth of the historical Christ; we will use the shorter description for convenience).<sup>22</sup> Intuitively, ‘Necessarily, the year of the birth of Christ was 2,000 years before January 1, 2001’ is false. Christ could have been born earlier or later than he was (or Dionysius could have thought him to be born earlier or later). But if ‘January 1, 2001’ were equivalent to ‘the first day of January 2,000 years after the

year of the birth of Christ', it would be true, at least on the narrow scope reading. But there is no true reading of the original. To avoid this objection, we could introduce rigidified definite descriptions such as 'the year of the actual birth of Christ', but speakers' competence with the use of date terms does not seem to be contingent on knowing any particular description of the anchor time. We will settle then for a reference clause for date formats, as in (31), using 'Annus Domini' as a *proper name* referring to the year Dionysius Exiguus thought to be the year of Christ's birth.

- (31) For any speaker  $s$ , time  $t$ , numerals  $n_1, n_2$ , month term  $M$ , if  
 $t = \text{day ref}_{[s, t]}(n_1)$  of the month of the year  $\text{ref}_{[s, t]}(n_2) - 1$  years  
 after Annus Domini that satisfies  $M$ , then  $\text{ref}_{[s, t]}(\ulcorner n_1 M n_2 \urcorner) = t$ .

We follow King (2001) here in treating month terms as predicates of time intervals.<sup>23</sup> 'This month is January' uttered in January 2001 is not, for instance, elliptical for 'This month is January 2001', since one could know what the former is used to express without knowing what the latter is used to express, and thus the 'is' here is the copula. This seems also required for the natural semantic treatment of quantifiers using month terms as nominals, such as 'Every January it is cold' and 'Some Aprils are windy, but not all', which would be represented as '[Every time  $t : t$  is January](it is( $t$ ) is cold)' and '[Some times  $t : t$  is April]( $t$  is windy) &  $\sim$ [All times  $t : t$  is April]( $t$  is windy)'. Similar remarks apply to day terms: 'Monday', 'Tuesday', and so on. These terms express properties of time intervals they have in virtue of being intervals individuated in a certain way and lying in a certain order in a calendar system.<sup>24</sup>

## 1.5 Temporal Adverbs and Adverbials

In this section, we discuss relational temporal adverbials such as 'at midnight', 'before noon', 'two days hence', 'yesterday', 'tonight', 'between 2 and 3 p.m.'.<sup>25</sup> Temporal adverbials may be forward looking ('tomorrow', 'next week'), backward looking ('yesterday', 'a month ago', 'last week'), about the present ('now', 'at this moment', 'currently'), or neutral ('on Tuesday', 'in May'). We will call these *future*, *past*, *present*, and *unanchored* adverbials, respectively.<sup>26</sup> A verb's tense restricts what modifiers it can take. The simple past may take past adverbials or

unanchored adverbials, but neither present nor future adverbials. ‘John slept last week’ and ‘John slept through May’ are fine, but ‘John slept right now’ and ‘John slept in three days’ are not. The future tense may be modified by unanchored, present, or future adverbials, but not past adverbials. ‘John will sleep on Tuesday’, ‘John will sleep now’, and ‘John will sleep tomorrow’ are all acceptable, but ‘John will sleep last week’ is not. An event verb in present tense may be modified by unanchored or future adverbials, as in ‘John leaves on Tuesday’ and ‘John leaves next week’, and perhaps by present adverbials, as in ‘John leaves now’, but it will not accept a past adverbial, as in ‘John leaves yesterday’. In contrast, present tense state verbs take only present adverbials. ‘I am tired right now’ is acceptable, but ‘I am tired next week’ and ‘I am tired last year’ are not.

We begin with adverbial modification of sentences in the simple past. We propose a uniform treatment of relational adverbials that will secure entailment relations like those in (32).

- (32) Bill loved Mary yesterday.  
 Therefore, Bill loved Mary sometime.  
 Therefore, Bill loved Mary.

We are already committed to quantifying over times because of our treatment of simple tenses. ‘Bill loved Mary’ is equivalent to ‘[There is a time  $t_1 : t_1 < t^*$ ](Bill loves( $t_1$ ) Mary)’. Modifying ‘Bill loved Mary’ with the adverb ‘yesterday’ has the effect of specifying the time interval in the past relative to the present when Bill loved Mary—that is, specifying that it is identical with or included in yesterday. This recommends assigning ‘Bill loved Mary yesterday’ satisfaction conditions equivalent to (33), where ‘ $\subseteq$ ’ is read as ‘is included in or identical with’.

- (33) [There is a  $t_1 : t_1 < t^*$  &  $t_1 \subseteq$  yesterday](Bill loves( $t_1$ ) Mary).

We include the adjunct in the restriction on the quantifier because the adverb is intuitively modifying the element contributed by the tense.

Adverbial phrases formed by combining a preposition with a temporal designator receive similar treatment. What varies is the temporal property expressed by the prepositional phrase. ‘Bill loved Mary for two hours’ is equivalent to ‘[There is a  $t_1 : t_1 < t^*$  & the duration of  $t_1$  is two hours](Bill loves Mary( $t_1$ ))’. ‘Bill loved Mary before midnight’ is equiva-

lent to ‘[There is a  $t_1 : t_1 < t^*$  &  $t_1$  is before midnight](Bill loves( $t_1$ ) Mary)’. ‘Bill loved Mary in June’ is equivalent to ‘[There is a  $t_1 : t_1 < t^*$  &  $t_1$  is in some June/the first June before  $t^*$ ](Bill loves( $t_1$ ) Mary)’. The satisfaction conditions in (33) underwrite the entailments in (32). Our treatment correctly predicts restrictions on modifiers of verbs in the past tense. Future or present adverbials will require the time of an event to be in the future or the present, but the tense of the verb requires it to be in the past. Unanchored adverbials are treated as existentially quantified or implicitly deictic, where neither requires the times of which they are predicated to be in the future, past, or present vis-à-vis the time of utterance.

The future tense receives a parallel treatment (with ‘>’ substituted for ‘<’). However, we must say something about the use of ‘now’ with a future tense verb; to avoid incoherence, this should be understood as sentential and not adverbial modification. ‘John will sleep now’ should be read as ‘It is now the case that John will sleep’. Our discussion of tense in complement clauses will cover this case. For present tense state verbs, satisfaction conditions are illustrated for ‘Bill loves Mary now’ in (34).

(34) Bill loves( $t^*$ ) Mary &  $t^* \subseteq$  now.

Our treatment of past and future tense event verbs exactly parallels that of present and past tense state verbs, but the situation is more complex with present tense event verbs, such as ‘leaves’ or ‘speaks’. One can modify a state verb with a present adverbial, but not with future, past, or unanchored adverbials. In contrast, while present tense event verbs, like present tense state verbs, cannot be modified by past adverbials, they can be modified by future adverbials, and, arguably, present adverbials, though unlike with state verbs it is awkward to do so. (35) is unexceptional, (36) unacceptable, while (37) is awkward.

(35) John leaves tomorrow.

(36) John leaves yesterday.

(37) John leaves now.

We suspect that anyone who finds (37) acceptable is imagining it as a reply to ‘When does John leave?’, where the reply is expected to indicate a future time, while in fact John’s departure is scheduled for the present.

If ‘John leaves’ is an open sentence, adding a modifier binds the free argument place for time. If (36) and (37) are semantically unacceptable, the quantifier is restricted to future times; if (36) alone is unacceptable, the restriction is to times contemporaneous with the utterance or later. We tentatively assume (37) is semantically acceptable. ‘John leaves tomorrow’ then receives the following satisfaction conditions:

(38) [There is a  $t_1 : t_1 \geq t^* \ \& \ t_1 \subseteq \text{tomorrow}$ ](John leaves( $t_1$ )).

The restriction to present or future times explains the restriction on which adverbials can modify a present tense verb. Present tense verbs modified by unanchored adverbials, such as ‘on Tuesday’, are likewise interpreted as future looking.

This account treats nonquantificational temporal adverbials as predicates of an implicitly quantified temporal variable. Unacceptable combinations of tense and adverbials are due not to a structural or logical defect, but to semantic incompatibility. Even for unacceptable forms, there is no difficulty in identifying their logical form. What renders them unacceptable is a conflict between the requirement imposed on the event time by tense and what the meaning of the adverbial requires. (Our treatment of temporal adverbials is reminiscent of Davidson’s (1980) treatment of event adverbials. However, Davidson treats temporal adverbials as predicates of events as well. In section 1.9, we will argue that this is mistaken.)

## 1.6 ‘Before’ and ‘After’

‘Before’ and ‘after’ can function as sentential connectives (as in ‘Brutus hailed Caesar before he killed him’), as components in relational predicates flanked by event or temporal designators when concatenated with the copula (as in ‘Midnight is before noon’), and as adverbials (as in ‘before tomorrow’, ‘before Mary’). An adequate semantic account of ‘before’ and ‘after’ should exhibit them playing the same semantic role in each of these constructions. A simple unified account is suggested by our approach. A sentence such as ‘Brutus hailed Caesar before he killed him’ will be represented as involving two existential quantifiers over past times relative to the present. ‘Before’ naturally modifies the verb in the clause preceding it by relating its time to that of the verb used in the

clause following it. So ‘before’ is a relational predicate of times. Satisfaction conditions for ‘Brutus hailed Caesar before he killed him’ would then be represented as in (39).

- (39) [There is a time  $t_1 : t_1 < t^*$ ][there is a time  $t_2 : t_2 < t^*$  &  $t_1$  is before  $t_2$ ](Brutus hails( $t_1$ ) Caesar and Brutus kills( $t_2$ ) Caesar).

This suggestion extends to ‘after’ and other temporal relational terms, such as ‘at the same time as’ (or simply ‘as’), ‘until’ (‘before but not after’), and their modifications, such as ‘a few minutes before’. (‘Since’, which is used with the perfect tenses, is more complicated, but the same idea applies; see the appendix for discussion.) Some relational terms are themselves complex. But there appears to be a uniform contribution of the modifiers of simple relational terms. ‘ $x$  is  $M$  before  $y$ ’ can be unpacked as ‘ $x$  is before  $y$  and  $\text{INT}(x, y) = M$ ’, where ‘ $\text{INT}(x, y)$ ’ means ‘the interval between  $x$  and  $y$ ’. This licenses general satisfaction conditions for sentences of the form  $\ulcorner \varphi M R \psi \urcorner$ , where ‘ $R$ ’ is replaced by a simple temporal relational predicate and ‘ $M$ ’ by its modifier. This treatment explains why ‘before’ and ‘after’ are not truth-functional connectives, for the underlying logical form exhibits ‘before’ and ‘after’ as contributing temporal relational predicates.

Occurrences of ‘before’ and ‘after’ in adverbials function to relate times as indicated in the previous section. Satisfaction conditions for (40) are given in (41).

- (40) John will leave before tomorrow.

- (41) [There is a  $t_1 : t_1 > t^*$  &  $t_1$  is before tomorrow](John leaves( $t_1$ )).

Sentences of the form  $\ulcorner \varphi$  before  $\alpha \urcorner$ , where  $\varphi$  is a sentence and  $\alpha$  a noun phrase but not a temporal designator, will be treated as having the underlying form  $\ulcorner \varphi$  before  $\psi \urcorner$ , where  $\varphi$  and  $\psi$  are sentences. If  $\alpha$  is a predicate nominalization, such as ‘being fined’, then  $\psi = \alpha\text{UNOM}(\alpha, T)$ , where  $\text{UNOM}(x, y)$  yields a predicate of which  $x$  is a nominalization with the tense marker  $y$ , where  $y$  will be the tense of the main verb.  $\text{UNOM}(\text{‘being fined’}, \text{future}) = \text{‘will be fined’}$ , while  $\text{UNOM}(\text{‘being fined’}, \text{past}) = \text{‘was fined’}$ . If  $\alpha$  is a singular term or quantified noun phrase,  $\psi = \alpha\text{PRED}(\varphi)$ , where  $\text{PRED}(x)$  is the predicate of  $x$ .  $\text{PRED}(\text{‘John will leave’}) = \text{‘will leave’}$ . ‘John will leave before Mary’ has the satisfaction conditions represented in (42).

- (42) [There is a time  $t_1 : t_1 < t$ ][there is a time  $t_2 : t_2 < t$  &  $t_1$  is before  $t_2$ ](John leaves( $t_1$ ) and Mary leaves( $t_2$ )).

## 1.7 Temporal Quantifiers

Natural languages provide a large variety of temporal quantifiers. In English, these include, for example, (1) unrestricted temporal quantifiers such as ‘always’, ‘anytime’, ‘sometimes’, ‘once’, ‘twice’; (2) restricted-interval temporal quantifiers, such as ‘someday’, ‘every day’, ‘daily’, ‘weekly’, ‘monthly’, ‘yearly’, ‘two times a day’, ‘twice a week’; (3) non-specific frequency quantifiers, such as ‘seldom’, ‘often’, ‘infrequently’, ‘frequently’, ‘regularly’, and ‘intermittently’, which do not specify a particular interval, and some of which exhibit topic dependence; and (4) unrestricted temporal quantifiers such as ‘when’ and ‘whenever’, which, though adverbs, introduce subordinate clauses and function syntactically as sentential connectives. All of these quantify over times, binding unarticulated argument places in one or more verbs.<sup>27</sup> We treat these four classes in order. This is intended to be an illustrative, rather than exhaustive, treatment of temporal quantifiers in English.

1. The past and future tenses interact with temporal quantifiers differently than the present. We begin with present tense. (43) (typical uses of which would be hyperbole) means roughly that John’s hair is a mess at all times, and it can clearly be used on different occasions to express the same proposition.

- (43) John’s hair is always a mess.

Although (43) is in the present tense, when modified by a temporal quantifier, it does not function as an indexical. In representing its truth conditions, then, we should treat the unarticulated argument place as bound by the temporal quantifier, rather than as functioning indexically. This leads to (44) (*mutatis mutandis* for other unrestricted temporal quantifiers).

- (44) [For all times  $t_1$ ](John’s hair is( $t_1$ ) a mess).

In contrast, utterances of (45) at different times express different propositions.

- (45) John’s hair was always a mess.

An utterance of (45) yesterday would be true if and only if at every time before it John's hair was a mess, but its utterance today would require also that in the intervening time his hair remain unkempt. Similarly for the future tense. Thus, whereas by modifying a present tense verb we can transform a context-sensitive sentence into a context-independent one (other deictic terms aside), past and future tense verbs remain deictic when so modified. This is one reason not to treat the present tense as involving quantification like the past and future, for it would mean treating it as combining with quantificational adverbials differently from the past and future, although they would share underlying structure. The effect of the modification is to replace the default existential quantification over past times with quantification appropriate for the modifier. Satisfaction conditions of (45) then would be represented as in (46).

(46) [For all times  $t_1 : t_1 < t^*$ ](John's hair is( $t_1$ ) a mess).

2. Adverbs such as 'someday', 'every day', 'daily', 'weekly', 'monthly', and 'yearly' quantify over specific intervals and indicate that the event expressed by the verb they modify occurs in, as appropriate, some or every (etc.) interval of the appropriate kind. Thus, they supply two quantifiers over time intervals. The first is restricted to quantification over time intervals of a type indicated by the noun from which the quantifier is formed. The quantifier is existential in the first example above and universal in the other examples (indicated by the 'ly' in the last four). The second quantifier is an existential quantifier that binds the argument place for event time in the modified verb, which is restricted to fall within the interval picked out by the first quantifier. Thus, we represent (47) as (48).

(47) John goes to the barber monthly.

(48) [For all months  $m$ ][there is a time  $t : t \subseteq m$ ](John goes( $t$ ) to the barber).

We extend this to the past and future tense as indicated in the shift from (45) to (46); that is, the months would be restricted to times in the past, or future, of the utterance. This treatment extends to complex restricted-interval temporal quantifiers as well, as in 'Most years he vacations in France'; that is, this means that there is a time interval contained in most years during which he vacations in France. A complex restricted-interval

quantifier like ‘twice a week’ introduces two quantifiers. If John washes his car twice a week, then each week there are two times at which John washes his car. Thus, we would represent ‘John washes his car twice a week’ as in (49).

(49) [For all weeks  $w$ ][there are two times  $t: t \subseteq w$ ](John washes( $t$ ) his car).

3. Nonspecific frequency adverbials such as ‘regularly’, ‘intermittently’, ‘frequently’, ‘often’, ‘seldom’, and ‘infrequently’ intuitively indicate that the event expressed by the modified verb recurs at intervals of time. In the case of ‘regularly’, this seems simply to involve intervals of at least roughly the same length. The core meaning of ‘intermittently’ is not *continuously*, with the implication often of irregularity, though to say something is intermittent but regular is not a contradiction. These adverbs can be treated like ‘sometimes’ and ‘always’, namely, as introducing a simple quantifier: ‘John woke up intermittently/regularly last night’ can be represented as ‘[There are intermittent/regular times  $t: t < t^*$  and  $t \subseteq$  the night before  $t^*$ ](John wakes up( $t$ ))’.

For our other examples, the length of the interval is understood relative to the modified verb.<sup>28</sup> For example, someone may fly frequently (twice a week) and comb his hair frequently (every five minutes), though if he combed his hair only as often as he flies, he would not be said to comb his hair frequently. This topic relativity appears to attach to those frequency adverbials from which one can form a comparative, ‘more frequent/often than’ or ‘less seldom/infrequent than’. Thus, suggestively, these frequency adverbials exhibit a kind of topic relativity similar to that of adjectives or nontemporal adverbs formed from comparatives, such as ‘large’ or ‘tall’. A large mouse is not a large animal, but rather *larger than most mice*. Here we can represent the adjective as contributing a conjunct in the representation of the truth conditions that involves quantification over most members of a comparison class. ‘Mickey is a large mouse’ may be represented as ‘Mickey is a mouse and Mickey is larger than most mice’ (see Lepore & Ludwig 2001, sec. V). This suggests treating topic-dependent frequency adverbials as involving a comparison of the intervals at which an event recurs to intervals in some appropriate comparison class indicated by the modified verb. In our sample case, ‘John combs his hair frequently’, we want to compare

the frequency with which John combs his hair with that for most hair combers. (It may be that some subset of all the hair combers is typically intended, though since this seems to be something that can shift in context independently of any features of the sentence, it is natural to think that this is the effect of pragmatic factors on interpretation of speaker's meaning.) Since it follows from John's combing his hair frequently that there are times at which he combs his hair (or that John combs his hair; see the next section for discussion of habituais), we want this to be reflected in the representation as well. Thus, we suggest representing 'John combs his hair frequently' roughly as 'There are times at which John combs his hair and his hair combings are more frequent than those for most of those who comb their hair'. More formally, where we make use of plural definite descriptions and plural temporal variables, this sentence is represented as follows:

- (50) [There are times  $t$ ](John combs( $t$ ) his hair) & [the times  $t$ :  $t$  are times of John's hair combings][most  $x$ :  $x$  are hair combers][the times  $t'$ :  $t'$  are of  $x$ 's hair combings]( $t$  are more frequent than  $t'$ ).

We use 'most' because its vagueness matches that of 'frequently'. 'Seldom' and 'infrequently' are handled in a similar manner. One does *F* seldom/infrequently if one does it but less frequently than most do.

4. The adverbs 'when' and 'whenever' are syntactically sentential connectives, but should likewise be treated semantically as quantificational. In (51), 'when' and 'whenever' are interchangeable.

- (51) John blushes whenever/when Mary looks at him.

For this reason, we will treat 'when' in such contexts as abbreviating 'whenever'. They are not interchangeable in (52), which requires a separate treatment.

- (52) I did it when he wasn't looking.

The difference is that between a universal and an existential quantifier. (51) is true if and only if at *any* time Mary looks at John, John blushes; that is, (51) is roughly equivalent to a universally quantified conditional with 'whenever' functioning as a quantifier with wide scope binding the unarticulated argument place for time in both verbs. Employing restricted quantifiers, we need not represent (51) counterintuitively as containing sentential connectives, but instead may represent its satis-

faction conditions as in (53); treating ‘when’ as a restricted existential quantifier in (52) yields (54).

(53) [For all times  $t_1$ : Mary looks( $t_1$ ) at John](John blushes( $t_1$ )).

(54) [There is a time  $t_1$ :  $t_1 < t^*$  & he is( $t_1$ ) not looking](I do( $t_1$ ) it).

As above, the past and future tenses remain deictic, though the present of state verbs does not. (It may seem natural to treat ‘when’ in some contexts as a definite description, as in ‘He was electrocuted when he used his hair dryer in the shower’, but this is only because we know some things have happened only once. Interpreting ‘when’ as a definite description cannot be correct, since, for example, ‘Caesar defied the Roman senate when he crossed the Rubicon’ is obviously consistent with ‘Caesar crossed the Rubicon many times’.)

Notice that sentences with mixed simple tenses grammatically conjoined by ‘when’ or ‘whenever’, such as ‘John blushes whenever Mary looked at him’ or ‘John blushed when Mary will look at him’, have no intelligible interpretation. This is what we would expect if (53) and (54) are correct, since a single quantifier must bind the argument place for time in each verb, which renders restrictions signaled by different tenses unsatisfiable.

## 1.8 Habitual Sentences and Frequency Adverbials

So-called habitual sentences are about events that occur at (more or less) regular intervals. Many habitual sentences are simply sentences whose event verbs are modified by a restricted interval or frequency adverbial, as in examples (55)–(57).

(55) Mary often smokes in her office.

(56) Bill complains frequently.

(57) Mary lectures three times a week.

If our discussion in the previous section is correct, then the classification of (55)–(57) as habituais just comes to their being sentences with restricted interval or frequency adverbials, which can be treated straightforwardly as contributing temporal quantifiers and, in the case of the topic-dependent adverbs in (55) and (56), a comparative and a

quantification over a comparison class. If the proposals of the previous section are correct, it is easy to see why these are called ‘habituals’, since their truth would typically be grounded in a habit of smoking in the office, or complaining, or lecturing.

However, not all sentences with habitual interpretations contain explicit frequency adverbials modifying the main verb. (58) and (59), for example, are classified as habituals.

(58) John works for a living.

(59) Rover barks.

In these cases, though, it is natural to say that we understand speakers to be intending that we read in a contextually appropriate frequency adverbial, more or less specific, perhaps, depending on context. With (58), the adverbial ‘for a living’ together with the present tense event verb tells us that it is to be understood as quantified. A living cannot be earned from a single event of working, wages being what they are, and the present tense of an event verb typically has no use unless modified by a temporal adverbial. Thus, (58) would usually be interpreted roughly as (60).

(60) John works *regularly* for a living.

The use of present tense in (59) likewise requires a modifier, and since it is not future or past directed, it is naturally taken to be a frequency adverb of some sort (‘often’ or ‘frequently’) or perhaps a vague cardinality quantifier (‘a lot [of times]’ or ‘from time to time’) (the speaker could not be intending to convey that Rover barks all the time). Thus, (59) might be interpreted roughly (again, though, depending on context) as (61).

(61) Rover *often* barks.

These would receive satisfaction conditions appropriate for the implicitly understood adverbials on the model proposed above. (In practice, what adverbial is intended will be no more precise than the context requires.)

Although (58) and (59) employ present tense verbs, it is clear that their future and past analogues may be interpreted habitually as well: in these cases, however, there is an alternative reading of the sentences as existentially quantified, compatible with their modifiers. Discussing Rover’s laryngitis, you may remark, ‘Don’t worry, Rover will bark again’. This

would receive the habitual reading. However, if *A*, after remarking to *B* that Rover always barks three times before going to sleep, continues, ‘I’ve counted only two barks so far. Rover will bark again’, the same sentence does not receive a habitual reading. Sometimes an adverbial will force a habitual reading, since it is incompatible with the existential reading, given what we know about how things work. This is so for ‘will work for a living’ and ‘worked for a living’. Both would receive the habitual reading, because making a living by working requires, for most, regular application.<sup>29</sup>

Thus, habituais do not need a special semantics, and they do not involve a special tense or aspect.

### 1.9 Relation to the Event Analysis

In this section, we consider how our account interacts with the Davidsonian event analysis of adverbial modification. The event analysis assigns (62) the satisfaction conditions in (63).

(62) John walked up the hill at midnight in his dressing gown.

(63) For any function  $f$ , speaker  $s$ , time  $t$ ,  $f$  satisfies<sub>[ $s$ ,  $t$ ]</sub> ‘John walked up the hill at midnight in his dressing gown’ iff there is an ‘ $e$ ’-variant  $f'$  of  $f$  such that  $f'$  satisfies<sub>[ $s$ ,  $t$ ]</sub> ‘ $e$  is a walking by John and  $e$  is a going up the hill and  $e$  occurs at midnight and  $e$  occurs with John in his dressing gown’.

On the Davidsonian account, the temporal adjunct is a predicate of an event, not a time.

(63) does not really avoid treating adjuncts as introducing a predicate of times, because ‘ $e$  is a walking by John and  $e$  is a going up the hill and  $e$  occurs at midnight and  $e$  occurs with John in his dressing gown’ is tensed, so its satisfaction conditions must be unpacked by tenseless verbs in the metalanguage. (One might insist that these predicates are tenseless, but then they cannot be in English; in any case, reference must be secured to the time of utterance (or its equivalent) to accommodate the sensitivity of tense to time of utterance. See note 30 for further discussion.) Once we do this, we see that ‘at midnight’ introduces a predicate of times, as in (64).

- (64) For any function  $f$ , speaker  $s$ , time  $t$ ,  $f$  satisfies<sub>[s,t]</sub> ‘John walked up the hill at midnight in his dressing gown’ iff there is an ‘ $e$ ’-variant  $f'$  of  $f$  such that  $f'$  satisfies<sub>[s,t]</sub> ‘[There is a  $t_1 : t_1 < t^*$ ]( $e$  is( $t_1$ ) a walking by John) and [there is a  $t_1 : t_1 < t^*$ ]( $e$  is( $t_1$ ) a going up the hill) and [there is a  $t_1 : t_1 < t^*$  &  $t_1 = \text{midnight}$ ]( $e$  occurs( $t_1$ )) and [there is a  $t_1 : t_1 < t^*$ ]( $e$  occurs( $t_1$ ) with John in his dressing gown)’.

(64), however, is inadequate, because it does not require each conjunct to be made true by the same time. For any event in which more than one agent could participate at different times, such as building a house, satisfaction conditions modeled on (64) would be incorrect. We need a single quantifier over temporal argument places for every modifier introduced by an adverbial phrase. So we should treat the main verb as introducing an existential quantifier over times that binds the temporal variable in the main verb and in any other verb introduced by its adverbials. This has an unexpected benefit. Because two quantifiers bind the adjuncts to the main verb (represented as having three places), it becomes possible to treat some adjuncts as modifiers of the agent of the act and not the event he performs. Thus, the awkwardness of treating an adverbial such as ‘in his dressing gown’ as a modifier of an event can be dispensed with. The result is illustrated in (65).

- (65) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies<sub>[s,t]</sub> ‘John walked up the hill at midnight in his dressing gown’ iff there is an ‘ $e$ ’-variant  $f'$  of  $f$  such that  $f'$  satisfies<sub>[s,t]</sub> ‘[There is a  $t_1 : t_1 < t^*$  &  $t_1 = \text{midnight}$ ](walks(John,  $e$ ,  $t_1$ ) &  $e$  is( $t_1$ ) a going up the hill & John is( $t_1$ ) in his dressing gown)’.

Similarly, we are now able to treat what are intuitively adverbials of place (e.g., ‘on a mountain top’) or of condition (e.g., ‘in top form’) as modifying objects rather than events (or states). This pleasing result is available only if we treat tense as introducing a quantifier binding argument places in each adjunct introduced by an adverbial.<sup>30</sup>

### 1.10 Thought and Tense

Sentences used to describe particulars are indexed to the time of their utterance, and the contents of thoughts expressed using them are deter-

mined by what they express. Consequently, thoughts about particulars are invariably thoughts directly about the times of the thoughts themselves. Since sentences speakers use to express thoughts express them only once, when speakers want to attribute thoughts or speech acts to others or to themselves at times other than the time of attribution, which sentences they use to articulate their contents must be indexed to the time of the reported thought or speech act. In this section, we consider how this is reflected in the interpretation of tense in complement clauses of indirect discourse and attitude sentences.

We will approach the topic of tense in attitude sentences and indirect discourse as a design problem for constructing reports of attitudes and speech acts, given a straightforward semantics for unembedded tensed sentences. Consider John's potential assertions at  $t_0$  of (66a–c), and their corresponding representations in English\* interpreted relative to  $t_0$  in (67a–c).

- (66) a. Mary was tired.  
 b. Mary is tired.  
 c. Mary will be tired.
- (67) a. [There is a  $t_1 < t_0$ ](Mary is at  $t_1$  tired).  
 b. Mary is at  $t_0$  tired.  
 c. [There is a  $t_1 > t_0$ ](Mary is at  $t_1$  tired).

We may report John's assertion (or the belief he thereby expresses) either before or after it occurs, or even simultaneous with it. Our temporal position with respect to John's utterance determines the tense of the main verb in our report; the tense of the complement clause, however, must be sensitive to the tense John used to express his belief. Let us consider first a report of what John said from the perspective of a time later than his assertion. The main verb will be in the past tense, but how do we report, given available resources, the content of John's assertion?

Deictic elements in complement clauses are usually interpreted relative to the speaker's context. Thus, although in direct speech we would report that John said, 'I am tired', in indirect discourse we would report the same act by 'John said that *he was* tired'. However, unlike demonstrative pronouns and indexicals, such as 'I' and 'now', which are always interpreted relative to speaker context, just as they are when not em-

bedded in a complement clause, tense is more complex. In reporting an assertion by John of any of (66a–c) at  $t_0$  from the perspective of a later time, it would be inappropriate to interpret a tense in the complement clause relative to speaker context, for that would attribute to the subject an assertion about the speaker's time and not his own. Thus, the tense in the complement clause must have its reference time (the time with respect to which the tense of the complement clause verb indicates the time of the occurrence of the event it expresses) fixed by the tense of the main verb; that is, the argument place that functions indexically when the sentence is unembedded must be bound by the quantifier introduced by the main verb when embedded in an indirect discourse. Then the verb in the complement clause must indicate that the event expressed occurred before, at, or after the time of the reported utterance.

From a design standpoint, it would be simplest to reuse in the complement the tense used by the subject. If the argument place that usually functions indexically were bound by the quantifier the main verb introduces, this would capture the relative present, past, or future directedness of the content of the original assertion. However, while some languages work like this (e.g., Russian, and, though without verb inflection, Chinese and Japanese<sup>31</sup>), English does not: in indirect speech, if the main verb is in the past, the tense of the complement clause *must* shift to the past perfect, past, or past future, respectively, according to whether the tense of the main verb in the reported utterance is past, present, or future.<sup>32</sup> This tense-sequencing rule<sup>33</sup> is illustrated in table 1.1. These reported utterances would be interpreted respectively as (68)–(70).<sup>34</sup>

(68) [There is a  $t_1 < t^*$ ](John says( $t_1$ ) that [there is a  $t_2 < t_1$ ](Mary is( $t_2$ ) tired)).

(69) [There is a  $t_1 < t^*$ ](John says( $t_1$ ) that Mary is( $t_1$ ) tired).

Table 1.1

Sentence uttered by John	Tense shift in complement clause with past tense main verb
Mary was tired.	John said that Mary had been tired.
Mary is tired.	John said that Mary was tired.
Mary will be tired.	John said that Mary would be tired.

- (70) [There is a  $t_1 < t^*$ ](John says( $t_1$ ) that [there is a  $t_2 > t_1$ ](Mary is( $t_2$ ) tired)).

The tense of the main verb controls the temporal argument place of the verb in the complement clause, which functions indexically when unembedded. For in order to articulate what John said using (66a), we must represent him as saying at some past time that at some prior time Mary was then tired; this is represented by (68). This has been identified traditionally as the function of the past perfect, namely, to pick out a time prior to some past time indicated by a verb in the sentence. Were the verb in the complement clause to be interpreted relative to the speaker's time, the report would be false of John, since he said nothing about the time of the speaker's utterance. Likewise, to capture what John said using (66b), we must say that there is some time such that John said at that time that Mary was then tired, which is what (69) expresses. To report that in the past John said that in the future relative to the time of his utterance Mary would be tired, the reference time of the embedded verb must be fixed by the time of John's utterance, as shown in (70).<sup>35</sup> If we are right, most indirect discourse and attitude sentences quantify into the complement clause.

The tense-sequencing phenomenon occurs only with the main verb in the past. So reports of John's future speech act use the tense John would use, as in table 1.2. Their interpretations would then be represented as in (71)–(73).

- (71) [There is a  $t_1 > t^*$ ](John says( $t_1$ ) that [there is a  $t_2 < t_1$ ](Mary is( $t_2$ ) tired)).
- (72) [There is a  $t_1 > t^*$ ](John says( $t_1$ ) that Mary is( $t_1$ ) tired).
- (73) [There is a  $t_1 > t^*$ ](John says( $t_1$ ) that [there is a  $t_2 > t_1$ ](Mary is( $t_2$ ) tired)).

**Table 1.2**

The sentence that will be used by John	Complement clause tense with future tense main verb
Mary was tired.	John will say that Mary was tired.
Mary is tired.	John will say that Mary is tired.
Mary will be tired.	John will say that Mary will be tired.

The tense of the main verb, again, controls the temporal argument places of the verb(s) in the complement clause, which, when unembedded, index to the time of utterance.<sup>36</sup>

Reports of present sayings use the same tense as used by the person whose speech act is being reported, but use the present progressive for the main verb, as illustrated in table 1.3. Here the main verb does not express quantification over times; hence, in complement clauses verbs are simply interpreted relative to the utterance time, which gives correctly the content of John's assertions if he uses those or synonymous sentences. The interpretations are given in (74)–(76).

(74) John is saying( $t^*$ ) that [there is a  $t_1 < t^*$ ](Mary is( $t_1$ ) tired).

(75) John is saying( $t^*$ ) that Mary is( $t^*$ ) tired.

(76) John is saying( $t^*$ ) that [there is a  $t_1 > t^*$ ](Mary is( $t_1$ ) tired).

This provides further support for rejecting the treatment of the present tense in (12).

So far as we can see, there is no deep reason why English must employ a tense-sequencing rule for indirect discourse and attitude sentences when the main verb is in the past tense. Not all natural languages do. Furthermore, the tense-sequencing rule appears to prevent unambiguous reports of certain past speech acts. If a speaker uses a sentence in the past perfect (e.g., 'Mary had been tired') or in the present perfect (e.g., 'Mary has been tired'), no tense can be used unambiguously to report him indirectly, since the past perfect has already been allocated to reporting utterances of sentences in the simple past. In English, the past perfect is used to report speech in the past perfect and the present perfect as well as the simple past, and speakers rely on context for disambiguation. This limitation can be gotten around to some extent by employing adverbial

Table 1.3

Sentence used by John	Complement clause tense with present tense main verb
Mary was tired.	John is saying that Mary was tired.
Mary is tired.	John is saying that Mary is tired.
Mary will be tired.	John is saying that Mary will be tired.

modifiers. We can say, ‘John said then that Mary had been tired before some previous time’. This fails to assign content correctly, even if the quantifiers take wide scope, since the modifier is still represented as a conjunct. But such peculiarities of English cannot be philosophically significant, since languages can plainly be designed so as to avoid them.

A brief remark on adverbial modifiers in complement clauses is in order. We take indirect discourse again as our model. By and large, we use the same modifiers as those in the reported utterance. John’s assertion of ‘Mary left before Jim’ would be reported as ‘John said that Mary had left before Jim’. This would be represented as ‘[There is a time  $t_1 : t_1 < t^*$ ](John says( $t_1$ ) that [there is a  $t_2 : t_2 < t_1$ ][there is a  $t_3 : t_3 < t_1$  &  $t_2 < t_3$ ](Mary leaves( $t_2$ ) and Jim leaves( $t_3$ ))’]. Adverbials that contain deictic referring terms such as ‘now’ and ‘today’, however, are evaluated relative to the time of utterance, which forces a shift from the adverbial originally used. Thus, if John said yesterday, ‘Mary will leave before the day after tomorrow’, he would be reported indirectly today as in (77), which is interpreted as in (78).

(77) John said that Mary would leave before tomorrow.

(78) [There is a time  $t_1 < t^*$ ](John says( $t_1$ ) that [there is a  $t_2 > t_1$  &  $t_2 < \text{the day after } t^*$ ](Mary leaves( $t_2$ ))).

Unanchored adverbials, which seem to function deictically when unembedded, such as ‘at midnight’ and ‘by noon’, are an exception. In (78), the referent of ‘midnight’ is determined relative to the time of John’s saying, not the time of utterance. Similarly for other expressions that pick out times relative to a day or other standard unit. (79) would be interpreted as in (80).

(79) John said that Mary had left before midnight.

(80) [There is a time  $t_1 < t^*$ ](John says( $t_1$ ) that [there is a time  $t_2 < t_1$  &  $t_2 < \text{the midnight of } t_1$ ](Mary leaves( $t_2$ ))).

This fits in with our earlier suggestion that unembedded uses of unanchored adverbials are implicitly deictic or quantified.

The account generalizes straightforwardly to iterated attitude and discourse sentences. In (81), the tense of ‘said’ governs ‘had told’, which in turn governs ‘would be leaving’.

(81) John said last week that Mary had told him three days earlier she would be leaving tonight.

‘Last week’ indexes to the present, as does ‘tonight’, but ‘three days earlier’ expresses a relation whose second term is suppressed yet is evidently the time of John’s report. (81) is represented as in (82).

(82) [There is a  $t_1 < t^*$  &  $t_1 \subseteq$  the week before  $t^*$ ](John says( $t_1$ ) that [there is a  $t_2 < t_1$  &  $t_2 \subseteq$  the day three days earlier than  $t_1$ ](Mary tells( $t_2$ ) him that [there is a  $t_3 > t_2$  &  $t_3 =$  tonight](Mary is( $t_3$ ) leaving)).

If ‘would say’ is embedded in a report with a main verb in the past, the verbs it governs are also governed by the sequencing rule. In (83), the tense of ‘would tell’ governs ‘loved’, but ‘loved’ indexes to the time of the telling, not to a prior time. (83) would be represented as in (84).

(83) John said that he would tell Mary that he loved her by next week.

(84) [There is a  $t_1 < t^*$ ](John says( $t_1$ ) that [there is a  $t_2 > t_1$  &  $t_2 <$  next week](he tells( $t_2$ ) Mary that he loves( $t_2$ ) her)).

Earlier, we noted that present tense event verbs true of speech acts may be used performatively, as in ‘I promise I won’t be late’ or ‘I promise to be there’. We suggested that these are understood to be modified implicitly by ‘hereby’, which refers to the utterance act itself, and that this modifier provides a quantifier to bind what would otherwise be a free variable in the main verb. We can now suggest a representation of the logical form of such sentences in light of our discussion of indirect discourse. We will take ‘I promise I won’t be late’ as our example, which we represent as in (85).

(85) [There is time  $t_1 : t_1 = t^*$ ](I promise( $t_1$ ) by this act that it is not the case that [there is a  $t_2 : t_2 > t_1$ ](I am( $t_2$ ) late)).

We likewise suggested that sometimes ‘now’ modifies a sentence, not a verb, as in ‘Now he will resign for sure’, which is equivalent to ‘It is now the case that he will resign’ and might be represented as in (86).

(86) [There is a  $t_1 : t_1 = t^*$  and  $t_1 =$  now](it is( $t_1$ ) the case that [there is a  $t_2 : t_2 < t_1$ ](he resigns( $t_2$ )).

The chief moral here is that reports of others' attitudes at times other than the present do not completely report the content of their attitudes, since they involve quantifying into the complement clause. What is conveyed is that some completion of the complement clause gives the content of the speaker's assertion (belief, etc.). There appears to be no way in English to be more precise, since even adding an adjunct does not eliminate quantifying into the complement clause, because the main verb's tense must control verb(s) in the complement clause.<sup>37,38</sup>

### 1.11 Semantics and the Metaphysics of Time

What light does our account of tense shed on traditional issues in the philosophy of time? A semantic theory for a language by itself has only conditional implications for what there is. It reveals the commitments of the sentences of a language, but nothing follows about what there is independently of which of them are true. Likewise, nothing follows about our commitments independently of our commitment to the truth of some sentences. However, since we are all committed to the truth of what we say using tensed sentences, we can confidently say that we are committed to whatever must be true if most of what we thereby say is true.

A first obvious, though not insignificant, point is that we are committed to times or, time intervals, if the semantics for tense and tense devices proposed here is correct. Not only do we refer to times using temporal referring devices, but we quantify over times as well. So there are times, if most of what we say is true. Moreover, if most of what we say is true, presentism, the view that only the present time is real, must be false, since we quantify over times before and after the present time.

Our account also takes sides in the debate over whether time is an A-series or a B-series, in McTaggart's terminology. Time is a B-series if temporal moments or intervals do not themselves have changing properties, and talk about the present, past, and future is always relativized to some time or other as a reference point. Time is an A-series if times have changing properties of being present, past, or future, where the property of being present is one that each time has in succession. Our semantics for tense is not committed to time's being an A-series in virtue of com-

mitments to what people ordinarily say; indeed, it is not clear that talk of being the present, past, or future time makes sense. Talk about times undergoing change appears to be a category error: if change involves an object's having a property at one time and lacking it at another, for times to change, we would have to treat times as persisting through time! This would confuse times with objects, as one might confuse places with objects located at them and talk of places changing places.

Appeal to use of a predicate such as 'is the present time' is illusory. This predicate is an indexical, since its component verb is tensed. To correctly capture its use, we must exhibit it as being used in accordance with a rule that makes its utterance true of a time if and only if that time is the time of utterance. Its satisfaction clause then can be represented as in (87).

- (87) For any function  $f$ , time  $t$ , speaker  $s$ ,  $f$  satisfies<sub>[s,t]</sub> 'x is the present time' iff  $f('x') = t$ .

No property is attributed using the predicate. It would be a mistake to object that 'is the present time' employs the identity sign plus a definite description, for in this case 'present' has no life independent of its use in 'the present time'. (While 'is present' has a use, it is used to mean the same thing as 'is here', and it is not used as a simple predicate of times.) 'The present time' does not function as a complex expression; instead, it functions like 'now'. (Similar remarks apply to 'is in the past' and 'is in the future'.) Likewise, simply using tense-inflected verbs does not commit us to properties of being present, past, or future.<sup>39</sup>

So if the account of tense proposed here is correct, the metaphysics of English—and, presumably, other natural languages—treats time as a B-series (the alternative not only being uncountenanced by compositional semantics, but of doubtful intelligibility: an example of the 'bewitchment of our intelligence by language'). We are left with a variety of puzzles: why we experience times as a succession of instants with a single direction, and why we cannot, as it were, travel in either direction through time the way we can travel in any direction through space. Such puzzles, however, can yield only to conceptual analysis. The project of a compositional semantics is complete after the logical form of the sentences we use to express our thoughts about times has been revealed.

## 1.12 Conclusion

This chapter sketches a truth-theoretical approach to the phenomenon of tense and temporal modification in English. By treating tense as a device of restricted indexical quantification, we can account for the simple tenses and their modifiers in a way that conforms to our intuitive sense of what we say when we use tensed sentences, and we can show how understanding tensed sentences rests on a finite number of semantic rules. Tense is not very systematic, and we have seen that no simple compositional story can be told about how tenses interact with modifiers and how they behave when embedded. On the other hand, the number of rules required to understand these interactions is small, and we should not expect natural languages to be logically perfect.

While we lack a proof, we still think it would be difficult, compatibly with our methodological requirement that an interpretive truth theory be context insensitive, to give an account of the truth conditions of tensed sentences without treating tense as a quantificational device of some kind. We are aware of only two ways in which to do this: our approach and one that involves quantifying over events or states, as discussed in note 30, in which we also explain why we prefer our approach.

If this approach is correct, then, as noted, a number of conditional consequences can be drawn about the philosophy of mind, language, and metaphysics. First, many of our sentences and thoughts are directly about the present. Second, giving an account of the semantics of propositional attitudes that countenances quantification into their complement clauses is necessary for an adequate semantics for propositional attitudes, for virtually all attitude reports turn out to quantify into the complement clause. *Contra* Quine, quantifying-in cannot be incoherent on pain of making most of what we wish to say about the attitudes of another incoherent. Third, if much of what we say in ordinary speech is true, times or time intervals are real, and there are past as well as future times. On this condition, irrealism about time and presentism (irrealism about past and future times) are both false. Fourth, the semantics proposed here for tense and temporal referring devices gives no comfort to anyone who views time as an A-series, that is, who views times as undergoing change themselves. The quantificational approach does not

treat tense as attributing properties to times at all, but as quantifying over, and indicating relations among, them by means of indexical reference to the time of utterance. Anyone who wishes to maintain that tensed sentences attribute properties to times needs to provide a semantics for tense that achieves as least as much as we have shown is possible with our quantificational approach.

### Appendix: Present Perfect, Past Perfect, Future Perfect

In this appendix, we discuss the perfect tenses (or the perfective aspect, as it is often called) and how they differ from simple tenses.<sup>40</sup> Table 1.4 gives the forms of the perfect tenses. The perfect expresses a completed event. The present perfect is used to indicate that an event has been completed as of the present. It differs from the simple past in allowing that the event's terminal point coincides with the time of utterance. One can say, 'John has finished swimming now', but not 'John finished swimming now'. Likewise, one can say, 'John has worked here since 1980', which means that from 1980 to the present John has worked here, but not 'John worked here since 1980', because the simple past requires the time of the event expressed by the verb to be in the past. (Adverbials of the form 'since'  $\delta$ , where  $\delta$  is a temporal designator, are acceptable only with perfect tenses, though there is the idiomatic 'It is a year since we left'.) However, contrary to what some philosophers and linguists claim (see Dowty 1982, p. 27, and references therein), the event need not extend into the present, as shown by the acceptability of 'John has been a lifeguard, but isn't any longer'. The future perfect is used to indicate that something has been completed as of some future time. The past relative to the future reference time may be past relative to the speaker's time of utterance, or it may be completed at any time up to and including the future reference time. If it is true now to say that John sat

Table 1.4

Tense	Form	Example
Future perfect	'will'/'shall' + 'have' + past participle	John will have seen it.
Present perfect	present of 'have' + past participle	John has seen it.
Past perfect	past of 'have' + past participle	John had seen it.

down yesterday, it is true to say that John will have sat down by tomorrow. Likewise, if tomorrow at 3 p.m. one says truly, ‘John has finished swimming now’, it would be correct to say today, ‘John will have finished swimming by 3 p.m. tomorrow’. The past perfect is used to say that something has been completed by some past time. So if John finished swimming at 3 p.m. yesterday, it would be correct to say today, ‘John had finished swimming by 4 p.m. yesterday’.

The effect of projecting these future, present, or past reference times relative to which an event is said to have been completed can be accommodated within our framework by introducing another quantifier and a relation restricting the relations among the bound temporal variables. The past perfect of (88a) is illustrated in (88b), and the future perfect of (89a) in (89b).

- (88) a. John had seen it.  
 b. [There is a  $t_1 : t_1 < t^*$ ][there is a  $t_2 : t_2 \leq t_1$ ](John sees( $t_2$ ) it).
- (89) a. John will have seen it.  
 b. [There is a  $t_1 : t_1 > t^*$ ][there is a  $t_2 : t_2 \leq t_1$ ](John sees( $t_2$ ) it).

For convenience, we will adopt Reichenbach’s terminology to distinguish among the times represented by ‘ $t_1$ ’, ‘ $t^*$ ’, and ‘ $t_2$ ’, the *reference* time, the *speaker* time, and the *event* time, respectively (see Reichenbach 1947, pp. 287–98). The event time is the time of the action expressed by the main verb, the speaker time is the time of utterance, and the reference time is the time relative to which the event time is located. In (88) and (89), ‘have’ contributes a restricted existential quantifier that relates its temporal variable, the reference time, to the speaker time as before or after it, depending on whether the tense of ‘have’ is past or future, and the past participle likewise contributes a restricted existential quantifier binding the variable associated with the event time, which is related to the reference time as before or simultaneous with it. The present perfect of (90a) receives a parallel treatment, as in (90b).

- (90) a. John has seen it.  
 b. [There is a  $t_1 : t_1 = t^*$ ][there is a  $t_2 : t_2 \leq t_1$ ](John sees( $t_2$ ) it).

Though we could simplify (90), it is plausible that the function of combining a tense of ‘have’ with the past participle is the same in every perfect tense but for the contribution of the tense of ‘have’.<sup>41</sup> This leads

to a pleasing symmetry in the interaction of perfect tenses with various adverbials.<sup>42</sup>

The utility of the perfect becomes apparent when we consider its interaction with certain adverbial modifiers that (partially) fix the reference time. In ‘John will have seen it by tomorrow’, ‘by tomorrow’ modifies the reference time, that is, the future time in the past relative to which the event is said to occur. Similarly for the past perfect and the present perfect. Thus, ‘John will have finished swimming by tomorrow’ has the representation in (91).

- (91) [There is a time  $t_1 : t_1 > t^* \ \& \ t_1 = \text{tomorrow}$ ][there is a  $t_2 : t_2 \leq t_1$ ](John finishes swimming( $t_2$ )).

This explains why ‘John will have finished swimming by yesterday’ seems ill formed: it would require the reference time, which the quantifier restriction requires to be in the future relative to the utterance time, to be also in the past relative to the time of utterance. Similar remarks apply to the past perfect. One cannot say, ‘John had seen it by tomorrow’. The perfect tenses are useful, particularly the past and future perfect, because they allow us to set time boundaries other than the present for events. This is accomplished by adverbial modification on the past or future reference time with respect to which another event is to have occurred in the past relative to it. This explains why unembedded and unmodified uses, or context-free uses, of the perfect (e.g., an unadorned use of ‘John had been there’) can seem odd. The perfect tenses are almost never used without adverbial modification, or without an appropriate context in which an implicit adverbial modification is provided by the surrounding discourse.

Not all adverbials modifying verbs in a perfect tense modify the reference time; some modify the event time. In ‘John had arrived on Tuesday’, ‘on Tuesday’ modifies only the event time. Generally, it appears that adverbials introduced by limiting prepositions, like ‘by’, ‘before’, and ‘after’, modify the reference time. Adverbials that indicate a specific date are used to specify the event time. Often, such modifications will sound odd, as in ‘John will have arrived Tuesday next week’. They sound odd because using the perfect tense when the adverbial modifies the event time is usually pointless. ‘John had arrived on Tuesday’ seems less strange because it is easy to imagine a narrative in which the use of the

past perfect would have a point—for example, ‘Mary, who arrived on Wednesday, thought she had arrived before John. But John had arrived on Tuesday.’<sup>43</sup>

An interesting test of our proposal is whether it can explain the interaction of adverbials introduced using ‘since’ followed by a temporal designator with the various tenses, which seem acceptable only with perfect tenses. While we can say, ‘John has/had/will have worked since 1980’, we cannot say felicitously, ‘John worked/works/will work since 1980’. With the past perfect and the future perfect, ‘since 1980’ adds that the activity expressed by the verb has taken place in the period from 1980 to the *reference* time; with the present perfect, ‘since 1980’ adds that the activity expressed by the main verb has taken place in a period from 1980 to the present,<sup>44</sup> but since this is the reference time, we can represent ‘since 1980’ as requiring for all three that the activity take place between 1980 and the reference time, as illustrated in (92)–(94) (where ‘ $t - x$ ’ means ‘the time interval from  $x$  to  $t$ ’).

(92) [There is a  $t_1 : t_1 = t^*$ ][there is a  $t_2 : t_2 \leq t_1$  &  
 $t_2 = t_1 - 1980$ ](John works( $t_2$ ) here).

(93) [There is a  $t_1, t_2 : t_1 < t^*$ ][there is a  $t_2 : t_2 \leq t_1$  &  
 $t_2 = t_1 - 1980$ ](John works( $t_2$ ) here).

(94) [There is a  $t_1, t_2 : t_1 > t^*$ ][there is a  $t_2 : t_2 \leq t_1$  &  
 $t_2 = t_1 - 1980$ ](John works( $t_2$ ) here).

So modifying a verb in a perfect tense with ‘since 1980’ is to say that the *event* time is equal to the time interval between 1980 and the *reference* time. We can see why ‘since 1980’ does not sit comfortably with the simple tenses. It designates a time interval identified with the event time. But for the simple tenses, the anchor time for determining the time interval would be the time of utterance (i.e., the event time would be identified with  $t^* - 1980$ ), but the requirements imposed on the event time by the simple tenses are incompatible with this. Notice how nicely the account adapts to the embedding of ‘since’ in other modifiers, as in ‘several times since 1980’. The adverbial ‘since 1980’ modifies ‘several times’, which quantifies over the event time. So ‘John has worked several times since 1980’ is represented as ‘[There is a  $t_1 : t_1 < t^*$ ][several  $t_2 : t_2 \subseteq t_1 - 1980$ ](John works( $t_2$ ))’.

Quantificational adverbials, and ‘before’ and ‘after’ used as sentential connectives, likewise modify the event time. Consider (95) and (96).

(95) John had loved Mary long before he said it.

(96) John had never been to Arizona.

‘Before’ relates event (or state) times; that is, it relates the argument places in the main verbs of the sentences flanking it. In (95), ‘long’ modifies the state time. (95) is paraphrasable as (97).

(97) [There is a  $t_1 : t_1 < t^*$ ][there is a  $t_2 : t_2 \leq t_1$ ][there is a  $t_3 : t_3 < t^*$   
&  $t_2$  is long before  $t_3$ ](John loves( $t_2$ ) Mary and John says( $t_3$ ) it).

The extra quantifier effectively is inert, which explains why (95) and (98) express the same thing.

(98) John loved Mary long before he said it.

The past perfect in (95) serves mostly as a way of emphasizing that John’s love was past relative to a relevant time also in the past. The quantifier ‘never’ in (96) binds the temporal argument place in its main verb. (96) conveys that at no time prior to some former time had John been to Arizona, which does not entail that John has never been to Arizona. (96) is paraphrased as (99).

(99) [There is a  $t_1 : t_1 < t^*$ ][for no  $t_2 : t_2 < t_1$ ](John is( $t_2$ ) in Arizona).

‘When’ may be used with the past perfect, but apparently only if the ‘when’-clause is in the simple past. (100) is acceptable; (101) is not.

(100) He had gone when Bill arrived.

(101) He had gone when Bill had arrived.

In (100), ‘when’ binds the event time for the restricting clause, and the reference time for the past perfect, as shown in (102).

(102) [There is a time  $t_1 : t_1 < t^*$  & Bill arrives  $t_1$ ][there is a time  
 $t_2 : t_2 < t_1$ ](he goes( $t_2$ )).

When we assigned satisfaction conditions to sentences of the form  $\lceil \varphi$  when  $\psi \rceil$ , when  $\varphi$  and  $\psi$  were in the past tense, we showed that semantically  $\varphi$  shifts to present tense. Now we see that when  $\varphi$  is in the past perfect, it effectively functions like the past, with the argument place that usually functions indexically being bound by ‘when’.<sup>45</sup> The problem

with (101) is that for ‘when’ to bind across both sentences, it must bind the reference time in ‘Bill had arrived’ and what would be the indexical reference to the speaker time in ‘He had gone’ when unembedded. This yields (103),

(103) [There is a time  $t_1 : t_1 < t^*$  &  $t_2 < t_1$  & Bill arrives  $t_2$ ][there is a time  $t_3 : t_3 < t_1$ ](he goes( $t_3$ )).

which conveys no useful information about the temporal relations between the two event times. ‘Whenever’, like ‘when’, is comfortable with the past perfect only when the restricting clause is in the simple past, as in (104), which would be paraphrased as in (105).

(104) He had tried to buy it whenever he had money.

(105) [For any time  $t_1 : t_1 < t^*$  & he has( $t_1$ ) money][for a time  $t_2 : t_2 < t_1$ ](he tries( $t_2$ ) to buy it).

These examples illustrate how to combine our account of adverbial modification with perfect tenses. There is some interest in looking at the possible combinations of tenses with ‘when’ and ‘whenever’, but that would be too involved a task for the present context. Depending on its kind, a modifier will modify either the reference time or the event time. Quantificational adverbials that are not sentential connectives invariably modify the event time. Limiting adverbs invariably modify the reference time. Temporal sentential connectives like ‘before’ and ‘after’ invariably connect event times. ‘When’ and ‘whenever’ bind the event time in the first clause and the speaker time in the second.<sup>46</sup>

## Notes

1. An extensive study of the categories of tense and aspect across languages can be found in Dahl 1985. See also Gabbay and Rohrer 1979 for a comparison of the expressive resources of English and Hebrew.

2. See Ludwig 1997 for an account of how to extend the truth-theoretic approach to nondeclaratives.

3. Though we will not argue for it here, we believe these are the only contextual parameters that are needed to devise an adequate semantics for tense. Throughout, quantifiers over times will range over time intervals, and ‘is a time’ will be true of time intervals. We will include as a limiting case of a time interval temporal instants. In fact, it seems likely we should construe the restriction to be relative to a speaker’s reference frame. Here, we will omit this complication,

which would have more the character of an update of the semantics of English than a description of it.

4. (5) is sometimes said to be untensed (see, e.g., Palmer 1974, pp. 33, 36–38), since its verb is constructed from a modal auxiliary ‘will’ and an infinitive verb stem and does not involve inflection. As we noted above, our classification is guided not by syntactic but by semantic considerations, and the semantic function of ‘will’ + infinite verb stem is to indicate that the action or state expressed by the verb occurs or obtains at a time later than the time of utterance, and thus it semantically functions like the present and past tenses.

5. The future tense is also expressed by using ‘is’ + ‘going’ + the infinitive, as in ‘Mary is going to love Bill’. Since these are equivalent, what we say about the modal + bare infinitive applies equally to the alternative form.

6. Nonfinite verbs, infinitives, participles, and gerunds are said to lack tense. However, they do not function as main verbs, but rather nominally, adjectivally, or adverbially.

7. The expression ‘ $\text{ref}_{[s,t]}(y) = x$ ’ is read as ‘the referent of  $y$  as used by  $s$  at  $t = x$ ’.

8. The truth conditions we offer, in broad outline, we believe underlie most thinking about tense in other frameworks. As far as truth-theoretic accounts go, we draw attention to the formulation using restricted quantifier notation, which we think better captures the semantic structure of the past and future tenses. While we will identify some salient differences with other approaches, we will not try to provide a systematic comparison, as that would be a book-length task.

9. The recursive clause for restricted quantifiers has the form (i),

(i) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies $_{[s,t]}$   $\lceil [Qx: Fx](Gx) \rceil$  iff  $Q$  ‘ $Fx$ ’-variants  $f'$  of  $f$  satisfies $_{[s,t]}$  ‘ $Gx$ ’.

where ‘ $Q$ ’ is a placeholder for a quantifier, and the metalanguage embeds the object language. ‘ $Fx$ -variant  $f'$  of  $f$ ’ is defined as follows:  $f'$  is an ‘ $Fx$ ’-variant of  $f$  iff  $f'$  differs from  $f$  at most in that  $f'$  satisfies $_{[s,t]}$  ‘ $Fx$ ’.

10. See Ludwig 1996 for a general argument for this view.

11. This neatly handles the need for a potentially arbitrarily large number of independent reference times for events in subordinate clauses, as in ‘John saw the man who kissed Mary, who bought a farm from the woman Bill divorced’.

12. As we remarked earlier, metalanguage verbs are tenseless. Object language quantifiers range over every extant object, taken tenselessly (i.e., not relativized to any time). If natural language quantifiers were evaluated relative to the time of utterance, so that their domains were restricted to what existed at that time, this would have to be represented in our semantics by restricting the domain to objects existing at the time of utterance. This is not, however, how quantifiers are used in English: ‘Everyone who lived in the nineteenth century suffered from gout’ is not vacuously true but rather factually false. As we point out below (note 35), for *restricted* quantifiers the nominal restriction can be interpreted as in a tense other than that of the predicate to which it is attached. We anticipate some

discomfort arising from the reflection that a sentence such as ‘Everyone was at the party’ will be false on this view because the quantifier will range over people at all times. But this is no more puzzling than that the quantifier is used with an implicit restriction even on the domain of people at the present time.

How does negation interact with tense? Consider ‘John did not sleep last night’. If negation can take different scopes with respect to tense, then there should be two readings of this. On one, it would be true if and only if for every past time last night it is not the case that John slept at that time. That is, this reading requires wakefulness the whole night. On the other, it would be true if and only if there is at least one time last night at which John did not sleep. This reading would be true if John woke momentarily in the middle of the night but fell asleep again quickly without waking until morning. Is there then a reading on which an assertion of ‘John did not sleep last night’ would be true if he woke momentarily in the middle of the night? We might try to imagine a situation in which what is at issue is the effectiveness of a certain sleeping pill. We give it to John at bedtime and wish to know whether it was effective in giving him a good night’s sleep. Can John report its failure in the morning by saying, ‘I did not sleep last night’, if all he means to report is that there is at least one time last night at which he was not asleep? Even in this context it seems to us we would take John’s report to be false. In addition, if negation could systematically take narrow or wide scope with respect to tense, we would expect ‘That will not turn red’ to have a reading on which it is true even if it is also true that it will turn red, so that ‘That will not turn red and that will turn red’ would not be necessarily false, on one reading, even when ‘that’ picks out the same thing in both its uses. But there does not appear to be any such reading. We therefore tentatively conclude that negation does not insert itself between the quantifier introduced by tense and the verb.

13. Some authors (see, e.g., Burge 1974; Partee 1973) suggest that simple tenses are implicitly demonstrative. An utterance of ‘I didn’t turn off the stove’ is usually understood to involve a specific past time interval, and not just any past time. Space constraints prevent us from discussing this suggestion fully. While a truth-theoretic approach can easily incorporate devices that work this way, we believe these phenomena are pragmatic and not semantic.

14. There are two exceptions. First, there is the so-called narrative or historical present (or, sometimes, “vividly reporting present”), as in live broadcasts of a sporting event, in which the announcer attempts to convey a sense of immediacy by reporting events in the simple present: ‘He hits a terrific serve, approaches the net, and hits a winner down the line to win the game’. (See Visser 1972, p. 724), for a wealth of other examples.) The naked present can also be used in chronological tables: for example, ‘579 B.C. Nebuchadnezzar takes Tyre’. These are so specialized that we are unsure what weight to grant them. Their aim is clearly to achieve a kind of vividness in reporting that a past tense report would fail to convey. The present tense of event verbs, so oddly used in the present, lies ready to hand: it is no wonder it is pressed into use for such an effect, even if there is something odd about it. But it does seem to be a kind of play with words recog-

nized as a bit odd or out of place, and partly effective for that reason. We are inclined to say this is an *extended* and not a *core* use of the present, despite its appearing throughout the history of English.

The second case is the use of the present tense of event verbs in issuing performatives, as in ‘I promise to meet you there’ or ‘I warn you not to do that’. It is unclear what to say about such uses. It would be odd to interpret them as anything other than promises or warnings, though it is tempting to say that one promises, warns, and so on, by way of asserting one is doing so. But contrast ‘I promise to meet you there’ with ‘I am promising to meet you there’. The latter cannot ordinarily be used to make a promise. So no performative is accomplished by asserting one is performing the act in question as one speaks. It seems, rather, that utterances of ‘I promise to meet you there’ intended as promises are implicitly self-referential, that is, are interpreted as ‘I hereby promise to meet you there’, where ‘hereby’ makes implicit reference to the utterance; we may treat this modification as introducing a reference to the time of utterance. We will discuss these cases in section 1.10.

15. Though denying that the progressive is a tense is not novel, it is not universally accepted. See Comrie 1985.

16. For discussion, see Dowty 1977; Parsons 1990, chap. 9. It is called the ‘imperfective paradox’ because ‘imperfect’ in grammatical usage means ‘uncompleted’. The puzzle is how a verb that expresses essentially a complete event can have an imperfect tense, in other words, a tense that implies that the event has not been completed.

17. See Vendler 1967 for a classic discussion of verb classification. According to Vlach (1993, pp. 241–43), progressives are state verbs. So to say that John is leaving is to say that John is in the state of a process of his leaving’s being in progress. We see no reason to force the progressive into any category of this dichotomy.

18. See the appendix of Lepore and Ludwig 2000 for detailed discussion of the semantics for demonstratives.

19. (25) and (26) are indexed to the use of the demonstrative because someone can perform more than one demonstration at a time—for example, pointing to a calendar to benefit one interlocutor, while using ‘then’ to pick out a different time. Further modifications would be required to get it just right, but we omit them here to avoid the distraction an adequate discussion would require. See the appendix of Lepore and Ludwig 2000 for discussion.

20. This explains why temporal indexicals always index to the time of the speaker even when embedded in sentences that otherwise are interpreted relative to a time distinct from the present, as in ‘John said that Mary had believed that Bill would be here by now’. Difficulties introduced by such terms (and similar phenomena—see note 37) led to two-dimensional tense logics (see Kamp 1971). In the truth-conditional approach, we can provide a simple and natural explanation of this behavior by treating such terms as singular referring terms and assigning them reference axioms that determine referents relative to the time of a

speaker's use. This cuts through the difficulties Dowty (1982, esp. secs. 4.4.5–4.4.6) encountered working in another framework.

21. Multiple temporal demonstratives and indexicals present an additional complexity, which space constraints force us to touch on only briefly. See Lepore and Ludwig 2000. Sentences such as 'Now isn't now' and 'Now you see it, and now you don't', in which each use of 'now' indexes to a different time, require satisfaction axioms that quantify over times for each occurrence of 'now' as well as for the utterance as a whole, and for each contained sentence (form) in molecular sentences. To accommodate this need, we define a family of relational predicates:

- (i) Def.  $\Delta(s, t, t_1, \dots, t_n, \alpha_1, \dots, \alpha_n)$  iff  $t_1 < t_2 < \dots < t_n$ , and  $t_1, \dots, t_n$  occur in  $t$ , and  $s$  uses  $\alpha_1$  at  $t_1$ ,  $s$  uses  $\alpha_2$  at  $t_2, \dots, s$  uses  $\alpha_n$  at  $t_n$ .

The six-place predicate so defined holds between a speaker  $s$ , three times  $t, t_1, t_2$ , and two temporal designators  $\alpha_1, \alpha_2$  iff  $t_1, t_2 \subseteq t, t_1 < t_2$ , and the speaker uses  $\alpha_1$  at  $t_1, \alpha_2$  at  $t_2$ . We give satisfaction conditions for a two-place predicate,  $R$ , expressing a temporal relation as follows: For any speaker  $s$ , function  $f$ , temporal designators  $\alpha_1, \alpha_2$ , and times  $t, t_1, t_2$ , such that  $\Delta(s, t, t_1, t_2, \alpha_1, \alpha_2)$ ,  $f$  satisfies $_{[s, t]}$   $\ulcorner \alpha_1 R \alpha_2 \urcorner$  iff  $\text{ref}_{[s, t_1]}(\alpha_1) R(t) \text{ref}_{[s, t_2]}(\alpha_2)$ . This can be extended to predicates with an arbitrary number of temporal argument places. For molecular sentences, we index the utterance time of the contained sentences. For conjunction: For any speaker  $s$ , function  $f$ , formulas  $\varphi, \psi$ , and times  $t, t_1, t_2$ , such that  $\Delta(s, t, t_1, t_2, \varphi, \psi)$ ,  $f$  satisfies $_{[s, t]}$   $\ulcorner \varphi \text{ and } \psi \urcorner$  iff  $f$  satisfies $_{[s, t_1]}\varphi$  and  $f$  satisfies $_{[s, t_2]}\psi$ . This allows for the possibility of saying truly, 'Though John has not smiled yet, he is smiling now, and now has smiled'.

22. Dionysius Exiguus introduced the anno Domini dating system in Rome in the sixth century A.D.; it became the dominant dating system in the West only after its adoption by Charlemagne.

23. King argues interestingly that day designators are referring terms and not descriptions, but in contrast to our position that they are also nonrigid. King argues that since what the length of a day is depends on the rate of rotation of the earth, and the interval a month term is true of depends on the length of the days it includes, the extension of month terms can differ from possible world to possible world. Thus, 'January 2001' may pick out different time intervals in different possible worlds; similarly, 'January 1, 2001' may pick out different time intervals in different worlds. The same reasoning applies to 'is 2001', since the length of the year depends on how long it takes the earth to rotate around the sun. We are not quite convinced, however, for it is compatible with this that we say that in different possible worlds the same date system would be used to pick out different times, rather than saying that the terms we use pick out different times in different possible worlds. The issue hinges on intuitions about counterfactuals and modal claims that are not easy to adjudicate. We find it odd, for example, to assert, 'January 2001 might not have been January 2001', while there is no puzzle about asserting, for example, 'The president of the United States in January 2001 might not have been the president of the United States in January 2001'.

24. As King (2001) notes, since it may be Monday in the United States but Tuesday in Japan, or January in Tokyo but December in New York, these terms properly express relations between time intervals and locations. We can accommodate this by giving, for example, ‘January’ the satisfaction clause ‘ $f$  satisfies<sub>[s,t]</sub> “ $x$  is January” iff January( $f(x), s$ )’, where ‘January( $x, y$ )’ expresses the appropriate relation between a time interval  $x$  and a location picked out relative to a person  $y$ . This need not be the speaker’s location, since someone may say on the phone, for instance, ‘Is it January yet?’, intending to ask about whether it is January in his interlocutor’s location. Understanding exactly what relation is being expressed requires quite a bit of knowledge of the intricacies of the calendar system. In the division of linguistic labor, most of us rely on a few when we use date names.

25. There is a class of adverbials we will not discuss whose members are used routinely to connect sentences in narratives. These are exemplified by ‘three hours later’ in the following passage, borrowed from Hinrichs 1986: ‘They wheeled me into the operating room and put me under sedation. Three hours later I woke up’. The reference time for ‘later’ here is understood to be the time the narrator was put under sedation. Examples of this sort, as well as the conventions of narrative more generally, in which times of narrated events are understood to occur in an order indicated by the order of narrative, have suggested to many that the proper unit for semantic analysis is larger than the sentence and that the traditional focus on sentential semantics distorts the semantic structures of natural languages. We will sidestep this debate. Although we think our understanding of narrative can be accommodated by a sentence-level semantics, nothing in our approach prevents our incorporating semantic-level cross-sentential anaphoric reference.

26. We borrow this terminology and classification scheme from Smith 1978.

27. Some uses of temporal adverbials suggest that they are not always used to quantify over times, as in the sentence ‘Even numbers are always divisible by 2’. On such grounds, Lewis (1975) argues that they should be treated as quantifying over “cases.” This desperate expedient should be resisted. Given that forms of ‘to be’ in English will have a suppressed temporal argument place, there can be no difficulty in including a temporal quantifier even in sentences that are about abstract objects. Indeed, not supplying a universal quantifier for a sentence such as ‘Even numbers are divisible by 2’ might be thought to be misleading when a speaker intends to be conveying that this is so necessarily or by definition. The effect of introducing ‘always’ is to emphasize the noncontingency of the claim, although what is said strictly speaking falls short of what is intended.

28. We are indebted here to comments by Samuel Wheeler.

29. Vlach (1993, p. 231) claims that “[n]o existing framework for temporal semantics provides a general treatment of durative ... and frequency ... adverbials” and that, in particular, none can deal with a sentence such as (i).

(i) Allen worked out regularly for two weeks last month.

Our account handles this straightforwardly. The frequency adverb is a quantifier that replaces the existential quantifier of the tense of ‘worked out’, keeping the past time restriction. The duration adverbial ‘for two weeks last month’ (where ‘last month’ modifies ‘two weeks’) modifies the time so bound, which is understood to be within the time so designated, represented as follows:

(ii) [Regular  $t_1 : t_1 < t^* \ \& \ t_1 \subset \text{two weeks last month}$ ](Allen works out( $t_1$ )).

Vlach’s account of tense (or more properly, tense inflection) is that it makes no truth-functional contribution to sentences in which it occurs, but is like the gender of pronouns, which, he assumes, does not contribute to truth conditions. English speakers are supposed to follow the convention of using ‘he’ when talking about a male and ‘she’ when talking about a female, but one may, he asserts, say truly of a woman, ‘He is tall’. Similarly, one is supposed to obey a convention of using present and past when talking about the present and the past, but this is no part of the truth conditions of the utterance, taken literally. All the work of semantic temporal reference, Vlach says, is really done by adverbial modification. This is an interesting suggestion, but it certainly swims against the tide! It hardly comports with our intuitive judgments about the truth of utterances using tensed verbs. If one asserts, ‘John died’, but John is alive and well, one offends not just against usage, but against the truth.

30. Can we account for tense using a quantifier over events and not times? The difficulty is to anchor reference to events to the time of utterance. The only way we can see how to do this is to force every utterance to refer to itself, since each utterance is guaranteed to occur at the time of speech. (Such an approach is sketched in Higginbotham 1995.) For the past tense, we might treat, say, ‘John kissed Mary’ as equivalent to ‘[There is an event  $e : e < u^*$ ](Kisses( $e$ , John, Mary))’. Then ‘ $u^*$ ’ would receive this reference axiom: For any speaker  $s$ , time  $t$ , utterance  $u$  by  $s$  at  $t$ ,  $\text{ref}_{[s,t]}(‘u^*’) = u$ . It seems counterintuitive, however, to treat every utterance as self-referential. Furthermore, it seems intuitively clear that what one says in uttering, for example, ‘It will rain this afternoon’, could have been true even if there had been no utterances. It could not have been true, however, if there had been no times. For these reasons, we reject this alternative approach.

31. See Comrie 1985, p. 109, for Russian; and see Ogihara 1996.

32. There are apparent exceptions to this rule—for example, reports of certain states that continue into the present, as in ‘I heard last night that Mary is sick’ or ‘The Egyptians knew that the earth is round’ (borrowed from Smith 1978, p. 66). In this case, the present tense is interpreted relative to the speaker’s context rather than that of the event or state being reported. This seems acceptable only when the verb is factive or a verb of indirect discourse. One cannot say, for instance, ‘I thought that the earth is round’. We suspect that in this case the present tense is used to indicate that the content of the reported state or event is not relativized simply to the time of the reported event or state, but is about a state that would extend from that past time into some indefinite future time that at least includes the time of utterance. (Abusch (1997) gives a different account that makes the

appropriateness hinge on what the speaker believes, but if we wish the reports to be possibly true, the right account should focus on what the reportee knows, hears, says, and the like; one of Abusch's examples, 'John believed that Mary is pregnant', we find hard to interpret!) A related case is 'I asked him who that lady in the tiara is'. Here there is the pull of the demonstrative construction, interpreted relative to the speaker's time, as well as the assumption, forced by the use of the expression in the nominal modifying the demonstrative, that the lady in question is still wearing a tiara. (The example is borrowed from Visser 1972, p. 779, a rich source of examples from Old to Modern English. Visser notes that the use of the present in the complement has been common in all periods of the language, though more recently neglected by grammarians (p. 827). The examples all seem, however, to fit the diagnosis here given. An event or process definitely located only in the past relative to the time of speech is quite unhappily reported in the present in the complement, as in 'He said that he is tired yesterday'.)

33. This terminology is not used consistently in the literature. Sometimes it is used for the semantic phenomenon of the tense in one clause controlling that in another; sometimes to refer to the syntactic phenomenon of back shifting of tense markers. We use it here in the latter sense.

34. We are following traditional rules for sequence of tense in reporting indirect discourse and attitude sentences. No doubt many speakers of English are not so systematic and tend to use the simple past for both the simultaneous reading (69) and the past relative to the time of uttering (68). Higginbotham (1995) assumes this, as does Abusch (1997), who offers examples in which reading (68) would be forced by the narrative context: 'John mostly slept through the sixties. But Joan later claimed that he was active in the antiwar movement' (our example). Locating the saying in the discourse at a time later than the time the mentioned speaker intends to comment on forces an auditor to interpret indirect the discourse as in (68). Our usage seems to track the tradition; but, in any case, tense-sequencing rules are not a deep feature of natural languages, though the underlying semantic structures are.

35. Tense sequencing shows up even without an explicit tense marker governing it, as in Abusch 1997, p. 29: 'Mary's desire to marry a man who resembled her is bizarre'. The past shifting of 'resemble' indicates that the desire is located prior to the time of utterance. This tells us that in its canonical paraphrase, '[The  $x$ :  $x$  is Mary's desire to marry a man who resembled her]( $x$  is bizarre)', the appropriate tense for the copula in the restriction on the quantifier is the simple past. This also points to an account of the acceptability of 'The fugitives are all in jail now' (borrowed from Vlach 1993, p. 259), which, while perfectly acceptable, might seem odd because prisoners are not fugitives. By understanding the predicate introduced by 'fugitives' in the past tense, this unwelcome conflict is resolved.

36. As we remarked earlier, there is a clear reason not to interpret the tense in these sentences relative to the speaker's context: this would guarantee that the report is false since the reportee will not say anything in the future directly about the present time (that has the right structure). We are treating indirect speech

as a model for attitude sentences. But with attitude sentences, there appears to be a counterexample to our analysis, in a sentence noticed by Terence Parsons (reported in Dowty 1982, p. 50).

(i) One day John will regret that he is treating me like this.

In (i), the tense of the complement verb 'is treating' is independent of that of the main verb; that is, it indexes to speaker time. Loose talk or counterexample? If what one intends to say by (i) is true, John will one day be disposed to report himself by saying, 'I regret that I treated him like that'. But interpreted relative to their respective contexts, sentences in the complement clauses do not express the same proposition, being directly about different times. How then could (i), interpreted as intended, be true? What one intends to convey could have been reported by (ii).

(ii) One day John will regret that he (has) treated me like this.

This gets it just right. We suggest the following account of the use of (i). A speaker, resentful of John, wishes to emphasize John is mistreating him, and to emphasize the objective wrongness of John's actions by asserting that John will regret (someday) his mistreatment of him (his treating him like this). Our speaker could say, 'John is treating me like this and one day he will regret his treating me like this', but this is a mouthful, and in the heat of the moment, out comes a fusion of the two, natural enough, given that 'his treating me like this' is the nominalization of 'he is treating me like this'. We so interpret him because 'this' is used to pick out a current activity of John's, which requires the tense of 'is treating' to index to the present and not to the time of John's regret. We understand what he intends well enough though he issues an inaccurate report and violates some (well-grounded) rules of usage.

37. Similar binding phenomena occur between the tenses of verbs generally in superordinate and subordinate clauses, where we find the past shifting of tense as a marker of this binding as well. Consider the contrast between (i) and (ii),

(i) A child was born who would be king.

(ii) A child was born who will be king.

discussed in Kamp 1971, in which they form part of Kamp's motivation for a two-dimensional tense logic. The effect of the past shifting is to introduce the same kind of binding relation between the tense of the main verb and the tense of the subordinate clause found in complement clauses of indirect discourse. Whereas in (ii) the tense of the verb in the subordinate clause is interpreted relative to the speaker's context, in (i) it is interpreted relative to the time bound by the past tense of the main verb. This can be represented as '[There is a time  $t_1 : t_1 < t^*$ ][there is a time  $t_2 : t_2 > t_1$ ](a child is( $t_1$ ) born who is( $t_2$ ) king)'. ((i) is true even if a child was born who at some time after the speech act is king, although, given the availability of (ii), it would be pragmatically misleading to use (i) except when the time of the child's being king precedes the time of speech.) Similarly, the use of the simple past in the superordinate and the past perfect in the subordinate signals that the tense of the main verb controls that of the subordinate. In 'A president was elected who had been jailed', the natural interpre-

tation requires that the event expressed in the subordinate clause occur prior to the event expressed in the superordinate clause. It is not clear that we find the same effect with the simple past in the subordinate clause, however, which, if it followed the pattern of indirect discourse, would index to the same time as the event expressed by the main verb. 'A president was elected who was jailed' does not suggest that the jailing and the election occurred simultaneously; rather, the restriction seems to be that both occurred prior to the time of utterance. The phenomenon occurs with other tenses. Consider 'John will meet a man who has been/is/will be king'. In appropriate contexts, we can force readings in which the tense in the subordinate clause either is independent of the main clause and indexes to speaker time, or is controlled by that of the main clause. It is clearly useful to have both readings, but lamentable that English, in this as in many other cases, provides no means of systematic disambiguation. Using back shifting of tense for verbs in subordinate clauses whose main verbs are in the past can be seen as a half-hearted attempt to disambiguate, which when employed in discourse and attitude sentences leads regrettably to the difficulties we noted with reporting unambiguously past speech acts employing the past and present perfect. But this lack of systematicity should not be too surprising. Natural languages are feral shrubs, untrimmed to the shapes of a logically perfect language.

38. A word may be in order about the implications of our treatment of tense in complement clauses for certain argument forms given in natural language. Consider, for example, this argument: John thought that Mary loved him, and he still thinks that; therefore, John thinks that Mary loved him. (The genre we treat here was brought to our attention by Richard 1981.) The argument is intuitively valid (relativizing both sentences to a set of contextual variables), but what is the function of 'that' in the second conjunct of the first sentence? If it is a referring term, then it cannot be taken to pick out a proposition referred to in the first conjunct, since the only proposition expressed there is that expressed by the full sentence, since the complement clause semantically contains variables bound from outside it. Thus, either we must treat it as something like a pro-sentence, which is to be replaced by 'Mary loved him'; or, if we treat it as a referring term, it looks as if it must refer to the sentence 'Mary loved him'. In favor of the first alternative, perhaps, is the naturalness of replacing 'that' with 'so'. The second alternative, however, could be made to work as well in a sophisticated sententialist account (see Ludwig and Ray 1998).

39. This shows also that modifying our proposal by introducing predicates such as 'Past( $t$ )', 'Present( $t$ )', and 'Future( $t$ )' fails to avoid the result. These must be interpreted indexically, and their analysis treats them as equivalent to ' $<t^*$ ', ' $=t^*$ ', and ' $>t^*$ '. It might be objected that our account rules out the past and future tensed predicates 'was the present time' and 'will be the present time'. But these are handled by imposing our account of past and present tense onto our analysis of the present tense predicate. So, for the past tense predicate:

- (i) For any speaker  $s$ , time  $t$ , function  $f$ ,  $f$  satisfies<sub>[ $s, t$ ]</sub> 'x was the present time' iff [there is a  $t_1 < t$ ]( $f('x') = t_1$ ).

Similarly for the future tense version. No property is attributed in this clause.

40. The reader may wish to compare our account with that of Parsons (1990, chap. 10), who does not analyze the perfect as a tense. Rather, more in the vein of our account of the progressive, Parsons's treats what we call the perfect tenses as perfect *forms* of verbs, which are state verbs that express being in the state of having done or been something (analogous to the structure, subject + tense + 'have' + adjective + noun, as in 'John has red hair') and which can be in the past, present, or future ('had', 'has', 'will have'). This has the same effect as our suggestion below. It is not clear that anything we say rules decisively against this alternative, which could be adopted in the framework we pursue. On the other hand, we are unpersuaded that etymological considerations, which Parsons cites, show that our analysis is incorrect: English speakers use these constructions perfectly ignorant of their history, and there is nothing in their dispositions that would suggest they see a strong analogy with the use of 'have' in state-attributing sentences such as 'John has red hair'. Furthermore, the double quantifier approach interacts in an intuitively compelling way with adverbial modification of perfectives.

41. In this we differ from Taylor (1977), who treats the present perfect as semantically equivalent to the simple past. We already noted it cannot be equivalent to the simple past, which requires that the event expressed occur strictly in the past, while the past perfect does not. We also depart from Taylor in taking syntactic structure as a guide to the semantic structure of the present perfect. Taylor's paraphrases of the perfect tenses employ demonstratives for reference times, for which there is no sanction in the original; in other words, to say that, for example, John had been a major in the army, one does not *need* to have any specific past time in mind relative to which John before that time had been a major in the army, although, of course, one may. Taylor also errs in his treatment of the future perfect in supposing that the event time must lie strictly in the future. This isn't so, as our example in the text shows.

42. An oddity about which adverbials the present perfect will take comfortably is that it does not happily accept adverbials that precisely specify the event time when the time is clearly in the past, though this is not so for the past or future perfect. Although one can say felicitously, 'I have seen her today', one cannot say, 'I have seen her yesterday'. (This fact is discussed in the useful Mittwoch 1988, p. 218.) Our account presents no semantic barrier to this, though it would be pragmatically odd, since given the difference between the present perfect and the past, when an adverbial definitely locates the event time in the past, using the present perfect will seem pointless.

43. Reichenbach (1947, p. 294) incorrectly suggests that such modifiers modify the reference time. In 'John had arrived on Tuesday, a day before Mary', it is not reference time but event time that is in question. Likewise in Reichenbach's example 'I had met him yesterday', 'yesterday' does not modify the reference time, but rather the event time. For we can likewise say, 'I had met him yesterday, but Mary did not meet him until this morning'. So when Reichenbach claims that modifiers modify the event time only when the event and reference time coincide,

he is mistaken. Rather, different modifiers should be taken to modify different times, according to their character.

44. There is another (though less natural) reading, according to which to say that 'John has worked here since 1980' is to say that at some time between 1980 and now, John has worked here. It may be that 'since' is ambiguous. On the other hand, it may be that there is a univocal reading that in standard contexts generates the reading we offered in the text. Three possibilities suggest themselves. First, the sense of 'since' is univocally 'between now and 1980', and it is usually understood as elliptical for 'ever since'. Second, '=' should be replaced with ' $\subseteq$ ', in (92)–(94) and the implication that the period is equal to the whole is pragmatically generated as the most salient period in the conversational context. Third, the latent sense is generated by the possibility of using 'since' in a context in which an implied numerical quantifier modifies it, as in answering 'Has John worked here at any time since 1980?' by saying, 'Yes, he has worked here since 1980'. Nothing fundamental hinges on resolving this.

45. This analysis, together with our treatment of the tenses when unembedded, helps explain the peculiar behavior of an adverb that seems happiest with perfect tenses, namely, 'already'. 'He has already arrived' is felicitous enough, but 'He arrived already' is odd. This is explained by combining the plausible reading of 'already' as conveying that the event time is before the reference time with our analysis. (We cannot treat it as 'before now' because it does not always relate event time to the present, as in 'By the time he had arrived, we had already finished dinner'.) We represent 'John has already arrived' as '[There is a  $t_1 : t_1 = t^*$ ][there is a  $t_2 : t_2 \leq t_1 \ \& \ t_2 < t_1$ ](John arrives( $t_2$ ))'.

46. Space constraints prevent us from comparing our account with Reichenbach's celebrated discussion Reichenbach 1947, pp. 287–98). Reichenbach postulates a speaker, reference, and event time for all tenses, not just the perfect tenses. While we think Reichenbach's basic picture is correct for the perfect tenses, he does not give adequate reasons to postulate a reference time for the simple tenses.

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