
Tense and Singular Propositions

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I. Information Content

David Kaplan's semantic theory of demonstratives and indexicals is rich and imposing.² The theory can be seen, and more importantly *should be seen*, as essentially a modification of the naive theory of cognitive information content against which Frege rebelled in his classic "Über Sinn und Bedeutung."³

The primary presupposition of any philosophical theory of cognitive

¹Portions of my book *Frege's Puzzle* (Cambridge, Mass.: MIT Press/Bradford Books, 1986) have been incorporated into the present article with the permission of the MIT Press. Some of the material contained here was read at a conference on Themes from David Kaplan held by Stanford University's Center for the Study of Language and Information in March 1984. The article benefited from the discussion that followed, from written comments by Graeme Forbes, Hans Kamp, and Scott Soames, as well as from discussions with Joseph Almog, Keith Donnellan, Graeme Forbes, Hans Kamp, David Kaplan, Christopher Peacocke, and Scott Soames.

²Kaplan's theory is presented in his widely read and discussed manuscript *Demonstratives* (draft #2, UCLA, 1977, published in this volume. References to *Demonstratives* are to this volume.). Certain elements of Kaplan's theory may also be found in "Dthat," and in "On the Logic of Demonstratives," both in *Contemporary Perspectives in the Philosophy of Language*, ed. P. French, T. Uehling, and H. Wettstein (Minneapolis: University of Minnesota Press, 1977), 338-400, 401-12.

³In *Zeitschrift für Philosophie und Philosophische Kritik* 100 (1893): 25-50; in English in Frege, 1984, 157-77; also in Frege, 1952, 56-78.

content is that the (or at least one) semantic function of declarative sentences is to encode information.⁴ I mean the term 'information' in a broad sense to include misinformation—that is, inaccurate or incorrect pieces of information—and even pieces of information that are neither true nor false. A declarative sentence may be said to *contain* the piece of information it semantically encodes, and that piece of information may be described as the *cognitive information content*, or more simply as the *information content*, of the sentence.

Pieces of information are, like the sentences that encode them, abstract entities. Many of their properties can be "read off" from the encoding sentences. Thus, for instance, it is evident that pieces of information are not ontologically simple, but complex. The information that Frege is clever and the information that Frege is busy are both, in

⁴A word of clarification is needed concerning my use of the semantic predicates 'encode' and 'information'. Throughout this essay, I am concerned with discrete units of information that are specifiable by means of a 'that'-clause, e.g., the information that Socrates is wise. These discrete units are *pieces of information*. I shall generally use the mass noun 'information' as if it were shorthand for the count noun phrase 'piece of information', i.e., as a general term whose extension is the class of pieces of information. Thus, I write 'information that is such-and-such' to mean "pieces of information that are such-and-such," 'the same information' to mean "the same piece(s) of information," 'different information' to mean "different pieces of information," and so on. I use the verb 'encode' in such a way that an unambiguous declarative sentence encodes (with respect to a given possible context *c*) a *single* piece of information, which is referred to (with respect to *c*) by the result of prefixing 'the information that' to the sentence and which is to be called 'the information content' of the sentence (with respect to *c*). A declarative sentence may encode (with respect to a given context) two or more pieces of information, but if it does so, it is ambiguous. Pieces of information encoded by the proper logical consequences of an unambiguous sentence are not themselves encoded, in this sense, by the sentence. The (piece of) information that snow is white and grass is green is different information (a different piece of information) from the (piece of) information that snow is white, though intuitively the latter is included as part of the former. The sentence 'Snow is white and grass is green' encodes only the former, not the latter. This constitutes a departure from at least one standard usage, according to which the information content of a sentence is perhaps something like a class of pieces of information, closed under logical consequence.

I am not concerned in this essay with a notion of an *amount* of information, which arises in the mathematical theory of communication or information. The information that *snow is white and grass is green* and *Socrates is Socrates* may be no more or less information than the information that *both snow is white if and only if grass is green and either snow is white or grass is green*. Nevertheless general considerations involving Leibniz's Law strongly suggest that they are numerically distinct pieces of information. For instance, the first concerns Socrates whereas the second does not.

the same way, pieces of information directly about Frege; hence, they must have some component in common. Likewise, the information that Frege is clever has some component in common with the information that Russell is clever, and that component is different from what it has in common with the information that Frege is busy. Correspondingly, the declarative sentence 'Frege is clever' shares certain syntactic components with the sentences 'Frege is busy' and 'Russell is clever'. These syntactic components—the name 'Frege' and the predicate 'is clever'—are separately semantically correlated with the corresponding component of the piece of information encoded by the sentence. Let us call the information-component semantically correlated with an expression the *information value* of the expression. The information value of the name 'Frege' is that which the name contributes to the information encoded by such sentences as 'Frege is clever' and 'Frege is busy'; similarly, the information value of the predicate 'is clever' is that entity which the predicate contributes to the information encoded by such sentences as 'Frege is clever' and 'Russell is clever'. As a limiting case, the information value of a declarative sentence is the piece of information it encodes, its information content.

Within the framework of so-called possible-world semantics, the information value of an expression determines the semantic *intension* of the expression. The intension of a singular term, sentence, or predicate is a function that assigns to any possible world w the *extension* the singular term, sentence, or predicate takes on with respect to w . The extension of a singular term (with respect to a possible world w) is simply its *referent* (with respect to w), i.e., the object or individual to which the term refers (with respect to w). The extension of a sentence (with respect to w) is its truth-value (with respect to w)—either truth or falsehood. The extension of an n -place predicate (with respect to w) is the predicate's semantic characteristic function (with respect to w), i.e., the function that assigns either truth or falsehood to an n -tuple of individuals, according as the predicate or its negation applies (with respect to w) to the n -tuple. Assuming bivalence, the extension of an n -place predicate may be identified instead with the class of n -tuples to which the predicate applies.

Since ordinary language includes so-called indexical expressions (such as 'I', 'you', 'here', 'now', 'today', 'yesterday', 'this', 'that', 'he', 'she', 'there', and 'then'), the information value of an expression, and hence also the semantic intension, must in general be indexed, i.e., relativized, to the context in which the expression is uttered. That is, strictly one

should speak of the information value of an expression (e.g., the information content of a sentence) *with respect to* this or that context of utterance, and similarly for the corresponding semantic intension of an expression; the information value and corresponding intension of an expression with respect to one context may be different from the information value and corresponding intension of the same expression with respect to a different context. This generates a higher-level, nonrelativized semantic value for expressions, which Kaplan calls the *character* of an expression. The character of an expression is a function or rule that determines, for any possible context of utterance *c*, the information value the expression takes on with respect to *c*. For example, the character of a sentence is a function or rule that assigns to any possible context of utterance *c* the piece of information that the sentence encodes with respect to *c*, that is, the information content of the sentence with respect to *c*.

In addition to the character of an expression, we may consider a related nonrelativized semantic value: the function or rule that determines for any possible context of utterance *c* the extension (e.g., the referent, the class of application, or the truth-value) that the expression takes on with respect to *c*. Let us call this the *contour* of an expression. The contour of an expression is fully determined by its character, as follows: Given any context *c*, the character of an expression determines the information value of the expression with respect to *c*. This, in turn, determines the intension of the expression with respect to *c*. Applying this intension to the possible world of the context *c* yields the extension of the expression with respect to *c*.⁵

⁵I use here, and throughout this essay, a quasi-technical notion of the *context* of an utterance, which is such that, for any particular actual utterance of any expression by anyone, if any facts had been different in any way, even if they are only facts entirely independent of and isolated from the utterance itself, then the context of the utterance would, ipso facto, be a different context—even if the utterance is made by the very same speaker in the very same way to the very same audience at the very same time in the very same place. To put it another way, although a single utterance occurs in indefinitely many different possible worlds, any particular possible context of an utterance occurs in one and only one possible world, so that in every possible world in which the same utterance occurs, it occurs in a new and different context—even if the speaker, his or her manner of uttering, the time of the utterance, the location of the speaker, the audience being addressed, and all other such features and aspects of the utterance remain exactly the same.

There is a very good reason for using the term 'context' in this way: Suppose, for example, that it will come to pass that a Democrat is elected to the presidency in the year 2000, and consider a possible world *W* that is exactly like the actual world in every detail up to 1 January 1999, but in which a Republican is elected

The systematic method by which it is secured which information is semantically encoded by which sentence is, roughly, that a sentence semantically encodes that piece of information whose components are the information values of the sentence-parts, with these information values combined as the sentence-parts are themselves combined to form the sentence.⁶ In order to analyze the information encoded by a sentence into its components, one simply decomposes the sentence into its information-valued parts, and the information values thereof are the

to the presidency in 2000. Suppose I here and now utter the sentence

Actually, a Republican will be elected to the U.S. presidency in 2000 A.D.

In the actual world, I thereby assert a piece of information that is necessarily false. In *W*, on the other hand, I thereby assert a piece of information that is necessarily true. I utter the very same sequence of words of English, with the very same English meanings, in both possible worlds, yet I assert different things. If we were to use the term 'context' in such a way that the context of my utterance remains the same in both worlds, we would be forced to say, quite mysteriously, that the sentence I uttered is such that it would have encoded different information with respect to the context in which I uttered it if *W* had obtained even though both its meaning and its context of utterance would remain exactly the same. The information content of the sentence would emerge as a function not only of the meaning of the sentence and the context of utterance, but also of the apparently irrelevant question of which party wins the U.S. presidency in the year 2000. Using the term 'context' as I shall throughout this essay, we may say instead that, although I make the very same utterance both in *W* and in the actual world, the context of the utterance is different in the two worlds. This allows us to say that the sentence I utter-takes on different information contents with respect to *different* contexts of utterance, thereby assimilating this phenomenon to the sort of context-sensitivity that is familiar in cases of such sentences as 'A Republican is presently U.S. president'.

⁶The latter clause is needed in order to distinguish 'Bill loves Mary' from 'Mary loves Bill', where the sequential order of composition is crucial. This succinct statement of the rule connecting sentences and their information contents is only an approximation to the truth. A complicated difficulty arises in connection with the latter clause of the rule and with such quantificational locutions as 'someone' in 'Someone is wise'. Grammatically the sentence 'Someone is wise' is analogous to 'Socrates is wise', though logically and semantically they are disanalogous. In 'Socrates is wise', the predicate 'is wise' attaches to the singular term 'Socrates'. This situation is reversed in 'Someone is wise', wherein the restricted quantifier 'someone' attaches to the predicate 'is wise'. Thus, whereas grammatically 'someone' is combined with 'is wise' to form the first sentence in just the same way that 'Socrates' is combined with 'is wise' to form the second sentence, the information values of 'someone' and 'is wise' are combined very differently from the way the information values of 'Socrates' and 'is wise' are combined.

A perhaps more important qualification to the general rule is noted in the next paragraph of the text. Yet another important qualification concerns overlaid quan-

components of the encoded information. In this way, declarative sentences not only encode but also codify information.

One may take it as a sort of general rule or principle that the information value of any compound expression, with respect to a given context of utterance, is made up of the information values, with respect to the given context, of the information-valued components of the compound. This general rule is subject to certain important qualifications, however, and must be construed more as a general guide or rule of thumb. Exceptions arise in connection with quotation marks and similar devices. The numeral '9' is, in an ordinary sense, a component part of the sentence 'The numeral '9' is a singular term', though the information value of the

tifiers. It is necessary to distinguish between the information contents of such constructions as:

(A) For everyone x there is someone y such that x loves y

and

(B) For everyone x there is someone y such that y loves x .

One method, due to Alonzo Church and pointed out to me by David Kaplan, employs Russellian propositional functions, i.e., functions from an individual to a singular proposition involving that individual. (Church himself applies the general method in such a way as to invoke only Fregean functions from pure concepts of individuals to Fregean purely general propositions, although the general method can also accommodate anti-Fregean theories by invoking propositional functions.) The information values of the quantifiers 'for everyone' and 'there is someone such that' are certain higher-order properties. (Specifically, they are properties of one-place functions from individuals to truth-values.) Let us designate them by ' Π one' and ' Σ one', respectively. Then on this method, the information content of sentence (A) is regarded as having the structure of the following ordered pair:

$\langle \lambda x(\lambda y(x, y, \text{loving}), \Sigma\text{one}), \Pi\text{one} \rangle$.

The information content of sentence (B), on the other hand, is regarded as having the following structure:

$\langle \lambda x(\lambda y(y, x, \text{loving}), \Sigma\text{one}), \Pi\text{one} \rangle$.

(For complete accuracy, the relation of loving should be replaced throughout by the temporally indexed relation of *loving at t* , which may be identified with the ordered pair $\langle \text{loving}, t \rangle$ —see section VIII below). The first element of the former proposition is the propositional function that assigns to each individual x the proposition made up of the propositional function that assigns to each individual y the proposition that x loves y and the second-order property Σ one. The first element of the latter proposition is the appropriate analogue.

A variant of this method replaces these propositional functions with the properties of loving someone (at t) and of being loved by someone (at t), respectively. The information content of sentence (A) may be regarded as the following complex proposition: that the function that assigns truth to an individual x if x loves someone or other, and assigns falsehood otherwise, assigns truth to everyone whatsoever.

former is no part of the information content of the latter. I shall argue below that, in addition to quotation marks, there is another important though often neglected class of operators that yield exceptions to the general rule in something like the way quotation marks do. Still, it may be correctly said of any English sentence free of any operators other than truth-functional connectives (e.g., 'If Frege is clever, then so is Russell') that its information content is a complex made up of the information values of its information-valued components.

II. The Naive Theory

The naive theory is a theory of the information values of certain expressions. According to the naive theory, the information value of a singular term, as used in a possible context, is simply its referent in that context. This is similar to what Gilbert Ryle called the '*Fido*'-*Fido theory*, according to which the "meaning" or content of a singular term is simply its referent. Elements of this theory can be traced to ancient times. Likewise, the information value of a predicate, as used in a particular context, is identified with something like the semantically associated attribute with respect to that context, that is, with the corresponding property in the case of a monadic predicate or the corresponding n -ary relation in the case of an n -place predicate. On the naive theory, an atomic sentence consisting of an n -place predicate Π and n occurrences of singular terms, $\alpha_1, \alpha_2, \dots, \alpha_n$, when evaluated with respect to a particular possible context, has as its cognitive content in that context a piece of information, called a *proposition*, which is supposed to be a

This powerful method need not assign any information value to an open sentence such as ' x loves y ', except relative to an assignment of values to its free variables. Unlike some other possible proposals, it thus generates no counterexamples to a certain principle of compositionality (or interchange) for information value, commonly attributed to Frege, according to which the information value of a compound expression such as (A) or (B) is a function solely of the information values of its information-valued components. (See A. Church, "Intensional Isomorphism and Identity of Belief," *Philosophical Studies* 5 (1954): 65-73, for a similar but more sharply articulated principle.) However, the method does generate counterexamples to a stronger compositionality principle, also attributable to Frege, according to which the information value of a compound expression is a complex made up entirely of the information values of its information-valued components. If the first element of the information content of sentence (A) is the information value of any component of the sentence—for example, the component ' x there is someone y such that x loves y '—then the information value of that component is not made up of the information values of its information-valued components.

complex consisting of something like the attribute referred to by Π with respect to that context and the sequence of objects referred to by the singular terms with respect to that context. For example, the cognitive information content of the sentence 'Frege is clever' is to be the singular proposition consisting of Frege and cleverness. On the naive theory, a sentence is a means for referring to its information content by specifying the components that make it up. A sentential connective may be construed on the model of a predicate. The information value of a connective would thus be an attribute (a property if monadic, a relation if polyadic)—not an attribute of individuals like Frege, but an attribute of pieces of information, or propositions. For example, the information value of the connective 'if and only if' might be identified with the binary equivalence relation between propositions having the same truth-value. Similarly, the information value of a quantifier might be identified with a property or properties of individuals. For example, the information value of the unrestricted universal quantifier 'everything' may be the (second-order) property of being a universal (first-order) property, i.e., the property of being a property possessed by every individual. The information value of a sentence, as used in a particular context, is simply its information content, the proposition made up of the information values of the information-valued sentence components.

Within the framework of the naive theory, the *meaning* of an expression might be identified with the expression's character, i.e., the semantically correlated function from possible contexts of utterance to information values. For example, the meaning of the sentence

(1) I am busy

will be thought of as a function that assigns to any context of utterance c the singular proposition composed of the agent of the context c (= the referent of 'I' with respect to c) and the property of being busy.

III. The Singly Modified Naive Theory

The naive theory is, as its name suggests, a prototheory of information value. For all its naiveté, there is a great deal to be said in its favor. First and foremost, it is a natural and compelling result, perhaps *the* natural result, of a preliminary philosophical investigation into the nature and structure of information. Some of the great thinkers in the philosophy of language, among them Frege and Russell, came to the subject with an initial presupposition of some rudimentary form of the naive theory.

The theory yields a plausible rendering of the claim that the proposition that Frege is clever is information *about* or *concerning* Frege: The proposition is about Frege in the straightforward sense that Frege is an individual constituent of it. The naive theory extends easily to more complex sentential structures involving variables, connectives, quantifiers, and propositional operators. It gives substance to the oft-repeated slogan that to give (or to know) the semantic content (or “meaning,” in the sense of information content) of a sentence or statement is to give (know) its truth-conditions. Its notion of information content is exemplary of the kind of notion of proposition that is needed in connection with questions of *de re* modality: If I utter the sentence ‘Frege is clever’, I assert something that is true if and only if the individual Frege has the property cleverness. Moreover, what I assert is such that it is true with respect to an arbitrary possible world *w* if and only if that same condition, the very individual Frege having cleverness, obtains in *w*. It is not enough, for instance, that someone in *w* who resembles or who represents the actual Frege in a certain way be clever in *w*, or that someone in *w* who fits a certain conceptual representation of the actual Frege be clever in *w*. It must be Frege, the very individual. The naive theory also yields a straightforward notion of *de re* belief, and other *de re* propositional attitudes: To believe *p* is to believe the proposition *p*. So to believe *of* or *about* Frege that *he* is clever is to believe the proposition *of* or *about* Frege that *he* is clever, that is, the piece of information consisting of Frege and cleverness. Indeed, these considerations concerning *de re* modality and *de re* propositional attitudes constitute important considerations favoring the naive theory over its principal rival, the orthodox Fregean theory, as well as over the theory of Russell.

Perhaps the most important thing to be said for the naive theory is that it has cogency and intuitive appeal as a theory of assertion. When I utter ‘Frege is clever’, my speech act divides into two parts: I single someone out (Frege), and I ascribe something to him (cleverness). These two component speech acts, singular reference and ascription, correspond to two components of *what I assert* when I assert that Frege is clever. My asserting that Frege is clever consists in my referring to Frege and my ascribing cleverness to him; so too, that Frege is clever (what I assert) consists of Frege (what I refer to) and cleverness (what I ascribe to him).

Compelling though it is, the naive theory has two fundamental flaws and must be modified if it is to yield a viable theory of information value. The first flaw is that the naive theory is in a certain sense internally

inconsistent; the second concerns the eternalness of information. I shall consider each of these problems in turn.

The naive theory rests upon two central ideas. The first is the identification of the information value of a singular term with its referent, i.e., the 'Fido'-Fido theory. By analogy, the referent of a predicate, a connective, or a quantifier is identified with its information value: the semantically correlated attribute of individuals, of propositions, or of properties of individuals, respectively. The second major idea is that the information value of a sentence, as uttered on a particular occasion, is made up of the information values of its information-valued components. Unfortunately, these two ideas come into conflict in the case of definite descriptions. According to the naive theory, the information value of a definite description such as 'the individual who wrote "Thoughts"' is simply its referent, Frege. Consequently, the sentence 'The individual who wrote "Thoughts" is clever' is alleged to encode the singular proposition about Frege that he is clever. But the definite description is a phrase that, like a sentence, has parts with identifiable information values—for example, the dyadic predicate 'wrote' and the singular term (article title) 'Thoughts', as well as the monadic predicate 'wrote "Thoughts"'. These information-valued components of the definite description are, ipso facto, information-valued components of the containing sentence. If the information value (= information content) of a sentence is made up of the information values of its information-valued components, the information values of these description-components must also go in to make up part of the information that the author of "Thoughts" is clever. And if the information value of a sentence is something made up of the information values of its information-valued components, it stands to reason that the information value of a definite description, which is like a sentence at least in having information-valued components, should also be something made up of the information values of those components. Thus, instead of identifying the information value of 'the individual who wrote "Thoughts"', as used on a particular occasion, with its referent, one should look instead for some complex entity made up partly of the relational property of having written "Thoughts" (which, in turn, is made up of the binary relation *having written* and the work "Thoughts") and partly of something else—something that serves as the information value of the definite-description operator 'the'. On this modification of the naive theory, the information that the author of "Thoughts" is clever is not the singular proposition about Frege that he is clever but a different piece of information, one that does not have Frege as a component

and has in his place something involving the property of authorship of "Thoughts".

Let us call this corrected version of the original theory the *singly modified naive theory*. One extremely important wrinkle in the singly modified naive theory is that a definite description 'the ϕ ', in contrast with other sorts of singular terms, is seen as involving a bifurcation of semantic values taken on with respect to a context of utterance. On the one hand, there is the description's referent, which is the individual to which the description's constitutive monadic predicate (or open formula) ϕ applies if there is only one such individual and is nothing otherwise. On the other hand, there is the description's information value, which is a complex made up, in part, of the information value of the predicate (or formula) ϕ . By contrast, a proper name or other single-word singular term is seen as involving a collapse of semantic values: its information value with respect to a particular context is just its referent with respect to that context. From the point of view of the singly modified naive theory, the original naive theory errs by treating definite descriptions on the model of a proper name. Definite descriptions are not single words but phrases, and therefore have a richer semantic constitution.

On the singly modified naive theory, any expression other than a simple singular term is, at least in principle, capable of bifurcation of reference and information value. For example, though the information value of a sentence is its information content, sentences might be regarded as referring to something other than their information contents. The singly modified naive theory, as defined so far, is tacit on the question of the referents of expressions other than singular terms (sentences, predicates, connectives, quantifiers, and other operators). However, a familiar argument, due primarily to Alonzo Church and independently to Kurt Gödel, establishes that the closest theoretical analogue of singular-term reference for any expression is its extension.⁷ Accordingly, the singly modified naive theory will be understood henceforth to include the thesis that any expression may be thought of as referring, with respect to a given context, time, and possible world, to its extension with

⁷ See Alonzo Church, "Review of Carnap's *Introduction to Semantics*," *The Philosophical Review* 52 (1943): 298–304 at 299–301; and Kurt Gödel, "Russell's Mathematical Logic," in *The Philosophy of Bertrand Russell*, ed. P. A. Schilpp. The Library of Living Philosophers, Evanston, Illinois (New York: The Tudor Publishing Company, 1944), at 128–29. The general argument is applied to the special case of monadic predicates in my *Frege's Puzzle*, at 22–23, and in greater detail to the special case of common nouns in my *Reference and Essence* (Princeton: Princeton University Press, and Oxford: Basil Blackwell, 1981), at 48–52.

respect to that context, time, and possible world.

IV. Propositions and Proposition Matrices

Kaplan's theory of demonstratives and indexicals is a version of the singly modified naive theory. Although this theory eliminates the inconsistency built into the original naive theory, it retains a second defect of the original theory. This defect is illustrated by the following example: Suppose that at some time t^* in 1890 Frege utters sentence (1) (or its German equivalent). Consider the piece of information, or proposition, that Frege asserts in uttering this sentence. This is the information content of the sentence with respect to the context of Frege's uttering it. Let us call this proposition ' p^* ' and the context in which Frege asserts it ' c^* '. We may suppose that the piece of information p^* is made up of the information value of the indexical term 'I' with respect to c^* and the information value of the predicate 'be busy' with respect to c^* . According to the naive theory, these information values are Frege and the property of being busy, respectively, so p^* —the information value (= information content) of the whole sentence with respect to c^* —is a complex abstract entity made up of Frege and the property of being busy, something like the ordered couple (Frege, being busy). Let us call this complex 'Frege being busy', or ' fb ' for short. Thus, according to the naive theory, $p^* = fb$. But this cannot be correct. If fb is thought of as having truth-value, then it is true if *and when* Frege is busy (if and when Frege has the property of being busy) and false if and when he is not busy. Thus, fb vacillated in truth-value over time, becoming true whenever Frege became busy and false whenever he ceased being busy. (This forces a misconstrual of the intension of sentence (1) with respect to Frege's context c^* as a two-place function which assigns to the ordered pair of both a possible world w and a time t a truth-value, either truth or falsehood, according as Frege is busy in w at t or not.) But p^* , being a piece of information, has in any possible world in which Frege exists a fixed and unchanging truth-value throughout Frege's entire lifetime, and never takes on the opposite truth-value outside his lifetime. In this sense pieces of information are *eternal*.

Not just some; all information is eternal. The eternalness of information is central and fundamental to the very idea of a piece of information, and is part and parcel of a philosophically entrenched conception of information content. For example, Frege, identifying the cognitive information content (*Erkenntniswerte*) of a sentence with what he called

the 'thought' (*Gedanke*) expressed by the sentence, wrote:

Now is a thought changeable or is it timeless? The thought we express by the Pythagorean Theorem is surely timeless, eternal, unvarying. "But are there not thoughts which are true today but false in six months' time? The thought, for example, that the tree there is covered with green leaves, will surely be false in six months' time." No, for it is not the same thought at all. The words 'This tree is covered with green leaves' are not sufficient by themselves to constitute the expression of thought, for the time of utterance is involved as well. Without the time-specification thus given we have not a complete thought, i.e., we have no thought at all. Only a sentence with the time-specification filled out, a sentence complete in every respect, expresses a thought. But this thought, if it is true, is true not only today or tomorrow but timelessly.⁸

The same sort of consideration is used by Richard Cartwright to show that the meaning of a present-tensed sentence is not its information content when uttered with assertive intent, or what is asserted by someone who utters the sentence. Cartwright's argument exploits the further fact that the truth-value of a piece of information is constant over space as well as time:

Consider, for this purpose, the words 'It's raining'. These are words, in the uttering of which, people often (though not always) assert something. But of course *what* is asserted varies from one occasion of their utterance to another. A person who utters them one day does not (normally) make the same statement as one who utters them the next; and one who utters them in Oberlin does not usually assert what is asserted by one who utters them in Detroit. But these variations in what is asserted are *not* accompanied by corresponding changes in meaning. The words 'It's raining' retain the same meaning throughout ... [One] who utters [these words] speaks correctly only if he [talks about] the weather at the time of his utterance and in his (more or less) immediate vicinity. It is this general fact about what the words

⁸G. Frege, "Thoughts," in *Logical Investigations*, ed. P. T. Geach (New Haven: Yale University Press, 1977), 1-30, at 27-28.

mean which makes it possible for distinct utterances of them to vary as to statement made . . . They are used, without any alteration in meaning, to assert now one thing, now another.⁹

Similar remarks by G. E. Moore make essentially the same point about information expressed using the past tense:

As a general rule, whenever we use a past tense to express a proposition, the fact that we use it is a sign that the proposition expressed is *about* the time at which we use it; so that if I say twice over "Caesar was murdered," the proposition which I express on each occasion is a different one—the first being a proposition with regard to the earlier of the two times at which I use the words, to the effect that Caesar was murdered before *that* time, and the second a proposition with regard to the latter of the two, to the effect that he was murdered before *that* time. So much seems to me hardly open to question.¹⁰

Consider again Frege's "thought" that a particular tree is covered with green leaves. Six months from now, when the tree in question is no longer covered with green leaves, the sentence

(2) This tree is covered with green leaves

uttered with reference to the tree in question, will express the information that the tree is *then* covered with green leaves. This will be misinformation; it will be false. But that information is false even now. What is true now is the information that the tree *is* covered with green leaves, i.e., the information that the tree is *now* covered with green leaves. This is the information that one would currently express by uttering sentence (2). It is eternally true, or at least true throughout the entire lifetime of the tree and never false. There is no piece of information concerning the tree's foliage that is true now but will be false in six months. Similarly, if the information p^* that Frege asserts at t^* is true, it is eternally true, or at least true throughout Frege's lifetime and never false. There is no noneternal piece of information concerning Frege that vacillates in truth-value as he shifts from being busy to not being busy.

⁹R. Cartwright, "Propositions," in *Analytical Philosophy*, ed. R. Butler, first series (Oxford: Basil Blackwell, 1966), 81–103, at 92–94.

¹⁰G. E. Moore, "Facts and Propositions," in his *Philosophical Papers* (New York: Collier Books, 1962), 60–88, at 71.

The complex *fb* is noneternal, neutral with respect to time; hence, it is not a complete piece of information, i.e., it is no piece of information at all, properly so-called.

This is not to say that the noneternal complex *fb* is not a semantic value of the sentence Frege utters, or that *fb* has nothing to do with information content. Indeed, *fb* is directly obtained from the sentence Frege utters in the context *c** by taking the individual associated with 'I' with respect to *c** and the property associated with 'be busy' with respect to *c**. Moreover, *fb* can be converted into something more like a piece of information simply by *eternalizing* it, i.e., by infusing a particular time (moment or interval) *t* into the complex to get a new abstract entity consisting of Frege, the property of being busy, and the particular time *t*. One may think of the noneternal complex *fb* as the matrix of the proposition *p** that Frege asserts in *c**. Each time he utters sentence (1) Frege asserts a different proposition, expresses a different "thought," but always one having the same matrix *fb*. Similarly, in some cases it may be necessary to incorporate a location as well as a time in order to obtain a genuine proposition, e.g., 'It is raining' or 'It is noon'. A proposition or piece of information does not have differing truth-values at different locations in the universe, any more than it has different truth-values at different times. A proposition is fixed, eternal, and unvarying in truth-value over both time and space.

It has been noted by William and Martha Kneale, and more recently and in more detail by Mark Richard, that this traditional conception of cognitive information content is reflected in our ordinary ascriptions of belief and other propositional attitudes.¹¹ As Richard points out, if what is asserted or believed were something temporally neutral or noneternal, then from the conjunction,

In 1971 Mary believed that Nixon was president, and today
she still believes that

it would be legitimate to infer

Today, Mary believes that Nixon is president.

Such an inference is an insult not only to Mary but also to the logic of English, as it is ordinarily spoken. Rather, what we may infer is

¹¹See William Kneale and Martha Kneale, "Propositions and Time," in *G. E. Moore: Essays in Retrospect*, ed. A. Ambrose and M. Lazerowitz (New York: Humanities Press, 1970), at 235; Mark Richard, "Temporalism and Eternalism," *Philosophical Studies* 39 (1981): 1-13.

Today, Mary believes that Nixon was president in 1971.

The reason for this is that what Mary is said by the first sentence to have believed in 1971 is not the noneternal proposition matrix Nixon being president but the eternal proposition that Nixon is president (at such-and-such time) in 1971. The point is bolstered if 'know' is substituted for 'believe'.¹²

To each proposition matrix there corresponds a particular property of times—or, where necessary, a binary relation between times and places. For example, the time property corresponding to the proposition matrix *fb* is the property of being a time at which Frege is busy. It is often helpful in considering the role of proposition matrices in the semantics of sentences to think of a proposition matrix as if it were its corresponding property of times (or its corresponding relation between times and places).

V. Information Value and Information-Value Base

Let us call the proposition matrix that a sentence like (1) takes on with respect to a particular context *c* the *information-content base*, or more simply, the *content base*, of the sentence with respect to *c*. More generally, we may speak of the *information-value base*, or more simply the *value base*, with respect to a context, of a singular term, a predicate, a connective, a quantifier, etc. The value base of an expression is the entity that the expression contributes to the proposition matrix taken on by (i.e., the content base of) typical sentences containing the expression (where a "typical" sentence containing an expression does not include occurrences of such devices as quotation marks or the 'that'-operator other than those already included in the expression itself).

On the modification of the naive theory described above, the value base of a proper name, a demonstrative, or some other single-word singular term, with respect to a particular possible context *c*, would simply be the referent of the term with respect to *c*. The value base of a simple

¹²The length of the time interval is a vague matter. For many purposes it may be taken to be the entire year of 1971. It should be noted that when the time interval involved in a proposition is significantly long, the proposition may mimic its noneternal matrix—for example, in contexts like 'Mary once believed that Nixon was a Republican, and she still believes that'—as long as one stays within the boundaries of the time interval in question. Relatively stable properties (such as being a Republican, as opposed to being U.S. president) tend to lengthen the time interval in question. This is similar to a point made by Kneale and Kneale, "Propositions and Time," at 232–33.

predicate, such as 'busy' (i.e., 'be busy') or 'taller than', with respect to a context c , is the attribute—property or relation—semantically associated with the predicate with respect to c , e.g., the property of being busy or the relation of being taller than. The value base of a compound expression with respect to a context c is (typically) a complex made up of the value bases of the simple parts of the compound expression with respect to c , so the value base of a sentence is just its content base. In keeping with the singly modified naive theory, the value base of a definite description, unlike that of a single-word singular term, is not simply its referent but is a complex made up partly of the property associated with the description's constitutive predicate.

Since ordinary language includes indexical expressions such as 'this tree', the value base of an expression is to be indexed to the context of utterance. This generates a new higher-level nonrelativized semantic value for an expression, on the same level as character, which is the function or rule that determines for any possible context c the value base the expression takes on with respect to c . Let us call this new semantic value the *program* of an expression. An indexical expression is precisely one that takes on different value bases with respect to different possible contexts—that is, the expression's program is not a constant function; its value base varies with the context.

The value base of an expression with respect to a context c determines a corresponding function that assigns to any time t (and location l , if necessary), an appropriate information value for the expression. (In fact, the function also determines the corresponding value base.) For example, the proposition matrix fb , which is the content base of 'Frege is busy' with respect to any context, determines a function that assigns to any time t the information about Frege that he is busy at t . (This is the propositional function corresponding to the property of being a time at which Frege is busy.) Let us call the function from times (and locations) to information values thus determined by the value base of an expression with respect to a given context c the *schedule* of the expression with respect to c . In the special case of a single-word singular term, its schedule with respect to any context is always a constant function; however, this need not be true for other sorts of expressions, e.g., sentences. Since the information value of an expression determines its semantic intension, the value base of an expression with respect to a context c also determines a corresponding function that assigns to any time t (and location l , if necessary) the resulting intension for the expression. Let us call this function from times (and locations) to intensions

the *superintension* of the expression with respect to *c*. Accordingly, we should speak of the information value, and the corresponding intension, of an expression *with respect to a context c and a time t (and a location l, if necessary)*.

We should also like to speak, as we already have, of the information value of an expression (e.g., the information content of a sentence) with respect to a context *simpliciter*, without having to speak of the information value with respect to both a context *and a time (and a location)*. This is implicit in the notion of the character of an expression, as defined earlier. How do we get from the value base of an expression with respect to a given context to the information value with respect to the same context *simpliciter* without further indexing, or relativization, to a time (and location)?

In the passage quoted above, Frege seems to suggest that the words making up a tensed but otherwise temporally unmodified sentence, by themselves, and even the words taken together with contextual factors that secure information values for indexical expressions such as ‘this tree’, at most yield only something like what we are calling a ‘proposition matrix’, i.e., the content base of the sentence with respect to the context of utterance, which is “not a complete thought, i.e., . . . no thought at all.” He suggests further that we must rely on the very time of the context of utterance to provide a “time-specification” or “time-indication”—presumably a specification or indication of the very time itself—which supplements the words to eternalize their content base, thereby yielding a genuine piece of cognitive information, or “thought.” Earlier in the same article, Frege writes:

[It often happens that] the mere wording, which can be made permanent by writing or the gramophone, does not suffice for the expression of the thought. The present tense is [typically] used . . . in order to indicate a time If a time-indication is conveyed by the present tense one must know when the sentence was uttered in order to grasp the thought correctly. Therefore the time of utterance is part of the expression of the thought.¹³

On Frege’s view, strictly speaking, the sequence of words making up a tensed but otherwise temporally unmodified sentence like (2), even together with a contextual indication of which tree is intended, does not

¹³G. Frege, “Thoughts,” in *Logical Investigations*, 10.

have cognitive information content. Its information value is incomplete. Presumably, on Frege's view, the sequence of words together with a contextual indication of which tree is intended has the logico-semantic status of a predicate true of certain times—something like the predicate

is a time at which this tree is covered with green leaves,

accompanied by a pointing to the tree in question—except that (2) thus accompanied may be completed by a time, serving as a specification or indication of itself, rather than by a syntactic singular term such as 'now'. Accordingly, on Frege's theory, the information value, or "sense" (*Sinn*), of (2) together with an indication of the intended tree but in isolation from any time would be a function whose values are pieces of cognitive information, or "thoughts" (*Gedanken*).¹⁴ Only the sequence of words making up the sentence *together with* an indication of which

¹⁴On Frege's theory, the domain of this function would consist of senses that determine times, rather than the times themselves.

There is on Frege's theory no reason why the time-indication or time-specification that supplements the incomplete present-tensed sentence could not be verbal, e.g., 'At 12:00 noon on 4 July 1983, this tree is covered with green leaves'. This aspect of Frege's theory allows for a solution to the problem of failure of substitutivity of coreferential singular terms in temporal contexts—a solution very different from Frege's solution to the parallel problem of failure of substitutivity in propositional-attitude contexts. Consider the following example. The expressions 'the U.S. president' and 'Ronald Reagan' refer to the same individual with respect to the time of my writing these words, but the former cannot be substituted *salva veritate* for the latter in the true sentence 'In 1978, Ronald Reagan was a Republican'. Substitution yields 'In 1978, the U.S. president was a Republican', which is false on the relevant reading (the Russellian secondary occurrence or small-scope reading), since in 1978 Jimmy Carter was president and a Democrat. Frege may solve this problem, not implausibly, by noting that the expression 'the U.S. president' is incomplete and requires supplementation by a time-specification, such as may be provided by the time of utterance, before it can refer to an individual. The description 'the U.S. president', supplemented by the time of my writing these words, refers to the same individual as the name 'Ronald Reagan'. Supplemented by the year 1978, or by a verbal specification thereof, it refers to Jimmy Carter. The sentence 'In 1978, the U.S. president was a Republican' includes a verbal time-specification, 'in 1978', which, we may assume, supersedes the time of utterance in completing any expression occurring within its scope in need of completion by a time-specification. This solution is dissimilar from Frege's treatment of substitutivity failure in propositional-attitude contexts. On Frege's theory, a propositional-attitude operator such as 'Jones believes that' creates an oblique context in which expressions refer to their customary information values ("senses") instead of their customary referents. On the Fregean solution to substitutivity failure in temporal contexts presented here, the referent of 'the U.S. president', as occurring within the context 'in 1978, _____', is just its customary referent.

tree is intended and a time-indication or time-specification, as may be provided by the time of utterance itself, is “a sentence complete in every respect” and has cognitive information content.

Now, it is not necessary to view the situation by Frege’s lights. Whereas Frege may prefer to speak of the cognitive thought content (or *Erkenntniswerte*) of the words *supplemented by* both a contextual indication of which tree is intended and a “time-indication,” one may speak instead (as I already have) of the information content of the sequence of words themselves *with respect to* a context of utterance and a time. The information content of sentence (2) with respect to a context *c* and a time *t* is simply the result of applying the schedule, with respect to *c*, of the sequence of words to *t*. This is the singular proposition about the tree contextually indicated in *c* that it is covered with green leaves at *t*. In the general case, instead of speaking of the information value of an expression supplemented by both a contextual indication of the referents of the demonstratives or other indexicals contained therein and a “time-indication,” as may be provided by the time of utterance, one may speak of the information value of the expression *with respect to* a context of utterance and a time (and a location, if necessary). Still, Frege’s conception strongly suggests a way of constructing a singly indexed notion of the information value of an expression with respect to (or supplemented by) a context of utterance *c simpliciter*—without further relativization to (or supplementation by) a time (and a location)—in terms of the doubly (or triply) indexed locution: The information value of an expression with respect to a context *c (simpliciter)* is definable as the information value of the expression with respect to both *c* and the very time of *c* (and the very location of *c*, if necessary).

In particular, then, the information content of a sentence with respect to a given context of utterance *c* is its information content with respect to *c* and the time of *c* (and the location of *c*, if necessary). Consequently, any temporally unmodified sentence or clause encodes different information with respect to different contexts of utterance (*simpliciter*). For example, sentence (2) (or more accurately, the untensed clause ‘this tree be covered with green leaves’), encodes different information with respect to different times of utterance, even when pointing to the same tree. Uttered now, it encodes the information about the tree in question that it is covered with green leaves, i.e., that it is now covered with green leaves. Uttered six months from now, it encodes the information about the tree that it is then covered with green leaves. The existence of this linguistic phenomenon is precisely the point made by Frege and echoed

by Moore and Cartwright in the passages quoted in section IV above.

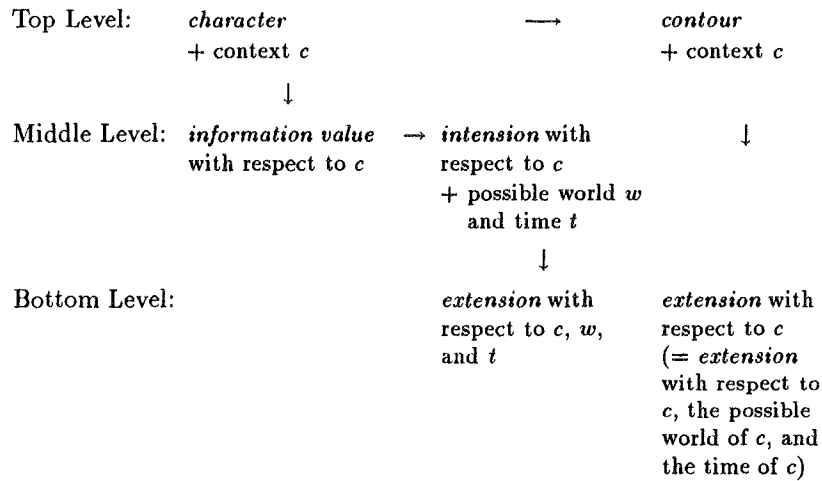
Let us call this latest version of the naive theory the *doubly modified naive theory*, abbreviated as simply the *modified naive theory*. The doubly modified naive theory is the singly modified naive theory modified further to accommodate the eternalness of information value.

It follows from our definition of the singly indexed notion of the information value of an expression with respect to a context *simpliciter* that the program of an expression fully determines the expression's character, since, given any context *c*, the program fully determines the resulting schedule, which together with the time (and location, if necessary) of *c* fully determines the resulting information value. From this it follows that the program of an expression also determines the expression's contour, as defined earlier. Within the framework of the modified naive theory, the meaning of an expression is better identified with its program, rather than with its character. This allows one to distinguish pairs of expressions like 'the U.S. president' and 'the present U.S. president' as having different meanings, despite their sharing the same character (or at least trivially equivalent characters). More accurately, the program of an expression is the primary component of what is ordinarily called the 'meaning' of the expression, though an expression's meaning may have additional components that supplement the program.¹⁵

The original and the singly modified naive theories recognize three distinct levels of semantic value. The three primary semantic values are *extension*, *information value* (misconstrued as possibly noneternal), and *character*. In addition, these theories admit two subordinate semantic values. On the same level as, and fully determined by, information value is *intension* (misconstrued as a two-place function from possible worlds and times); on the same level as, and fully determined by, character is *contour*. The various semantic values on the original or the singly modified naive theory, and their levels and interrelations, are diagrammed in figure 1. (Of course, these are not the only semantic values available on the naive theory, but they are the important ones.)

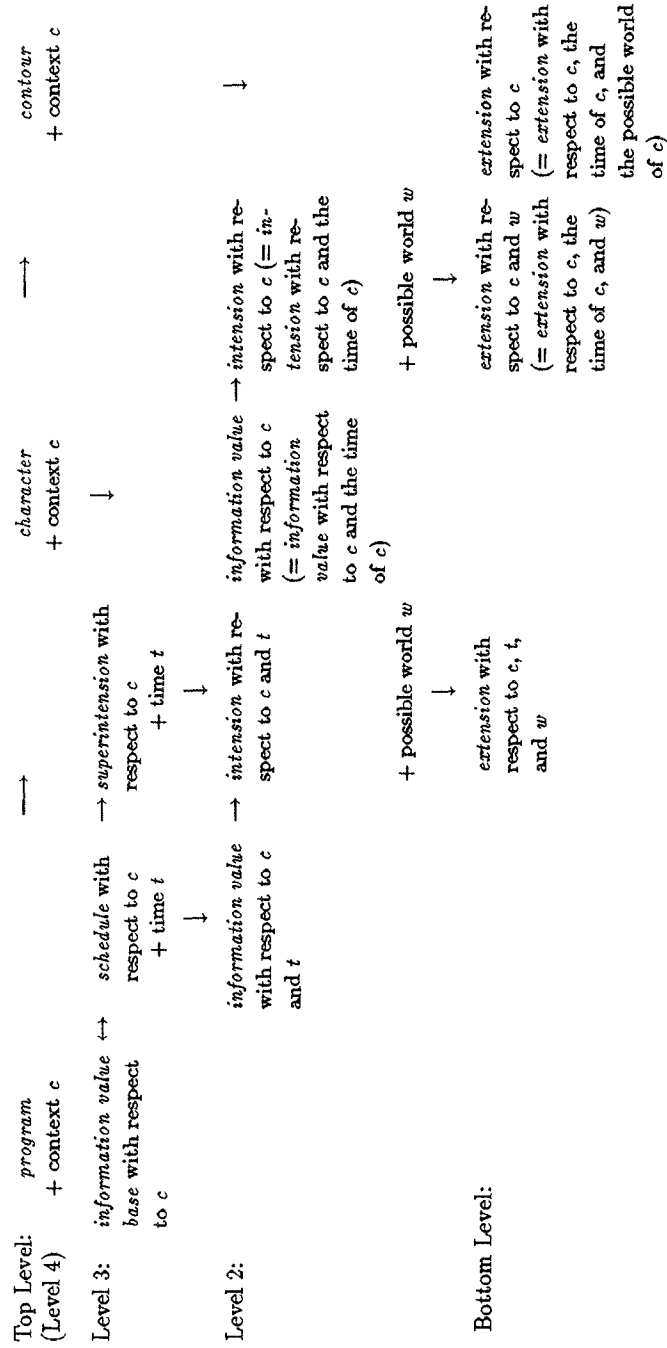
¹⁵For example, the meaning of the term 'table' might include, in addition to its program, some sort of conceptual content, e.g., a specification of the function of a table. If so, it does not follow that this sort of conceptual entity is any part of the information value of the term. Nor does it follow that it is *analytic*, in something like the classical sense, that tables have such-and-such a function. What does follow is that, in order to know fully the meaning of 'table', one would have to know that the things called 'tables' are conventionally believed to have such-and-such a function.

Figure 1: Semantic Values on the Naive Theory



The modified naive theory's notion of the value base of an expression with respect to a given context, and the resulting notion of the program of an expression, impose a fourth level of semantic value, intermediate between the level occupied by Kaplan's notion of the character of an expression and the level of information value. In fact, the introduction of the notion of value base reduces character to the status of a subordinate semantic value. The four primary semantic values, from the bottom up, are *extension*, *information value* (construed now as necessarily eternal), *information value base*, and *program*. In addition, there are a number of subordinate semantic values. Besides intension (construed now as a one-place function from possible worlds), character, and contour, there are *schedule* and *superintension*, both of which are on the same level as, and fully determined by, value base. The various semantic values on this modification of the original naive theory, and their levels and interrelations, are diagrammed in figure 2. (Notice that figure 1 is virtually embedded within figure 2, as its right half.)

Figure 2: Semantic Values on the Modified Naive Theory



On the modified naive theory, the extension of an expression with respect to a given context of utterance (*simpliciter*, without further relativization to a time, a place, or a possible world) is the result of applying the intension of the expression with respect to that context—which, in turn, is the result of applying the superintension of the expression with respect to that context to the very time of the context—to the very possible world of the context. Thus, for example, the referent of a singular term—say ‘the U.S. president’s actual wife’—with respect to a particular context of utterance *c* is semantically determined in a sequence of steps. First, the program of the expression is extracted from its meaning. This program is then applied to the context *c* to yield the time-neutral value base of the expression with respect to *c*. This value base yields the schedule of the expression with respect to *c*, which assigns to any time *t* the information value of the expression with respect to both *c* and *t*. This schedule is applied to the very time of *c* itself to give the eternal information value of the expression with respect to *c* (*simpliciter*). This information value, in turn, yields the expression’s intension with respect to *c*, which assigns to any possible world *w* the extension of the expression with respect to *c* and *w*. The expression’s extension with respect to any context *c*’ and possible world *w*’ is the individual who is the wife in the possible world of *c*’ at the time of *c*’ of the individual who is the U.S. president in *w*’ at the time of *c*’. Finally, this intension is applied to the very possible world of *c* itself to yield the individual who is the wife in the possible world of *c* at the time of *c* of the individual who is the U.S. president in the possible world of *c* at the time of *c*. Eureka!

VI. Tense vs. Indexicality

It may appear that I have been spinning out semantic values in excess of what is needed. We needed a singly indexed notion of the information value of an expression with respect to a context, and as a special case, a notion of the information content of a sentence with respect to a context. This led to the original and singly modified naive theories’ identification of meaning with character. In the special case of a single-word singular term, what I am calling its value base with respect to a context *c* is the very same thing as its information value with respect to *c*, so the program of a single-word singular term is just its character. The only thing that prevents this from holding also for a sentence such as (1) or (2) is that its content base with respect to a context is neutral with respect to time, whereas its information content with respect to the same context

is eternal, somehow incorporating the time (and location, if necessary) of the context. It may seem, then, that in the case of a sentence or phrase, what I am calling its 'value base' with respect to a context c is just its information value with respect to c but for the deletion of the time of c (and the location of c), so that the information content of a sentence with respect to a context c is made up of the information values (= value bases) with respect to c of its simple information-valued parts *plus* the time (and location) of c .

If the rule of information-content composition is that information contents are constructed from the information values of the simple information-valued components *together with* the time (and location, if necessary) of utterance, then why bother mentioning those partially constructed pieces of information I have been calling 'proposition matrices'? Singling out content bases as separate semantic values generates the doubly indexed notion of the information content of a sentence with respect to both a context c and a time t , and thereby the nonrelativized higher-level notion of program. What is the point of this doubly indexed notion, and of the resulting notion of program? Are we not interested only in the case where the time t is the time of the context of utterance c (and where the location l is the location of the context c)? Why separate out the time as an independent semantic parameter that may vary independently of the context of utterance? The character of a sentence seems to be meaning enough for the sentence. Semantic theorists heretofore have gotten along fine by indexing the notion of information content once, and only once, to the context of utterance, without relativizing further and independently to times.

For example, in discussing the phenomenon of tense, Frege considers also various indexicals—'today', 'yesterday', 'here', 'there', and 'I'—and suggests a uniform treatment for sentences involving either tense or indexicals:

In all such cases the mere wording, as it can be preserved in writing, is not the complete expression of the thought; the knowledge of certain conditions accompanying the utterance, which are used as a means of expressing the thought, is needed for us to grasp the thought correctly. Pointing the finger, hand gestures, glances may belong here too.¹⁶

¹⁶G. Frege, "Thoughts," in *Logical Investigations*, 10–11.

Following Frege, it would seem that we can handle the phenomena of tense and indexicality together in one fell swoop, with tense as a special case of indexicality, by simply relativizing the notion of information value once and for all to the complete context of utterance—including the time and location of the utterance as well as the speaker and his or her accompanying pointings, hand gestures, and glances. Any aspect of the complete context of utterance may conceivably form “part of the expression of the thought,” or contribute to the information content. Once information content is relativized to the complete context, including the time of utterance, gestures, and so on, there seems to be no need to relativize further and independently to times.

It has become well known since the middle of the 1970s that the phenomenon of tense cannot be fully assimilated to temporal indexicality, and that the presence of indexical temporal operators necessitates “double indexing,” i.e., relativization of the extensions of expressions—the reference of a singular term, the truth-value of a sentence, the class of application of a predicate (or better, the semantic characteristic function of a predicate), etc.—to utterance times independently of the relativization to times already required by the presence of tense or other temporal operators.¹⁷ (Something similar is true in the presence of an indexical modal operator such as ‘it is actually the case that’ and in the presence of indexical locational operators such as ‘it is the case here that’.) Here is an illustration: The present-perfect-tense operator functions in such a way that for any untensed clause *S* (e.g., ‘Frege be busy’), the result of applying the present-perfect-tense operator to *S* (‘Frege has been busy’) is true with respect to a time *t* (roughly) if and only if *S* is true with respect to some time *t'* earlier than *t*. Similarly, the nonindexical operator ‘on the next day’ + future tense functions in such a way that the result of applying this operator to any untensed clause *S* is true with respect to a time *t* if and only if *S* is true with respect to the day next after the day of *t*. For example, suppose that at time *t**, instead of uttering sentence (1), Frege speaks the following words (perhaps as part of a larger utterance):

I will be busy on the next day.

¹⁷The need for double indexing was apparently first noted in 1967 by Hans Kamp in unpublished material distributed to a graduate seminar while Kamp was a graduate student at UCLA. See his “Formal Properties of ‘Now’,” *Theoria* (1972): 227–73. Kamp’s results were reported in A. N. Prior, “‘Now’,” *Noûs* 2 (1968): 101–19.

This sentence, in Frege's mouth, is true with respect to a time t if and only if Frege is busy on the day next after the day of t —whether or not t is t^* , and hence even if it is not. Indeed, our primary interest may be in some time t other than t^* , for example, if Frege's complete utterance at t^* is of the sentence

On 24 December 1891 I will be busy on the next day.

On the other hand, the indexical operator 'tomorrow' + future tense functions in such a way that the result of applying it to any untensed clause S is true with respect to a context c and a time t if and only if S is true with respect to c and the day after the day of the time of c , forgetting about the time t altogether. If at t^* Frege had uttered the sentence

I will be busy tomorrow

the sentence, in Frege's mouth, would be true with respect to a time t if and only if Frege is busy on the day after the day of t^* .

Were we to attempt to accommodate 'on the next day' + future tense using relativization only to possible contexts of utterance, without further relativization to times, we would be forced to say that the result of applying this operator to S is true with respect to a context c if and only if S is true with respect to some possible context c' just like c in every respect, e.g., agent, location, etc., except that the time of c' is a day later than that of c . For example, 'I will be busy on the next day' would be regarded as being true with respect to a context of utterance c if and only if its untensed operand

(3) I be busy

is true with respect to a possible context c' whose day is the day after that of c , but which involves the same agent as c , to preserve the referent of 'I'. Let us assume, for the time being, that an untensed clause such as (3) is a mere surface grammar variation of its present-tensed counterpart, so that (3) and (1) share the very same semantics.

This singly indexed account seems to yield the correct results, until we consider sentences that embed one temporal operator within the scope of another. Consider the following sentence:

(4) It used to be that the present U.S. president was a Democrat.

This sentence results from applying the temporal operator ‘it used to be that’ + past tense to the untensed indexical clause

the present U.S. president be a Democrat

in which the phrase ‘present U.S. president’ resulted from applying the indexical temporal operator ‘present’ to the phrase ‘U.S. president’. According to the singly relativized account, sentence (4) is true with respect to a context of utterance c (roughly) if and only if there is some time t' earlier than the time of c such that the U.S. president at t' is a Democrat at t' (in the possible world of c). But this is the wrong truth-condition for the sentence. In fact, it is the correct truth-condition for the wrong sentence, to wit, the *nonindexical* sentence

(5) It used to be that: the U.S. president was a Democrat

or more idiomatically,

The U.S. president has been a Democrat

on one of its readings (the Russellian secondary occurrence or small-scope reading). Sentences (4) and (5) differ in their truth-conditions; if both sentences are uttered at a time when the person occupying the presidency is a life-long Republican, though previously the presidency had been held by the Democrats, sentence (4) is false whereas sentence (5) is true. Sentence (4) is true with respect to a context of utterance c (roughly) if and only if there is some time t' earlier than the time of the context c such that the U.S. president *at the time of the context of utterance c* —rather than at t' —is a Democrat *at t'* (in the possible world of c), rather than at the time of c . The temporal operator ‘it used to be that’ + past tense directs us to evaluate its operand clause ‘the present U.S. president be a Democrat’ with respect to times t' earlier than that of the context of utterance c . This clause is true with respect to the same context c and a time t' earlier than that of c if and only if the description ‘the present U.S. president’ refers with respect to c and t' to something to which the predicate (naked infinitive) ‘be a Democrat’ applies with respect to c and t' . In computing the referent of the description with respect to c and t' , the indexical operator ‘present’ directs us to seek an object to which its operand phrase ‘U.S. president’ applies with respect to the very time of the context of utterance c itself, forgetting about the time t' . Thus in evaluating sentence (4) with respect to a time of

utterance t (the time of its context of utterance c), we are concerned simultaneously with the extension of 'U.S. president' with respect to t and the extension of 'be a Democrat' with respect to some time t' earlier than t . The truth-value of the whole depends entirely and solely on whether the unique object to which the phrase 'U.S. president' applies with respect to t is something to which the predicate 'be a Democrat' applies with respect to an earlier time t' . It is for this reason that a systematic theory of the extensions of the expressions of a language containing indexical temporal operators requires double indexing, i.e., in general the notion of the extension of an expression (e.g., the truth-value of a sentence) is relativized to both a context and a time, treated as independent semantic parameters. The notion of the extension of an expression with respect to a context c *simpliciter* is then definable as the extension of the expression with respect to the context c and the time of c (and the possible world of c , and if necessary, the location of c).

A systematic singly indexed theory gives the wrong results. Frege's theory, for example, must regard the indexical description 'the present U.S. president' as extensionally semantically equivalent to the nonindexical 'the U.S. president'. Both would be regarded as expressions that are incomplete by themselves (and hence, refer by themselves, in abstraction from any context, to functions), but that when completed by a "time-specification" or "time-indication" (as may be provided by the time of utterance) refer to the individual who is U.S. president at the specified or indicated time. Using extensional semantic considerations alone, Frege's theory is unable to find any difference with respect to truth or even with respect to truth-conditions between sentence (4), taken as uttered at a certain time, and the tensed but nonindexical (5), as uttered at the very same time.¹⁸

This example illustrates that where an indexical temporal operator

¹⁸This is partly a result of Frege's principle of compositionality (or interchange) for reference. (See footnote 6.) On Frege's theory of tense and indexicality, both 'the U.S. president' and 'the present U.S. president' refer, in abstraction from context, to the function that assigns to any time t the individual who is U.S. president at t —as if they were the functor 'the U.S. president at time _____',—except that the expression may be completed by a time rather than by a verbal time-specification (the time of utterance acting as a self-referential singular term). By Frege's compositionality principle for reference, it follows that any complete sentence built from 'the U.S. president' without using oblique devices (e.g., 'In 1978, the U.S. president was a Democrat'), has the same truth-conditions, and therefore the same truth-value, as the corresponding sentence built from 'the present U.S. president' ('In 1978, the present U.S. president was a Democrat'). See footnote 14.

occurs within the scope of another temporal operator within a single sentence, the extensions of expressions are to be indexed to both the time of utterance and to a second time parameter, which may be other than the time of utterance and other even than a function of the time of utterance. Temporal operators determine which time or times the extension of their operands are determined with respect to. In the special case of indexical temporal operators, the time so determined is a function of the time of the context of utterance. What is distinctive about indexical expressions (such as 'I', 'this tree', or 'the present U.S. president') is not merely that the extension with respect to a context c (*simpliciter*) varies with the context c , or even that the intension or information value with respect to a context c (*simpliciter*) varies with the context c . That much may be true of even a nonindexical expression, such as 'the U.S. president' or 'Frege is busy'. What makes an expression indexical is that its extension with respect to a context c and a time t and a location l and a possible world w varies with the context c , even if the other parameters are held fixed. This is to say that its superintension, and hence its value base, with respect to a context c varies with the context c . It is precisely this that separates 'the present U.S. president' from its nonindexical counterpart 'the U.S. president'.

Though it is less often noted,¹⁹ it is equally important that double indexing to contexts and times (or triple indexing to contexts, times, and locations, if necessary) is required at the level of information value (e.g., with information content) as well as at the level of extension (e.g., with truth-value). For illustration, consider first the sentence,

(6) At t^* , I believed that Frege was busy.

By the ordinary laws of temporal semantics, this sentence is true with respect to a context of utterance c if and only if the sentence

I believe that Frege is busy

is true with respect to both c and the time t^* . This, in turn, is so if and only if the binary predicate 'believe' applies with respect to c and t^* to the ordered pair of the referent of 'I' with respect to c and t^* and the referent of the 'that'-clause

that Frege is busy

¹⁹See Mark Richard, "Tense, Propositions, and Meanings," *Philosophical Studies* 41 (1982): 337–51, at 346–49. The idea of double-indexing information content to both contexts and times is Richard's.

with respect to c and t^* . Hence, sentence (6) is true with respect to c if and only if the agent of c believes at t^* the piece of information that is the referent of the 'that'-clause with respect to c and t^* .

What piece of information does the 'that'-clause in (6) refer to with respect to c and t^* ? Obviously, the 'that'-clause refers to the information content of its operand sentence 'Frege is busy', but which proposition is that?

If information content is to be singly indexed to context alone, it would seem that the 'that'-clause 'that Frege is busy' refers with respect to c and t^* to the information content of 'Frege is busy' (or of 'Frege be busy') *with respect to c* (forgetting about t^* altogether). This is the proposition that Frege is busy at t , where t is the time of c . However, this yields the wrong truth-condition for sentence (6). This would be the correct truth-condition for the sentence

At t^* , I believed that Frege would be busy now.

Sentence (6) ascribes, with respect to c , a belief at t^* that Frege is busy *at t^** . Assuming that information content is singly indexed to context alone, we are apparently forced to construe the 'that'-operator in such a way that a 'that'-clause 'that S ' refers with respect to a context c and a time t' not to the information content of S with respect to c but to the information content of S with respect to a (typically different) context c' exactly like c in every aspect (agent, location, etc.) except that its time is t' . (The contexts c and c' would be the same if and only if t' were the time of c .) This yields the desired result that the displayed sentence is true if and only if the agent of c believes at t^* the information that Frege is busy at t^* .

This account appears to yield exactly the right results until we consider a sentence that embeds an indexical temporal operator within the 'that'-operator, and embeds the result within another temporal operator. Consider the following:

- (7) In 1989, Jones will believe: that the present U.S. president is the best of all the former U.S. presidents.

This sentence is true with respect to a context c if and only if Jones believes in 1989 the piece of information referred to by the 'that'-clause

that the present U.S. president is the best of all the former U.S. presidents

with respect to c and the year 1989. On the singly indexed account of information content, sentence (7) comes out true if and only if Jones believes in 1989 that the U.S. president in 1989 is the best of all the U.S. presidents before 1989. But this is the wrong truth-condition for sentence (7). It is the right truth-condition for the wrong sentence:

In 1989, Jones will believe: that the then U.S. president is the best of all the former U.S. presidents.

Sentence (7) ascribes, with respect to c , a belief that the U.S. president at t (the time of c) is the best of all the U.S. presidents before 1989. In order to obtain this result, the 'that'-clause in (7) must be taken as referring with respect to c and the year 1989 to the proposition that the U.S. president at t is the best of all the U.S. presidents prior to 1989 (or to some proposition trivially equivalent to this). This cannot be accommodated by a singly indexed account; it requires seeing information content as doubly indexed: to the original context c (so that the ascribed belief concerns the U.S. president at t rather than in 1989) and the year 1989 (so that the ascribed belief concerns the class of presidents before 1989 rather than those before t).

VII. Temporal Operators

The example just considered illustrates the need for the double indexing of information content that is generated by the modified naive theory's notion of the content base of a sentence. In addition to this, there is an important semantic function for the content base of a sentence, a function that cannot be fulfilled by its information content. To see this, it is important to look more closely at the semantics of temporal operators.

Consider the temporal operator 'sometimes' + present tense, which attaches to an untensed clause S to form a new sentence. An appropriate extension for this operator would be a function from some aspect of the operand clause S to a truth-value. What aspect of S ?

Two sorts of operators are very familiar to philosophers of language. An *extensional* operator is one that operates on the extensions of its operands, in the sense that an appropriate extension for the operator itself would be a function from *extensions* appropriate to the operands (as opposed to some other aspect of the operands) to extensions appropriate to the compounds formed by attaching the operator to an appropriate operand. An extensional sentential connective (such as 'not' or 'if ...

then - - -') is truth-functional; an appropriate extension would be a function from (n -tuples of) truth-values to truth-values, and hence an appropriate information value would be an attribute (property or relation) of truth-values—for example, the property of being falsehood, or the following relation: either u is falsehood or v is truth. An *intensional* or *modal* operator is one that operates on the intensions of its operands. An appropriate extension for a modal connective like 'it is necessarily the case that' or 'if it were the case that . . . , then it would be the case that - - -' would be a function from (n -tuples of) sentence intensions (functions from possible worlds to truth-values) or propositions to truth-values, and an appropriate information value would be an attribute of intensions or propositions—for example, the property of being a necessary truth.

Now, is the 'sometimes' operator extensional? Certainly not. With respect to my actual present context, the sentences 'It is cloudy' and ' $2 + 2 = 5$ ' are equally false, though 'Sometimes it is cloudy' is true whereas 'Sometimes $2 + 2 = 5$ ' is false. Thus, 'sometimes' + present tense is not truth-functional, and hence not extensional. Nor is the 'sometimes' operator intensional, in the above sense. With respect to my actual present context, the two sentences

The senior senator from California is a Republican

and

The present senior senator from California is a Republican

have precisely the same intension—indeed, they have (very nearly) the same information content—though

(8) Sometimes the senior senator from California is a Republican

on the relevant reading (the Russellian secondary occurrence or small-scope reading), is true whereas

(9) Sometimes the present senior senator from California is a Republican

on either of its two readings (Russellian small-scope vs. large-scope), is false. Thus, 'sometimes' + present tense is neither an extensional operator nor an intensional or information-content operator. What, then, is it?

Let us try the following theory: suppose that 'sometimes' + present tense operates on the contour of its operand clause, its function from

contexts of utterance to truth-values. The result of applying this operator to an untensed clause S would be true with respect to a context c if and only if there is some context c' that coincides exactly with c in every aspect (agent, location, etc.) other than time and such that S is true with respect to c' . Thus, for example, on this theory the sentence,

(10) Sometimes this tree is covered with green leaves

is true with respect to a context of utterance c if and only if there is some time, which may be other than the time of the context c , at which the tree indicated in c is covered with green leaves. Similarly, the sentence

(11) Sometimes I am busy

is true with respect to Frege's context c_* if and only if there is some time at which Frege is busy. Sentence (10) would be regarded as encoding, with respect to a context c , the information about the contour of the untensed operand clause

this tree be covered with green leaves

that it yields the value truth for some context or other (not necessarily c) which includes the same contextual indication of a tree as c (e.g., the same agent pointing to the same tree in the same way, to preserve the referent of 'this tree') and the same possible world as c but which may have a different time from c . Similarly, sentence (11) would be regarded as encoding with respect to a context c the information about the contour of its untensed operand clause (3) that it yields the value truth for some context or other which includes the same agent and the same possible world as c , but which may have a different time from c . On this theory, then, the information value of 'sometimes' + present tense varies with the context of utterance. Its information value with respect to a context c is always a property of functions from contexts to truth-values, to wit, the property of yielding the value truth for some context or other that coincides exactly with c in every aspect other than time. In general, on this theory, all temporal operators—such as 'present', 'sometimes' + past tense, 'today' + present tense, 'yesterday' + past tense, 'in 1989' + future tense, and various tense operators such as present perfect tense—operate on the contours of their operands, so that the extension of a sentential temporal operator is a function from sentence contours to truth-values, and its information value is a property of sentence contours.

Here again, this theory seems to yield exactly the correct results until we embed an indexical temporal operator within the scope of another temporal operator. Consider again the sentence:

- (9) Sometimes the present senior senator from California is a Republican.

Here the indexical operator 'present' is embedded within the operator 'sometimes' + present tense. According to the theory under consideration, sentence (9) contains with respect to a context of utterance *c* the information about the contour of the operand clause

the present senior senator from California be a Republican

that it yields the value truth for some context or other exactly like *c* in every aspect other than time. Thus, according to the theory, sentence (9) is true with respect to a context *c* if and only if there is some time *t'*, which need not be the time of *c*, such that the senior senator from California at *t'* is a Republican at *t'* (in the possible world of *c*). This is the wrong truth-condition for sentence (9), and the correct truth-condition for the nonindexical sentence

- (8) Sometimes the senior senator from California is a Republican

on one of its readings (the Russellian secondary occurrence or small-scope reading). Sentence (9) is true with respect to a context *c* if and only if there is some time *t'* such that the senior senator from California *at the time of the context c*—rather than at *t'*—is a Republican at *t'* (in the possible world of *c*)—rather than at the time of *c*.

In fact, the theory that a temporal operator such as 'sometimes' + present tense is a contour operator is simply the singly indexed theory all over again. In order to obtain the correct results, one must regard a sentential temporal operator such as 'sometimes' + present tense as operating on some aspect of its operand clause that is fixed relative to a context of utterance (in order to give a correct treatment of such temporally modified indexical sentences as (9)) but whose truth-value typically varies with respect to time (so that it makes sense to say that it is *sometimes* true, or true at such-and-such time). On the original and singly modified naive theories' three-tiered array of semantic values (as diagrammed in the right half of figure 2 in section V above), once it is acknowledged that information content is eternal, there simply is no such semantic value of a sentence. Nothing that is fixed relative to

a context is also time-sensitive in the required way. In order to find an appropriate semantic value for temporal operators such as ‘sometimes’ + present tense to operate on, one must posit a level of semantic value intermediate between character and information content. This strongly suggests that the objects of sentential temporal operators—the things operated on by sentential temporal operators such as ‘sometimes’ + present tense—are something like proposition matrices, or perhaps sentence superintensions. The ‘sometimes’ operator is neither an extensional operator nor an intensional (i.e., modal) operator, nor is it even a contour operator. Instead, ‘sometimes’ + present tense is a superintensional operator.²⁰ That is, an appropriate extension for ‘sometimes’ + present tense with respect to a context c , a time t , and a possible world w , would be a function from the superintension (or, equivalently, from the schedule or content base) of its operand clause (with respect to c) to a truth-value—namely, the function that assigns truth to a proposition matrix (or to its corresponding schedule or superintension) if its value for at least one time (the resulting proposition or sentence intension) itself yields truth for the world w , and which otherwise assigns falsehood to the proposition matrix (or the corresponding schedule or

²⁰Modal operators on the so-called branching worlds (or “unpreventability”) interpretation emerge as superintensional operators.

The burden of Richard’s article cited in the previous footnote is to show that one can consistently hold that propositions are eternal while temporal sentential operators operate on noneternal semantic values of sentences, by holding that temporal sentential operators operate on two-place functions from contexts and times to eternal propositions. These two-place functions are similar to (and determined by) sentence programs. Indeed Richard calls his two-place functions the ‘meanings’ of sentences. However, the claim that temporal operators operate on the “meanings” of expressions is misleading. When each of Richard’s two-place functions is replaced by its corresponding one-place function from contexts to one-place functions from times to eternal propositions—i.e., the corresponding function from contexts to schedules—it emerges that temporal operators operate on something at the level of schedule rather than operating on something at the level of program.

Richard also apparently misconstrues to some extent what Kaplan (and others) mean in saying that an operator “operates on” such-and-such’s. In general, to say that a given operator operates on the such-and-such of its operand is to say that an appropriate extension for the operator would be a function from such-and-such’s appropriate to expressions that may serve as its operand to extensions appropriate to the compounds formed from the operator together with the operand. For example, to say that a modal sentential operator operates on the information content or on the intension of its operand sentence (the correlated function from possible worlds to truth-values) is to say that an appropriate extension for a modal operator would be a function from propositions or from sentence intensions to truth-values (that is, to the appropriate extensions for sentences).

superintension). In general, temporal operators—such as ‘sometimes’, tense operators (including complex ones such as present perfect and future perfect), indexical temporal operators (e.g., ‘present’), and even nonindexical specific time indicators (e.g., ‘on 24 December 1989’ + future tense or ‘when Frege wrote “Thoughts” ’ + past tense)—may all be seen as superintensional operators.

The result of applying ‘sometimes’ + present tense to an untensed clause S may be regarded as encoding, with respect to a given context c , information concerning the content base of the operand clause S with respect to c . For example, sentence (11) contains, with respect to Frege’s context c^* (or any other context in which Frege is the agent), the information about the proposition matrix fb that it is sometimes true. Accordingly, an appropriate information value for a temporal operator such as ‘sometimes’ + present tense would be a property of proposition matrices—in this case, the property of being true at some time(s).

It is in this way that temporal operators such as ‘sometimes’ + present tense provide a place for proposition matrices in temporal semantics, and thereby generate a doubly indexed notion of the information value of an expression (e.g., the information content of (1) or (2)) with respect to both a context c and a time t that may be other than the time of c . Just as it is the information content of its operand that a modal operator says something about (e.g., that it is a necessary truth), so it is the information content base of its operand that a temporal operator says something about.

VIII. Predicates and Quantifiers

An important point about predicates, quantifiers, and certain other operators emerges from the four-tiered modified naive theory, and from the distinction between information value and value base in particular: The value base of a predicate such as ‘be busy’, with respect to a given context of utterance c , is an attribute, i.e., a property or relation. This, together with a time t , determines the information value of the predicate with respect to c and t . In turn, the information value of a predicate with respect to c and t , together with a possible world w , determines the extension of the predicate with respect to c , t , and w . It follows that the information value of a predicate such as ‘be busy’ with respect to a context c and a time t is not just the property of being busy (or anything similar, such as the function that assigns to any individual x the proposition matrix, x being busy). The property of being busy to-

gether with a possible world w cannot determine the extension of 'be busy' with respect to both the world w and the time t . The property of being busy together with a possible world w determines only the class of (possible) individuals who are busy *at some time* in w , or, at most, the function that assigns to any time t the class of (possible) individuals who are busy at t in w . The information value of 'be busy' with respect to a given time t must be such as to determine for any possible world w the class of (possible) individuals who are busy *at the given time* t in w . Only some sort of complex consisting of the property of being busy *together with the given time* t is such as to determine for any possible world w the extension of 'be busy' with respect to both w and t . Thus, the information value of 'be busy' with respect to a given time t is not merely the property of being busy but a complex consisting of this property and the time t . This, it may be assumed, is a *temporally indexed attribute*—in this case, the temporally indexed property of *being busy at t* .

In general, the information value of a predicate with respect to a time t (and a location l , if necessary) is not the same attribute as the value base of the predicate but is the temporally (and, if necessary, spatially) indexed attribute that results from taking the value base of the predicate together with the time t (and location l , if necessary). Exactly analogous remarks apply to quantifiers, other second-order predicates, the definite-description operator 'the', and certain other operators.

This heretofore unrecognized fact about the information values of predicates allows us to retain, at least as a sort of general guide or rule of thumb, the principle that the information value of a compound expression, such as a sentence or phrase, is a complex made up solely and entirely of the information values of the information-valued components that make up the compound. In particular, the information content of sentence (1), or of clause (3), with respect to a context of utterance c may be thought of as made up of the agent of the context c and the property of being busy at t , where t is the time of c . There is no need to introduce the time t as a third and separate component; it is already built into the information value of the predicate.

Since the information value of an expression with respect to a context c *simpliciter* is the information value with respect to both c and the time of c (and the location of c , if necessary), it follows that the information value of a typical predicate with respect to a context c *simpliciter* varies with the context c —whether or not the predicate is indexical (such as one possible reading of 'current', as in 'current journal issue'), and hence

even if it is not, such as 'be busy'. It is this previously unnoticed feature of predicates that accounts for the fact that a nonindexical temporally unmodified clause, e.g., 'Frege be busy', or the sentence 'Frege is busy', takes on not only different truth-values but also different information contents when uttered at different times, even though the expression is not indexical. It is also this feature of predicates that accounts for the fact that certain noneternal (i.e., temporally nonrigid) definite descriptions, such as 'the senior senator from California', take on not only different referents but also different information values when uttered at different times, though the description is not indexical. Recall that the distinctive feature of an indexical like 'I' or 'the present senior senator from California' is that it takes on different information-value bases in different contexts. The predicate 'be busy', the definite description 'the senior senator from California', and the sentence 'The senior senator from California is busy' all retain the same value base in all contexts. Their information value varies with the context, but not their value base.

The account presented here of the information values of temporal operators as properties of proposition matrices (or other value bases) makes for an important but usually unrecognized class of exceptions to the general principle that the information value of a compound expression is made up of the information values of its information-valued components. Where T is a monadic temporal sentential operator, e.g., 'sometimes' + present tense or 'on 4 July 1968' + past tense, the information content of the result of applying T to a clause S , with respect to a context c , is made up of the information value of T with respect to c together with the information-content *base* of S with respect to c , rather than the information content of S itself. In general, if T is a temporal operator, the information value with respect to a context c of the result of applying T to an expression is a complex made up of the information value of T with respect to c and the value base, rather than the information value, of the operand expression with respect to c . Ordinarily, the information value of an expression containing as a part the result of applying a temporal operator T to an operand expression is made up, in part, of the value base of the operand expression rather than its information value. (For complete accuracy, the notion of information value with respect to a context, a time, and a location, for a language L should be defined recursively over the complexity of expressions of L .)²¹

²¹The value base of the result of attaching an information content operator (such as 'necessarily' or the 'that'-operator) to a sentence is a complex made up of the value base of the operator and the content base of the sentence, rather than its

IX. Information-Value Base vs. Kaplan's Content

The notion of value base, and the attendant notion of program, are analogous in certain respects to the notion of information value and Kaplan's notion of character, respectively. In particular, the notion of value base is highly reminiscent of Kaplan's use of what he calls the 'content' of an expression in his seminal work on the logic and semantics of indexicals, *Demonstratives*. In fact, I came upon the notions of program and value base in musing over Kaplan's distinction between character and what he calls 'content', and over the work of Mark Richard on the relations between sentence meanings, tense operators, and propositions. (See footnotes 18 and 19 above.) In order to avoid confusion with my use of the term 'content' in the phrase 'information content', I shall use the expression 'kontent' as a term for Kaplan's notion. That is, I shall use the word 'kontent' as a general term for all and only those things that fit Kaplan's notion of what he calls a 'content', and I shall use the phrase 'kontent of' as a term for the semantic binary many-one relation (or the semantic one-place function) between anything that fits Kaplan's notion of what he calls the 'content of' an expression and the expression itself. Thus, the kontent of an expression with respect to a given context is the thing that fits Kaplan's notion of what he calls the 'content' of the expression in that context.

Kaplan defines²² the kontent of a sentence, in a given context, to be *what is said* in uttering the sentence in the given context, adding that the kontent of a sentence "is what has traditionally been called a proposition," and that Frege used the word 'thought' (*Gedanke*) for the kontent of a sentence. Kaplan also claims that a modal operator, such as 'it is necessary that' or 'it is possible that', operates on the kontent of its

information content. Thus, for example, the value base of the 'that'-clause 'that Frege is busy' with respect to any context c does not involve the information content of 'Frege is busy' with respect to c , which is the proposition that Frege is busy at t , where t is the time of c . Instead, it is something like the ordered pair of two elements: (1) A certain abstract entity, analogous to a property, which is the operation of assigning any proposition to itself (this operation—call it ' O_p '—is the value base of the 'that'-operator with respect to any context); and (2) the proposition matrix fb . Thus the value base of 'that Frege is busy' has the following structure: $\langle O_p, \langle \text{Frege, being busy} \rangle \rangle$. The information content of 'Sometimes Frege believes that he is busy' has the following structure, where ' Σ times' designates the property of proposition matrices of being true at some time(s):

$\langle \langle \text{Frege, } O_p, \langle \text{Frege, being busy} \rangle, \text{believing} \rangle, \Sigma \text{times} \rangle$.

For further details see appendix C of my *Frege's Puzzle*, op. cit.

²² *Demonstratives*, this volume, 500–501.

operand sentence. On the basis of Kaplan's definition, together with his accompanying remarks, it would seem that the kontent of a sentence is indeed simply its information content, the piece of information asserted by someone who utters the sentence, and in general, that the kontent of an expression, in a given context, is just its information value, with respect to that context. But Kaplan goes on to claim²³ that temporal operators and modal operators alike operate on kontents. He adds that if sentence kontents were eternalized by the infusion of particular times,

thus ... making [kontents] *specific* as to time ... , it would make no sense to have temporal operators. To put the point another way, if *what is said* is thought of as incorporating reference to a specific time ... , it is otiose to ask whether what is said would have been true at another time ... Temporal operators applied to ... sentences [whose kontents] incorporate a specific time ... are redundant.

Kaplan elaborates in a footnote to the passage containing these remarks:

Thus we think of the temporally neutral 'proposition' [i.e., sentence kontent] as changing its truth-value over time. Note that it is not just the noneternal sentence ... that changes its truth-value over time, but the 'proposition' itself An alternative (and more traditional) view is to say that the verb tense in [a tensed sentence] *S* involves an implicit temporal indexical, so that *S* is understood as synonymous with ['It is now the case that *S*'] Technically, we must note that [temporal] operators must, if they are not to be vacuous, operate on [kontents] which are neutral with respect to [time]. Thus, for example, if we take the [kontent of a sentence] to be [an eternal, time-specific proposition rather than a noneternal, temporally neutral proposition matrix], the application of a temporal operator to such a [kontent] would have no effect; the operator would be vacuous.²⁴

Continuing this line of thought in the text, he writes:

This functional notion of the [kontent] of a sentence in a context may not, because of the neutrality of [kontent] with

²³ Ibid., 503.

²⁴ Ibid., 503–4, footnote 28.

respect to time and place, say, exactly correspond to the classical conception of a proposition. But the classical conception can be introduced by adding the demonstratives 'now' and 'here' to the sentence and taking the [kontent] of the result.²⁵

Claiming that the temporal sentential operators operate on sentence kontents, and having already defined the kontent of a sentence as the information asserted by someone who utters the sentence, or *what is said*, Kaplan is forced to construe the information kontent of a sentence—what is said—as something that may take on different truth-values with respect to different times, and in some cases even with respect to different places. But we saw in section IV above that this is incorrect. As Frege, Moore, and Cartwright correctly pointed out—and as Kaplan seems to acknowledge—propositions do not vacillate in truth-value over time or space. Moreover, as Kneale and Kneale and Richard point out, *what is said* in uttering a sentence is similarly eternal, temporally and spatially fixed. This is precisely because what is asserted in uttering a sentence is a piece of information, an eternal proposition. The truths truthsayers say and the soothsayers soothsay—these all are propositions fixed, eternal, and unvarying. Eternal are the things asserters assert, the things believers believe, the things dreamers dream. Eternal also are the principles we defend, the doctrines we abhor, the things we doubt, the things we cannot doubt. The truths that are necessarily true and those that are not, the falsehoods that are necessarily false and those that are not—these are one and all eternal propositions.

It does not follow, as Kaplan argues, that temporal sentential operators become redundant or vacuous, so that it makes no sense to have them. It is true that a temporal sentential operator, if it is not to be vacuous, must operate on some aspect of its operand sentence that yields different truth-values with respect to different times—something that is time-neutral or noneternal. What follows from this is that, contrary to Kaplan, temporal operators do not operate on information contents. In fact, we have already established this much in section VII above with the two sentences

The senior senator from California is a Republican
and

The present senior senator from California is a Republican

²⁵Ibid., 504.

which, if uttered simultaneously, yield the same (or at least trivially equivalent and very nearly the same) information content, but whose temporal existential generalizations (sentences (8) and (9), respectively), if uttered at the time of my writing these words, yield very different information contents and even different truth-values. Since they are not generally vacuous or redundant, temporal operators must operate on some aspect of their operands other than the information content, something other than *what is said* in uttering the operand. What we have already seen is that temporal operators are superintensional operators. The extension of a sentential temporal operator is a function from proposition matrices or from sentence superintensions (i.e., from functions from times to eternal propositions) to truth-values, and its information value may be thought of as a property of proposition matrices or of sentence superintensions.

Kaplan's notion of what he calls the 'content' of an expression is in fact a confused amalgamation of the information content and the information-content base. On the one hand, Kaplan defines the kontent of sentence (1) with respect to Frege's context c^* to be *what is said* by Frege in c^* , the information he asserts. This is the eternal singular proposition p^* about Frege that he is busy at t^* . It is precisely this proposition p^* that is said to be possible (possibly true) in 'It is possible that Frege is busy', when uttered at t^* . On the other hand, the kontent is also supposed to be something that is noneternal and neutral with respect to time; it is supposed to be that which is said to be sometimes the case in 'Sometimes Frege is busy'. This is the content base, the proposition matrix fb . But fb is not p^* ; it is only the matrix of p^* . Kaplan mistakenly assumes at the outset—and indeed explicitly asserts (without argument)—that both modal and temporal operators operate on the very same semantic value of their operand sentences. This semantic value is what kontents are supposed to be. In fact, Kaplan's intended notion would have been better captured by defining the kontent of a sentence S to be what is operated on by both a modal operator, as in 'It is possible that S ', and a temporal operator as in 'Sometimes S '.

Kaplan is aware of the tension between his notion of what he calls 'content' and the eternalness of information, and he attempts to accommodate the "traditional" or "classical" conception of a proposition by identifying the traditional proposition expressed, with respect to a given context, by a sentence such as (1) with the kontent of the result of inserting 'now' in an appropriate position—that is, with the content base

of

(12) I am busy now

with respect to the same context. This clever proposal exploits the fact that the content bases of temporally modified sentences are eternal and time-specific rather than noneternal and time-neutral. But it also obscures the equally important fact that what is said by Frege in uttering (1) at t^* is the eternal proposition p^* , and not just its matrix fb —a fact that Kaplan fails to recognize. He comes tantalizingly close to recognizing this latter fact when he shows (p. 500) that what is said in uttering a temporally indexical sentence such as (12) at different times is different. His argument for this is that if such a sentence is uttered by me today and by you tomorrow, then

[if] what we say differs in truth-value, that is enough to show that we say different things. But even if the truth-values were the same, it is clear that there are possible circumstances in which what I said would be true but what you said would be false. Thus we say different things.

This is indeed correct. But the same argument could equally be made for a nonindexical tensed sentence. Thus it is not surprising to find the following analogous argument given earlier by G. E. Moore:

It seems at first sight obvious that, if you have a number of judgements [i.e., utterances] with the same content, if one is true the rest must be.

But if you take a set of judgements [i.e., utterances] with regard to a given event A, [using words to the effect] either that it is happening, or that it is past, or that it is future, some of each set will be true and some false, which are true and which false depending on the time when the judgement [i.e., utterance] is made.

It seems a sufficient answer to say that a judgement [i.e., an utterance of a sentence of the form] “A is happening” made at one time never has the same content as the judgement [i.e., an utterance of the sentence] “A is happening” made at another.²⁶

²⁶G. E. Moore, “The Present,” Notebook II [c. 1926], in *The Commonplace Book 1919–53*, ed. C. Lewy (New York: The Macmillan Company, 1962), 89.

Consider the sentence 'Frege is busy'. Mimicking Kaplan, and following Moore, one may argue that if it is uttered at t^* and again on the next day, and if what are said on the two occasions of utterance differ in truth-value (across time), as indeed they may, that is enough to show that different things are said. This is precisely because it is known in advance that what is asserted is not the sort of thing that can switch in truth-value from one moment to the next. Of course, the very same content base is expressed with respect to the two occasions. Since what is said or asserted on the one occasion is different from what is said or asserted on the other, it is not the content base that is said or asserted.

Once it is acknowledged that the information contents of sentences—what is said or asserted—are eternal propositions rather than proposition matrices, it emerges that a simple proposal to identify the traditional proposition expressed by a sentence S with the content base of the result of attaching the 'now'-operator to S is inadequate. This proposal delivers the wrong result, for example, with a sentence such as (6) or the following:

Although I cannot claim to be wealthy today, in ten years I will be able to assert truly (the proposition, as traditionally conceived) that I am wealthy.

Kaplan's proposal delivers only the singly indexed notion of the ("traditionally conceived") proposition expressed by 'I am wealthy' with respect to a context c . As we have seen (sections VI and VII), what is needed in order to deal adequately with this construction is a more general, doubly indexed notion of the information content of 'I am wealthy' with respect to both a context c and a time t that may be other than the time of c .

In general, the kontent of an expression is a confused amalgamation of the information value and the value base. Kaplan's notion of what he calls the 'character' of an expression is defined and understood in terms of his notion of what he calls 'content'—roughly, as a function from contexts to kontents. Consequently, the former is correspondingly a confused amalgamation of program and what I am calling 'character'. I have chosen to follow Kaplan's explicit definition of the kontent of a sentence as the thing asserted, or *what is said*, in defining character as a function or rule that assigns information values, rather than value bases, to contexts—although one would be equally justified in using Kaplan's term 'character' for what I am calling the 'program' of an expression. If the truth be told, there simply is nothing that is the kontent of sentence (1) with respect to a context c , for nothing is both *what is said* (the

proposition asserted) in uttering (1) in c , and also what is said to be sometimes the case in sentence (11) (the proposition matrix). Likewise, nothing is the *karacter* of sentence (1); that is, there is nothing that exactly fits Kaplan's notion of what he calls the 'character' of (1).

It is instructive to look at how the four-tiered modified naive theory treats a simple, untensed clause, such as (3) as well as various complex sentences built from it. The program of (3) is given by the following rule:

For any context c , the value base of (3) with respect to c is the proposition matrix *A being busy*, where A is the agent of c . This proposition matrix is made up of A (the value base of 'I' with respect to c) and the property of being busy (the value base of 'be busy' with respect to c).

The schedule of (3) with respect to a given context c is thus given by the following rule, where A is the agent of c :

For any time t , the information value of (3) with respect to c and t is the singular proposition about A that he or she is busy at t , which is made up of A (the result of applying the schedule of 'I' to t) and the property of being busy at t (the result of applying the schedule of 'be busy' to t).

The information value of (3) with respect to a context c *simpliciter* is therefore the singular proposition about the agent of c that he or she is busy at t , where t is the time of c itself.

We may contrast this with the indexical sentence (12). Its program is given by a rule something like the following:

For any context c , the content base of (12) with respect to c is the higher-order singular proposition made up of the following two things, where A is the agent of c and t is the time of c : (i) the proposition matrix *A being busy* (the value base of (3) with respect to c); and (ii) the property of proposition matrices of obtaining (or being true) at t (the value base of 'now' + present tense with respect to c).

This rule reveals the fact, exploited by Kaplan, that the content base of the eternal sentence (12) is in fact already a full-fledged, eternal proposition, rather than a noneternal proposition matrix. The schedule of (12) with respect to a context c is thus a constant function from times

to the higher-order proposition about the proposition matrix *A being busy* that it obtains at *t*. The information content of (12) with respect to a context *c simpliciter* is this same higher-order singular proposition, whereas the information value of the simpler (3) with respect to *c* is the singular proposition about *A* that he or she is busy at *t*. Now, obviously, *A* is busy at *t* if and only if *A being busy* obtains at *t*. Consequently, the information values of (3) and (12) with respect to any context of utterance are trivially equivalent. If we assume that sentence (1) is merely a surface transformation of (3), then *what is said* by uttering either (1) or (12) at the same time is very nearly the same, as long as the speaker is the same. Still, the content bases are very different. With respect to any context *c*, the content base of (1) is noneternal, neutral with respect to time, whereas the content base of (12) is eternal. As Kaplan notes, only the former can be felicitously operated upon by temporal operators.

Contrary to Kaplan, since the information contents, *what is said*, are trivially equivalent, the function of 'now' cannot be primarily to affect what is said in context. Its effect on information content is in fact negligible, virtually nil. Rather, the function of 'now' is primarily to affect the content base of its operand, eternalizing it and thereby sealing it off from the influence of external occurrences of temporal operators. For example, applying the 'sometimes' operator to sentence (1), whose content base with respect to any context is noneternal, aptly yields sentence (11), whose content base is eternal. By contrast, 'sometimes' is at best superfluous in

Sometimes I am busy now.

Compare also the role of the 'present' in sentences (4) and (9).

Analogously, the schedule of such a sentence as

I will be busy tomorrow

as uttered by someone *A* at time *t*, is the constant function that assigns to any time *t'*, the eternal proposition about the proposition matrix *A being busy* that it obtains on *d⁺*, where *d⁺* is the day after the day of *t*. The schedule of the sentence

I will be busy on the next day

with respect to the same context, on the other hand, is a nonconstant function that assigns to any time *t'*, the proposition about *A being busy*

that it obtains on the day next after d' , where d' is the day of t' . The information contents of the two sentences with respect to any context (*what are said*) are very similar, though the schedules are very different, and only the latter sentence may be felicitously operated upon by temporal operators. Consider: 'On 24 December 1989 I will be busy on the next day' vs. 'On 24 December 1989 I will be busy tomorrow'.

X. Pure Tenses

A considerably richer semantic theory of temporal operators may be obtained by drawing a three-way distinction among *quantificational* or *general* temporal operators, *specific* or *singular* temporal operators, and *pure tense* operators such as simple past or future tense. Quantificational or general temporal operators include such operators as 'sometimes', 'always', present perfect tense (as in 'I have been busy' in the sense of 'I have sometimes been busy'), 'it will always be that' + present tense, and 'twice before' + past tense, etc. Specific or singular temporal operators include 'it is now the case that', 'on 24 December 1989' + future tense, 'when Frege wrote "Thoughts"' + past tense, etc. (Compare: 'possibly' vs. 'actually'.) The difference between these two sorts of temporal operators lies in their accompanying semantics. Very roughly, a specific sentential temporal operator T is one such that there is some specific time t semantically associated with T , with respect to a context (and a time and a possible world), in such way that the result of applying T to a sentence S is true with respect to a time t' if and only if S is true with respect to t , and t stands in some appropriate temporal-order relation to t' . For example 'On 24 December 1989 I will be busy' is true with respect to a context c and the year 1983 if and only if both of the following conditions obtain: (i) clause (3) (or sentence (1)) is true with respect to c and 24 December 1989, and (ii) 1989 is later than 1983. A general sentential temporal operator T is a nonspecific temporal operator such that there is some specific property P of classes of times semantically associated with T (with respect to semantic parameters) in such a way that the result of applying T to a sentence S is true with respect to a time t' if and only if the class of times with respect to which S is true and which stand in some appropriate temporal-order relation to t' has P . For example, in the case of the present perfect tense, the property P is that of being nonempty, and the appropriate temporal-order relation

is the earlier-than relation.²⁷

Consider now ordinary past or future tense, as in

Frege was busy

or 'Frege will be busy'. Past tense is sometimes treated by philosophers as though it were a quantificational temporal operator, so that the displayed sentence is regarded as being true with respect to a time t if and only if 'Frege be busy' (or 'Frege is busy') is true with respect to some time t' earlier than t . (See, for example, the quote from G. E. Moore in section IV above.) While a simple past-tensed sentence might sometimes be used in this way (roughly, as equivalent to the corresponding present-perfect-tensed sentence), it generally is not. Ordinarily, when a simple past-tensed sentence such as 'Frege was busy' is used, it is used with implicit reference to a specific (though perhaps vaguely delineated) time, so that if Frege was not busy at the relevant time, then what is said is false even if Frege was busy at some time or other prior to the utterance. Consider: 'I asked Frege to come along, but he was busy' vs. 'I have sometimes asked Frege to come along, but he has sometimes been busy'. Analogous remarks apply to future tense.

Moreover, most simple temporal operators other than tense operators seem to require, in idiomatic English, an appropriate adjustment in the tense of the operand. For example, if I wished to apply the temporal operator 'at 3:00 P.M. on 4 December 1983' to sentence (1), at the time of my writing these words—which happens to be 2:55 P.M. on 4 December 1983—I should use the sentence

At 3:00 P.M. on 4 December 1983 I will be busy.

²⁷These explications of the notions of specific and general temporal operators cannot be regarded as strict definitions, and are intended only to convey a general idea. The operator 'when Frege wrote "Thoughts"' + past tense is to count as a specific temporal operator even if it should turn out that Frege did not write "Thoughts." Also, given a sufficiently liberal notion of a property of a class, some precaution must be taken if a specific temporal operator is to be precluded from being a general temporal operator. It may be appropriate to define a general temporal operator as a *nonspecific* temporal operator of a certain sort. (A similar difficulty is encountered in defining ordinary quantifiers in such a way as to preclude ordinary singular terms.) More importantly, the explications provided here are appropriate for what I shall call 'complete' temporal operators below, although the terminology of 'specific' or 'singular' and 'quantificational' or 'general' temporal operators will be used also for the components of these which I shall call 'incomplete' temporal operators below, e.g., 'when Frege wrote "Thoughts"' *without* an accompanying tense operator. These various notions can be made precise, though it is preferable to leave them at an intuitive, informal level in motivating the account under consideration here.

That is, in addition to affixing the operator, I would shift from present to future tense. If I waited six minutes and forever thereafter, I must instead use the sentence

At 3:00 P.M. on 4 December 1983 I was busy.

These adjustments in tense seem to be required, although the content base of each sentence is eternal, and the same proposition (or at least trivially equivalent, and very nearly the same, propositions) would be asserted at each time. It is as if it is insufficient merely to indicate the particular time; one must also indicate the temporal direction of the indicated time—either earlier or later—relative to the time of utterance. The simple specific temporal operator ‘at 3:00 P.M. on 4 December 1983’ is, in a sense, an *incomplete* temporal operator; it applies to a tensed but otherwise temporally unmodified sentence such as ‘I will be busy’ to form a new sentence. Indeed, one might also regard simple past tense (or simple future tense) as another sort of incomplete temporal operator, one that modifies an untensed, temporally unmodified clause such as (3) to form a sentence that may now be modified by an incomplete specific or incomplete general temporal operator. It is as if the tense operator primes the atomic clause for the application of a specific or general (incomplete) temporal operator. An incomplete specific or general temporal operator combines with a pure tense operator to form a *complete* temporal operator; the complete temporal operator applied to (3) is ‘at 3:00 P.M. on 4 December 1983’ + future tense. And of course, the extension of a complete temporal operator is a function from sentence superintensions to truth-values.

In light of these facts, it is instructive to regard ordinary past tense as a superintensional operator with the following distinguishing property: its extension with respect to a time t and a possible world w is the function that assigns to any sentence superintension f (i.e., to any function from times to sentence intensions) not a truth-value, but the class of times t' earlier than t and for which the value of f yields truth for the world w (or equivalently, the characteristic function of this class of times). An analogous construal is possible for the future tense operator, replacing ‘earlier’ by ‘later’. A past-tensed or future-tensed but otherwise temporally unmodified sentence would thus have as its extension not a truth-value, but a class of times (or the corresponding characteristic function from times to truth-values).

For example, the extension of the simple past-tensed sentence

(13) I was busy

with respect to a context c , a time t , and a possible world w would be the class of times t' earlier than t and such that its component untensed clause (3) is true with respect to c , t' , and w . An unmodified past tense sentence such as (13) might be represented formally as

Past Tense[*Busy*(I)].

Such a sentence is essentially *incomplete*, standing in need of completion by an incomplete temporal operator, either specific or general, in order to achieve genuine truth-value.

The extension (with respect to a context, a time, and a possible world) of an incomplete specific temporal operator, such as 'at 3:00 P.M. on 4 December 1983', may be taken to be simply the indicated time, rather than the corresponding function from sentence superintensions to truth-values. Indeed, even the information values of certain incomplete specific temporal operators, such as 'now' and 'at 3:00 P.M. on 4 December 1983', may plausibly be regarded as simply the indicated time, rather than the corresponding property of proposition matrices of being true at that time. In the case of an incomplete descriptive specific temporal operator, such as 'when Frege wrote "Thoughts"', its information value may plausibly be regarded as analogous to that of the corresponding definite description 'the earlier time at which Frege writes "Thoughts"'. The word 'when' in such constructions may be regarded as the temporal analogue of the definite-description operator 'the'.

Where T is any incomplete specific temporal operator, without an accompanying tense operator, the result of applying T to a past-tensed sentence such as (13) is representable formally as

T (*Past Tense*[*Busy*(I)]).

This is a *complete* sentence, one whose extension is a truth-value. The sentence is true (with respect to semantic parameters) if and only if the extension (with respect to those parameters) of T is an element of the extension (with respect to those parameters) of the operand past-tensed sentence (13). It is thus as if the past-tense operator in (13) transformed its operand clause (3) into the corresponding predicate

is an earlier time at which I am busy.

An incomplete specific temporal operator such as 'at 3:00 P.M. on 4 December 1983' attaches to the tensed sentence as if the operator were a singular term to which a monadic predicate attaches. Hence

the complete temporal operator 'at 3:00 P.M. on 4 December 1983' + future tense is a one-place connective, whose extension may be regarded as a function from proposition matrices (or from sentence schedules or superintensions) to truth-values.

In ordinary use, a past-tensed but otherwise temporally unmodified sentence such as (13), standing alone as a declarative sentence in a piece of discourse, may be regarded as involving an implicit, specific, demonstrative temporal operator 'then', or 'at that time', in order to obtain a complete sentence,

I was busy then.

This ordinary sort of use of (13) would thus be represented formally as

Then(Past Tense[Busy(I)])

and would be taken to mean something very much like 'That time is an earlier time at which I am busy'. If the time implicitly designated in an utterance of (13) (standing alone as a declarative sentence in a piece of discourse) is not one at which the speaker is busy, what is said is false even if the speaker has been busy at other times prior to the utterance. Analogous remarks apply to the future-tensed 'I will be busy'.²⁸

Since the extension of an incomplete specific temporal operator such as 'at 3:00 P.M. on 4 December 1983', without an accompanying tense operator, is simply the indicated time, in order to obtain a complete sentence whose extension is a truth-value from an incomplete specific temporal operator and an untensed clause as operand, a tense operator *must be* supplied as a bridge connecting the superintension of the operand clause with respect to a time *t* (e.g., the time of utterance) to the extension of the temporal operator with respect to *t*, thereby achieving truth-value. Which tense operator is appropriate will depend on the direction of the indicated time, earlier or later, relative to the time *t*. This account thus accommodates the fact that the appropriate complete temporal operator typically shifts its constitutive tense from future to past with the passage of time.

Just as an incomplete specific temporal operator may be plausibly treated as a singular term, so an incomplete quantificational temporal operator may be plausibly treated as a corresponding quantifier. The extension of 'sometimes', for example, may be taken to be the class of all

²⁸Cf. W. V. O. Quine, *Word and Object* (Cambridge, Mass.: MIT Press, 1960), at 170-71.

nonempty classes of times (or equivalently, the characteristic function of this class), and its information value may likewise be taken to be the corresponding higher-order property of being a nonempty class of times. A quantificational temporal operator thus also requires an accompanying tense as a bridge connecting the superintension of its operand clause to its own extension. The result of applying a quantificational temporal operator to a tensed sentence is true if and only if the extension of the tensed sentence (which is not a truth-value, but a class of times) is an element of the extension of the quantificational temporal operator. Thus, for example, the sentence

Sometimes Frege was busy

is true with respect to a time t if and only if the class of times earlier than t at which Frege is busy (the extension of 'Frege was busy' with respect to t) is nonempty, i.e., if and only if some time t' is a time earlier than t at which Frege is busy. (The complete quantificational temporal operator 'sometimes' + past tense provides a roughly correct, albeit somewhat strained, definition of one use of the present perfect tense, as in 'Frege has been busy', as well as of philosophers' alternative use of simple past tense.) Incomplete quantificational temporal sentential operators such as 'sometimes', 'always', 'twice before', etc., are thus regarded as attaching to tensed sentences in the way that quantifiers such as 'something', 'everything', and 'exactly two smaller things' attach to monadic predicates, whereas incomplete specific temporal operators such as 'on 4 December 1983', 'when Frege wrote "Thoughts"', etc., are regarded as attaching to tensed sentences in the way that singular terms are attached to by monadic predicates.²⁹

²⁹A problem for this account arises in connection with such constructions as 'Frege always was busy', which does not mean that every time is a past time at which Frege is busy. The sentence seems to mean instead that every past time is a time at which Frege is busy. But on the account proposed here, the past-tense operator operates on the value base of the untensed clause 'Frege be busy' and the incomplete operator 'always' attaches to the result (i.e., to the past-tensed 'Frege was busy'), apparently resulting in the incorrect former reading for the sentence. The alternative, latter reading would seem to require seeing the past-tense operator as somehow modifying the 'always' rather than the untensed clause.

Whereas the latter reading of the sentence is closer to the actual meaning than the former (which is clearly a misreading), it also does not seem exactly correct. The sentence in question generally is not used with this meaning (although, of course, it *can be* so used). As with a simple past-tensed sentence, a sentence such as 'Frege always was busy' is ordinarily used with implicit reference to a particular (perhaps vaguely delineated) period or interval of time in mind, so that what is

There are complications involved in extending this account of temporal operators to cases in which temporal operators such as ‘sometimes’, ‘always’, ‘now’, and ‘today’ are applied directly to present-tensed sentences, as in any of the examples (8)–(11). The account would suggest that such instances of present tense be regarded as instances of a pure tense operator, analogous to past or future tense except that its extension with respect to a time t and a possible world w , is the function that assigns to any sentence superintension f the class of times t' —whether earlier than, later than, or overlapping with t —for which the value of f yields truth for the world w (or equivalently, the characteristic function of this class of times). Such an operator is required, on the account being considered here, in order to prime a temporally unmodified clause such as (3) for an operator such as ‘sometimes’ or ‘today’, to bridge the superintension of the unmodified clause with the extension of the incomplete specific or general temporal operator.

Consider now the simple present-tensed sentence (1). Strictly speaking, this probably should not be regarded as the atomic sentence formed by attaching the temporally unmodified predicate corresponding to the naked infinitive phrase ‘be busy’ to the term ‘I’, as represented formally by

Busy(I).

What this represents is the English clause (3) or ‘me be busy’ (as in ‘One can see me be busy’). Although (3) is not a grammatical sentence of English, it is complete in itself. Its extension (with respect to appropriate semantic parameters) is a truth-value; it is true with respect to a context c , a world w , and a time t if and only if the agent of c is busy at t in w . What, then, becomes of such a sentence as (1)?

On the account of temporal operators under consideration, the result of applying present tense to (3), represented formally as

said is true as long as Frege is busy throughout that period even if at some other times he is not busy. This feature of such constructions can be accommodated on the present account by taking incomplete quantificational temporal operators, such as ‘always’, to involve implicit reference to a particular period or interval—very much in the manner of implicitly relativized uses of quantificational constructions in English (as, for example, the ‘everything’ in ‘Everything is in order’ or the ‘everyone’ in ‘Is everyone here?’). A sentence such as ‘Frege always was busy’, standing alone as a declarative sentence in a piece of discourse, may thus be taken to mean something like the following: Every time during *that period* is an earlier time at which Frege is busy (with reference to a contextually indicated period of time).

Present Tense[Busy(I)]

is not a complete sentence of English, capable of truth-value standing alone. Its extension is a class of times rather than a truth-value. Yet surely one who wishes to assert what is encoded by a simple, atomic clause such as (3) uses a tensed sentence, (1). How are we to accommodate the fact that a simple, present-tensed sentence such as (1) is capable of achieving truth-value when standing alone as a declarative sentence without an additional temporal operator?

On this theory, such uses are regarded as involving an implicit use of a specific, indexical temporal operator such as 'now'. For example, sentence (1) standing alone would be seen as elliptical for (12), represented formally as

Now(Present Tense[Busy(I)]).

This account of simple present tense is exactly analogous to the treatment suggested above of simple past tense according to which a simple past-tensed sentence such as (13) or 'Frege was busy', standing alone as a declarative sentence in a piece of discourse, is elliptical for a temporally indexical completion, e.g., 'Frege was busy then'. We may call this *the ellipsis theory of present tense*.³⁰

³⁰One alternative to the ellipsis theory of present tense is the theory that the English construction represented by '*Busy(I)*' is simply sentence (1). Indeed, it is commonplace in most discussions concerning logical form to assume that this English sentence is, at least as typically intended, an atomic sentence constructed from the singular term 'I' and the simple predicate 'am busy', while regarding the present tense of the latter not as a separate component of the sentence but as somehow built into the predicate. In an effort to facilitate understanding of the general theory of temporal operators presented here, much of the preceding discussion was based on the presumption of some such theory. However, if verb tenses are to be taken seriously in accordance with the general theory of temporal operators presented here—as semantically significant contributions to sentences in themselves—this alternative theory ultimately requires the postulation of a systematic semantic ambiguity in the present tense, so that a simple, present-tensed sentence such as (1) is ambiguous between the complete

Busy(I)

and the incomplete (in need of supplementation by an incomplete specific or general temporal operator)

Present Tense[Busy(I)].

The first would be an instance of the *tenseless* use of present tense, the second of the *tensed* use of present tense. The *tenseless* (1) has a truth-value for its extension and would be an appropriate operand for any complete temporal operator, whereas the *tensed* (1) would be the result of applying a certain tense operator (viz., present

It is not my purpose here to fill out the details of the ellipsis theory of present tense or to cite linguistic evidence either in favor of or against this general account of the simple tenses. I offer the theory in order to provide an indication of the richness of the apparatus of the modified naive theory for dealing with complete and incomplete temporal operators.³¹

It is interesting to note that on the ellipsis theory of present tense suggested here, a present-tensed sentence such as (2) is taken to be an incomplete sentence standing in need of completion, much as if it were the corresponding predicate 'is a time at which this tree is covered with green leaves'. At the level of information value, the present-tense operator thus converts the content base of its untensed operand clause into something like its corresponding property of being a time at which the particular tree in question is covered with green leaves. In a sense, this theory of the pure tenses partially vindicates Frege's construal of a present-tensed sentence as standing in need of completion or supple-

tense qua tense operator) to the tenseless (1). The more complex logical form of the latter would have to be regarded on this theory as going entirely unrepresented in the surface grammar. We may call this *the ambiguity theory of present tense*.

Certain general considerations tend to favor the ellipsis theory over the ambiguity theory of present tense. In general, when attempting to explain apparently divergent uses of a single expression or locution, if an ellipsis account is available, it is to be preferred over the postulation of a systematic semantic ambiguity—although, of course, some third alternative may be preferable to it. See Saul Kripke, "Speaker's Reference and Semantic Reference," in *Contemporary Perspectives in the Philosophy of Language*, ed. P. French, T. Uehling, and H. Wettstein (Minneapolis: University of Minnesota Press, 1979), 6–27, especially 19.

³¹It is probably important for a full theory of the simple tenses to take account of the fact that the proper operands of tenses in English seem not to be whole clauses but simple predicates (or, more accurately, verbs). Since tenses are to be treated in any case as superintensional operators, it is largely a simple problem of formal engineering to transform the theory of pure tenses presented here into a theory of tenses as operators on the value bases of simple predicates rather than on the value bases of whole clauses. For example, in accordance with the spirit of the general theory of tenses presented here, a past-tensed predicate such as 'was busy'—which results from applying the past tense operation to the simple predicate (naked infinitive) 'be busy'—may be regarded as having for its extension, with respect to a possible world w and a time t , not a class of individuals (or its corresponding characteristic function from individuals to truth-values) but the function that assigns to each (possible, past, present, or future) individual i the class of times before t at which i is busy in w .

It may also be important to recognize that the 'that'-operator, which transforms a sentence into a singular term (typically) referring to the sentence's information content, may be attached in English to a tensed but apparently otherwise temporally unmodified sentence, e.g., 'When Frege wrote "Thoughts," he knew that he was busy'. It may be necessary to regard such 'that'-clauses as involving an implicit 'then' or 'now' operator. See footnote 21 above.

mentation, typically provided by the time of utterance. Frege's theory works remarkably well as a theory of tense. Unfortunately, as we saw in sections VI and VII above, it fails as an account of temporal indexicality.

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