

TEMPORALITY. Philosophers of language have given considerable attention to the role of time in semantics, and especially to the interplay between content and temporal operators, including tense operators. Since the work of Prior 1968, philosophers have recognized a very high degree of analogy between temporality in language (as indicated by, e.g., *always* and *sometimes*) and "modality" (as indicated by such corresponding items as *must* and *might*). It is natural and customary in temporal semantics (also called 'tense logic') to relativize or 'index' such extensional semantic notions as reference, application, and truth value to times--just as it is customary (though not uncontroversial) in modal semantics to index these same notions to "possible worlds," i.e. to complete world-histories that might have transpired. Thus the sentence *Hiyakawa is awake* is true with respect to some times, false with respect to others. Indexing to times yields a natural recursive development, along the lines of Alfred Tarski, of a definition (or at least of a theory) of truth (in-a-model) for a language containing temporal operators. An example of the type of recursive clause that may occur in such a development is the following:

Any well-formed sentence that results from applying the temporal operator *in 15 minutes* + future tense to a (temporally unmodified) clause *S* is true (in a model *M*) with respect to a time *t* if and only if the clause *S* is itself true (in *M*) with respect to *t* + 15 minutes.

However, this traditional approach faces a serious dilemma. How shall one accommodate the adverb *now*? One might think that *Hiyakawa is awake now* is true if and only if the simpler sentence *Hiyakawa is awake* is itself true with respect to the present moment. But this yields undesirable results. Suppose Hiyakawa is awake now but will be asleep in 15 minutes, at which time Mary will utter the words *Hiyakawa is awake now*. Although *Hiyakawa is awake* is indeed true with respect to the present moment, Mary will have spoken falsely. If our definition of truth is to have more than merely ephemeral value, it must reflect the fact that whenever one utters *Hiyakawa is awake now*--whether now or later--it is true if and only if Hiyakawa is awake THEN. The sentence is exactly on a par in this respect with the simpler *Hiyakawa is awake*. Hence, it would seem that the result of modifying a clause with *now* is true with respect to a time *t* if and only if the clause itself is also true with respect to the very same time *t*. But this account fares badly with a complex sentence like *During the 1930's, the man who is now U.S. president was under 35*. Here the adverb *now* denotes the time of utterance, despite the fact that it occurs within the scope of *during the 1930's*. The new account treats this sentence (which is true with respect to the author's present context) as equivalent to *During the 1930's, the man who was then U.S. president was under 35* (whose truth is constitutionally prohibited). An exactly analogous dilemma threatened possible-world semantics for modality--in connection with such constructions as *It could not have been that the person who is actually U.S. president*

was a woman.

The solution was discovered in 1967 by Hans Kamp. Indexical temporal operators (i.e. those that are context-sensitive in the manner of *now* and *yesterday*) require that one keep track of the time of the context independently of the time determined by other temporal elements that may also be operative (*during the 1930's*); an indexical temporal operator is one for which the time of the context supercedes the latter. In order to accommodate temporal indexicality, one must "doubly index" the extensional semantic notions (e.g. truth value) to two times simultaneously--one representing the floating time required by temporal semantics generally, and the other specifically representing the context ("two-dimensional tense logic"). A more full-blown development would employ full contexts (conceived of as including at least their own agent, time, and possible world) in place of their times: Any well-formed sentence that results from applying the temporal operator *now* + present tense to a clause *S* is *true with respect to* a context *c* and a time *t* (and a possible world *w*) if and only if the clause *S* is itself true with respect to *c* and the very time of *c*, in lieu of *t* (and with respect to *w*). The singly indexed notion of truth-with-respect-to-a-context is definable in terms of the doubly indexed notion: A sentence is *true respect to* a context *c* if and only if it is true with respect to *c* and the time of *c* (and the possible world of *c*).

Hiyakawa is awake now is thus context-sensitive in a particular way that *Hiyakawa is awake* is not. Yet both sentences vary their truth value with context. In fact, the sentences are logically equivalent, sharing the same truth values with respect to exactly the same contexts. What special sort of context-sensitivity does only the former sentence exhibit? In the mid 1970's David Kaplan distinguished between the "content" of an expression with respect to a context and its "character." An expression's *content* is, roughly, the contribution made by the expression to the proposition--or piece of information, "what is said"--expressed (with respect to the relevant context) by typical sentences containing it. An expression's *character* is the rule or function that determines the expression's content for any possible context. For example, the character of *Hiyakawa is awake now* may be taken to be the function that assigns to any context *c* the proposition that Hiyakawa is awake at c_T , where c_T is the time of *c*. (Kaplan proposed identifying an expression's *meaning* with its character.) This conceptual scheme provided a philosophical underpinning for double indexing: starting with the character of *The man who is now president is under 35*, given only a context *c* the result is the proposition that the man who is president at c_T is under 35. In order to arrive at a truth value for the sentence one must be given further a *circumstance*, i.e. a pair consisting of a possible world and a time (e.g. the actual world during the 1930's)--which need not be the circumstance of *c*. Kaplan's scheme also allowed for an explication of the particular way in which indexical expressions are context-sensitive: An indexical expression is one that

yields not merely different extensions (e.g. truth values) but different contents for different possible contexts, i.e. one whose character is not a constant function.

Is *Hiyakawa is awake* not also indexical by this definition? Kaplan conceived of a sentence's content not only as the sort of thing that typically can obtain at some possible worlds and fail to obtain at others, but also as the sort of thing that typically can obtain at some times within a given possible world and fail to obtain at others. Kaplan recognized that his temporally neutral notion of the content of a sentence did not correspond exactly to the classical conception of a proposition. On the traditional view, a proposition is conceived of as modally neutral but eternal and unvarying in truth value within any given possible world. On this conception, a sentence like *Hiyakawa is awake* expresses different propositions at different times. (Cf. Frege 1918: 53.) Kaplan argued, however, that temporal operators (*in 15 minutes* + future tense, *during the 1930's* + past tense, etc.) would be otiose unless the propositions on which they operate were temporally neutral as well as modally neutral. Kaplan thus forged an even closer analogy between tense and modality.

Some philosophers remained unconvinced. In the early 1980's Mark Richard objected that Kaplan's account has the unacceptable consequence that someone who in 1971 believed that Richard Nixon was U.S. president, and who today believes everything he believed in 1971, believes even now that Nixon is president. Richard proposed repairing Kaplan's account (roughly) by treating temporal sentential operators as operating not on a sentence's content, but on the sentence's "meaning"--where the latter is identified with the rule or function that determines the sentence's content (conceived of traditionally as temporally fixed) for any pair of a possible context and a time. Thus on Richard's account, the notion of content must be indexed to a context-time pair, whereas the extensional semantic notions (truth value, etc.) are to be doubly indexed, to a context-time pair and a possible world.

Richard's idea that temporal operators operate on something that is simultaneously context-functional as well as time-functional seems to accord temporal operators with more versatility than they actually exhibit. Indeed, Kaplan had argued that standard English cannot include operators (other than quotational operators) that operate on context-functional entities. Moreover, although Richard's objection to Kaplan's conception of propositions is compelling, the traditional conception poses a difficulty for the theory of indexicals: If propositions are temporally fixed, one cannot distinguish *Hiyakawa is awake now* from *Hiyakawa is awake* on the grounds that the character of the former is not a constant function. If contents are temporally fixed, then each time one utters either sentence, one asserts a new and different proposition; some of these propositions are eternally true while others are eternally false. Yet we have seen that there

is a critical difference between the the indexical clause *who is now president* and the nonindexical *who is president*. If the indexical expressions are not those that yield different contents for different contexts, what feature of an indexical expression is it that varies with the context, by virtue of which the expression is properly called *indexical*?

In the mid 1980's, the present author proposed replacing Kaplan's three-tiered account (character, temporally neutral content, and extension), as well as Richard's ("meaning," temporally fixed content, and extension), with a four-tiered account, by inserting a new semantic value, *content base*, between Kaplan's character and content. It is on the content base of its operand that a temporal operator operates. Hence, the content base of a sentence (or of a predicate or descriptive phrase) is (typically) temporally neutral. Given a particular time, it determines a corresponding content, which is temporally fixed. The content base of *Hiyakawa is awake*, for example, is something like the state of affairs ("proposition matrix") of Hiyakawa's being awake--something that obtains at some times and not at others. The content of *Hiyakawa is awake* with respect to a given context *c* is the (temporally fixed) proposition that Hiyakawa is awake *at t*, where *t* is the time of *c*. For any context, the content of *Hiyakawa is awake* is thus equivalent to that of *Hiyakawa is awake now*. The temporally modified sentence *Hiyakawa is always awake* nevertheless differs dramatically from the corresponding sentence *Hiyakawa is always awake now* because the temporal operator *always* does not operate on the proposition that Hiyakawa is awake at *t* (the content of the operand *Hiyakawa is awake*) but on the temporally neutral state of affairs of Hiyakawa's being awake (the content base).

The duration of the time parameter may be a vague matter. When the interval involved in a proposition is significantly long, the proposition may mimic its non-eternal matrix—for example, in contexts like 'Mary once believed that Bush was a Republican, and she still believes that'—as long as one stays within the boundaries of the interval in question. Relatively stable properties (being a Republican, as opposed to being U.S. president) tend to prolong the interval in question. This point is crucial to the proper analysis of phenomena that seem to tell against the four-tiered account (Aronszajn 1996).

On this account, the notion of content is doubly indexed, to a context and a time, whereas the extensional semantic values are triply indexed to a context, a time, and a possible world. In addition, a more discriminating context-functional semantic value, *program*, was proposed. An expression's program is the rule or function that determine's the expression's content base for any possible context. (This is more closely akin to the expression's meaning.) This conceptual scheme allows for a more accurate definition of indexicality: An expression is indexical if it yields different content bases for different contexts, i.e. if its program is not a constant function. The new scheme also yields the

erstwhile unrecognized result that the content of a predicate like *is awake* with respect to a given time t is not simply the property (or concept, state, etc.) of being awake, but the temporally indexed property of being awake *at t* , and hence varies with the temporal parameter t .

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Nathan Salmon