sentences about continuants is now '$\varphi\langle t\rangle(x)$'. This is the form introduced in section III. But the expression in '$\langle \ \rangle$' need not be interpreted as the name of a temporal individual; it is a qie. The reformed language of this section, even after its revision, is extensional. For temporal connectives are not sentential connectives; all sentential connectives are truth-functional.

VI

In the preceding section I made good my claim that a language can be formulated to reflect a substance ontology without terms for temporal individuals. This is sufficient to show that Bergmann is wrong when he insists that a substance ontology that does not admit temporal individuals will end in contradiction. I have also indicated how my reformed language can incorporate sentences from a predicate-calculus language, although it is a predicate-calculus language with multi-link functors.

The reformed language contains an irreducible category of temporal connectives. On my way of understanding the reformed language, this irreducible category indicates an inescapable ontological commitment of the substance ontologist. Anyone who holds that there are continuants having different properties and relations at different times must accept temporal relations. And these temporal relations are not "ordinary" relations: they do not connect individuals. Instead, temporal relations hold between individuals-having-properties. (And I would claim that an event is just an individual having a property or several individuals being related.) This shows how different, for a substance ontology, are time and space. Spatial relations are ordinary relations, relating continuants. Temporal relations relate individuals-having-ordinary-properties-and-relations. Individuals-having-spatial-relations occur in the temporal sequence.

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COMMENTS AND CRITICISM

A NOTE ON TIME AND RELATIVITY THEORY †

JOHN W. LANGO has discussed the relativistic theory of time,* taking issue in some points with a paper of mine on that subject.** I have a few comments to offer in reply and elaboration.

* "The Logic of Simultaneity," this JOURNAL, LXVI, 11 (June 5, 1969): 340–350.
** "On Einstein-Minkowski Space-Time," this JOURNAL, LXV, 1 (Jan. 11, 1968): 5–23.

I

First, a matter of terminology: The expression 'topologically simul-
taneous' is commonly used, in the recent philosophical literature, to
characterize a pair of space-time points that lie outside one another's
light-cones. I prefer to avoid this term, which seems to me unhappily
chosen: the ordinary acceptation of 'simultaneous' (namely, "at the
same time") makes rather harsh its use for a nontransitive relation;
and in the established mathematical sense of 'topological', the rela-
tion in question is not a topological one.[1] Phrases better suited to
denote this relation are, for example, 'chronologically disparate' or
'causally alien'. I shall use the latter term here; in the paper cited,
I made do with the somewhat clumsy phrase 'b has spacelike rela-
tion to a' (Lango is mistaken when he says—340, fn 1—that I there
had "no term for topological simultaneity").

Whatever one's preferences in diction, however, I think one ought
to distinguish such issues (which do matter) from questions of con-
ceptual clarity, which matter a great deal more. According to Lango
(*loc. cit.*), my terminology *blurs the distinction* between "topolog-
ical" and "metrical" simultaneity. On pondering the question, and
rereading my paper, I do not find this blurring; on the contrary,
the two conceptions (although not those terms) do occur in that
paper, and in what seems to me very distinct form. Can *not* using
the same word in the names for two different ideas be reasonably
said to "blur a distinction"?

II

The chief aim of Lango's article is to define an invariant notion of
"relativistic instantaneous cross section" (I shall say 'r.i.c.s.') and
through the use of this notion to clarify philosophical issues—in
particular, that of the "reality" of present and future. By an r.i.c.s.
Lango means a maximal set of causally alien space-time points. This
is unquestionably a relativistically invariant notion. But Lango is
betrayed into a serious error by an equivocal formulation of this
fact: namely, he says (347, line 6*) that "the relativistic instanta-
neous cross sections are invariant"; and this in explicit contrast to
the statement (*ibid.*, lines 19*–17*), "Now the spacelike slices or-
thogonal to a timelike direction . . . are not invariant, because they
are not definable independently of choice of a timelike direction."
But what is relativistically invariant is the property of being an

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[1] A topology can be defined on space-time for which this relation is topolog-
ically invariant (see E. C. Zeeman, "The Topology of Minkowski Space," *Topol-
ogy*, VI [1967]: 161–170); but that topology is not the standard one (e.g., for it all
accelerated motions are discontinuous).

r.i.c.s., or the set of all r.i.c.s.'s; that is to say, under any automorphism of space-time (i.e., map of space-time onto itself that preserves the Einstein-Minkowski structure), the image of each r.i.c.s. is an r.i.c.s. One often says, loosely, in such a case, that "the r.i.c.s.'s" are invariant; but in a literal sense this is false: automorphisms do not (in general) leave the individual r.i.c.s.'s invariant, but permute them among themselves. There are, to be sure, proper (and non-empty) invariant subsets of the collection of all r.i.c.s.'s. The most interesting invariant subset—and a minimal one—is the set of *flat* (or affine) r.i.c.s.'s; these are just the three-dimensional spacelike affine subspaces of space-time: i.e., the "spacelike slices orthogonal to a timelike direction"—taking, however, not a fixed timelike direction, but all possible ones. Thus nothing has been gained in point of invariance, so far as special relativity is concerned, by going to the more general notion defined by Lango.

III

From the "invariance of the r.i.c.s.'s," Lango infers the existence of "absolute" distinctions of past, present, and future, in the following way (347–348):

> [T]he relativistic instantaneous cross sections are invariant. . . . Therefore, given space-time points a and b that are topologically simultaneous, a relativistic instantaneous cross section containing both a and b is a "present" that a and b have in common; moreover, the class of space-time points such that a space-time point is in the class just in case it is in the past of at least one of the space-time points in the relativistic instantaneous cross section containing a and b is a "past" that a and b have in common, and [analogously for the future]. In short, despite the relativity of relativistic metrical simultaneity, there are distinctions between past, present, and future that are "absolute."

But whenever there is an r.i.c.s. containing both a and b, there are infinitely many such; to speak of "the relativistic instantaneous cross section containing a and b" is therefore indefensible, on any of the usual constructions of the definite article, unless the phrase is taken as elliptical for "the *given* r.i.c.s. containing a and b." It is thus evident that the distinctions intended to be "absolute"—or, more precisely, to be invariantly related to a and b—are, in fact, *"relative" to a given r.i.c.s.* If we require the given r.i.c.s. to be flat, it will be determined by the timelike direction orthogonal to it; in this case, we may equally well characterize the distinctions as "relative to a timelike direction (or time axis)"—i.e., we have not moved an inch from the conceptions ordinarily employed in special rela

tivity.[2] And we see that Lango's concept, which does not impose the restriction of flatness, is more general but no less "relative"; indeed, the "special" notion is relative to the choice of one element of the three-dimensional manifold of all timelike directions, whereas the "general" one is relative to the choice of one element of the "infinite-dimensional manifold" of all r.i.c.s.'s.

A similar difficulty occurs when Lango proposes (350) to regard a point x as "indirectly real" for a point y provided "x and y are in the same instantaneous cross section": this must either be construed as a relation of x (not to y but) *to an r.i.c.s.* (containing y); or be read as meaning "x and y are in *some* common r.i.c.s." But the latter is equivalent to "x and y are causally alien," and thus makes no essential use of the notion of r.i.c.s.; if this is Lango's meaning, he attributes "indirect reality for y" to the whole exterior of y's light-cone, and "reality for y" ("direct" or "indirect") to every point exterior to the future lobe of y's light-cone.

IV

I have not found it possible, from a careful reading of Lango's paper, to form a confident interpretation of his notion of "indirect reality"—that is, to be sure whether he attributes such reality to an r.i.c.s. or to the whole exterior of a light-cone. The latter interpretation is the only one that would justify the phrase "indirectly real for y," where y is a space-time point; and the statement (349) that "things in the (topological) present . . . are only real 'indirectly' " might seem to confirm it as the correct reading—except that "topological present" itself may refer to an r.i.c.s., and reflect Lango's belief that the r.i.c.s.'s are invariant. The references to Whitehead, and Lango's identification (349) of "the present" with what Whitehead calls "a unison of becoming," suggest the other interpretation—that the present, which is indirectly real (for itself?), is an r.i.c.s. In any event, two remarks about Whitehead's conceptions seem worth making in connection with these matters:

First, Whitehead is very clear about the nonuniqueness of "durations" (or "unisons of becoming"), which, as Lango rightly says, are (in the context of Whitehead's metaphysical system) the same as Lango's instantaneous sections. Whitehead claims to obtain the concept of "*the* present" (or "the presented duration") of a given "actual entity" only through the operation of that "difficult metaphysical system" from which Lango says (348) that he himself has abstracted. According to Whitehead, there may be ("in the present

2 Cf. Stein, *op. cit.*, 10–12.

cosmic epoch"),[3] for an actual entity, a unique duration that in-
cludes the entity's "immediate present" or "strain locus"; this hap-
pens only where there is such a "strain locus": namely, for "an
occasion in the history of an enduring object" (485); the duration
so selected is always a flat one (492); and that duration is uniquely
associated with the *state of motion* of the object to which the occa-
sion belongs (191, 486, 488, 489f., 492). In short, Whitehead's dis-
tinctions of past, present, and future (for an actual entity), are ex-
tensionally equivalent to the distinctions *relative to a time axis* in
special relativity: the "presented duration" is (approximately) the
subspace orthogonal to the time axis determined by the object's
motion; and the "past" and "future" are the two connected com-
ponents of the remainder of space-time.

Second, this metaphysical doctrine of Whitehead's, although
imaginative and in some ways very appealing, has (in my opinion)
to be judged a failure. For crucial to it is Whitehead's extremely
obscure theory of "strain loci"—and his even more obscure view that
such a strain locus (perceived in the mode of "presentational im-
mediacy") can be associated with a duration (which is a set of actual
entities, and is utterly different from a strain locus). The relation-
ship of the strain locus to the duration is just that old bugbear of
epistemology, the relation of "perceptual" to "physical" space; this
relationship Whitehead postulates, but then leaves hanging.[4] There-
fore Whitehead's analysis fails to provide a sufficient account of the
structure of space and time. But on the other hand an account of
this sort—that is, of how the state of an observer singles out one
"duration" or r.i.c.s. as "his present"—is unnecessary. This was the
purport of the remark, in my paper already cited (16, fn 15), that an

[3] *Process and Reality* (New York: Macmillan, 1929), p. 191.
[4] *Ibid.*, 492: "This recapitulation of the theories of durations and strain-loci
brings out the entire disconnection of their definitions. There is no reason,
derivable from these definitions, why there should be any close association be-
tween the strain-locus of an experient occasion and any duration including that
occasion among its members. It is an empirical fact that mankind invariably con-
ceives the presented world as consisting of such a duration. . . . But close asso-
ciation does not necessarily involve unqualified identification. It is permissible,
in framing a cosmology to accord with scientific theory, to assume that the asso-
ciated pair, strain-locus and presented duration, do not involve one and the same
extensive region."—The justification for departing from the common opinion of
mankind is not, however, what is most crucially needed: the main issue is, rather,
to identify some basis for an "association" of two things "entirely disconnected"
in concept. On this point, Whitehead rests upon the common opinion of man-
kind *that* the association exists; but offers no account of *how* such an association
is determined. And even the appeal to experience shows, not that there is such
an association, but only that there is "conceived" to be one.

observer's state of motion does not impose upon him, according to relativity theory, a special view of the world's structure. The view that it does—that the observer has some distinguished subjective or perceptual relation to "his present"—leads only to confusion.

V

Finally, I want to correct an erroneous impression of my views on the "reality" of past, present, and future. Lango says (349) that, according to me, only the past is real. In fact, I do not regard the issue as at all clearly posed, and I therefore have no such opinion (as I believe pp. 21–22 of my previously cited paper will show). I certainly have no objection to Lango's attribution of "indirect reality" to causally alien events [5] (provided the principle for selecting those events is specified clearly); nor do I object to predicating "reality" of the future. What one says "is real" surely depends (among other things) upon what one means by 'real'. My concern, in the previous paper and in this note, has been to clarify what distinctions can and what distinctions cannot be made in a meaningful way, within the structure that the special theory of relativity attributes to space-time.

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CHANGE AND TIME*

SYDNEY SHOEMAKER argues in his "Time without Change"† that it makes sense to speak of a situation in which the whole world remains frozen for an extended period, during which absolutely nothing happens except that time passes by. First, he asks us to consider a world that is divided into three regions of space A, B, and C. Each of these regions is subject to periods of total freeze, and, of course, there is nothing problematic about this since, when A is having one of its periods of freeze while B is not, the inhabitants of B can observe how everything in A comes to a complete standstill and remains so without any movement or change for a given period.

Now past observations have taught the inhabitants of this world that all periods of local freezes are preceded by periods of local sluggishness during which it takes more than the normal amount of effort to move about and that the duration of this period of sluggish-