

mate concern – not in any particular being (e.g. God) but in Being-Itself (“the God above God,” the ground of being). This is essentially the *Protestant principle*, which prohibits lodging ultimate concern in any finite and limited reality (including state, race, and religious institutions and symbols).

Tillich was especially influential after World War II. He represented for many a welcome critical openness to the spiritual depths of modern culture, opposing both demonic idolatry of this world (as in National Socialism) and sectarian denial of cultural resources for faith (as in Barthian neo-orthodoxy).

See also AUGUSTINE, EXISTENTIALISM, FREUD, NIETZSCHE. W.L.S.

time, “a moving image of eternity” (Plato); “the number of movements in respect of the before and after” (Aristotle); “the Life of the Soul in movement as it passes from one stage of act or experience to another” (Plotinus); “a present of things past, memory, a present of things present, sight, and a present of things future, expectation” (Augustine). These definitions, like all attempts to encapsulate the essence of time in some neat formula, are unhelpfully circular because they employ temporal notions. Although time might be too basic to admit of definition, there still are many questions about time that philosophers have made some progress in answering by analysis both of how we ordinarily experience and talk about time, and of the deliverances of science, thereby clarifying and deepening our understanding of what time is. What follows gives a sample of some of the more important of these issues.

Temporal becoming and the A- and B-theories of time. According to the B-theory, time consists in nothing but a fixed “B-series” of events running from earlier to later. The A-theory requires that these events also form an “A-series” going from the future through the present into the past and, moreover, shift in respect to these determinations. The latter sort of change, commonly referred to as “temporal becoming,” gives rise to well-known perplexities concerning both what does the shifting and the sort of shift involved. Often it is said that it is the present or now that shifts to ever-later times. This quickly leads to absurdity. ‘The present’ and ‘now’, like ‘this time’, are used to refer to a moment of time. Thus, to say that the present shifts to later times entails that this very moment of time – the pre-

sent – will become some other moment of time and thus cease to be identical with itself! Sometimes the entity that shifts is the property of nowness or presentness. The problem is that every event has this property at some time, namely when it occurs. Thus, what must qualify some event as being now *simpliciter* is its having the property of nowness now; and this is the start of an infinite regress that is vicious because at each stage we are left with an unexpurgated use of ‘now’, the very term that was supposed to be analyzed in terms of the property of nowness. If events are to change from being future to present and from present to past, as is required by temporal becoming, they must do so in relation to some mysterious transcendent entity, since temporal relations between events and/or times cannot change. The nature of the shift is equally perplexing, for it must occur at a particular rate; but a rate of change involves a comparison between one kind of change and a change of time. Herein, it is change of time that is compared to change of time, resulting in the seeming tautology that time passes or shifts at the rate of one second per second, surely an absurdity since this is not a rate of change at all. Broad attempted to skirt these perplexities by saying that becoming is *sui generis* and thereby defies analysis, which puts him on the side of the mystically inclined Bergson who thought that it could be known only through an act of ineffable intuition.

To escape the clutches of both perplexity and mysticism, as well as to satisfy the demand of science to view the world non-perspectively, the B-theory attempted to reduce the A-series to the B-series via a linguistic reduction in which a temporal indexical proposition reporting an event as past, present, or future is shown to be identical with a non-indexical proposition reporting a relation of precedence or simultaneity between it and another event or time. It is generally conceded that such a reduction fails, since, in general, no indexical proposition is identical with any non-indexical one, this being due to the fact that one can have a propositional attitude toward one of them that is not had to the other; e.g., I can believe that it is now raining without believing that it rains (tenselessly) at t_7 . The friends of becoming have drawn the wrong moral from this failure – that there is a mysterious Mr. X out there doing “The Shift.” They have overlooked the fact that two sentences can express different propositions and yet report one and the same event or state of affairs; e.g., “This

is water' and 'this is a collection of H₂O molecules', though differing in sense, report the same state of affairs – this being water is nothing but this being a collection of H₂O molecules.

It could be claimed that the same holds for the appropriate use of indexical and non-indexical sentences; the tokening at t_7 of 'Georgie flies at this time (at present)' is coreporting with the non-synonymous 'Georgie flies (tenselessly) at t_7 ', since Georgie's flying at this time is the same event as Georgie's flying at t_7 , given that this time is t_7 . This effects the same ontological reduction of the becoming of events to their bearing temporal relations to each other as does the linguistic reduction. The "coreporting reduction" also shows the absurdity of the "psychological reduction" according to which an event's being present, etc., requires a relation to a perceiver, whereas an event's having a temporal relation to another event or time does not require a relation to a perceiver. Given that Georgie's flying at this time is identical with Georgie's flying at t_7 , it follows that one and the same event both does and does not have the property of requiring relation to a perceiver, thereby violating Leibniz's law that identicals are indiscernible.

Continuous versus discrete time. Assume that the instants of time are linearly ordered by the relation R of 'earlier than'. To say that this order is continuous is, first, to imply the property of density or infinite divisibility: for any instants i_1 and i_2 such that Ri_1i_2 , there is a third instant i_3 , such that Ri_1i_3 and Ri_3i_2 . But continuity implies something more since density allows for "gaps" between the instants, as with the rational numbers. (Think of R as the 'less than' relation and the i_n as rationals.) To rule out gaps and thereby assure genuine continuity it is necessary to require in addition to density that every convergent sequence of instants has a limit. To make this precise one needs a distance measure $d(,)$ on pairs of instants, where $d(i_m, i_n)$ is interpreted as the lapse of time between i_m and i_n . The requirement of continuity proper is then that for any sequence i_1, i_2, i_3, \dots , of instants, if $d(i_m, i_n) \rightarrow 0$ as $m, n \rightarrow \infty$, there is a limit instant i_e such that $d(i_n, i_e) \rightarrow 0$ as $n \rightarrow \infty$. The analogous property obviously fails for the rationals. But taking the completion of the rationals by adding in the limit points of convergent sequences yields the real number line, a genuine continuum.

Numerous objections have been raised to the idea of time as a continuum and to the very notion of the continuum itself. Thus, it was

objected that time cannot be composed of durationless instants since a stack of such instants cannot produce a non-zero duration. Modern measure theory resolves this objection. Leibniz held that a continuum cannot be composed of points since the points in any (finite closed) interval can be put in one-to-one correspondence with a smaller subinterval, contradicting the axiom that the whole is greater than any proper part. What Leibniz took to be a contradictory feature is now taken to be a defining feature of infinite collections or totalities.

Modern-day Zenoians, while granting the viability of the mathematical doctrine of the continuum and even the usefulness of its employment in physical theory, will deny the possibility of its applying to real-life changes. Whitehead gave an analogue of Zeno's paradox of the dichotomy to show that a thing cannot endure in a continuous manner. For if (i_1, i_2) is the interval over which the thing is supposed to endure, then the thing would first have to endure until the instant i_3 , halfway between i_1 and i_2 ; but before it can endure until i_3 , it must first endure until the instant i_4 halfway between i_1 and i_3 , etc. The seductiveness of this paradox rests upon an implicit anthropomorphic demand that the operations of nature must be understood in terms of concepts of human agency. Herein it is the demand that the physicist's description of a continuous change, such as a runner traversing a unit spatial distance by performing an infinity of runs of ever-decreasing distance, could be used as an action-guiding recipe for performing this feat, which, of course, is impossible since it does not specify any initial or final doing, as recipes that guide human actions must. But to make this anthropomorphic demand explicit renders this deployment of the dichotomy, as well as the arguments against the possibility of performing a "supertask," dubious. Anti-realists might deny that we are committed to real-life change being continuous by our acceptance of a physical theory that employs principles of mathematical continuity, but this is quite different from the Zenoian claim that it is impossible for such change to be continuous.

To maintain that time is discrete would require not only abandoning the continuum but also the density property as well. Giving up either conflicts with the intuition that time is one-dimensional. (For an explanation of how the topological analysis of dimensionality entails that the dimension of a discrete space is 0, see W. Hurewicz, *Dimension Theory*, 1941.) The philo-

sophical and physics literatures contain speculations about a discrete time built of “chronons” or temporal atoms, but thus far such hypothetical entities have not been incorporated into a satisfactory theory.

Absolute versus relative and relational time. In a scholium to the *Principia*, Newton declared that “Absolute, true and mathematical time, of itself and from its own nature, flows equably without relation to anything external.” There are at least five interrelated senses in which time was absolute for Newton. First, he thought that there was a frame-independent relation of simultaneity for events. Second, he thought that there was a frame-independent measure of duration for non-simultaneous events. He used ‘flows equably’ not to refer to the above sort of mysterious “temporal becoming,” but instead to connote the second sense of absoluteness and partly to indicate two further kinds of absoluteness. To appreciate the latter, note that ‘flows equably’ is modified by ‘without relation to anything external’. Here Newton was asserting (third sense of ‘absolute’) that the lapse of time between two events would be what it is even if the distribution and motions of material bodies were different. He was also presupposing a related form of absoluteness (fourth sense) according to which the metric of time is intrinsic to the temporal interval.

Leibniz’s philosophy of time placed him in agreement with Newton as regards the first two senses of ‘absolute’, which assert the non-relative or frame-independent nature of time. However, Leibniz was very much opposed to Newton on the fourth sense of ‘absolute’. According to Leibniz’s relational conception of time, any talk about the length of a temporal interval must be unpacked in terms of talk about the relation of the interval to an extrinsic metric standard. Furthermore, Leibniz used his principles of sufficient reason and identity of indiscernibles to argue against a fifth sense of ‘absolute’, implicit in Newton’s philosophy of time, according to which time is a substratum in which physical events are situated. On the contrary, the relational view holds that time is nothing over and above the structure of relations of events.

Einstein’s special and general theories of relativity have direct bearing on parts of these controversies. The special theory necessitates the abandonment of frame-independent notions of simultaneity and duration. For any pair of space-like related events in Minkowski space-time there is an inertial frame in which the events are

simultaneous, another frame in which the first event is temporally prior, and still a third in which the second event is temporally prior. And the temporal interval between two timelike related events depends on the worldline connecting them. In fact, for any $\varepsilon > 0$, no matter how small, there is a worldline connecting the events whose proper length is less than ε . (This is the essence of the so-called twin paradox.) The general theory of relativity abandons the third sense of absoluteness since it entails that the metrical structure of space-time covaries with the distribution of mass-energy in a manner specified by Einstein’s field equations. But the heart of the absolute–relational controversy – as focused by the fourth and fifth senses of ‘absolute’ – is not settled by relativistic considerations. Indeed, opponents from both sides of the debate claim to find support for their positions in the special and general theories.

See also EINSTEIN, METAPHYSICS, RELATIVITY, SPACE, SPACE-TIME. J.Ea. & R.M.Ga.

time lag argument. See PERCEPTION.

time slice, a temporal part or stage of any concrete particular that exists for some interval of time; a three-dimensional cross section of a four-dimensional object. To think of an object as consisting of time slices or temporal stages is to think of it as related to time in much the way that it is related to space: as *extending* through time as well as space, rather than as *enduring* through it. Just as an object made up of spatial parts is thought of as a whole made up of parts that exist at different locations, so an object made up of time slices is thought of as a whole made up of parts or stages that exist at successive times; hence, just as a spatial whole is only partly present in any space that does not include all its spatial parts, so a whole made up of time slices is only partly present in any stretch of time that does not include all its temporal parts.

A *continuant*, by contrast, is most commonly understood to be a particular that *endures* through time, i.e., that is wholly present at each moment at which it exists. To conceive of an object as a continuant is to conceive of it as related to time in a very different way from that in which it is related to space. A continuant does not *extend* through time as well as space; it does not exist at different times by virtue of the existence of successive parts of it at those times; it is the continuant itself that is wholly present at each such time. To conceive an object as a continuant, therefore, is to conceive it as not made