HENRI BERGSON, ALBERT EINSTEIN, AND HENRI PIÉRON

Remarks Concerning Relativity Theory

Remarks by the Editor. In 1905 Albert Einstein published his first paper on the special theory of relativity. This was followed, in 1908, by Hermann Minkowski's formulation of a "four dimensional space-time geometry" and, in 1914, by Einstein's general theory of relativity, which in 1919 received dramatic verification. Though originally associated with the names of Hendrik Lorentz, Henri Poincaré, and others who had helped to build its mathematical and physical foundations, relativity theory had come (by the time of the exchange between Bergson and Einstein [1922] translated here) to be identified almost exclusively with the work of Einstein.

Duration and Simultaneity (1922) is Bergson's attempt to confront the basic tenets of his philosophy with the philosophically significant conclusions of the theory of relativity. The result of this confrontation is a thoroughgoing criticism of the special theory of relativity, and, in particular, of the relativistic notion of multiple time-series. There is, Bergson holds, only one time-series in the universe—the qualitative temporal series which "living and conscious" beings share in common. The plurality of times presupposed by the special theory of relativity must be construed as illusion or, rather, as the "effects of perspective."

Bergson's seemingly destructive attack on relativity theory understandably has drawn bitter criticism. But it should not be concluded that because Bergson criticizes relativity he is attempting to force science back into the narrow framework of Newtonian physics. Einstein, he insists, has created a "new way of thinking" as well as a new physics; the new way of thinking appears to Bergson uniquely fruitful, and the new physics is indisputably an advance in precision and scope over its predecessor. Further, Bergson insists, relativity theory rests on a more complete and accurate awareness of change. For Newtonian physics all states of motion or rest must be understood in relation to a universal and static "reference system": absolute space, at absolute rest. But relativity theory abolishes this fiction of an overarching static framework. The principle of relativity asserts that no physical system is really any more "at rest" or "in motion" than any other: where there is motion there is, simply, relative displacement; where there is change, an entire physical situation is transformed, without there being any unmoving space in relation to which this change must be understood.

Not only, then, does Bergson view relativity theory as a theoretical and empirical advance over earlier physics: he sees it as coinciding at many points with his own philosophical preconceptions. The difficulty is, however, that certain of the concepts of relativity theory appear to Bergson to be "conventional"; that is, they are useful to the scientist though they do not depict real characteristics of physical nature. Among these are the concepts of multiple time-series and the relativity of simultaneity. But the task of the philosopher, according to Bergson, is precisely to discern what is conventional in science and what is not. This is the basic task undertaken in *Duration and Simultaneity:* to discover what is conventional and what is not, in the relativistic conception of time.

Bergson's explanation of the appearance of conventional elements in relativity theory is the same as his explanation of the appearance of conventional elements in scientific thought generally: that is, it is caused by the science's inability to give a completely adequate description of change, motion, and variability. In the case of relativity theory this basic limitation is caused, Bergson holds, through the introduction of privileged reference systems which are for purposes of mathematical expression *assumed to be at rest.* This artificial but useful introduction of static elements into relativity theory can be explained by reference to an example. Let us assume, Bergson suggests, two physical systems S and S′ in motion relative to each other. The principle of relativity informs

us that neither of these systems is any more in motion or at rest than the other: we observe only their mutual displacement. But in order to assure the invariance of the equations of the special theory of relativity (the Lorentz transformation), the physicist must make a radical distinction between these two systems. One system is to be transformed into a *reference system;* it is then said to be at rest and to suffer no relativistic effects. The other system is said to be in motion; its time is thereby retarded, in accordance with Lorentz' equations. But the choice of one system as being *at rest,* though unavoidable, is not based on any characteristic of physical nature; and the static viewpoint thereby introduced must be understood as thoroughly artificial: a fiction, but a necessary fiction.

But, having introduced a "conventional" immobility into his calculations, the relativity physicist is then free to introduce it arbitrarily, at will. Again, let us assume systems S and S′ moving with respect to each other. If system S is the earth, and system S′ a rocket departing from the earth with a high uniform velocity, and if the earth is agreed to be "at rest" (that is, if it is decreed to be a reference system), then the rocket will undergo the well-known relativistic effects: its length will contract, its time will retard, its mass will increase. But it is equally possible to declare system S (the earth) in motion and system S′ (the rocket) at rest. When this is done, the relativistic effects will be undergone by the earth, while the length, mass, and duration of the rocket will now be unchanged. Effects, however, which may be introduced and erased by sheer fiat, can not be interpreted as real effects; they are, rather, mere "effects of perspective."

Bergson's essential argument against accepting relativistic space-time effects at face value, however, rests on his belief that, when taken as descriptions of physical reality, they generate contradictory descriptions. Let us again assume our two systems, the earth and the rocket, in motion relative to each other. Let us assume, further, that a real, "living and conscious" physicist is placed in each system. What, Bergson asks, will then transpire? The physicist in the rocket will assert that his system is a reference system, and therefore "at rest": the earth's time will thus seem to him to be retarded. The physicist on the earth will also declare his own system to be a reference system and therefore "at rest": time will seem to him to be retarded aboard the rocket. But can we really believe that the system comprised by the rocket *at the same time* exhibits both the nonretarded time discovered by its occupant and the retarded time imputed to it by the physicist on the earth? Or, from the other point of view, is it possible to believe that the earth possesses not only the nonretarded time discovered by its occupant but, at the same time, the retarded time which it appears to have from the viewpoint of the physicist on the rocket?

Critics will be quick to object that the phrase "at the same time" begs the question at issue. They will further object that unless some acceptable meaning can be given to this phase, the supposed contradiction which Bergson believes he has discovered is not really a contradiction. Bergson's reply is that an unambiguous characterization of the phrase "at the same time" can be derived from the scientist's experience of duration. The physicist on the earth, in our example, *imputes* a retarded time to the rocket; but he *actually measures and experiences* a constant duration in his own reference system. The physicist on the rocket *imputes* a retarded time to the earth; but in his own reference system he *actually measures and experiences* a constant duration. But, all human consciousness being essentially alike and enduring at the same rate, we can legitimately state that all scientists in all frames of reference experience and measure the same time. Borrowing a metaphor from mathematics, we discover that experienced time is a constant in relation to which other aspects of reality are "variable." If Bergson's reasoning on this point is valid, then the contradiction which he believes can be derived from the relativistic retardation of time is quite real and quite serious: it is indeed impossible for the same system to have two different "times" at the "same time." But experience shows us, Bergson insists, that any given system really has only one time: the actually measured and experienced time discovered by the scientist inhabiting it.

In his discussion with Einstein, Bergson is at pains to develop

his criticism of relativity theory in terms of the concept of simultaneity. His argument requires three steps. First, Bergson points out that the concept of a universal time is derived by common sense from the extension of the "proper time" experienced in our immediate environment to increasingly distant surroundings. Second, he argues that our most basic concept of simultaneity is derived from our *experience* of two or more events occurring "at an instant": an experience which requires that our consciousness be both one and multiple. The concept of absolute simultaneity is derived, like the concept of a single, universal time, by extending this immediate experience to more and more distant events. Finally, Bergson shows that the "simultaneity" involved in relativity theory is based not on an immediate experience but on the regulation of clocks by means of optical signals. In systems moving uniformly with respect to each other, this type of "simultaneity" is discovered to be not absolute, but relative: two events which appear simultaneous within a moving system will appear successive to an observer viewing them from a system "at rest." This second kind of "simultaneity" is necessary in physics, and relativity theory has gained much by utilizing it. But, Bergson holds, it is dependent on our immediate experience of "absolute" simultaneity, without which we should never have been able to make or utilize clocks in the first place.

In replying to Bergson, Einstein distinguishes between the time studied by the psychologist and the time studied by the physicist. The concept of a universal time is indeed, Einstein agrees, derived from the psychological experience of simultaneity and is a first step toward objectivity. But our capacity to deal with the high propagational velocity of light reveals to us that the concept of simultaneity derived from ordinary perceptual experience leads to contradictions. In relativity theory we discard psychological time in order to attain to the objective time of objective events and thus overcome our originally subjective impressions. There is no "philosopher's time" which is both physical and psychological; there is only a psychological time which is different from the time of physics.

To Henri Héron's objection that the "psychological" experience of simultaneity can be in error, Bergson replies that imprecision provides no grounds for rejecting psychological considerations. The laboratory experiments through which Piéron establishes the imprecision of our perception of simultaneity are themselves dependent on "psychological observations of simultaneities." *The following interview of April 6, 1922, originally published in the* BULLETIN DE LA SOCIÉTÉ FRANÇAISE DE PHILOSOPHIE *(July, 1922), appears here in translation with the permission of the Société Française de philosophie.*

HENRI BERGSON—I came here to listen. I had no intention of taking up discussion. But I acquiesce to the friendly insistence of the *Société de Philosophie.*

And I begin by stating at which point I admire M. Einstein's work, which seems to me to impose itself on the attention of philosophers as well as scientists. I see in this work not only a new physics, but also, in certain respects, a new way of thinking.

A complete study of this work would naturally treat of the general as well as the special theory of relativity, the question of space as well as that of time. Since it is necessary to choose, I will take the problem which interests me particularly, that of time. And since it is not possible to speak of time without taking account of the hour, and since the hour is late, I will limit myself to summary remarks on one or two points. It will be necessary for me to leave the essential to one side.

Common sense believes in a single time, the same for all beings and all things. What does such a belief stem from? Each of us feels himself endure: this duration is the flowing, continuous and indivisible, of our inner life. But our inner life includes perceptions, and these perceptions seem to us to involve at the same time ourselves and things. We thus extend our duration to our immediate material surroundings. Since, moreover, these surroundings are themselves surrounded, there is no reason, we think, why our duration is not just as well the duration of all things. This is

the reasoning that each of us sketches vaguely, I would almost say, unconsciously. When we reach a higher degree of clarity and precision, we represent to ourselves, beyond what can be called the horizon of our external perception, a consciousness whose perceptual field impinges on our own, then, beyond that another consciousness situated analogously with resepect to it, and so on again, indefinitely. All these consciousnesses, being human, seem to live the same duration. All their outer experiences unfold thus in the same time. And since all these experiences, impinging on each other, have, by pairings, a common part, we end by representing a single experience, occupying a single time. From then on we can, if we wish, eliminate the human consciousnesses we have disposed at long intervals like so many resting places for the movement of our thought: there is now only the impersonal time in which all things elapse. Here we have the same reasoning in a more precise form. Whether we remain vague or whether we seek precision, in both cases the idea of a universal time, common to minds and to things, is a simple hypothesis.

But it is a hypothesis that I believe to be well founded and which, in my opinion, contains nothing incompatible with the theory of relativity. I cannot undertake to demonstrate this point. It would be necessary to study much more minutely than I have just done, real duration and measurable time. It would next be necessary to take the terms which enter into Lorentz' equations one by one and search for their concrete significance. Then one would find that the multiple times of relativity theory were all far from being able to pretend to the same degree of reality. As one advanced in this study, it would be seen how the relativistic concept corresponding to the scientific viewpoint and the concept of common sense which roughly translates the data of intuition or of consciousness complete each other and even lend each other mutual support. It is true that it would be necessary, in making this study, to dissipate a very grave confusion, to which certain currently accepted interpretations of relativity theory owe their paradoxical form. All this would carry us too far.

But what I cannot establish as regards time in general, I beg your permission to achieve at the very least a glimpse into, in the particular case of simultaneity. Here it will be seen without difficulty that the relativistic point of view does not exclude the intuitive point of view, and even necessarily implies it.

What is meant ordinarily by the simultaneity of two events? I will consider, for simplicity's sake, the case of two events which will not endure, will themselves not be in flux. Thus posed, it is evident that simultaneity implies two things: 1) an instantaneous perception, 2) the possibility, for our attention, of sharing itself without dividing itself. I open my eyes for a moment: I perceive two instantaneous flashes departing from two points. I term them simultaneous because they are *one* and *two* at once: *one*, insofar as my act of attention is indivisible, *two*, insofar as my attention nevertheless divides itself between them and doubles without splitting itself. How can the act of attention be one or many at will, all at once and all at one time? How can a trained ear perceive at each instant the global sound produced by an orchestra and nevertheless unravel, if it wishes, the notes produced by two or more instruments? I do not take it upon myself to explain it; it is one of the mysteries of the psychological life. I simply observe it and make the remark that in declaring simultaneous the notes produced by a number of instruments, we express 1) that we have an instantaneous perception of the ensemble and 2) that this ensemble, indivisible if we wish, is divisible if we wish, also: there is a single perception, and nevertheless there are many. This is simultaneity, in the current meaning of the word. It is given intuitively. And it is absolute in that it depends on no mathematical convention, on no physical operation like the regulation of clocks. It can never be established, I realize, save between neighboring events. But common sense does hesitate to extend it also to events as distant from each other as possible. It is said instinctively that distance is not an absolute, that it is "large" or "small" according to the point of view, according to the term of comparison, according to the instrument or organ of perception. A superman with a giant's vision will perceive the simultaneity of two "extremely distant" instantaneous events as we perceive that of two "neighboring" events.

When we speak of absolute simultaneities, when we represent to ourselves instantaneous sections of the universe which pluck out, so to speak, definitive simultaneities between events as distant as could be wished from each other, it is of this superhuman consciousness, coextensive with the totality of things, that we think.

Now, it is undeniable that the simultaneity defined by relativity theory is of an entirely different order. Two events more or less distant, belonging to the same system S, are here called simultaneous when they take place at the same time, when they correspond to an identical indication, given by two clocks which are found next to each of them. These clocks have been regulated mutually by means of an exchange of optical, or more generally electromagnetic, signals on the hypothesis that the signal pursues the same trajectory both going and returning. And this is true, without doubt, if one takes up the viewpoint of the observer inside the system, who takes the system to be immobile. But the observer within another system S′, in motion with respect to S, takes his own system as a reference system, takes it to be immobile, and sees the first in motion. For him, the signals coming and going between two clocks in system S do not traverse, in general, the same trajectory coming and going; and consequently, for him, the events taking place in this system when two clocks mark the same time are not simultaneous; they are successive. If one grasps simultaneity in this oblique way [*de ce biais*]—and this is what relativity theory does—it is clear that simultaneity contains nothing absolute and that the same events are simultaneous or successive according to the point of view from which they are considered.

But, in posing this second definition of simultaneity, is not one obliged to accept the first? Does not one admit the first implicitly alongside of the second? We term E and E′ the two events to be compared, H and H′ the clocks placed respectively next to each of them. Simultaneity, in the second sense of the word, exists when H and H′ mark the same time; and it is relative, because it depends on the operation through which the two clocks are mutually regulated. But, if such is really the simultaneity between the indications of clocks H and H′, is it the same for the simultaneity between the indication of clock H and event E, between the indication of clock H′ and event E′? Evidently not. The simultaneity between the event and the indication of the clock is given by a perception which unites them in an indivisible act; it consists essentially in the fact—independent of all regulation of clocks—that this act is *one* or *two* at will. If this simulaneity did not exist, the clocks would count for nothing. Clocks would not be made, or at least no one would buy them. For clocks are only bought in order to know what time it is; and "to know what time it is" consists in observing a correspondence, not between an indication of a clock and another indication of a clock but between an indication of a clock and the moment at which one finds oneself, the event taking place—something, finally, which is not the indication of a clock.

You tell me that the simultaneity intuitively witnessed between any event whatever and this particular event which is the indication of a clock is a simultaneity between neighboring events, closely neighboring events, and that the simultaneity which you deal with generally is that of events distant from each other. But, again, where does proximity begin, where does distance end? Scientific microbes, posted respectively at points E and H, will find the distance separating them enormous, that is, the distance between the clock and the event you declare is its "neighbor." They will construct microbe clocks, which will be synchronized by an exchange of optical signals. And when you come to tell them that your eye established purely and simply a simultaneity between event E and the indication of clock H which is its "neighbor," they will reply to you: "Ah no! we will not admit that. We are more Einsteinian than you, Monsieur Einstein. There will be no simultaneity between event E and the indication of your human clock H, unless our microbe clocks, placed at E and H, mark the same time; and this simultaneity will be succession for an observer outside of our system; it will contain nothing intuitive or absolute."

I raise, moreover, no objection to your definition of simultaneity any more than I raise any objection against relativity theory

in general. The observations which I have just presented (or rather sketched, for I would be carried much further if I wished to give them a rigorous form) have an entirely different object. What I want to establish is simply this: once relativity theory is accepted as a theory in physics, everything is not finished. It remains to establish the philosophical signification of the concepts it introduces. It remains to discover at what point the theory renounces intuition, up to what point the theory remains attached to it. It remains to make allowance for the real and the conventional element in the results at which the theory arrives, or rather in the intermediaries the theory establishes between the posing of the problem and its solution. In taking up this task in regard to time, it will be seen, I believe, that relativity theory contains nothing incompatible with the ideas of common sense.

ALBERT EINSTEIN—The question is therefore posed as follows: is the time of the philosopher the same as that of the physicist? The time of the philosopher is both physical and psychological at once; now, physical time can be derived from the time of consciousness. Originally individuals have the notion of the simultaneity of perception; they can hence understand each other and agree about certain things they perceive; this is a first step toward objective reality. But there are objective events independent of individuals, and, from the simultaneity of perceptions one passes to that of events themselves. In fact, that simultaneity led for a long time to no contradiction due to the high propagational velocity of light. The concept of simultaneity therefore passed from perceptions to objects. To deduce a temporal order in events from this is but a short step, and instinct accomplished it. But nothing in our minds permits us to conclude to the simultaneity of events, for the latter are only mental constructions, logical beings. Hence there is no philosopher's time; there is only a psychological time different from the time of the physicist.

HENRI PIÉRON—I would like, in regard to the confrontation between psychological duration and Einsteinian time attempted by M. Bergson, to point out that there are instances in which this confrontation is experimentally realized, when the psychophysiologist studies the impressions of duration, succession, simultaneity by scientific method.

Now, for a long while, astronomers have already recognized that it is impossible to begin from psychological simultaneity in order to determine with precision a physical simultaneity when it is a matter, by the method of the eye or ear, of fixing the position of a star in the reticule of a telescope at the moment of a pendulum's swing. Here is the kind of concrete experience suggested by Bergson in order to show the possible intervention of impressions of duration in the relative determinations of physical time.

We know that it is physiologically impossible to obtain an exact mental translation of a physical simultaneity between heterogeneous sensory impressions. In fact, the latency of transformation of the external excitant in the nervous influx and the propagation time of that influx change with the bodily regions and the sense organs implied without taking account of the complex and irregular cerebral variations. But there is more: we suppose that two symmetrical retinal points receive a luminous impression; it seems that, under these conditions, the perceived simultaneity will be a certain index, within the limits of a given approximation, of physical simultaneity. Now, it suffices for these luminous impressions to have a different intensity in order for this not to be so. I have been able to determine a difference of intensities such that the most feeble luminous excitation, physically preceding the strongest excitation by a few hundredths of a second, is perceived in reality precisely as the later. Thus determinations of psychological succession or simultaneity can in no case be utilized as a measurement of physical time, which requires a spatial translation, following a scientific rule which has justly been illuminated by M. Bergson. It is through the coincidence or the noncoincidence of flashes left by signal-apparatuses on a surface animated with a more or less rapid motion that we judge physical simultaneity in taking account of all the useful corrections. For these measurements of time, as for all the others, it is the visual

acuteness which intervenes. And thus the Bergsonian duration seems to me to be obliged to remain a stranger to physical time in general and particularly to Einsteinian time.

Bergson—I am entirely in agreement with M. Piéron: the psychological establishing of a simultaneity is necessarily imprecise. But, in order to establish this point through laboratory experiments, it is to psychological observations of simultaneities—imprecise again—that it is necessary to turn: without these no instrument readings will be possible.

ANDRÉ METZ AND HENRI BERGSON

Exchanges Concerning Bergson's New Edition of Duration and Simultaneity

Metz: *Einstein's Time and Philosophy*

Remarks by the Editor. In 1923 Bergson, responding to criticisms of his interpretation of relativity, published a second edition of *Duration and Simultaneity* containing three new appendices. In the following article, which appeared in the *Revue de philosophie* in 1924, André Metz develops a threefold criticism of Bergson's newly restated position. Metz's discussion begins with an analysis of the nature of time measurement, which he describes as founded on purely physical facts and not on psychological considerations. If similar physical phenomena repeat themselves under exactly similar conditions, their durations are equal; any repetitive phenomenon (whether mechanical, chemical, or electromagnetic), since it marks out equal durations, may be used as a clock. Though time units pertain originally to the time-measuring instrument, they may be applied as well to the "vital phenomena" (*not* the