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Time as Form: Lessons from the Bergson-Einstein Dispute

Abstract

The confusion surrounding the early philosophical reception of Relativity theory can be traced back to a misconception regarding the status of “time” in philosophical—and possibly scientific—discourse. For all its empirical grounding in actual perception and measurement, time is neither an empirical object, nor a category in the ordinary sense. As Aristotle first acknowledged, time is not some abstract or idealized motion; as such, it cannot be reduced to a generic representation of becoming. Kant underscored that time itself is immune to change, suggesting that it is best characterized as a *form* whose function for understanding is to coordinate a cluster of ideas and problems pertaining to persistence and change, as well as coexistence, in accordance with the most general principles of experience. The vindication of the unity and universality of time by philosophers as far apart as Russell and Bergson stems from the conviction that such basic temporal ideas cannot easily be taken apart. The fact that time comprises a subjective or psychological element is, in that respect, a peripheral issue. Thus, Bergson’s “quarrel” with Einstein revolves around the possibility of apprehending simultaneity at a distance as a sheaf or envelope of durations unfolding in *real time*. Neither *proper time* (invariant, local) nor *coordinate time* (frame-dependent, global) can properly reflect the intuition of that thick present. While Bergson strives to incorporate it back into the relativistic framework based on the experience of lived simultaneity, Whitehead formalizes it in terms of *contemporaneous* extended events. Yet both seek a *regional* understanding of the matter, in line with some contemporary philosophers of spacetime. The (in)famous twin paradox is examined in this light, along with certain critical concepts in Bergson’s philosophy of time. The challenge is to unpack the meaning of coexistence beyond the immediate phenomenological features of proximal co-presence.

1 A Cautionary Tale

[T]he principle of relativity has given prominence to the conception of ‘local time’, and has somewhat diminished men’s confidence in the one even-flowing stream of time. Without dogmatising as to the ultimate outcome of the principle of relativity, however, we may safe-

ly say, I think, that it does not destroy the possibility of correlating different local times and does not therefore have such far-reaching philosophical consequences as is sometimes supposed. In fact, in spite of difficulties as to measurement, the one all-embracing time still, I think, underlies all that physics has to say about motion (Russell 1914, 103–104)

The author of these lines is not Henri Bergson, but none other than Bertrand Russell, one of his most vocal and sarcastic philosophical opponents. In his 1914 Lowell lectures, published as *Our Knowledge of the External World*, the Cambridge philosopher deemed it “safe” to assume that philosophy—if not physics itself—would not need to relinquish the idea of a unique, “all-embracing” time as long as local time measurements could be dealt with in a unified and consistent manner. This somewhat controversial claim can still be found unchanged in the 1922 reprint edition of his book. It is only a few years later, in the revised edition of 1926, that Russell chose to suppress the entire paragraph, no doubt prompted in doing so by the harsh polemic that followed the publication of Bergson’s essay on Relativity theory, *Durée et Simultanéité*.¹ In the meanwhile, *The ABC of Relativity* had put things straight, emphasizing, in what appears as a radical doctrinal U-turn, “the collapse of the notion of one all-embracing time” (Russell 1925, 225).² Russell’s ideas were now in line with the orthodox view that Relativity theory in fact destroys the possibility of singling out a uniquely defined cosmic “now”, and more generally of achieving a total temporal ordering of point-events in space-time.

One is left wondering why Russell did not realize this clearly before the early twenties, or why he chose to knowingly downplay one of the most far-reaching philosophical implications of Relativity theory and emphasize instead what may seem, under the most charitable interpretation, a rather trivial point: assuming we neglect gravity, the basic kinematic features of motion can always be referred to a unified system of time coordinates *within* any arbitrarily chosen inertial reference frame. According to this deflationary account of the situation, the point Russell was trying to make in 1914 and 1922 was basically repeating Kant’s argument in the *Metaphysical Foundations of Natural Science*, namely that the relativity of kinematic perspectives does not really challenge the rational ideal of an

1 Bergson’s book was released during the summer of 1922. It was republished the year after, augmented with several appendices (see Bergson 1999 and Bergson 2009 for the English translation).

2 See also Russell 1925, 56: the promotion of proper time suggests that we “abandon the old belief in one universal time”. The same argument is repeated in a piece for the *Encyclopaedia Britannica*, “Philosophical Consequences of Relativity” (Russell 1926), where Russell explains that time, being private to each body, does not constitute a single cosmic order.

all-embracing time serving as the backdrop of all determination of motion. In that sense, absolute time, just as absolute space, can be retained as a regulative Idea stripped of any cosmic substance. How this should impact actual physics is, naturally, another matter. It may be argued that Einstein's accomplishment resided in showing that, when it comes to elucidating the spatio-temporal underpinnings of the dynamics of moving bodies, the regulative Idea of absolute time is useless at best—as useless, that is, as the aether concept. As many of his colleagues, he believed that common sense and philosophical understanding alike had to reform themselves to embrace the new outlook—otherwise, they would be mere impediments to scientific progress.

If one is reluctant to dismiss Russell's original appraisal of Relativity theory as one more expression of some deep-seated philosophical prejudice in favor of absolutes, then a few hypotheses suggest themselves. Was Russell on to something more substantial, in the spirit of his early rebuttal of relational conceptions of time and space, leading to the epistemological vindication of absolute motion?³ Was he echoing, rather, Whitehead's view that time, considered as the form of actual process, extends in some sense "beyond the spatio-temporal continuum of nature" (Whitehead 1925, 181)? Or was he merely applying a basic principle of philosophical prudence regarding such fundamental concepts as time, space or causality?

Whatever the answer may be, the example of Russell's Lowell lectures should encourage us to adopt, in turn, a principle of hermeneutic relativity (or symmetry) when it comes to reassessing certain episodes in the early philosophical reception of Relativity theory. Bergson's engagement with Einstein is a case in point. More generally, Russell's cautionary tale should prompt us to think carefully about the reasons that can bring well-informed philosophers to advocate an ideal of temporal unity that is *prima facie* at odds with the mainstream interpretation of physical theory offered by people in the trade.

2 On the Formal Character of "Time"

My contention in what follows is that the difficulty can be traced back to the formal nature of the time concept, or to be more accurate, the fact that time is best characterized in terms of *form*. The implications of this claim need to be clarified before undertaking any serious research on topics related to the "philosophy of

³ See Russell (1901), echoing his discussion with Poincaré regarding the relativity of space. See also Russell 1903, 489–493.

time". The underlying intuition, negatively formulated, is that what we call "time" can neither be a thing-concept in the usual sense, nor a proxy for an abstract, relational structure holding between pre-existing things. *Time* does not stand for an object or an empirical state of affairs, even one endowed with a remarkably high degree of generality. In this regard, it is very much like *information*, *energy* or *matter*—which, as Lenin reminds us, is not a concept but a category. Along similar lines, Wittgenstein argues that names such as *thing*, *object*, *event*, *existence*, or indeed *concept* really stand for what the *Tractatus*, 4.126 ff, introduces as "formal concepts" (Wittgenstein 1974, 33–34). That there are objects and events is not a fact, it is a constitutive part of our form of representation. Time too cannot be treated as any other element of fact. And yet its formal character does not prevent it from having genuine content,⁴ conferring in effect rational coherence on a plurality of contrasting dimensions and aspects of becoming. Accordingly, if time indeed does something for us, it cannot be reduced to a mere intellectual device superimposed upon the varieties of temporal experience (for instance, an ordering scheme for events happening "in" time according to relations of succession and simultaneity); nor can it be assimilated to an empty framework for the manipulation of metric variables.

The most perceptive among philosophers have acknowledged this special status of time in some way, even when their instinct led them to discard the usual conception of form as overly abstract. Whether any of this should concern the physicist is of course debatable. Bergson and Russell had different views on this particular issue, but they did not stand very far apart regarding the special philosophical status for the concept of time. At any rate they both believed that once everything has been said about the physicist's handling of time measurements and the psychologist's elucidation of temporal experience, there is still room for a philosophical inquiry about the meaning of "time".

Now what are the indications that time indeed assumes the status of a form, for lack of a better word? The truth is that this theme runs throughout the entire history of philosophy. In the *Physics*, Aristotle emphasized the fact that time is not itself a variety of motion, that it is everywhere the same and cannot possibly flow at a faster or slower rate. In the section of his first *Critique* devoted to the *Analogies of Experience*, Kant famously insisted that time itself does not change and cannot be perceived as such. Wittgenstein, in a section of the *Tractatus* devoted to the formal nature of so-called "laws" in logic and physics (6.3611), claimed that there is "no such thing" as "the passage of time" (Wittgenstein

⁴ See Gilles-Gaston Granger's characterization of "formal content" in his 1982 postface to *Formal Thought and the Sciences of Man* (Granger 1983).

1974, 83), which of course isn't the same as saying that time does not pass—whatever *that* could mean. Heidegger, who confessed to being interested in time and temporal experience only in so far as they could contribute to an elucidation of the question of being, also insisted in *Sein und Zeit* that from an ontic point of view, the most conspicuous aspect of an ontological approach to time was its formality (*Formalität*), a formality verging on “emptiness” (Heidegger 1996, 230). Arthur Prior argued on metaphysical ground that the *present* cannot be relativized without compromising the very meaning of existence, thus drawing our attention to a point of conceptual grammar: existence and coexistence are related in a way that is independent from frame-relative ascriptions of simultaneity (Prior 1970). Russell, as we have just seen, did not recoil from maintaining an “all-embracing” time form even though the new physics held the one even-flowing stream of time as the “relic of a bygone age”, to paraphrase his famous statement about causal laws. Bergson in turn, while conferring special status on lived, concrete duration, identified its generic form as a multiplicity “resembling no other”: a *sui generis* qualitative multiplicity, at once continuous and heterogeneous, incorporating a double principle of conservation and differentiation.⁵ One wonders what is to be gained from characterizing such a concept as *psychological* time.

The list could go on. Each of these examples deserves to be carefully spelled out: such a task is beyond the scope of this contribution. For our purpose it is enough to observe that, taken together, all of the above claims exhibit a common thread. They converge in the sense that time is not an object, nor a sortal concept applying to whatever particular instance we take to exhibit *temporal* features. For lack of a better word, time is a form.

Given the prevalence of this formal theme, it was only natural for philosophers to approach Relativity theory with some circumspection. The shared feeling was that the significance of Einstein's new insights into the nature of time could not merely consist in proclaiming the relativity and plurality of times, as if some unfortunate accident had struck the temporal aether and disrupted its

⁵ This conservation principle should not be confused with the principle of permanence formulated in Kant's *First Analogy of Experience* under the category of substance. If duration is deemed *substantial* by Bergson, it is in virtue of the dynamic continuation of the past into the present, a process which clearly involves more than either endurance or perdurance, while remaining fundamentally neutral with respect to A-time and B-time interpretations of time's “passage”. As for the principle of differentiation, it is merely another aspect of continuation: the continuous weight exerted by the past upon the present implies that no moment of time can be repeated identically. Thus, Bergson suggests a temporal counterpart of the Leibnizian principle of indiscernibles that circumvents the concepts of substance and essence.

inherent unity, leaving us with a multiplicity of dispersed temporal shreds. Here we may take our cue from Gaston Bachelard: “when Einstein’s Relativity came along”, he writes, “it deformed primordial concepts that we thought were fixed forever. From then on, reason multiplied its objections, dissociating fundamental ideas and then making new connections between them, trying out the boldest of abstractions” (Bachelard 2002, 19). The implication, as far as time is concerned, is that the philosophical transformation brought about by the new physics did not primarily concern an enigmatic temporal substance that erring philosophers had previously defined in absolute, metaphysical terms. Dissociating fundamental ideas, trying new connections: the amount of conceptualization and problematization required to fit “time” into the relativistic framework suggests that something more is at stake than the overthrowing of a dubious theoretical entity of the aether kind. For the same reason, the fact that relativistic time can be given straightforward operational meaning under certain usage, lending itself to consistent measurement, is not enough to turn “time” itself into an empirical concept. The first step towards acknowledging the formal character of time consists in realizing that the dimensions of experience that “time” is intended to capture are not necessarily of the kind one may measure (like a flow rate), much less count and sort out (like apples in a basket). As will become apparent, this has little to do with the fact that time comprises a subjective or psychological element.

How is time not an empirical concept, given that we measure it? Here again, we can only offer cursory remarks. The following will suffice. Granted, we do measure durations in relation with particular processes. But the problem of time, properly speaking, only arises when it comes to coordinating such durations with a view to the totality of durations within the universe. At that level, “time” must be treated as a form effecting, in Russell’s words, the correlation of local times. As we shall argue, it is inseparable from an extended sense of co-existence. And yet physicists readily speak as if there were as many distinct “times” as there are reference systems in relative motion, or ways to causally connect time-like separated events, thereby suggesting that something more substantial is at stake than the sheer multiplicity of temporal measurements, as if the object previously known as “time” had been somehow pulverized. Such formulations are ambiguous at best. The only way to make sense of them is to include them in a comprehensive account of time form in which measurement is but one dimension among others.

The same logic of object-oriented discourse brings us to view relativistic time as a time *stripped out* of some of its classical features: unity, uniformity, distant simultaneity or a constitutive reference to the present moment. Thus, we customize the concept of time as if these were optional elements in the package, ele-

ments that one could assemble and re-assemble without compromising the integrity of temporal form. The bifurcation of temporal concepts into objective (physical) and subjective (psychological) sub-genres obeys a similar pattern: it reinforces the impression that time constitutes a particular field of study that one may choose to approach from different perspectives, laying emphasis on this or that particular set of aspects exhibited by temporal phenomena, pitting time consciousness against so-called “clock time”, and so on.

According to the boldest among physicists, time may turn out not to exist at all, as if time was again a thing, the existence or non-existence of which could be in question. No amount of relationist medicine will rid us from such category mistakes. Defining time as a relational structure does not make it any less *real*, unless one endorses strong metaphysical views regarding the nature of emergence and the ontology of relations. Admittedly, more often than not the alleged “disappearance of time” is merely a roundabout way of saying that, at the fundamental level, the world is best described in terms of an atemporal theory, or perhaps that the physical world as described by our best scientific theories does not exhibit a fixed temporal backdrop, a universal arena of change. This point has been made in different ways, and on different grounds, by such authors as Lee Smolin, Carlo Rovelli, Julian Barbour. One may for example underscore the fact that the Wheeler-De Witt equation, sometimes described as *the wave-function of the universe*—under the disputable assumption that the universe as a whole behaves as a Hamiltonian system—, does not include any reference to an external time.

There is much philosophical confusion behind the idea of *atemporal* dynamics, but the theme strikes a sympathetic chord with the formally minded philosopher of time because the fact that dynamics can be expressed without time is consistent with the sense that time itself does not change, and accordingly does not exhibit dynamic features. When pressed further, however, the natural philosopher that lays dormant in every physicist is tempted to utter something like this: “I have looked for ‘time’ everywhere, both at the microscopic and cosmological levels, and I have found nothing...”. This is baffling, for what on Earth did one expect to find? There is something vaguely reminiscent here of Yuri Gagarin’s famous pronouncement on returning from his orbital trip aboard Vostok 1: “I see no God up here!”. If the inexistence of time is a provocative way of saying that the universe is not bathing in a temporal aether of sorts, the claim is perfectly acceptable, albeit misleading. It only confirms the fact that time is not itself an object or process, not even a highly theory-laden one, such as the expansion of the universe described by current cosmology.

Once we relinquish the notion of time as a container of change, we may still want to ask what it means for things to be *in time* in the first place. Aristotle’s

Physics raised the question only to warn us about the limits of any analogy with the fact of occupying a place. Yet in the same book, time is sometimes likened to an *envelope* of motion, an image which, to be properly understood, would require rising to a higher degree of abstraction. Curiously enough, problems of this nature are almost never addressed in current debates over the substantial or relational nature of time and space-time, whose main focus is on knowing whether a particular object or structure, defined in geometrical terms, exists in its own right, whether it can be grounded in more primitive elements, and the like.

To be fair, the tendency to reify time and treat it as a thing-concept is largely counterbalanced by the operationalist proclivity to frame all temporal issues in terms of what we can actually bring the concept of time to *do* for us: for example, correlating measurements of durations. From this perspective, we may want to define time as the quintessence of all time-keeping devices. At this level of generality, time appears as an ingenious labelling procedure devised by the human mind in the course of its evolution. Scientists inherit from this device; they have only managed to give it a level of mathematical sophistication that enables them to sort the variable configurations that constitute the history of the universe and build everything from there. Yet, at the end of the day, such deflationary accounts of time leave everything untouched; they raise the same issues as the bolder metaphysical views about the “disappearance of time”. Oftentimes, the more empirically minded philosophers will offer sweeping ontological pronouncements to the effect that time, once again, doesn’t exist, not in virtue of some substantial theory about mathematical constructs, but simply because a universal time-keeping device evolved by higher organisms to make sense of their environment is fundamentally no different from any other human artifact. It is easy to see how an agreement can be found at this basic level with philosophers attached to the idea of time as a subjective form of experience: a pragmatic, historicized reformulation of the *a priori* will do the trick. But it is only a small step from this to the claim that time is nothing *out there*, or that its very passage is but an elaborate cognitive illusion. And more often than not, such considerations secretly trade on a hypostasized representation of time as some fundamental process underlying all processes. Is this process occurring in the mind only, or does it have genuine objective, physical grounding? If one is not in the mood for metaphysics, an easy way of fudging the problem is to refer to John Archibald Wheeler’s memorable dictum that time is the easiest way nature has found to keep everything from happening at once. We can do better than that.

3 A Functional Approach to Form

These scattered and sketchy remarks all point to the same direction: to assess the philosophical relevance of the physicist's pronouncements about time, it is well-advised to approach them in what Carnap described as the formal mode of speech, not only because temporal concepts do not necessarily have direct intuitive, empirical or material content, but more fundamentally because they generally operate at higher level of abstraction than any classifying concept or category. Their function, I surmise, is to provide a coherent framework for a cluster of related issues pertaining to being and event, identity and change, structure and process, purpose and causality, etc. It is to address such concerns that Kant came up with a doctrine of the "order of time" in his *Analogies of Experience*, bringing together the categories of substance, cause and community, to achieve a consistent and unified account of permanence, succession and simultaneity.

From this standpoint, it is clear that 'time' cannot be a mere placeholder for whatever physical theory deems relevant to the mathematical analysis of becoming. A philosophical account of time must somehow resonate with the entire cluster of problems mentioned above, including those stemming from the implicit reference of temporal predication to a present moment ("now", "then"), which may or may not be construed as the mark of an irreducibly *subjective* standpoint. By reminding us of this simple fact, the philosopher is not claiming privileged access to a special object that would lie outside the reach of scientific understanding. He is making a point about the kind of expectations that come with the concept of time. Such expectations and anticipations, as Bergson often emphasized, imply that we do not assume from the outset an unbridgeable gap between the experiential aspects of time disclosed in lived duration and the rules governing our use of the parameter t in physical theory. Otherwise, why continue to use the same word ("time") for both? From that standpoint, equating time with a mathematical object effecting the correlation of time measurements doesn't do it more justice than holding it as the immutable and irreducibly subjective form of inner sense. Our framing of time concepts needs to be checked against the complete theoretical background that motivates our reflection on the nature of time in the first place. That is why neither the mathematical nor the transcendental understanding of form can exhaust the meaning of time form. In fact, elucidating the formal character of time may well require a thorough examination of the entire spectrum of temporal experience. In the process, time may turn out to be a very peculiar kind of form indeed, a form of the non-Aristotelian and non-Kantian variety—a form *resembling no other*, to paraphrase Bergson, a form that is in some way adherent to its content.

The crucial question, in any case, is the following: what does it mean to work on a concept, rather than put it to service? Georges Canguilhem nicely puts it in a text about Bachelard:

To work on a concept is to vary its extension and comprehension, to generalize it through the incorporation of exceptional traits, to export it beyond its region of origin, to take it as a model or inversely, to search for a model for it—in short, to progressively confer upon it, through regulated transformations, the function of a form.⁶

For our purpose, assuming such a functional stance, making use of *form* as a regulative idea, appears more productive than attempting to flesh out its meaning and content from the outset in a definition. Admittedly, philosophers have generally shown more interest in “varying [time’s] extension and comprehension”, than in “generalizing it through incorporation of exceptional traits”. Physicists on the other hand, more particularly those involved in the development of Relativity theory, have achieved an unprecedented level of generalization of temporal concepts by showing that as a general rule—a rule which only becomes conspicuous in certain special conditions or limiting cases (when dealing with velocities close to the speed of light, for instance)—, temporal and spatial aspects must be handled together as part of one single mathematical form in which they appear tightly woven, rather than merely juxtaposed. The elucidation of the structure of relativistic space-time certainly constitutes an important landmark in that respect. On one level, it offers a paradigm of the formal approach to temporal issues. It is also quite helpful in dispelling certain misconceptions such as the alleged “slowing down” or “dilation” of time.⁷ Yet it remains to be seen in what sense time itself assumes *the function of a form* once it has been merged in this overarching structure.

Remarkably enough, the generalization achieved by the space-time approach may in fact amount to a *specification* of time form, and arguably to a reduction of its original scope, as indicated by the narrowing down of absolute simultaneity to sheer facts of coincidence and the subsequent promotion of local time, i.e., a quantity measured along spatio-temporal worldlines. Deprived from the independence it enjoyed in the classical setting, where four-dimensional

⁶ Canguilhem, “Dialectique et philosophie du non chez Bachelard” (1963), quoted in Hallward and Peden 2012, 13. This quote is featured as an epigraph of each of the volumes of the “Cahiers pour l’analyse” published between 1966 and 1969.

⁷ A more compelling image is that of space-time itself (its metrical features) acting as some sort of lattice or filtering device, forcing the flow of time to fork out and take spatio-temporal detours that turn out to be temporal *shortcuts* (i.e., routes of lesser elapsed duration).

space-time was merely the Cartesian product of temporal and spatial dimensions with no unified metrics, “time” has clearly not disappeared. It survives in different guises, deprived of some of its familiar privileges. But is it *real time*? Rather than brushing the question aside as an expression of philosophical conservatism, I suggest we rephrase it in formal mode so that the search for *real time* serves as a catalyst for the elucidation of time form, instead of mirroring some pre-existing standard—be it intuitive or conceptual—of what should count as the primordial meaning of “time”.

The same circumspection is in order when dealing with what Bergson holds as the main property attached to *real time* in physics: its unity or universality. Evidently, acknowledging a plurality of time forms would defeat the very purpose of adopting a formal stance in the first place. If we are serious about form, there can only be one time form. The challenge is to explain how such a form can accommodate a plurality of time measurements.

4 *Real Time is Measured Time!*

In that respect, Bergson comes across as somewhat more prudent than many of his colleagues, including the early Russell. For one thing, while advocating a single universal time, he left the question open as to the appropriate theoretical format that could instantiate this metaphysical claim at a physical level. In particular, he never entertained the notion that it would be philosophically sound to redeem Newton’s absolute time, or to maintain it in relativized form, in the manner of Poincaré or Lorentz, by granting privileged status to conventionally chosen reference frames bearing *true time*. This would have run against the general orientation of his discussion of the “cinematographic mechanism of thought”. Absolute, uniform time, like all concepts of time modelled after the mathematical time-dimension manipulated by classical mechanics, whether in parameter or coordinate format, implies precisely the kind of overall framing and schematizing of real change that is exposed and criticized in *Creative Evolution*.

In every case, the reconstruction of actual experience effected by cinematographic intelligence implies referring particular processes to the abstraction of a “single representation of becoming *in general* [...], a becoming always and everywhere the same, invariably colourless” (Bergson 1998, 304). Bergson was naturally suspicious of the metaphor of universal time flow, which in effect treats time as an all-embracing medium of change underlying every particular duration. It is worth noting that it matters little at this point whether time is one or several, whether absolute time is meant in the original sense intended by Newton, or in the relativized sense underlying the use of a unified system of tem-

poral coordinates within each particular reference frame. The latter solution merely multiplies and aggravates the problem by conjuring up the monstrous image of a “hyper-cinematograph” of sorts, projecting as many global renderings of actual becoming as there are ways of framing it according to particular kinematic perspectives.⁸ While it may still be appropriate for physical purpose, Bergson for one did not see any philosophical benefit in salvaging such a conception, let alone giving it genuine ontological status.

Besides, the knee-jerk reaction of dismay triggered by any mention of universal time in relation to Relativity theory should not overshadow this obvious fact: if the philosopher’s hidden agenda was to vindicate the conceptual framework provided by Newtonian time (the so-called universal time symbolized by the Greenwich meridian clock), he would have chosen a rather curious route to achieve this —first establishing the inherent limitations of all aether-based versions of Relativity (chapter I of *Duration and Simultaneity*), then systematically contrasting *real time* with the relative and ultimately fictitious nature of all frame-dependent determination of time. Likewise, if all he had in mind was to rescue absolute time, the paradoxical claim to the effect that Relativity theory brings out the “unity of real time” even more clearly than classical mechanics would remain utterly incomprehensible.

In view of all this, the notion that Bergson is clinging to an obsolete conception of absolute time for purely philosophical reasons is simply preposterous. The heart of the matter lies in what the critique of the cinematographic illusion brought to the fore, namely the *framing* function attributed to time in both relativistic and non-relativistic setting. Prima facie, the search for *real time* finds its motivation in a reaction against framed time. But to elucidate its concept on its own terms, we need to contrast it with what Bergson describes as *fictitious times*, i.e., the mathematical expression of the anamorphic transformations affecting temporal measurement as we shift from one reference frame to another. Granted, relativistic effects such as length contraction and time dilation are commonly observed. Such effects, however, do not make these times less fictitious, for they can always be construed as perspectival artefacts resulting from the use of arbitrary frames in the account of elapsed durations at a distance. The concept of *real time*, on the other hand, is meant to reflect certain aspects of time that are independent from any such framing, yet no less measurable for that.

The point deserves emphasis: the critical distinction between real and fictitious time operates within the very domain of *measured time*. Contrary to what is generally believed, *real time* is not another name for pure duration. *Duration and*

⁸ See During (2012); (2015).

Simultaneity unequivocally introduces it as a variety of *physical* time. It is the time actually measured (or potentially measurable) by a real clock attached to a portion of matter. Accordingly, when Bergson insists that *real time* is not the kind of thing that can be torn apart and dismantled by the mere effect of relative speed, he is really making a point about the grammar of *physical* time, which he argues cannot be handled as freely as a mathematical variable. This is a far cry from merely playing subjective or lived time against physical or measured time, even if all determinations of *real time* ultimately lead back to the conditions in which real observers perform actual measurements.

To repeat, *real time* is essentially measured time. It is the time of matter, to the extent that matter lends itself to measurement. For this reason, when it comes to appreciating the motivations behind Bergson's engagement with Einstein, it is entirely misleading to portray him as an advocate of the primacy of lived or psychological duration. If the philosopher and the scientist were confronting each other from the two opposite sides of the subjective/objective divide, they would be speaking at cross-purpose and their quarrel would appear pointless, turning around a homonymous use of "time". Accordingly, Einstein would be justified in proclaiming that there is in fact no third time—no "philosopher's time" besides the time of physicists and the time of psychologists.⁹ For once we have accounted for the metric properties of time and for the qualitative features attached to felt time, it seems there is indeed nothing left to study.¹⁰ That, however, is not really the issue. The formal understanding of "time" is the key here: if there is no such thing as the "philosopher's time", no third object requiring special scrutiny, it is only owing to the fact that time is not an object in the first place. So, we may say that Einstein was right after all, although not in the sense he himself intended.

5 The Prospect of Universal Time

In a nutshell, Bergson's claim is not that *real time* is lived, but that it is lived and counted, lived and measured. It is lived even more so as it is counted and meas-

⁹ This blunt statement can be found in the transcripts of the brief exchange that followed Bergson's lecture during Einstein's 1922 visit at the Collège de France in Paris (Bergson 1999, 158). See During 2020, 44–45.

¹⁰ It should be noted that Einstein himself readily acknowledges that a psychological or intuitive apprehension of time is necessarily presupposed by the actual use of measuring instruments (i.e., the reading of clocks). This entails no conflict or contradiction, as long as we agree on a correspondence scheme linking perceptual observations and theoretical constructs.

ured. More importantly, however, it is unique. Therein lies its most conspicuous characteristic.

The underlying metaphysical view can in turn be expressed in both material and formal mode. In material mode, Bergson is defending the view that the universe *as a whole* endures: as such, it is fundamentally analogous to lived, conscious duration. The deeper motivations behind such a view need not concern us at this point. Suffice it to say that the idea of a cosmic temporal wave sweeping across the entire universe is strongly suggested by common sense, not exactly through analogical reasoning, but by virtue of a principle of similarity allowing for gradual extensions from local to global. In any case, for Bergson universal time ultimately remains a conjecture or hypothesis that must be appraised on its own philosophical merits rather than as a blueprint for an alternative physical theory of Relativity along Lorentzian or Poincaréan lines.¹¹

In formal mode, the reaffirmation of the “unity of real time” stems from a profound discomfort with the ontological slackness resulting from the metaphorical spatialization and reification of time. It is one thing to say, for example, that there are as many time-systems as there are reference frames in relative motion, or as many elapsed durations between two time-like separated events as there are ways of connecting them causally; it is quite another to take the multiplicity of temporal measurements associated with particular movements or processes as evidence for an actual multiplicity of a-synchronous durations unfolding in space, as if these were themselves processes of some kind. At a fundamental level, the search for *real time* is an attempt to rectify the misconceptions fostered by the overused metaphor of time’s flow.

The remedy, once again, is to reaffirm the essential unity of time form as a matter of principle. However, this cannot be achieved entirely *a priori*. In keeping with the general orientation of Bergson’s empiricist method, the only way to effectively recover that sense of unity is to examine the actual operations carried out by the physicist, rather than dismissing measured time indiscriminately or simply positing genuine duration and the ideal of subjective unity as a transcendental pre-condition for all temporal determination. But this raises in turn a crit-

11 Édouard Guillaume, an early translator of Einstein in French and editor of Poincaré’s scientific writings, entertained just such a prospect. His theories are mentioned in *Duration and Simultaneity* with some reservations (see Bergson 2009, 133; 302–302). Another case in point is Herbert Dingle. An obstinate opponent of Relativity theory, he also authored a long introduction to the first English translation of *Durée et Simultanéité*, claiming that Bergson, objecting to the idea of asymmetric aging in the standard exposition of Langevin’s twin paradox, had thereby advanced “a perfectly relevant argument even from the physical point of view” (Bergson 1965, xvii). Fortunately, this introduction was not included in further editions (Bergson 1999).

ical question. If *real time* lends itself to measurement, if the structure of physical theory implies a way of coordinating the results of time measurements, to what particular aspect of physical time does *real time* correspond?

The difficulty with Einstein's Relativity is that "time" appears to be all over the place, refracted at different levels within the entire theory. On one level, space-time itself can be said to assume some of the traditional functions of time form. As we have seen, the phantasmal image of frozen becoming that is conjured whenever space-time is considered as a geometric object (or *block*) literally laid out in four dimensions, conceals a sophisticated machinery that in fact operates like a hyper-cinematograph, offering infinitely many projections of becoming—as many as there are reference frames. All these projections are virtually embedded in space-time and directly recoverable from its metrical form. The Lorentz equations express in algebraic terms the way these projections can be coordinated through appropriate transformations. To the extent that space-time thus achieves a formal totalization of becoming, it suggests itself as a substitute for absolute time, but it can only do so at a level of generality that does not even begin to address Bergson's concerns. The immutable unity of spatio-temporal form symbolized by the Lorentzian metric signature turns out to be too large to convey the temporal unity of interlocking durations within the actual universe. The space-time of Special Relativity has only tangential relevance to the variably curved space-time of General Relativity: it is, in the end, an ideal mathematical object. As such, Bergson believes it does not have any straightforward lesson to deliver regarding the nature of time—a form adherent to real becoming. That is the main thread running through the last chapter of *Duration and Simultaneity* devoted to four-dimensional space-time.

At another level, we find coordinate times attached to particular reference frames (or equivalence classes of coordinate systems), as well as proper times measured along individual worldlines. Obviously, these two determinations of time do not merely coexist alongside each other; they are closely entwined in the metric of space-time. Yet, despite this deep mathematical connection, it seems as if "time" had been split apart and projected upon different planes of expression as a result of its entanglement with space. In actual use, the relativistic framework displays a constant interference of parameter-time with coordinate-time, but the way this oscillation between local and global time is reflected on a discursive level reinforces the feeling that we are dealing with heterogeneous aspects of temporal form. Meanwhile, clocks are moved around, synchronized (either locally, or at a distance, by exchanging light signals) and desynchronized (owing to relative motion, and more importantly, dynamic factors). They time events and measure durations while mutually surveying each other in some sense, notwithstanding the disruptions. And if it is true

that time *itself* is never directly measured, if it is better defined, following Carlo Rovelli's suggestion, as an "exchange rate" between other magnitudes endowed with more immediate physical content, then the perfect clock is ultimately nothing but the universe as a whole (or alternately, the most comprehensive theory of that universe). This is yet another confirmation that the form of time cannot easily be pinned down, leaving open the question of where to locate its unity and universality beyond the form of space-time itself.

6 The Lure of Local Time

As far as the basic principles of physical theory, Bergson views himself as a thorough relativist. He has given up absolute space and its material counterpart, the aether. Relying on a privileged frame is not an option, especially if this involves redeeming absolute time in the classic form of frame-time. Clearly, the "unity of real time" must lie elsewhere. Can it be found in *proper time*, the local time introduced by Einstein in his analysis of the logic of measurement, based on rods and clocks? Here is a time marked out by the actual strokes of a clock, a time registered on the spot, so to speak, where the action takes place.¹² It seems time could hardly be any more "real" than that. Yet, given Bergson's criticism of the philosophical abuse of mathematical, homogeneous time, local time could only appear to him as a further development, rather than an overthrow, of the abstract representation of time epitomized by Newtonian absolute time. This deep-seated conviction certainly contributed to downplaying the real novelty behind the Einsteinian use of local time. For the most important lesson to be taken from Relativity, a lesson which many philosophers and physicists alike did not always fully appreciate, is not so much the fact that time is relative to the observer—that is, to the choice of an arbitrary frame of reference—, but more profoundly that time is relative to the varying intensities of motion affecting the observer in the general case where, being accelerated, it cannot be assigned a single inertial frame. Thus, proper time is typically referred to a worldline followed in space-time by a portion of matter (a clock, a human observer) undergoing various degrees of dynamic acceleration. It is, strictly speaking, a length measured along such a worldline, a length whose mathematical expression happens to be

¹² The definitions of proper time vary from one textbook to another, depending on the emphasis one wishes to lay on the intrinsic (frame-invariant) aspects of the situation. Some refer to the time measured by clocks sharing the same motion as the observer (i.e., clocks at rest in the reference frame of the observer), while others mention the time registered by a clock "carried" from one event to another.

independent of any particular framing. Taken as the paradigm of local time, it encapsulates the following basic idea: relativistic time is essentially a *path-dependent*—rather than *frame-dependent*—magnitude; it is relative to the observer to the extent that the observer is dynamically related to the universe as a whole.

Now, owing to the metric of relativistic space-time, the *shortest* (i.e., geodesic) path in space-time happens to be the *longest* in time. Langevin's famous paradox of the twins offers a direct illustration of this general point; hence its paradigmatic function.¹³ In Bergson's eyes, however, proper time is philosophically useless: the drawbacks of its path-dependency far outweigh the philosophical benefits of its frame-invariance. Its pivotal role in Relativity theory appears to him as a further step in the direction indicated by Descartes: that of a thorough geometrization of matter and motion. More importantly, the suspicion is that proper times measured along stretches of space-time do not have anything distinctly *temporal* about them besides the fact that, being predicated upon continuous motion in space, they suggest a natural temporal ordering of events along "time-like" paths—a proto-temporal schema that Piaget would describe as mere "spatial succession" (Piaget 1969, 26). In other words, what proper time has to offer is at best a local expression of causal order. But as a monotonously increasing parameter defined along space-time curves, it is really a 4D spatial magnitude in temporal clothing. To the extent that it captures something of the flow of causality propagating from place to place, it contributes to the spatio-temporal representation of becoming, but the only way it can infuse a genuine sense of temporal unfolding is by relying on a pre-existing intuition of duration, the prototype of which, Bergson argues, ultimately brings back consciousness in the form of lived duration (i.e., a succession of events without any clear-cut distinction between past and present states, conjoined with the perceived simultaneity of multiple flows distributed across space).

Thus, when some philosophers followed Langevin's suggestion that Bergsonian *real time* could be identified with the physicist's proper time, and thereby restore some sense of invariance and unity beneath the relative projections of frame-time,¹⁴ they could not be farther from Bergson's original intent. For strictly

13 The twin paradox epitomizes what Taylor and Wheeler describe as a chronogeometrical principle of "maximal aging". In informal mode: "The worldline of a free stone has maximum wristwatch time between adjacent events" (Taylor, Wheeler and Bertschinger 2006, section 1.6). "Wristwatch time" is another name for proper time; "free stone" stands for any system in uniform motion. According to the authors, the principle of maximal aging in relativistic spacetime is structurally analogous to Newton's first law of motion in classical spacetime.

14 "The philosopher adopts the perspective of *proper time*, the time particular to each [observer]. The physicist adopts the perspective of a common time: the questions he raises bring him to

speaking, proper time, though non-perspectival and invariant, is nothing but a local magnitude measured along spatio-temporal paths. When such paths are combined with moving clocks, it seems we have somehow captured time and fixed it along its course, so to speak. Indeed, each clock can be said to give an accurate measure of its own proper time as it moves around in space. But it is important to realize how unfamiliar this variety of “clock time” really is. For one thing, proper time does not come equipped with any sense of simultaneity besides trivial facts of local coincidence (i.e., intersections of space-time paths). Registering the time of the action only where it takes place, proper time entirely lacks the kind of “thickness” or perspectival depth attached to the idea of real, extensive becoming, to the point that one can doubt whether it has any immediate temporal meaning.¹⁵ The fact is that locality without perspective is not enough. To give proper time its full temporal scope, we need to associate it from the outset with some form of global time, or at least a synchronizing procedure allowing relations of simultaneity to occur at some level. Otherwise, it is at best a fibre-time of sorts: more elastic in some respects, yet in the end no less homogeneous and abstract than the more familiar frame-time underlying the use of time coordinates. Only when temporal fibres align and co-moving local observers can be said to share a reference frame, do we recover a sense of global time, albeit a relativized one. When all is said and done, Langevin’s universal use of proper time does no more than offer a mathematical substitute for the classic figure of time within a new chronogeometrical framework. The question of the roots of time’s unity remains open. For Bergson, it cannot be properly addressed on strictly local grounds.

7 Coexistence in Time: the Real Issue

The inherent limitation of purely local definitions of time is indicative of the extent to which our expectations regarding time form are dependent upon the more basic intuition of *coexistence* in time. From Plato’s *Timaeus* through Aristotle’s *Physics*, down to the “all-embracing” universal time of modern mechanics and Kant’s *Third Analogy of Experience*, philosophers have entertained the idea that time is an envelope or sheaf of becoming, and hence a medium of coexistence, even before it can be defined as a measure (or “number”) of local or cos-

compare the *proper times* of different observers” (Langevin, “Le temps, l’espace et la causalité dans la physique moderne”, a lecture at the Société Française de Philosophie, October 19, 1911, quoted in Bergson 2009, 382).

15 Cord Friebe makes a similar point. See Friebe (2012).

mic motion.¹⁶ Generalizing from this idea, we reach the conclusion that time's primary function is one of *co-ordination*—a conclusion corroborated by Piaget's research regarding the development of temporal frameworks in children. More precisely, time form is what enables us to make sense of a plurality of durations unfolding together, not only spatially, by virtue of being part of the same universe, but temporally, by virtue of being together in time. Time is what brings together durations conceived as contemporaneous, if not simultaneous in the strict sense.

Bergson inherits from this rich tradition. Like others before him, he advocates the formal unity of time as a dimension of both change and coexistence. But the concept of duration changes the deal by severing the form of time from the extensive scheme of number typified in the parametrical use of proper time. Accordingly, just as proper time takes on genuine temporal meaning when it is grounded in lived duration—otherwise, why interpret it as a length of “time”?—, the operational definition of simultaneity at a distance by way of light signals, and the subsequent foliation of space-time into frame-dependent planes of simultaneity, must ultimately be referred to what the third chapter of *Duration and Simultaneity* describes as the lived *simultaneity of flows*, rather than instantaneous events. Taken in this broad sense, simultaneity escapes the narrow definition of instantaneous simultaneity at a distance which Einstein famously showed to be relative to the choice of a particular system of reference. Bergson's emphasis on the “unity of real time”, together with his endorsement of “the one and universal time”, takes its full meaning in this perspective. What is at stake behind the issue of simultaneity is no less than the possibility of recovering a measure of connectedness and unity—a meaningful sense of community—in a universe that the relativistic overhaul of the concepts of simultaneity and duration have seemingly “disfigured” (Bergson 1946, 301–303). The intuition is that the consistent reappraisal of simultaneity as an inherent feature of time form must deliver an insight into the cohesion of the temporal fabric at a cosmic level.

If that was indeed Bergson's intent, it is fair to say that he was not very successful in driving the point home. His famous Paris meeting with Einstein (Bergson 1999, 154–159) was hosted by the Société Française de Philosophie on April 6, 1922 in the margins of a series of lectures given by the physicist at the Collège

¹⁶ In his 1770 *Dissertation* (section III, §14), Kant had already introduced simultaneity as the most important consequence of time, insisting on the necessity to acknowledge simultaneity as a relation in its own right, rather than as a shorthand for the non-successive. Thus, simultaneity is the expression of the actual coexistence of things joined in the same moment of interaction: as such, it manifests the ubiquity of time.

de France. The exchange between two of the most brilliant minds of the time has often been described as the intellectual equivalent of the ultimate fight in a heavyweight wrestling championship. The press naturally gave it substantial coverage at the time. Several chronicles and historical works have since provided informative and somewhat entertaining accounts of the circumstances surrounding it.¹⁷ But the editorial dramatization of this altogether disappointing episode has had several unwelcome consequences. It has led some critics and commentators—bolstered by Einstein himself, as it appears—to overemphasize certain peripheral issues at the expense of more fundamental ones.

A case in point is the status of “absolute simultaneity”, defined as simultaneity at-a-place (i.e., local coincidence). During the Paris meeting, in order to trigger a discussion with Einstein, Bergson had seen fit to present a section of his upcoming book on Relativity theory, in which a rather convoluted argument is made for an extended use of the concept of simultaneity beyond point-like occurrences. This somehow encouraged the false impression that he was questioning the physicist’s reliance on facts of local coincidence (i.e., two events occurring simultaneously at a given point in space), when his aim was merely to question the implicit assumptions underlying any idea of simultaneity. He attempted to do so by showing the hold that certain geometrical representations (such as the idealized point-like events) have on our conception of what counts as absolute, wittily referring to the fictional viewpoint of relativistic *microbes* (see During 2020, 40–42), but the fact is that the more substantial underlying issues were barely addressed in the pages he had chosen to read from. So much so that we are today in the difficult position of having to provide a rational reconstruction for an argument that the two thinkers could not actually have. For the commentator, this implies performing some sort of ventriloquism in Bergson’s name.

Let us give it a try, to the risk of anachronism. The observation that simultaneity at a distance, being frame-relative, loses all objective meaning in relativistic setting, is generally believed to have far-reaching and devastating implications for the philosophical understanding of time. Some argue that it inevitably leads to its fragmentation into a kaleidoscopic multiplicity of temporal projections, each reference frame bearing, so to speak, its own time. But is it truly the case? To make temporal sense of such relativization in the first place, isn’t it necessary to set it against the background provided by some notion of spatio-temporal coexistence? Bergson, for one, believes that the primitive meaning of simultaneity is founded upon the actual dynamics of interlocking “flows” of matter as apprehended by some perceptual event. He therefore as-

17 See Paty (1979); Biezunski (1987) and (1991); Canales (2015).

sumes the notion to be richer and more concrete—if less global—than the one suggested by “all-encompassing” *planes of simultaneity* cutting across the entire universe.

Others consider the relativization of simultaneity and the ensuing disruption of time as evidence of the need to account for temporal becoming in strictly local terms—i.e., in terms of proper time in the sense defined above. But as suggested, this only seems to aggravate the problem. As Mauro Dorato nicely puts it, once we have given up the notion of a world-wide advance of nature, of a ‘now’ moving like a front-wave on the ocean of becoming, if we nevertheless want to retain a sense of the overall temporal unity of the cosmic process, “the water provided by an uncorrelated, non-denumerable set of narrow creeks, each of which, representing the *proper time* of a worldline, ‘flowing’ at a different rate, may also prove insufficient” (Dorato 1995, 184). While the multiple perspectival projections of framed time at least obeyed uniform transformation rules (the symmetries of the Lorentz group), the intrinsic (i.e., frame-invariant) approach to temporal becoming seems to leave us with an utterly pulverized time: a multiplicity of loosely connected threads of proper time with no coordinating principle besides the metric structure of space-time itself and its underlying topology. General Relativity pushes things one step further, forcing us to acknowledge that a global temporal framing is unavailable as a matter of principle. In variably curved space-time, where Minkowski space-time only holds locally, there is no straightforward way of defining planes of simultaneity: the twin paradox becomes the general rule (see below, section 8).

At this point, it would seem as if we ought not be concerned with figurative models of time flow and resign ourselves instead to stripping the concept of time from any global scope. But if coexistence is assumed as a constitutive dimension of *real time*, that would be tantamount to denying the existence of time altogether. The very possibility of conceiving of beings and events as enduring *together* hangs on the coordinating function of time, beyond the trivial mode of coexistence suggested by the generic form of space-time itself (or its phantasmal counterpart, the 4D “block universe”). As mentioned before, the kind of unity achieved by space-time, whether we picture it as a solid made of agglomerated fibres, or as a porous and fluid medium, remains essentially abstract. As a result, the coexistence it exhibits is trivial at best and has nothing specifically temporal about it. Things coexist in the sense that they are part of the same spatio-temporal form. But what Bergson argues about absolute time is true of space-time too: whether we form the image of “an immense solid sheet” (Bergson 1946, 220) or of “an infinity of crystallized needles” (Bergson 1946, 219), in both cases we are committing a category mistake because the space of coexistence itself is in fact treated as *a thing* laid out in space. If the representation of threads of becoming

congealed in a “block universe” serves any purpose, it is that of emphasizing the need to come up with a non-trivial and more robust conception of temporal coexistence. The challenge is to achieve this without collapsing coexistence on the usual figures of global simultaneity.

But, to reiterate, there is no reason why philosophical reflection should confine the meaning of distant simultaneity to the physicist’s concept of world-wide instants (planes of simultaneity). Fixing simultaneity relations between space-like separated events by means of appropriate reference frames (i.e., systems of coordinates), implementing this through electromagnetic signalling procedures, is but one way to construe distant simultaneity. And the global temporal perspective obtained from the use of coordinate systems by no means exhausts the meaning of coexistence. As a matter of fact, the space-time framework already exhibits patterns of simultaneity that are neither global nor strictly local. We may refer to them as instances of *regional* simultaneity. Interestingly enough, they display intrinsic (i.e., frame-independent) characters, in the sense that they can be directly read off from the invariant topological structure of space-time underlying the causal order.

8 The Twins I: Regional Simultaneity

The twins’ story of separation and reunion, as introduced in 1911 by Langevin,¹⁸ is a touchstone in this respect, because it provides a straightforward, almost graphic staging of the oddly disjointed coexistence of two distant flows of duration unfolding and dephasing in parallel—or *in real time*, as it is. Despite the disruptions and discrepancies affecting any attempt at a continuous assessment of standard simultaneity relations between the stay-at-home and the traveller, their mutual history irresistibly conjures the image of a sheaf or envelope of shared time. One cannot simply ignore this on account of the irrecoverable character of absolute simultaneity, as commonly understood by the physicist. My conten-

18 Paul Langevin’s 1911 exposition does not mention “twins” but a travelling observer who, on getting back to Earth after a space cruise in space, turns out to have aged less than everyone at home. The difference in the overall elapsed durations can be derived from the basic equations of Special Relativity theory: it depends on the way the travelling observer is accelerated, as well as on the speed at which he is propelled across space during his round-trip. Generalizing the lesson, two accelerated clocks measure different proper times along their respective journeys, even if the interval under consideration is bounded by the same pair of events (separation, reunion). For a complete genealogy of “Langevin’s paradox” from Einstein to Bergson (through von Laue, Weyl, and Painlevé), see During (2014).

tion is that the genuine issue behind the Bergson-Einstein dispute crystallizes in this simple question: *in what sense are the twins contemporaneous?* For surely, they are contemporaneous in some sense. There may be no such thing as “the” duration of their separation, but why should we view them as temporally insulated from each other, each locked in his own proper duration, so to speak? Which in turn raises the following question: if we resist this form of temporal solipsism, if we acknowledge a sense of contemporaneity allowing the twins to be temporally related beyond the familiar figures of global instantaneity and local coincidence, how does this reflect on the coexistence of each of them with the rest of the universe? For in the absence of an overall physical connecting medium (aether or otherwise), it seems as if we were left once again with the formal aether of space-time as the sole factor of unity. Should we say that the temporal sense of cosmic unity can only be achieved from place to place, rather than in one stroke? But then how is it possible to overcome the limitations inherent to proper time? How can we recover a sense of temporal depth and perspective without once again framing time?

The truth is that philosophical reflection finds itself in a difficult position: standing halfway between locality and totality, with no clear sense of what could constitute its proper frame of reference, it is confronted with a web of interlocking durations somehow *surveying* each other temporally by the mere fact of belonging to the same universe. The exact nature of this reciprocal survey is what is at stake here, and it need not be formulated from the outset in metrical terms. For the twins separate only to meet again, and surely it makes sense to say that *while* the traveller was away, cruising in space, his brother on Earth got divorced and remarried, whatever the durations elapsed on either side. The twins may turn out to have aged differently, but this does not prevent them from being contemporaries all along, throughout their separation. This much is certain, at least in retrospect. It remains to be seen what is involved in this tenseless statement: the twins *coexist* as they go about their business along separate spatio-temporal routes. How can we confer genuine temporal sense to such a claim? Bergson’s appeal to *real time* takes on its full meaning in this context:

Not only do the multiple times of the Relativity theory do not destroy the unity of real time, but they even imply and uphold it. [...] Without this unique and experienced duration, without this time common to all mathematical times, what would it mean to say that they are contemporary, that they are contained in the same interval? What else could such an affirmation mean? (Bergson 1999, 118)

Thus the “unity of real time” is confirmed by the “the simultaneity of flows”—which Bergson contrasts with the “simultaneity of instants”—, and more cogently than any consideration regarding the metrical equality of proper

times. Considered in this light, Langevin's space-age scenario presents us with a theoretical toy-model for addressing a more general issue that is cosmological at its core. In fact, it can be argued that the twins' story cannot even be meaningfully told if it is not played out from the outset against a cosmic backdrop, rather than having them hang in abstract space-time as if nothing else existed. The traveller twin, as Whitehead and others have rightly pointed out in Machian fashion, ages less because his personal involvement with the universe as a whole is different from that of his stay-at-home brother (Whitehead 1923, 35).¹⁹ This shows in the fact that he is subjected to inertial forces in the acceleration phases of his journey, while the other is not. Admittedly, Bergson's repeated claim that the twins must nevertheless find themselves, once reunited, having aged the same, did not do much to clarify the matter. But the stubbornness with which he attempted to refute the very premise of the paradox was instrumental in bringing out certain aspects of the situation that are too easily overlooked. Chief among them is the question of the exact range of the twins' perspectives on the "wave" of becoming that carries their respective flows of duration. If these flows are commensurable (which they are, at least in the sense that their respective proper times can be compared), to what extent can they be synchronized? (For they can, at least in the limited sense where unilateral and relative simultaneity relations can be defined on each side). If there is no way of achieving consistent and continuous overall synchrony, in what sense do the twins share a common history? Are figures such as *waves* and *sheafs* suitable to describe the process in which they participate, knowing that the perspectival view taken by accelerated observers induces constant disruptions and shears in the account of elapsed durations? What is the exact locus of the relational present that the twins seem to share despite their diverging proper times? Finally, is the philosopher in a better position than the physicist for assessing the situation?²⁰

There is probably no univocal answer to such questions, because coexistence itself comes in a plurality of modes or regimes which appear to be embedded and somewhat superimposed within space-time itself. But it is difficult to ignore them altogether. Simply put, they stem from the sense that the twins

¹⁹ See French 1968, 156: "Would such effects as the twin paradox exist if the framework of fixed stars and distant galaxies were not there?"

²⁰ Bergson believes that this is the case, because the philosopher, who does not care much for actual measurement, is free to do without reference frames—leaving them to their mutual, reciprocal motion, overlooking the scene from nowhere, so to speak. It is as if a privilege of extrateritoriality allowed him to describe mirroring perspectives without having himself to choose any viewpoint in particular.

are indeed contemporaneous, although they account for this fact in different ways. In the quotation given above (“they are contained in the same interval”), Bergson likens the “time” elapsed between the moments of separation and reunion—a time which Langevin shows to be measured differently by each—to a thick interval of extended present that they both share within what may be called an interval or *region* of contemporaneity.

This can be given precise topological meaning in the space-time framework (Čapek 1971, 248 ff), provided that we do not forget that the disjoint space-time paths of the twins remain generally incommensurable as far as standard simultaneity is concerned. For introducing an inertial frame somewhere in the picture can yield no more than a relative and arbitrary perspective on the overall simultaneity of their unfolding durations: it is frame-time once again. There is no point denying the relativity of simultaneity defined in such a narrow sense, i.e., as a “simultaneity of instants”. Bergson consistently downplays its philosophical relevance because he is convinced that instants are unreal—ideal constructs, just as the frames themselves. No wonder that simultaneity relations between mere mathematical fictions should prove to be relative... The best one can say is that a continuous one-to-one correspondence between simultaneous events on both paths is available in *some* frames. This is already something, because as it happens the very fact that frame-time and global simultaneity relations are available in some frames is itself an absolute (frame-invariant) fact about the situation—a fact that may turn out to be more significant, as far as the “unity of real time” is concerned, than the discrepancy between elapsed proper times.

Thus, the Earth twin, occupying a single frame, can “sweep along” the traveller’s path, plotting his distant proper time against his own from one instant to another. The resulting account of the traveller’s elapsed time is necessarily relative to the choice of the Earth-bound reference frame: there is nothing absolute, nothing *real* in the kind of simultaneity achieved from such frame-time. A symmetrical attempt from the accelerated twin would necessarily result in gaps, blind-spots and temporal jump cuts, exacerbating the sense of disjunction and separation that is most likely inherent in any relation of simultaneity at a distance.²¹ However, this mutual framing of the shared zone of contemporaneity between the twins can be complemented by a continuous exchange of electromagnetic signals between the twins (factoring in Doppler effects), allowing each to form a concrete and continuous—though delayed and distorted—image of his co-

21 For a diagrammatic account of this oddity stemming from the metrical structure of relativistic space-time, see Whitehead (1923).

existence with the other. Langevin's original scenario introduces this additional twist. By opening a live stream of information between the twins, a measure of connectedness and continuity is restored within relativistic simultaneity.

9 The Twins II: Contemporaneity and the Active Present

The temporal perspective introduced by such real-time communication is essentially different from the one classically associated with reference frames, where simultaneity relations apply to distant events that are by definition causally insulated (space-like separated) from each other. It helps us realize, by contrast, what is really involved in the relativization of simultaneity defined in terms of instantaneous planes of simultaneity. Whitehead was perceptive enough to generalize the situation based on purely topological considerations. Drawing from the light-cone structure of relativistic space-time, he devised an elegant definition of "contemporary events": certain pair of events are indeterminate as to their time order simply because their mutual locations in space-time prevent them from influencing each other. In other words, an exchange of signals between them would have to be faster than the speed of light. Such events are said to stand in a relation of mutual causal independence.

This simple definition is also found in Reichenbach's contributions to the philosophy of space-time. One of its advantages is its universal scope: for any given event with its associated light-cone, the set of its "contemporaries" coincides with the set of events laying in the wedge-shaped region outside the cone. The form of the causal nexus thus appears hollowed out through and through: it is as if each event brought with it a negative nexus, the shadow cast by all that is concealed from it. This outer zone of contemporaneity, which Eddington called the "Absolute Elsewhere", is sometimes referred to as the "topological present" in the current literature on space-time coexistence (see, e.g., Balashov 2010, 68). It illustrates two essential facts about simultaneity: a) relations of simultaneity are based on facts of causal disconnection, and b) they extend to thick regions of space-time, rather than being confined to infinitely thin layers of instantaneous coexistence.²² Bergson already recognized that the simultaneity of instants finds its condition in the simultaneity of flows. Whitehead goes further, showing that for any two contemporary events,

²² In Eddington's terms: "the absolute past and future are not separated by an infinitely narrow present" (Eddington 1929, 48).

there will be some reference frame in which they are simultaneous in the usual, Einsteinian sense (Whitehead 1925, 77). Hence, the relativity of simultaneity can be reformulated in terms of the degrees of freedom we enjoy in slicing at different angles across the zone of contemporaneity attached to a given event. The resulting planes of simultaneity are so many perspectives taken on a more comprehensive region of contemporaneity. Hence their inherent relativity takes on objective meaning: it is an expression of the temporal underdetermination of disconnected events, as much as of the arbitrary choice of reference frames.

Compelling as it is, the interpretation of coexistence as contemporaneousness has some limits: it is restricted to certain classes of events (those that are space-like separated), and more importantly, from a practical standpoint it is ultimately relative to the point-like perspective opened by particular point-events in space-time, rather than space-time paths or stretches of duration. As a result, it is not easily applied to real enduring observers and more generally, extended processes. Nevertheless, the negative definition of coexistence in terms of disconnection or separation manages to capture a basic phenomenological feature of our extended present that is best illustrated by the experience of somewhat helplessly waiting for the answer to a message.²³ It is as if a siphon were draining the time elapsing emission and reception, creating a sense of absence and void.²⁴ This sheds light on the twins' scenario. For the twins too are separated while contemporaneous. In their case, the element of disconnection (in space) is dialectically intertwined with that of connection (in time). Absence is incorporated within an overall sense of distended co-presence. Following Whitehead, we may say that the situation typically "expresses how contemporary events are relevant to each other, and yet preserve a mutual independence. This relevance amid independence is the peculiar character contemporaneousness" (Whitehead 1958, 16). The point, however, is that the twins' separation is not absolute: the twins qua living observers *endure*; besides pairs of contemporary events on their re-

²³ This point is nicely illustrated by Eddington: "Suppose that you are in love with a lady on Neptune and that she returns the sentiment. It will be some consolation for the melancholy separation if you can say to yourself at some—possibly prearranged—moment, 'She is thinking of me now'. Unfortunately, a difficulty has arisen because we have had to abolish Now. There is no absolute Now, but only the various relative Nows differing according to the reckoning of different observers and covering the whole neutral wedge which at the distance of Neptune is about eight hours thick. She will have to think of you continuously for eight hours on end in order to circumvent the ambiguity of 'Now'" (Eddington 1927, 49). The "neutral wedge" refers to the wedge-shaped neutral zone between two light cones: the intersection of their respective outer zones of contemporaneity.

²⁴ Sartre has provided compelling phenomenological elucidations of this experience of separation (see During 2018, 423–425).

spective paths, there are innumerable events which can in fact be causally connected, as illustrated by Langevin's hypothesis of communicating observers. Thus, the various schemas of coexistence appear subtly entangled. As they continuously exchange electromagnetic signals, the twins coexist in the sense Bergson spoke of a simultaneity of flows, but in other respects they are contemporaneous with each other in the sense Whitehead spoke of the mutual relevance of independent events.

Other models of non-standard simultaneity suggest themselves to make sense of the distended coexistence of the twins. Taking one further step in the direction of co-presence, we may consider the active (or interactive) present based on the so-called "Alexandrov interval", defined by the intersection of the future light cone of an event A with the past light cone of an event B causally related to A.²⁵ Within this diamond-shaped region of space-time, all events can be causally related to both A and B. Thus, if A and B are two events punctuating the worldline of an observer, the interval defines a zone of active present comprising all the entities, objects, processes with which this observer can interact during a short but finite interval of proper time such as the one corresponding to the specious present. This seems rather intuitive, for the objects with which we can interact within the bounds of our specious present certainly contribute to our perception of a field of co-presence in which we participate with other beings. Each of the twins carries with it such an interval of active present. But to properly apprehend their coexistence requires that we pay attention to the patterns of intersection between their respective presents. For observers coexist in a relevant sense when their active presents substantially overlap, outlining a specific zone of co-presence that expresses the particular nature of their relation. (Incidentally, in the case of asymmetrical relations, coexistence may take a unilateral form, distinguishing itself from the common understanding of simultaneity relations as reflexive, symmetric and transitive.) What was introduced earlier as a region of simultaneity—a topological envelope defined by two doubly intersecting worldlines—can now be redescribed as a field of relational coexistence, provided that observers involved in that field interact in a symmetric way during the entire time of their separation. It is thus possible to account for the twins' story in a way that is both frame-independent and conjunctive, offering a unified picture of their shared history, notwithstanding the amount of temporal distortion and disruption induced by the underlying dynamics.

Kant's doctrine of simultaneity in the *Third Analogy of Experience* followed a similar pattern: the relational theme was given by the category of community or

25 On this and other issues of spatio-temporal coexistence, see Balashov 2010, 143 ff.

reciprocal action. Yet, despite the claim that simultaneity is a *sui generis* temporal relation that cannot be reduced to the non-successive, the positive meaning of that relation remained somewhat obscure. To give substance to simultaneity, the best Kant could do was to refer it to the sheer density of the links of mutual causal dependence between enduring objects. In true Leibnizian fashion, coexistence came in the form of a seamless *plenum* of interactions. By contrast, embracing the philosophical consequence Einstein's principle of locality—the idea that in the absence of instantaneous action at a distance, *every connection takes time*—, Whitehead's approach acknowledges the primordial function of causal separation, bringing to light the negative nexus embedded within relativistic space-time. In that respect, contemporaneity is the obverse of simultaneity. Taken together, they form a dual image of coexistence, giving it its full scope.

10 The Twins III: Zeno's Shadow

This survey of some varieties of coexistence served one main purpose, namely to drive home, once again, a rather simple message: we are not dealing with time, properly speaking, unless we make room for all its relevant dimensions, including simultaneity in the generalized sense just considered. The value of the twin paradox resides in the simplicity and generality of the situation from which it arises: it forces us to re-examine our ideas about coexistence. Reflecting these ideas against space-time, interpreting them in the light of a categorial scheme that physics itself does not provide, reveals an intricate and multi-layered dialectics of local and global, invariance and perspective, connection and separation.

The truth, however, is that Bergson argued his case quite differently. He made it seem as if he was trying to preserve at all costs, in an uncommonly *a priori* manner and for essentially conservative purposes, the sheer *equality* of the twins' elapsed durations. This assumption of metrical uniformity directly contradicted one of the tenets of Relativity theory, since the synchronicity of proper times is *not* preserved in the general case involving accelerated observers. More serious still, it obscured the underlying issue of coexistence by virtually aligning the entire situation on the trivial case of two co-moving inertial observers.

A few hypotheses may be ventured as to the reasons behind Bergson's misguided tenacity. The first thing to consider is simply the immediate benefit of refusing to acknowledge the difference in overall aging. Bergson realized that it was the most straightforward way of preserving a sense of temporal unity and shared human experience, while remaining faithful to the metaphysical views set forth in his earlier works (Bergson 1991, 209–211). The metrical uniformity

of time measurement was immediately compatible with the idea of an essential rhythmic uniformity of both matter (the most relaxed degree of duration) and human consciousness (characterized by its own specific degree of tension). Since the metaphysical grounds of this temporal uniformity were not directly discussed by Bergson in the context of Relativity, it was difficult to resist the impression that the philosopher was merely clinging to some intuitive and ultimately subjective concept of absolute time.

Why did Bergson lay so much stress on *metric* equality, when all he needed to establish was the somewhat looser connection between real time and the generic uniformity of lived duration acting as a connecting thread between dispersed flows of duration exhibiting various degrees of tension? To clarify his motives, it is important to bear in mind the basic insight behind the battery of arguments devised to expose the unreality of the temporal *perspective effects* underlying Langevin's paradox. These arguments can be traced back to another paradox. The "Stadium", also known as the paradox of the "Moving Rows", is arguably the least famous among Zeno's paradoxes of motion. Yet Bergson deems it the most instructive (Bergson 1991, 192). The classic version involves bodies (rows) of equal length moving along parallel tracks within a stadium, at different speeds and in opposite directions. If Aristotle's account in *Physics* VI, 9 is to be trusted, Zeno fallaciously argued that, given the appropriate speed ratio, the elapsed duration attached to a particular moving body would appear to be *double of itself* when measured by the trace left along another body moving at a different speed. It is easy to see that we are dealing here with reference frames in relative motion. In this regard, the pages devoted to "light figures" in *Duration and Simultaneity*, chap. V, while containing no direct mention of the "moving rows", offer a striking parallel with Zeno's paradox. Bergson substitutes for the moving rows a ray of light moving back and forth between two plates—a situation that should be familiar to anyone who has been introduced to Relativity theory by means of considerations regarding the behaviour of "light clocks". Viewed from different reference frames moving at various speeds, the light figure traced by the ray of light will appear variously slanted or distorted, it will exhibit shapes of different lengths—all equally valid spatial projections of one single time lapse.

Based on this example, Bergson interprets relativistic effects such as length contraction and time dilation as mathematical artefacts stemming from the conditions of measurement, more particularly from the correlation of all elapsed durations with trajectories in space. Since the spatial expressions of duration undergo deformations through the prism of speed, durations themselves admit as many values as there are degrees of speed—in fact infinitely many since reference frames can be arbitrarily chosen in order to track light. Relativity, in that

sense, offers a coherent theory of the changing kinematic perspectives one may take on real motion and duration: the Lorentz transformations account for the resulting perspective effects while giving mathematical expression to what remains invariant under the virtually infinite multiplication of dilated times. Bergson rightly emphasizes the invariance of proper times beneath the kaleidoscopic deformations of improper times; but as far as duration itself (“true duration”), the measuring operation only touches its surface. The internal change affecting matter remains indifferent to its spatial projections under perspective views. The “unity of real time” is thereby preserved, although mathematically this may seem to boil down to the invariance of local time which, as we have seen before, cannot be the last word on the matter. At this point, Bergson’s strategy seems to break down. But his diagnosis, delivered as a distant answer to Zeno’s arguments, remains valid as long as we are dealing with uniform motions and inertial frames.

The more pressing problem is to understand how this reflects upon the discussion of Langevin’s paradox, which involves accelerated observers. Quite simply, fascinated as he was with the relativistic transposition of the Stadium, Bergson was led to systematically overstate matters of symmetry, perspective and relativity in the more general case illustrated by the twin paradox. As Zeno’s shadow was cast over the twins, he was led to believe that the paradox could be diffused as yet another instance of purely perspectival effects. That is why he insisted that a rigorous formulation of Langevin’s scenario should maintain a complete symmetry between the twins’ space-time trajectories, each being entitled to take himself to be at rest, while the other is in motion.

What about the obvious geometrical objection? In order for the twins to eventually meet again, one of them must make a U-turn at midcourse. Regardless of *who* is actually travelling, a dissymmetry is bound to occur somewhere, at some point, resulting in an overall difference in elapsed durations. As previously stated, the longest route through space-time happens to be the shortest through time:²⁶ Bergson did not realize the full implications of this basic mathematical feature of Minkowski space-time, because he systematically downplayed the importance of space-time constructions, which he viewed at best as mathematical devices with no real ontological grounding. He generally believed

²⁶ In the idealized “3-clocks version” of the twin paradox where the round-trip involves only uniform motions, this metrical oddity is clearly exhibited by the relativistic counterpart of the more familiar Euclidean “triangle inequality”. The sum of the lengths (i.e., elapsed proper times) of the opposite sides of a triangle drawn in Minkowskian space-time is *shorter*, not longer. Hence the idea that crooked paths in space-time constitute temporal “shortcuts”. See During 2007, 99–100.

he could play the physicist at his own game by dealing with the paradox in a strictly relational manner, *de facto* abstracting from all the relevant physical features of the situation. By neglecting the dynamic aspects of the situation in favor of the kinematic reciprocity of the observers' perspectives upon their respective trajectories and timelines, he reduced the paradox to a mere thought experiment, an argument to be dealt with on purely conceptual grounds. He made it seem, in short, as if the task of plotting the twins' relative motions in space-time was essentially underdetermined, allowing for multiple equivalent spatio-temporal embeddings. Once the twins were construed as interchangeable, their respective durations could only end up coinciding.²⁷

In Bergson's defense, it is based on similar premises that Paul Painlevé, a first-class mathematician and member of the French government, had boldly challenged Langevin (in 1921), and later Einstein himself in 1922. The latter episode took place on April 5, one day before Bergson's meeting with Einstein (Bergson 2009, 402–409). It provides us with another test-case for the principle of hermeneutic symmetry. To make his point, Painlevé had devised an even simpler model than the original: Langevin's Jules-Vernesque rocket and its space journey had been replaced by a train leaving its station to make a round trip. More importantly, the story involved only constant velocities, suggesting a perfect symmetry or reciprocity between observers in relative, uniform motion. From there, Painlevé argued that time dilations being reciprocal, their effects should simply cancel out.

Einstein easily overturned the objection by reminding his eminent colleague that the situation he was describing did not in fact involve two frames of reference in relative motion, but *three*. By the mere fact of making a U-turn to come back to its starting point, the train observer was forced to "hop" on a new reference frame at midcourse. Therein lies the reason for the overall discrepancy in elapsed times. Painlevé immediately conceded Einstein's point and the matter was thus settled to the satisfaction of all parties. Understandably, Bergson did not see fit to take up the matter again the next day, when his turn came. Instead, he chose to deliver a lecture on simultaneity. Painlevé's 5-minutes argument with Einstein nevertheless left a durable trace on him, as attested by the fact that it is literally reproduced (and duly credited) in *Duration and Simultaneity*, and dis-

²⁷ The strategy is reminiscent of the way Berkeley, Mach or Poincaré criticized Newton's absolute space by using the symmetries of a physical situation to establish the actual indiscernibility of two states of affairs. Thus, if the universe were reduced to two particles in relative motion, there would be no way of telling which particle is *really* accelerated, or directly affected by time dilation. The two would be literally substitutable, so that anything said about the one could just as easily be said about the other.

cussed again at length in the appendices. Clearly, it must have had some philosophical merit in his eyes, despite the fact that it had been refuted. But there is little to be gained in defending the indefensible. With the benefit of hindsight, it cannot be denied that the more relevant issues regarding contemporaneity were obscured by Bergson's stubborn insistence on interpreting the twins' paradox through the lens of time-dilation, in terms of referential and reciprocal effects. Relativity, in the broad sense Poincaré gave to this term when speaking of the relativity or homogeneity of space (i.e., the symmetries accounting for the similarity of figures), certainly functioned as an *epistemological obstacle* in that respect. So did the projective metaphor of perspective underlying the criticism of so-called "fictitious times".

Conclusion

These elements of context may help us better appreciate, by contrast, the ongoing relevance of Bergson's otherwise frustrating debate with Einstein. Like several scientists and philosophers of his time, he certainly failed to appreciate the structural relevance of the twin paradox for Relativity theory. This blindspot in his assessment of relativistic time is palpable in the resistance he opposed to the idea of unsyncable durations, and more generally to the notion of local time. But the different circumstantial reasons reviewed in this paper should not overshadow the more fundamental ones, chief among which is a deep attachment to the idea of time as form, despite the emphasis on heterogeneous durations and rhythms. On the upside, from the commentator's perspective, Bergson's quasi-intentional "blunder" and the discussions it triggered provide an opportunity to clear the ground and allow vital questions to emerge in plain sight. The sublimated version of the twin paradox, unfolding in abstract homogeneous space, plainly distorts Langevin's original intent, but by doing so it also directs our attention to the fact that the lines of flow of extended matter, refracted and dispersed as they are throughout the universe, going out of sync at every moment, still do so *together* in a genuine temporal sense. These flows are contemporaneous, and in more than one way. Simultaneity does not reduce to absolute facts of spatio-temporal coincidence or to the conventional framing of world-wide instants: there are such things as sheaves of simultaneity. The twins illustrate this basic truth in their own inchoate manner. Realizing it opens up new perspectives on the problematic temporal unity of material process. This process may well turn out to be fundamentally open at the cosmological level because the universe itself endures and is subject to change, but this should not prevent us from trying to make sense of the unity of material dura-

tions. The same naturally holds true of the living in general. The challenge, in every case, is to approach this unity in temporal terms, *sub specie durationis*. What distinguishes Bergson's version of time form in that regard is that none of its concrete models can be achieved in one stroke: they are themselves in the making.

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