Gibson and Time:
The Temporal Framework of Direct Perception

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Abstract

The serious import of Gibson's statement warning that physics "abstractions" of space and time "are not appropriate to psychology," has not been understood. Underlying the space and time of physics is a largely unexamined metaphysic, what can be termed the "classic" (or spatial) metaphysic. This metaphysic is what Gibson implicitly rejected. His concept of direct perception, and necessarily then, direct memory, rely on, in fact, require, an alternative metaphysic of space and time for their understandability – what can be termed a "temporal metaphysic," a framework which was explicitly developed by Bergson in *Matter and Memory*.

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Introduction

Gibson's statements on time are, firstly, not that prolific, secondly, rather cryptic, and thirdly, hardly taken as clearly "directive" in terms of providing strong guidelines for ecological psychology and its understanding of both the brain and perception. He certainly expressed strong misgivings about importing physics concepts of space and time into psychology:

> The idea that 'space' is perceived and 'time' is remembered lurks at the back of our thinking. But these abstractions borrowed from physics are not appropriate to psychology. Adjacent order and successive order are better abstractions, and these are not found separate (Gibson, 1966, p. 276).

Though on one reading, this statement seems almost innocuous, I will argue this is far from the case. This is in fact a strong warning, in reality a prohibition, on relying on and employing physics concepts of space and time, i.e., its "abstractions" re space and time – which is really to say the *metaphysic* of space and time upon which rests the mathematics of physics framework of explanation, with its calculus. The chapter in which this statement is embedded, if not most of the entire work, is an analytical exercise in examining why these abstractions cannot hold. But the above quote, as a counsel, certainly has not been seen as precluding modeling psychology, perception and the brain on physics, and it certainly hasn't been taken as such in subsequent theorizing where the ecological framework has been explicitly modeled on the wave equation of quantum mechanics (Shaw, Kadar & Kinsella-Shaw, 1994) or exploited to explain direct perception (Turvey 2015), or relativistic space-time for direct memory (Smith, forthcoming).

But Gibson was implicitly saying that psychology, and obviously ecological psychology, must work within a different metaphysic of space and time. It is only within this framework that his "direct perception" obtains true comprehensibility, and as well, the implied and allied notion of *direct memory* – with his seemingly strange declaration that taking the brain as a "'storehouse' of memory…is stultifying" (1966, p. 277). This is what I intend to make explicit here.

Let me begin with a Gibson-anecdote which may (or should) give pause to efforts to fit ecological concepts into current physics.

Gibson on Relativistic Time

Most are familiar with the concept that special relativity (henceforth, SR) is thought to imply a "space-time block" – a frozen 4-D manifold in which there is no change, where all is already laid out – past, present and future (Figure 1). This is taken as the implication of the "relativity of simultaneity," for no "plane of universal becoming" can be defined, i.e., no universal present as an advancing plane defined across the universe from which all next "points/events" are in the future. In 1975, this had become a problem to me. My doctoral thesis was building the contention that Gibson's theory has to be placed within Henri Bergson's framework to give Gibson coherence, i.e., to actually explain the origin of the image of the external world – the coffee cup "out there" on the table surface with spoon stirring, surface swirling (note, already, this is a *time-extended* event – swirling, stirring), i.e., to explicate Gibson's "direct perception." But Bergson has a different model of time required to make his model "go" – actually a different metaphysic of time – and it intrinsically involves universal becoming. That is, he seemed at odds with SR's "block".

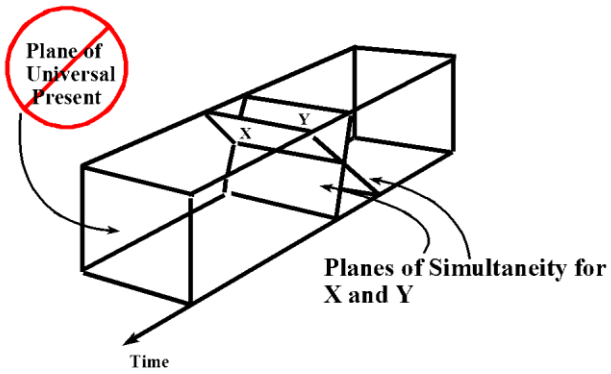

Figure 1: The 4D Space-Time "block" of Special Relativity. Observers in relative motion (X and Y) have different planes of simultaneity (a plane on which all events are in the "present" for that observer). No common present "plane" of universal

> "becoming" – a common plane for the entire universe where all next points are on a single "future" plane – for *all* observers seems possible.

My thesis advisor (at the University of Minnesota) at the time was Bob Shaw. I wrote a paper with the aim of reconciling Bergson with SR, maintaining SR and yet saving at least a form of "becoming." It keyed off a chapter by Milic Capek (1966) in which he examines the Minkowski space-time interval, "I", where $I = s - c^2(t_2 - t_1)^2$, s being the 3D spatial distance between two events at t_1 and t_2. He argued that this invariant quantity defined a tri-partition of event classes which in turn preserves a form of universal becoming, and as well, defines the relativization of events (outside the light cone defined by I) that commonsense would otherwise say should be simultaneous. Shaw (who liked this resolution) gave this paper to Gibson who was visiting Minnesota at the time for a conference.

Gibson, in his scribble on the front on the paper, essentially said, "Nice effort, big subject, but maybe look at other things." He gave no reason for this implicit rejection of my "resolution" at that point. His reason came out in his conference talk the next day, I'm sure in a statement coming "out of the blue" to everyone there, i.e., to everyone who had not written that paper, and was very likely unremarked by anyone (well, except by me):

> Physicists mislead us when they say there is no simultaneity. When the camera pans to the heroine tied to the rails and then to the hero rushing to the rescue on his horse – these events are simultaneous. (Gibson, 1975, U of Minnesota)

What did this mean? Obviously, Gibson is rejecting the "relativity of simultaneity." The question is: is Gibson right? The short answer is: yes. I am going to shorten the explanation here to enable more time on the deeper aspects of Gibson's warning on physics abstractions. At that time, I was intensely studying the debate that Bergson had with Einstein (circa 1922, cf. Gunter, 1969), particularly Bergson's book on the subject, *Duration and Simultaneity,* 1923 (henceforth, D&S). I realized immediately, when Gibson made his, "Physicists mislead us…" comment, that he was siding with Bergson. The debate had centered on the "twin paradox," proposed by Langevin in 1911, now at the core of physics current, ubiquitous, standard interpretation of SR

which has installed the relativity of simultaneity as real – as ontological – as a physical fact of the universe, thus installing the space-time "block" as a reality as well.

Langevin, Bergson argued, with his rocket-riding twin aging less (actually, physically) than his earth-bound brother, had destroyed the logical consistency of SR. In the reciprocal system in which Einstein had embedded the Lorentz equations (reciprocity: either observer is equally able to claim himself at rest, the other is in motion), all effects are *measurement* effects (cf. A. P. French, 1968). What is a measurement effect? I measure my toaster with two rulers, both of the same length, but one ruler says 6" long, the other 9" long. The toaster "expands" from 6" to 9" depending on the ruler, or contracts (if going from a 9" ruler to a 6"). Obviously, this is not a real, not an ontological expansion/contraction; it is purely a measurement effect – an effect of the rulers. In SR, the 'rulers' are light rays and clocks (synchronized or unsynchronized clocks depending on the observer). The Michelson-Morley experiment was "explained" precisely on this basis: while Lorentz had proposed an actual, physical contraction of the apparatus arm which lay in parallel with the ether flow, this seemed *ad hoc*; SR was eventually preferred as it argued there was no *actual* contraction – it is a measurement effect.

Langevin, with his hypothetical earth-bound twin, now with his cane, long beard and grey hair, very physically aging more rapidly than his rocket-riding, youngish brother, had, a) voided the reciprocity of the two systems (which implied that *either* twin could be construed as aging more), and, b) declared what could only be a measurement effect to be now an *ontological* effect – a real, physical effect, beards, grey hair and all. He had destroyed SR's logical structure. And note, one cannot declare "time-changes" as ontological and leave length changes as measurement effects (to preserve the Michelson-Morley explanation). In Einstein's system, as Bergson noted, time-units expand exactly in proportion as length-units contract; the equations are compensatory. They must be of the *same order*, i.e., they must be measurement effects. Thus, and this is what physicists did not want to accept: any use of SR to explain actual "time"-changes (better, the *retardation of processes*) – the very real slowing of clocks in jets (Hafele-Keating), the longer

lifespans of muons – is *invalid.*[1] Physics needs *a new theory* to explain these. SR cannot be so used. Yes, the so-called "confirmations" of SR are invalid – a misuse of SR.

All this was Bergson's argument in D&S (Robbins, 2010). He argued that SR, in its logically consistent structure, with all effects being measurement effects and with its intrinsic reciprocity, preserved the flow of time *as an invariant to all observers*, i.e., neither twin aged more or less than the other. And in this, he pointed out that this invariant flow contains multiple simultaneous causal flows, flows that cannot be relativized!

In his "hero rushing to the rescue, the heroine on the rails" (tied down, struggling, wildly kicking her feet, the locomotive roaring, steaming towards her down the track), Gibson was invoking this "simultaneity of flows." Bergson spent some time in D&S discussing their significance. I have taken to using my own illustration: Imagine an organically growing, blooming rose. Make it large, ten feet across. The leading edge of two petals on opposite sides strike two points, one on each side of the blossom (ten feet separated) – and do so simultaneously (to a stationary observer watching the rose). An observer, moving by (but who declares/thinks himself at rest) declares the first observer in motion, his clocks out of sync, the two points *not* being struck simultaneously. This is however absurd: the organic growth of the rose (a simultaneous causal flow) cannot be relativized – not without destroying the organic growth.

It is simple to demonstrate that there are causal consequences to the simultaneity of the flows that simply cannot be made to "go away" depending on the relative motions of observers. As an example, we'll change the rose to a growing tree. Two growing branches strike points on opposite sides of the tree simultaneously, each touching an electric switch that sends a current towards a bell. The bell only rings if both currents with their combined strength hit the bell's switch simultaneously. Presume the bell rings. The ring cannot be made to "go away" (i.e., a

[1] See, for example, Bergson's exchange in Revue Philosophique in 1924 with physicist, Andre Metz (Gunter, 1969, pp. 123-135). And note, in appeals to "accelerations" (hence to the General Theory) to explain these time-retardation effects, you are not "confirming" SR but rather confirming an explanatory apparatus supposedly in the General Theory, one that does not exist within SR.

valid claim made that it did not happen) simply because a physicist, moving by in a rocket, declares a stationary observer watching the tree to be in motion, his clocks out of sync, and the two branch-strikes "non-simultaneous". The simultaneous, organic, causal flow of the tree's growth cannot be relativized. In other words, the relativity of simultaneity is easily disproved. Gibson, the brilliant expositor of ecological perception, is right.

Even Einstein's iconic, relativized lightning bolts would in fact be part of a large storm front – a vast, boiling, organic system of flows – like the rose. The bolt-strikes can no more be relativized, in truth, than the flows of the rose. The bolt-strikes from within this front are "relative" only via an *artificiality*, namely, the mathematical characterization of time as a series of "instants," and in this, taking only instantaneous point-events in what is in reality a larger flow. The Minkowski schema, with its light cone and its interval, I, represents a causal chain proceeding from an instantaneous point (at the intersection of the past and future light-cones), not a flow.[2] As Bergson noted: "The theoreticians of relativity never note any simultaneity but that of two instants" (D&S, p. 103). This is but the index of the metaphysic underlying this framework, of which relativity is the logical expression.

The Two Metaphysics – The Classic

Just preceding his warning re physics space and time "abstractions," Gibson had noted:

> The essence of memory as traditionally conceived is that it applies to the past, in contradistinction to sense perception, which applies to the present. But this distinction is wholly introspective. It depends on feelings of "now" and "then," not to the facts of life…Information does not exist exclusively in the present as distinguished from either the past or the future...The stream of consciousness as described by William James (1890, Ch. 9, 15) exhibits the travelling moment of the present time, with a past extending backward and a future extending forward, but this is the stream of self-consciousness, not the process of perception. Physical events conform to the relation of before and after, not to the contrast of past and future (1966, p 276).

[2] Natasa Rakić (1997), in an analysis of the logic of the Minkowski schema that should have been given far more weight, demonstrated its failure to preserve simultaneities and causal relations that simply must be the case (in reality, as discussed here, the consequence of simultaneous flows). Diplomatically, in a strained concession, she calls SR, "an ontological theory, but not a temporal theory."

This passage is of far more import than is understood; it is describing the inescapable – and unusable for psychology – consequences of the classic (spatial) metaphysic. This metaphysic, as Bergson (1896) described it, is an *abstract space*, a "principle of *infinite divisibility*." Beneath (or thru) the concrete extensity of the physical world, we imagine a continuum of points/positions (Figure 2). A motion of an object, say a cup, from point A to B through the continuum is envisioned as a series of points – a trajectory – a line (i.e., again a *space*). As this continuum is infinitely divisible, we can imagine between each pair of points successively occupied (or passed thru), yet another line of points, also infinitely divisible, and between each pair of points on this line, yet another line… Already, one can see, motion treated in this way – as a series of *immobilities* – is both an absurdity and an infinite regress.

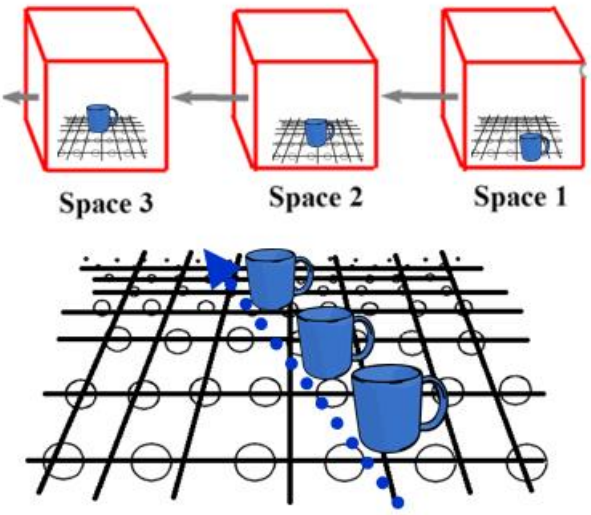

Figure 2. Successive positions of the moving cup across (or thru) the 3D continuum of points/positions. Each point/position of the cup corresponds to instant of the all of Space.

It is this infinitely divisible space, Bergson argued, that is at the heart of all of Zeno's paradoxes: In a scenario where two objects approach each other, both passing a third object that is stationary, Zeno, looking only at the *space* traversed, states that a "duration is the double of itself," or an arrow, always at a static point of the continuum, "never moves," or Achilles,

constantly dividing the intervening distance in half, thus into ever smaller intervals, "never catches the tortoise."

> At bottom, the illusion arises from this, that the movement, once effected, has laid along its course a motionless trajectory on which we can count as many immobilities [static points] as we will. From this we conclude that the movement, while being effected, lays at each instant beneath it a position with which it coincides. We do not see that the trajectory is created in one stroke, though a certain time is required for it; and that though we can divide at will the trajectory once created, we cannot divide its creation, which is an act in progress and not a thing. (1907, p. 309)

And Gibson:

> The traveler perceives the path to be traveled if he looks ahead, the path that has been traveled if he looks behind, and the position in between is called here. The *traveler is tempted to think of the linear path as the dimension of time* and to see the path traveled as the past, that to be traveled as the future, and the division point as the present. The *point* here and the *moment* now coincide. (1975, p. 300, emphasis added)

Yes, it has been argued in the Achilles case that this is resolved by taking the limit of a converging series (e.g., Whitehead, 1929). But taking the limit is merely a *mathematical convention* allowing us to arbitrarily stop what is in reality an infinite operation or division. Even the wave equation, Ψ, supposedly the basis of physical reality, harbors this mathematical sleight of hand. Intrinsic to it is Euler's identity, $e^{i\pi} + 1 = 0$, but this identity requires taking a limit to reach that "zero," to then begin the wave cycle again.

The mathematical treatment of Achilles is dealing only with divisible *lengths*, i.e., with the *ends* of the intervals, not the motion within the interval. There is no interval, however, no matter how minute, that Achilles is not *passing thru*. The mathematical framework is only a static backdrop to which Achilles has no actual physical relation.

Each point along the cup's trajectory is taken to correspond to an instant in time. Time is simply the 4th dimension of this abstract space. If that instant is taken as an instant of the all of space (envisioned as a Cube, Figure 2), time is a series of such spaces or Cubes and given there's an "end" to the infinite division, each Cube has the logical time-extent of a mathematical point (a *point* defined as having no beginning or end, thus no longer divisible). In effect, this is a frozen

Cube, in fact a frozen universe; no further change is possible; there is no way to transition from Cube 1 to Cube 2. It was in contemplating this implication, Bergson noted, that to account for change, Descartes felt the intervention of God was necessary (presumably *creating* cube after cube). Simultaneously, the frozen cube – again, a mathematical point in time-extent – is the one condition in which a fixed, determinate value for Achilles' motion is possible, else, again, the value is always *uncertain*; he is always passing through the interval, no matter how small. But the price of obtaining this determinant value is, again, no more change. As Lynds (2003) noted, to enable a changing universe, this is an intrinsic tradeoff – uncertainty for constant change.

In this instantaneity, as such, each Cube is utterly *homogeneous*. This (i.e., the metaphysic) is already the core of the "hard problem" (Chalmers, 1996), for no *qualities* can arise in such a space or in a series of such spaces, where each space instantly vanishes as the next (the "present") arrives, certainly no qualities of *motion* such as Valerie Hardcastle pictured in her description of qualia: "… the conductor waving her hands, the musicians concentrating, patrons shifting in their seats, and the curtains gently and ever-so-slightly waving…" (*Locating Consciousness*, 1995, p. 1).

In this classical framework, there is ever only one Cube – the present – the previous Cubes each having successively fallen into the past, the "past" being our symbol of *non-existence* in this metaphysic. The brain is equally just a "sub-cube" within these Cubes of the universe – sub-cube after sub-cube. Any event – stirring coffee – sub-cube after sub-cube. There is no actual *time extent* of any event nor of the brain taken as an event. It is this framework that Gibson is implicitly reacting to. Thus, "Resonance to information, that is contact with the environment, has nothing to do with the present" (1966, p. 276), i.e., nothing to do with this scheme of "present instants" and the artificial *ideal limit* the present instant represents within the metaphysic. He goes on, making the problem more explicit:

> …for the travelling moment of present time is certainly not a razor's edge, as James observed, and no one can say when perception leaves off and memory begins. The difficulty is an old one in psychology and Boring (1942) has

> described efforts to get around it in his chapter on the perception of time. The simple fact is that perceiving is not focused down to the present item in a temporal series. Animals and men perceive motions, events, episodes, and whole sequences. The doctrine of sensation-based perception requires the assumption that a succession of items can be grasped only if the earlier ones are held over so as to be combined with later ones in a single composite…This can be pushed into absurdity (1966, p. 276).

"Pushed into absurdity" because sub-cube after instantaneous sub-cube of the coffee stirring must be stored in a static space (supposedly in the brain), like a series of 3D snapshots laid out on a desktop – a vast, static structure. But now, how does one re-introduce the motion? As Turvey (1977) once pointed out, via some "internal scanner"? Then how, he argued, does the *scanner* register motion? An infinite regress begins again. This is just one of a number of problems arising from adherence to this metaphysic (Robbins, 2004, 2017, 2020). Another is invoking "the continuity of neural processes":

> The features of an object, bound by various mechanisms to activity in working memory, thereby provide the content of consciousness of the associated object… In these [neural activity loops], neural activity "relaxes" to a temporally stable state, therefore providing *the extended temporal duration of activity necessary* for consciousness… (Taylor, 2002, p. 11, emphasis added)

This is conveniently *ignoring the logic of the metaphysic* in which the theorist is working wherein the brain itself can only have the time-extent of a mathematical point (and thus, equally, *those neural processes*). This – the ever-disappearing present – is precisely the source of the seeking and theorizing as to how experience is stored in the brain in the first place, for as "matter" is defined as that being always "present" and the brain is matter, thus deemed always "present," the brain is deemed the only place for safe storage of the non-existent past.

The Two Metaphysics – The Temporal

So how does the brain specify time-extended, dynamically transforming events – the coffee being stirred, spoon circling, surface swirling?[3] As noted, Gibson is implicitly invoking, or better – requiring – a different metaphysic. Bergson had already laid this out.

[3] For reasons soon more apparent, I am treating "being specific to" as equally applicable to the brain. This is evident in Gibson's (1966) description of *perceptual activity* wherein he envisions the brain continuously

> Below homogeneous [abstract] time, which is the [spatial] symbol of true duration, a close psychological analysis distinguishes a duration whose heterogeneous moments permeate one another; below the numerical multiplicity of conscious states, a self in which succeeding each other means melting into one another and forming an organic whole. (1889, p. 128)

He would also compare this flow to a melody, where each "note" (read "instant") permeates the next, where the state of each reflects the entire preceding series, and where these comprise an organic continuity.

Motion, he argued, must be treated as *indivisible*. When, per Zeno, Achilles successively halves the distance to the tortoise, it is his track in space, the infinitely divisible line, of which we think. Rather, Achilles' motion (the *process*) is indivisible; he moves with indivisible steps, he most certainly catches the tortoise. Per Zeno, the arrow, always being coincident with a static point on this infinitely divisible line, "never moves." But the arrow in fact moves in an indivisible motion.

The abstract space of the classic metaphysic with its mathematical treatment erases *real*, concrete motion. The cup can move across the continuum (or coordinate system), or the continuum move beneath the cup. Motion now becomes immobility dependent purely on perspective. All real, concrete motion of the matter-field is now lost. But, Bergson argued, there must be *real motion*. In this he was already anticipating the "simultaneous flows" with which we began. The universe, the entire matter-field, must dynamically change and evolve over time. Trees grow. Roses bloom. People get older. Mountain ranges appear. Stars shrivel and die. He would insist then, already acknowledging the only partial validity of a relativistic point of view:

> Though we are free to attribute rest or motion to any material point taken by itself, it is nonetheless true that the aspect of the material universe changes, that the internal configuration of every real system varies, and that here we have no longer the choice between mobility and rest. Movement, whatever its inner

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adjusting, tuning to the invariants, seeking the highest fidelity reception relative to the (dynamic) information, i.e., symmetrically, the invariants specifying the event are equally defined over this resonant, attuning activity. See also Shaw and McIntyre's (1974) *principle of cognitive symmetry* where, "An organism achieves the highest degree of knowledge of its environment (i.e., has ecologically relevant knowledge of it), when there exists a persistent symmetry between its psychological states and its environment" (p. 83).

> nature, becomes an indisputable reality. We may not be able to say what parts of the whole are in motion, motion there is in the whole nonetheless. (1896/1991, p. 191)

We must, he argued, view the entire matter-field as a global motion over time. We must see the whole changing, he argued, "as though it were a kaleidoscope." We want to ask if individual object X is at rest, while individual object Y is in motion. But both "objects" are simply arbitrary partitions, phases in this globally transforming field. As such, the "motions" of "objects" are seen as *changes or transferences of state* – rippling waves – within the dynamic, indivisible motion of the whole.

So, again the question: how can time-extended events – events extending into the "past" – be specified? From the perspective described, this property of the dynamically transforming matter-field itself and of its melodic, indivisible transformation, where every "instant" (or "note) permeates the next, defines a "primary memory" (appropriating the term from James, 1890). This primary memory underlies the motion of the rotating cube, the swirling coffee and stirring spoon, the motion or flow in the neurons of the brain. The motion of the field, of which the rotating cube is just a phase or transference of state, does not consist of discrete instants ("presents") that fall away, one by one, into the past, into non-existence. For this reason, the brain, as a resonant wave embedded in this transformation (and equally time-extended) in Gibson's metaphor, is able to specify these transformations of the matter-field, even though from the standpoint of the classic metaphysic, they are now long in the "past." It is how we can be dealing with *successive order*, not with a series of "presents" each constantly moving into the past. The brain can specify "rotating" cubes, ever so gently waving curtains or the "singing" notes of violins. Yes, *qualia of motion*. To answer Gibson's question, there is no "dividing line" demarking when "perception leaves off and memory begins." We are always viewing the "past". Perception, as Bergson noted. is always, already a memory.

In such a flow, we should note, each instant interpenetrating, reflective of the preceding series, there is the foundation for qualities that only become so by *building in time*, e.g., the

"mellowness" of a violin, of a wine, or of a being. And nothing, due to this building, *ever precisely repeats.* Even in the classic case – the same force applied by the same cue to the same billiard ball with the same directional vector resultant over and over – the cue is never actually the same, the ball is never the same from time 1 to time 2 – only *practically* the same. This is why the classic metaphysic, in describing this qualitative transformation of the field, employing spatial conventions such as Euler's identity – a cycle always coming back to zero, i.e., to the *precisely same state* – is *an ideal limit*, and can ever only approximately capture the real nature of the transforming field.

The Scale of Time

There is another temporal aspect of this specification that should be registered. The specification is to a particular *scale of time*. The matter-field – the *environment* of ecological psychology – is not limited to our normal scale of "buzzing" flies, butterflies flapping their wings, grass fields barely perceptibly waving This normal experience of ours is a particular scale of time. That Minkowski space-time diagram with its light cones can as legitimately be depicting a manifold of nothing more than electrons whirling. Something must impose or "specify" a scale of time upon the manifold, and this is the resonant wave that is the brain. This time scale-specification, it is reasonable to assume, is based in the underlying chemical velocities of the neural processes, where chemical velocity has its standard expression in the Arrhenius equation. Such a velocity can be changed, as simply as by raising the temperature, or by introducing some form of catalyst. How LSD, for example, might work as such a catalyst, biochemically, in changing the normal, specified scale of time has been discussed in detail elsewhere (Robbins & Logan, 2022). The point is, one can imagine steadily *increasing* the brain's underlying chemical velocities, and in such a scenario our normally "buzzing" fly transitions to a heron-like fly slowly flapping his wings, and with a greater increase of chemical velocity, to a motionless fly whose vibrating crystalline structure can begin to be perceived, and on.

The buzzing fly, the heron-like fly, the motionless, crystalline vibrating fly are qualia – qualities of form and motion (Robbins, 2004, 2013). This – and the intrinsic role of time itself – has been lost on the theorists of the hard problem, but this form of qualia is a natural consequence of the brain as resonantly specifying the environment – at a scale of time. And as we started with special relativity, another natural consequence was pointed out by Bob Shaw long ago (in a seminar, 1972), for in essence in the thought experiment above we have done the analog of changing the relativistic "space-time partition." In SR, it is invariance laws only that hold across these partitions, e.g., the law d = vt in the stationary system becomes d' = vt' in the moving system. The same invariance laws that specify the buzzing fly also specify the heron-like fly, or concomitantly, the coffee being stirred in the buzzing fly partition as well as the slower coffee swirling and stirring in the (much slower) heron-fly partition, or in Shaw's original context, the same law holds that is specifying the aging of a facial profile, namely, a strain transformation on a cardioid (Pittenger & Shaw, 1975), whether in a very slow event (as is normal) or a much faster (rapidly aging) event.

Ecological Psychology in the Temporal Metaphysic

Let us briefly look at some distinctions and comparisons between what we've seen of Bergson's temporal metaphysic and some current ecological theory. Firstly, Bergson's "extensity" is the *concrete*, extended world – the lake with its wind-ripples and lily-pads before us – pre any conceptual imposition of the abstract space. Turvey (2004), discussing space as a *concept*, notes three possibilities: as a mathematical concept, a physiological/psychological concept, a biological/ecological concept wherein the defining properties of the space are found at the interface of organism and environment, and he backs this third view. Turvey has taken us to the conceptual level of space here, but for our consideration, I would note that it is concrete extensity that must characterize the environment of any organism, not the abstract space. So, when Gibson (1979) states, "Time and space…are simply the ghosts of events and surfaces" (p 101), and better, "Abstract space is a sort of ghost of the surfaces of the world, and abstract time

is the ghost of events of the world" (1975, p. 1), if Gibson's "time" and "space" here are taken as meaning the abstract, 4D space of the classic metaphysic as I've been arguing, then events and surfaces are characterized by Bergson's duration and extensity, i.e., concrete time (or indivisible flow) and concrete space. This distinction and relation between Gibson (and Turvey) and Bergson might well be kept in mind for clarity.

In other considerations of space and time, Turvey (1992) states: "There are no changeless things and there are no thingless changes; there are only changing things" (p. 175). Saying there are "only changing things" however, on analysis, would seem to inevitably lead to Bergson's (1907) statement:

> It is always provisionally, and in order to satisfy our imagination, that we attach the movement to a mobile...In the almost instantaneous perception of a sensible quality, there may be trillions of oscillations which repeat themselves…But in reality, the body is changing form at every moment; or rather, there is no form, since form is immobile and reality is movement. What is real is the continual change of form; form is only a snapshots view of a transition. (1907, pp. 301-302).

That is, again, there is only constant change, an object or form being an invariant over the change, or again, "…the 'motions' of 'objects' are changes or transferences of state". But the critical question: is this change seen as indivisible, melodic, each "instant" permeating the next, or is it held to be defined by the infinitely divisible space of the classic metaphysic? Clearly, I would hope the former.

This motion or development, when characterized as indivisible, as melodic, as interpenetrating, permeating "instants," is a form of *memory* per Bergson, i.e., the motion of the matter-field itself is memory (hence, the attribution to it of a "primary" memory). When we say, "perception is always already a memory," it might seem that we are re-introducing a distinction between a mathematical point-present and an extended, thick present, but there is no way to avoid this "already a memory" statement, i.e., the extended-present *is* memory. Secondly, going back to the very start of our discussion, for Bergson, there is *becoming*, defined, if staying in SR's block metaphor, as an ever-advancing plane of simultaneous events defined over the entire

universe, a plane poised before a myriad of (future) possibilities, and yet this "present" plane would be a cross-section or "instant" equally permeated by, continuous with, and reflective of the entire past history of the field.

This brings us to events as also affordances – aspects of perception spanning past-present-future, or as in Turvey (2019, p. 409), quoting Shaw, Flasher and Mace (1996), "Events, therefore, are sources of retrospective, perspective and prospective information because the "current" state of an event is spatiotemporally extended from the past to the present to the future" (p. 356). But what is the ontological status of this future? I must slightly anticipate the next section here: We will meet Bergson's succinct statement, "Perception is virtual action," a concept rooted in the idea that the body's *selection principle* from the plethora of information – what he will term the *real* actions – rippling throughout the material field, is that the information is relatable to the body's action systems, e.g., the tau ratio.

> The distinct outlines which we see in an object, and which give it its individuality, are only the design of a certain kind of influence that we might exert on a certain point in space; it is the plan of our eventual actions…Suppress this action…and the individuality of the body is re-absorbed in the universal interaction which, without doubt, is reality itself. (1907, p. 11)

Perception then is both, a) specification of a past extent of the transformation of field and, b), simultaneously specification of virtual (or possible) action (an affordance). But the virtual is the virtual – an array of possibilities, one or none perhaps ever being executed. It cannot be equivalenced to the past, i.e., to that which is already *realized*.

So, in this, it can be taken as warning for ecological theorizing that going with the temptation of *reifying* the future is mistaken, or similarly, to take Gibson's (1975) "nestings" of events (which is certainly the case) as involving a span of events which includes reified future events (e.g., in the larger event of "getting up and going to feed the chickens," I am "presently" eating cereal, but this event is bracketed by a span which includes my getting out of bed and going downstairs to the kitchen in the past, eating cereal (present), and *then* (future), going to feed the chickens). After all, one can ask, where would this nesting end? How long a span is allowed?

How far into the future? The nesting would not end, not until we end up with the static, becoming-less, 4D space-time "block" of SR with which this paper started – with its myriad of logical problems, to include explaining how there is even the experience of the *motion* of the spoon scooping the cereal.

Finally, when explicitly aware of the existence of the two metaphysics, questions on the relation of the computer model to human perception/cognition come into more principled focus, for one, whether a robot will achieve true intelligence, i.e., achieve perception involving affordances (cf. Blau and Wagman, 2022). From the perspective presented here, the answer is unequivocally, no. We know that a robot's *physical implementation* is irrelevant. What is relevant is its logical operations, and these are carried out entirely and sufficiently in the abstract space with its "states" – these are the robot's (or computer's) "operational dynamics" and can be achieved whether by abacus, a register machine made of beans and shoeboxes, a Turing Machine with its infinite tape, or a modern CPU. The robot is the expression of the classic metaphysic applied to mind, but equally then it is *in principle* excluded from conscious perception, for perception occurs only for a "device" or organism intrinsically embedded within the transforming universe of the temporal metaphysic where all the events of perception are time-extended – participants in the indivisible, melodic flow, even down to the most "instantaneous" of events, save ultimately for that extent defined by a mathematical point in the abstract space.

Time and Direct Perception

We've described the "temporal metaphysic" which underlies major aspects of direct perception, particularly the time-extent of ongoing events with a certain extent into the past, and as well, why this specification is at a scale of time. For most in the Gibsonian fold, this is already enough – we need add no more to explain how the brain is specific to the environment (or in the more standard statement, how invariants are "specific to," in fact, *unambiguously* specific to, the environment), i.e., how we see the coffee being stirred "out there," on the table. Turvey (2019), noting how the animal both sees the surface and *walks* on the surface, states simply:

"There is no other 'object' between the animal and surface. This two-term relation is all that is meant by direct perception" (p. 28). Relatedly, "To perceive things is to perceive how to get about among them and what to do or not to do with them" (p. 365). The latter, however, gives us little basis to distinguish from a robot (also navigating among things), Blau and Wagman (2022), in their speculations on whether a robot can achieve perception, bring in all the richness Turvey's statement implies – prospectivity, retrospectivity, flexibility – but theorists outside the Gibsonian community, focusing on the brain and/or the robot architecture, will repeat Chalmers' question: how does this architecture account for qualia (by implication part of the specification of the world)? And unfortunately for those outside the Gibson community, a principle like "this two-term relation is…direct perception" is a level of abstraction that is yet hardly comprehensible. Lehar (2001), in his discussion of Gibson's statements on direct perception can make no sense of it. Purves and Lotto (2010) flatly declare that Gibson's direct perception is generally viewed as "mystical." Searle (2015), actually trying to argue for and build a theory of direct perception, never bothers to even mention Gibson! Something is missing for direct perception's comprehension.

The brain in this time-extended resonance metaphor, with its perceptual activity, is still a mass of neural flows, where something about these flows and their chemical velocities is establishing a proportionality or ratio – a ratio of "brain events," shall we say, to the elementary micro-events of the external field, say, to the micro-events of the fly moving by, such that a scale of time is specified – a "buzzing" fly. There is obviously no image of the coffee cup or of the fly identifiable in this mass of flows. Addressing this aspect of the problem, we say that the flows (as a resonance) are "specific to" the coffee stirring, i.e., to the set of invariants defining these events (or the flows are in effect "resonating to" this structure).

If the concept of the brain's role in being "specific to" *a scale of time* is not introduced, this "specific to" is already incomprehensible in this sense: the environment, taken in the physics story as in reality existing as a mass of featureless atoms and whirling electrons, looks nothing

like the environment of trees, buzzing flies and coffee cups. We've alleviated this dilemma here by noting that the brain in its specification establishes a ratio, a ratio reflecting the comprehensible, familiar scale of time characterizing the environment. Nevertheless, "specific to" is a *magical* term here. It carries no actual mechanical, physical, concrete meaning that allows one to make concrete sense of it, i.e., to concretely understand how there is now an *image* of the world (at some scale of time). Gibsonians have gotten comfortable with this level of vague abstraction. To me, this really should not be so.

There is a *concrete* example – a very physical process – of specification (Robbins, 2000, 2006a) of an image. This is something I have hoped the ecological community would consider as the framework in which specification gains a concrete understanding. It too originated with Bergson. It appears in the first chapter of *Matter & Memory* (1896), a chapter considered "obscure" by his contemporaries. In it, Bergson noted that there can be nothing like a "photograph" of the external world developed in the brain. We will find nothing remotely looking like the coffee cup and spoon inside the skull. The neuroscience of his day was already clear enough on this. But Bergson went on:

> But is it not obvious that *the photograph, if photograph there be, is already taken, already developed in the very heart of things and at all points in space*. No metaphysics, no physics can escape this conclusion. Build up the universe with atoms: Each of them is subject to the action, variable in quantity and quality according to the distance, exerted on it by all material atoms. Bring in Faraday's centers of force: The lines of force emitted in every direction from every center bring to bear upon each the influence of the whole material world. Call up the Leibnizian monads: Each is the mirror of the universe (1896, pp. 31-32, emphasis added).

This was Bergson's declaration, 51 years before Gabor's 1947 discovery of holography, and 80+ years before Bohm (1980), that the universe – yes, our environment – is a holographic field, that at every point in the universe is the information for – the "photograph" of – the whole. But unlike Pribram (1971) where the *brain* is the hologram, or Bohm (1980) where the brain, very vaguely, somehow is involved in unfolding an "explicit" order in the field, Bergson, we can say in updated terms, saw the brain as being (or creating, supporting) a modulated reconstructive

wave passing through this holographic field (Figure 3). The neural processes – action potentials, neural spikes, etc. – seen currently as supporting "computations," in fact all that is presumed to support the "resonating" brain, become integral participants in the formation of this concrete waveform.

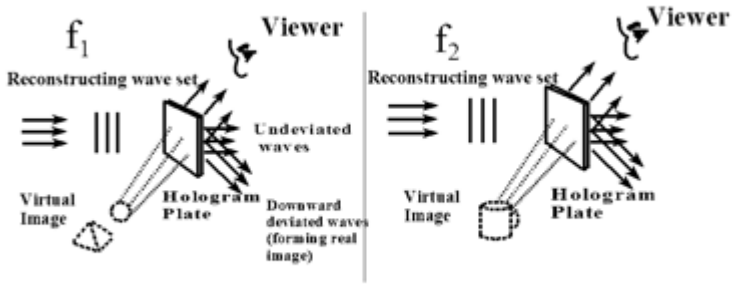

Figure 3. Modulating the reconstructive wave. Two object wave fronts are stored on the same hologram plate. Modulating the reconstructive wave to frequency 1 specifies the pyramid-ball; frequency 2 specifies the cup. The universe, in Bergson's framework, is now taken as the (dynamically changing) hologram "plate," the brain as the reconstructive wave "passing thru" the plate, specific to a source within the universal field.

Immediately after the "photograph" passage, Bergson noted:

> Only if when we consider any other given place in the universe we can regard the action of all matter as passing through it without resistance and without loss, and the photograph of the whole as translucent: Here there is wanting behind the plate the black screen on which the image could be shown. Our "zones of indetermination" [organisms] play in some sort the part of that screen. They add nothing to what is there; they effect merely this: That the real action passes through, the virtual action remains (1896, p. 32).

In Bergson's terms, the universal field is a vast field of "real actions" (one can read "waves," for concreteness) rippling everywhere – a vast interference pattern. Any given "object" acts upon all other objects in the field, and is in turn acted upon by all other objects. It is in fact obliged:

> ...to transmit the whole of what it receives, to oppose every action with an equal and contrary reaction, to be, in short, merely the road by which pass, in every direction the modifications, or what can be termed real actions propagated throughout the immensity of the entire universe (1896, p. 28).

The subset of these actions (or information) that the brain-supported reconstructive wave picks out is a portion related (or relatable) to the body's action. This action-relatability is the information-selection principle from the "hologram." Thus, perception, as Bergson argued, is *virtual action*. We are seeing how we can act. Or, put in a more ecologically familiar way, we are seeing what the environment "affords." When taken in conjunction with the brain's role in specifying the field at a scale of time, the virtual action principle (and equally so, or should have been so, for the "affordance" concept) indicates that as the specified time-scale changes, the possibility of action is equally changing, and this must be so for perception to be ecologically valid at all scales. If the "buzzing" fly is an index for the kind of action possible, say, to move the hand-arm quickly to *grab* the fly, a heron-like fly or even better, a nearly motionless fly is a specification of a different form of possible action, e.g., reaching out slowly and leisurely grasping the fly by the wing-tip. Such an implication should be ultimately testable.

In this, then, the brain is not "generating" an image; it is not generating "experience." The image, as a specification of a dynamically changing, time-extended *past* subset or aspect of the field, is within the external field, right "where it says it is," not "in the brain."

This, in brief, is a framework in which "specific to" gains a concrete coherence.[4] Yes, the detailed description/science of how the brain in effect forms a reconstructive wave certainly awaits, along with the physics of the holographic field (Bergson is *not* "the holographic principle" of current physics). This eventual description of the brain's dynamics must intrinsically incorporate the dynamic invariance structure of the external event, for one can argue, as in effect Gibson already has, that it is the invariance structure of the event that is driving, modulating the brain as this dynamic, specifying reconstructive wave. I use the term "invariance structure" here

[4] I must note here the brilliance of Bob Shaw as intrinsic to this development. Circa 1972, during a visit to U of Minnesota by Pribram, Shaw discussed holography in his seminar, reversing Pribram's "brain as a hologram" conception and arguing that the brain is in fact *within* a (universal) hologram, and acts as the reconstructive wave. It was this that made me suddenly realize what Bergson was saying in the obscure Chapter 1 of *Matter & Memory*. Shaw developed this (he had a large set of notes on it), but eventually quit pursuing this, telling me that he and R. McIntyre had determined they did not like the implied mode of

simply to designate the list of invariants involved in the event. For our "stirring coffee with a spoon," a partial list:

- A radial flow field defined over the swirling liquid
- An adiabatic invariant re the spoon, i.e., a ratio of energy of oscillation to frequency of oscillation (Kugler and Turvey, 1987)
- An inertial tensor defining the various momenta of the spoon (Turvey and Carello, 1995)
- Acoustical invariants
- Ratios relative to texture gradients and flows for the form, size constancy, even our grasping of the cup (Savelsbergh, Whiting and Bootsma, 1991)
- And more…

Certainly, all this is being related in the brain to the action systems, necessarily so for perception being the display of possible action. Again, a description of the neuro-dynamics of the brain that does not show how the dynamic invariance structure is reflected in its processes, in its resonant wave, must be considered off the track (Robbins, 2014b).

Raja (2019), reflecting on and explicating the resonance concept, reinforces this last comment, noting that, "…resonance is what is going on inside the organism, especially in the CNS, with regard to what is going on at the ecological scale (p. 33)." Thus, the invariants specific to the baseball's arc through the air (and simultaneously to the outfielder's catching the ball) must be reflected in the neural processes of the brain. However, as noted, there is the distinct possibility that one can alter the bio-chemical level of the CNS, that we can raise the resonant frequency, so to speak, of the CNS, and now what is going on in the CNS is relevant no longer "to what is going on at the ecological scale," at least to the *normal* ecological scale of humans, though perhaps it is now what is normal to frogs with their higher metabolic rate – a function perhaps of the ratio of body mass to oxygen consumption (Fischer, 1966). As opposed to "buzzing" flies, the flies now specified are nearly motionless, stable flies (easily flicked out of the air by a frog-tongue in *its* normal scale). I note this to again make the point that *what the brain is specific to* is equally critical; the invariants hold across all scales to time!

"information pickup." This is still a curiosity to me; as one reads this paper, I doubt one can see anything but support of Gibson's resonance model with the information pickup implied.

Raja rejects the current, standard, cognitive science-move or transition from a description based in the concrete physics and dynamics of the brain to a level of description that is purely computational. He moves to a description of the CNS and the invariants of the environmental event based in dynamic systems theory (DST), an approach which, given the right parameters, he nicely demonstrates allows us to see symmetric reflection of the structures. I would simply note that ultimately, this resonance (and Bergson's reconstructive wave) must be taken far more concretely than DST can capture. Yes, one can describe an AC-motor in terms of attractors and bifurcations, but this is ultimately unhelpful if building an AC motor, for now the actual forces and materials and configuration thereof become critical.[5] When describing the reconstructive wave in Bergson's framework (and which I'm arguing is in effect Gibson's) – the forces and materials supporting it – this concrete level will be required, for the brain is supporting or creating a very concrete wave "passing through" a very concrete holographic field. When we enter the biochemical level relative to perception, this concreteness and its complexity becomes especially evident (cf. Robbins & Logan, 2022).

Concluding Comments

Perception (experience) is not occurring solely within the brain. Therefore, it cannot be solely stored there. This is why the "brain-as-storehouse" is "stultifying" per Gibson; it cannot be correct. Placing Gibson within Bergson's temporal metaphysic and the indivisible transformation of the holographic field, it becomes explicit that we are dealing with the organism as a 4-D being, and that *direct memory* involves redintegrating some aspect of the experience comprising our 4-D, time-extended being – re-resonating to that experience in some form – the invariance structure of both a present event and some past event again playing a critical role (for a

[5] A fact Charles Steinmetz knew well when trying to formalize principles required for the construction of N. Tesla's AC motor (*The Theory and Calculation of Alternating Current Phenomena*, 1900), up to that point nearly non-replicable (they were burning up) because of the precise nature of the metals involved – a knowledge for a period of time apparently peculiar to Tesla.

start on this concept, cf. Robbins, 2006b, 2009, 2017, 2020).[6] The critical point here, however, is that once we have a clear, concrete model of how *the image of the external world* is specified – that cup of coffee being stirred – we become clearer that there must be a redintegrative mechanism for re-instantiating that image/experience of the past (as Bergson argued extensively in M&M).[7] In turn, our theory of cognition is no longer obligated to avoid all use of images (representations) (e.g., Barrett, 2011, Chemero, 2011, Hasselman, 2022); it is freed to consider the employment of dynamic images in thought. It can begin looking at thought involving dynamic images preserving invariance over transformations – what Penrose (1996) was pointing to in his examples of "non-computational thought" (Figure 4) – where the *indivisibility* of this transformation/flow allows the *globality* of the transformation to be perceived, the invariance registered. (Wertheimer's *Productive Thinking*, 1954, is filled with similar examples, as well as Piaget, 1946, Arnheim, 1973, Bruner, 1969 – a literature simply not being engaged with).

[6] "Redintegration" is a term coined by Christian Wolff in his *Psychologia Empirica* (1732), where part of a present event retrieves a whole past event – a rustle in the grass redintegrates an experience of encountering a snake. An event is *a structured pattern*, as Klein (1970) restated things, and the pattern can be recalled by reinstatement of a constituent part of the original pattern. Obviously, Gibson is the prime descriptor of these event patterns (Robbins, 2006b); it is the invariance structure of a present event (E') that cues/redintegrates a past event/experience (E) with similar structure, or, E' => E.

[7] Carello and Turvey (2020) argue for avoiding the use of "image" in the process of perception. As far as a required retinal image or for construing the image as a "copy," certainly so, but here I would argue Bergson is more correct. An image, he argued (1896, Chapter 1), is always a subset of the field, an aspect of the whole. Even just the "cup" on the kitchen table, as an image, is not the famous "thing-in-itself," this thing-in-itself cup being a far richer object, only existing via its relations with and within the entire field. Everything presented to us is under the aspect of an image – the "brain" is an image, so is a "neuron," an "atom," cups, molecules, and yes, an event – a disturbance in the external field – such as coffee stirring. In this understanding, we are not, we cannot, be specifying the actual event – the coffee stirring in all its richness; we are specifying the event as an image of a transformation in the whole. This is to say, unless you are a "point" in Bergson's holographic field, responding to, reflecting the influences of all other points in the field and influencing all other points, your experience will be of some aspect or part of the field – an image. The holographic field – a massive interference pattern – is itself non-image-able (as is true, it can be argued, of the optic array); the only way to specify an aspect – an image – being via a reconstructive wave. This is equally to say that the problem of image specification in perception is an *optical* problem, a problem of physics, albeit one that must be solved within the framework of the temporal metaphysic.

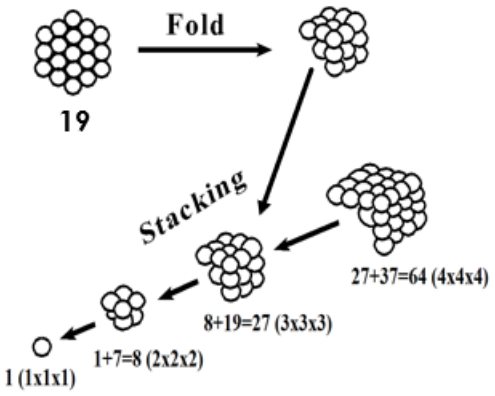

Figure 4: Penrose: A visual proof of a computation that does not stop – his *non-computational* thought. A hexagonal number/form is folded into a three-sided cube, and stacked over the previous, invariantly making a cube. (After Penrose, 1996)

This places Gibson as a comprehensible and concrete alternative to the computer metaphor of mind, giving substance to the term "non-computational thought." The computer model, as already noted, with its "states" (after state after state…) is the epitome – the realized dream re the nature of mind – of the classic metaphysic of space and time. It is the indivisible flow of these transformations, in which our consciousness participates, allowing the invariance to be registered, that Penrose, in reacting to the computer model, failed to recognize as intrinsic to what he was describing (Robbins, 2014a, 2014b). We can dump the "computer metaphor," but if the classic metaphysic beneath it is not recognized and is still blindly employed as the basic framework of explanation, not much is achieved.

In all of this we have been addressing aspects of the hard problem of consciousness. There are many correlated aspects that could be discussed – the relation of subject and object, additional observations on qualia (*every* qualia is a function of time), *explicit* memory, voluntary action and more. But none of this gets truly started or grounded without an explicit acknowledgement of the temporal metaphysic underlying Gibson. This does not mean that mathematics is rejected; certainly, in this paper for example one sees heavy allegiance to invariance laws.[8] But what it

[8] Bergson's (1907, pp. 10-22) discussion of entropy and time expands Gibson's (1975, p. 295-296) view on the irreversible transformations that are ubiquitous in the environment – the breaking of eggs that cannot be

does mean is that the mathematics must be placed within the proper context, namely, that mathematical description, with its inherent, spatial metaphysic foundation, is only an approximation within and to the temporal metaphysic – an *ideal limit*, never reached. As Gibson stated, "Time and space are concepts, abstracted from the percepts of events and surfaces...Time and space are intellectual achievements, not perceptual categories" (1975, p. 299). The brain does not dwell in the world of the classic metaphysic, and it is a mistake to exalt this metaphysic in which mathematics is based and must necessarily work, into a reality, that is, to confuse the artificial construct of the *abstract space*, which is derived by our brain via its cognitive development, with the temporal reality of the indivisibly transforming environmental field in which the brain – its cognition and perception – is intrinsically embedded and in fact dwells.

reversed, the collapse of a river bank, where the time-less (better *duration*-less) time-reversible equations of physics fail to be useful in the ecological case.

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