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Perceiving the Reality of Time

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I am hopeful that my research will open the question of temporal experience and perception to the scientific world. I am glad I had the chance to learn and share my work.

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Prologue

What is the reality of time? Is time something that we can successfully assert as being real or unreal by using perception or, conversely, eliminating it? Is it even possible to provide any meaningful account of time, as a human, without including even the slightest tinting of human perception? The careful consideration of human perception through our lived experience reveals that time is something real. We perceive the reality of time through the nature of our “being” and how beings themselves are intricately connected to one another through temporal and special relationships. Perceiving time as experientially real is fundamental to the reality we experience. Hence, the fabric of space and all things; past, present, and future must be included as the foundational prerequisite form of all reality itself if we are to generate a theory of reality at all. By using our perception to examine both scientific and metaphysical assertions we will become better equipped to answer questions regarding time, space, temporality and reality and, perhaps learn something meaningful about the world.

My journey to uncover the reality of time begins in my own back yard, meaning through my encounters with philosophers. First, Martin Heidegger’s *Being and Time* asserts, in a nutshell, that time basically *is* being insofar as we understand the experience of being. Heidegger builds upon the German philosophic perception of time that takes shape under Immanuel Kant. Second, Alfred North Whitehead’s metaphysical project *Process and Reality* hypothesizes that all existence is the unfolding of a process in which time is inseparable from the totality of existence. For Whitehead, it is the *process* of being that is at the core of reality and the process is interwoven with time. Third is with the famous scientist Albert Einstein. His Special Theory of Relativity, by contrast, treats time as dependent on individual inertial frames; hence, at the general level time is an illusion. (Einstein’s theory asserts that time as we experience it is relative

to individuals or individual spaces). Finally, but in no way least, Henri Bergson's *Time and Free Will* denies the homogeneity of time. He refers to the human experience of time through the concept of "duration" and he suggests that there is a uniqueness that can be found in each individual experience of time. Many other great thinkers reveal the hidden nature of time through speculative thought as well as scientific thought. The problem of time is persistent.

Heidegger and the piece of wood the wept an laughed like a child

Our perception reveals that exist in the world of an ever changing present which is the center of being, as far as we know. Heidegger calls this existing "*Dasein*."¹ The term *Dasein* means *being there, presence, or existence* as experienced by human beings. *Dasein* is the *being* of beings; for the being whose being is a problem for it. By *being*, we mean *Dasein's* existing; in the sense that *beings* are real and are existing "*in the world*" and they are "*of the world*." This mode of *being* is the major concern for *beings* like us who experience *being* as time. As human *beings* we are the historical creatures experiencing the existence of *being*, which is our objective world. We also live the experience of *being*, which is perceived as a subjective experience. Heidegger says, "What is in time and is thus determined by time, we call the temporal."² Human beings do experience *being* in time: thus we must be considered temporal *beings* in addition to *being* thought of as *beings* that exist in space, but we are separable into past present and future temporally and we perceive the world as such. That is, we believe we are real beings because of this perceptive quality of being and experiencing the world.

Presence is transitory. Heidegger states, "From the dawn of Western-European thinking until today, *being* means the same as presencing. Presencing, presence speaks of the present."³ The movement of time is experienced in the form of present moments or an experience of being *in the present*. The present is where existing (or presencing) occurs for all human beings. This is

the relevant perspective we have in terms of beings that can look back on the past and move forward into the future through our experience in the present. In Whitehead's *Process and Reality* he echoes this feature of our presence, which he calls causal efficacy. "Perception in its primary form is consciousness of the causal efficacy of the external world by reason of which the percipient is a concrescence from a definitely constituted datum."⁴ This means that the perceiving being experiences the present relative to the information it gathers from the actual world where both the perceptive being and the world are *real* in the concrete sense. Our perception of present moments of time is analogous to riding the crest of a wave on the ocean.

The Backstory of the Past: Whitehead and la Fata dai Capelli Turchini

In the wake of the present moments of time, the past recedes and it perishes perpetually. The march of time is unrelenting. Yet our past is active and it captures the present moments, encapsulating them forever insofar as those moments are available as memory. Unremembered time is no less real, per se, but without the aid of some sustaining entity the unremembered moments may be indefinitely lost. All humans recognize the past as constituted by events and experiences that actually occurred in the "real world" however that is understood. It would be very difficult to get at these events in any other way. Whitehead says, "Memory is perception relating to the data from some historic route."⁵ Our memory is the causal efficacy (meaning the result of achieved satisfaction in the past) of the events of *being* as experienced and felt by the actual entity in its present. The past is always with us. Without active memory of the past we would struggle with the simplest of tasks, such as walking and talking. We rely on learned information to form our "souls" (in Bergson's peculiar sense), in order to survive, or even to be aware that we indeed exist. We rely on our perception of the past to form an image of our history and define who we are in the present. Even those moments which are lost to us and not directly

or objectively remembered can claim the possibility of being responsible for the formation of our world. It seems clear that our being, all being for that matter, is the sum of temporal experience to date.

Our present activities are also forever leaning forward, toward the future. A series of seemingly endless and perpetually unfolding moments become seamlessly merged into the ever evolving continuum which yields “now.” The future is the realm of the possible, the place where novelty waits in a “not quite yet,” pre-gestation state of “maybe-ness.” We look toward the future as we project all our aspirations “as if” these moments will come to fruition; almost like we are wishing, but, often, with prophetic certainty. Whitehead says, “The stone has a reference to its past, when it could have been used as a missile if small enough, or as a seat if large enough. A stone has certainly a history, and probably a future.”⁶ Even a stone exists in the present and it has a past, a history. In its current form it is likely to continue to exist in a very predictable manner. The stone will continue into the future until it gradually deteriorates, becoming stone dust, as the forces of the world grind it away. With all its predictability, such a stone still has potential to travel the universe, becoming the staple of a rock garden, or, perhaps, be pulverized to dust by any number of natural catastrophes. The future for beings like us, humans, is much less predictable and has a much greater breadth of possibilities than does the stone. It is our hope for the future that drives us on. The future is the realm of potentiality and possibilities that have yet to be determined. The hopeful being is guided by its *feelings* towards the future and apprehends each novel instance ingesting possible outcomes that are intrinsic to each individual moment. Each being perceives a *possible* future while the real one unfolds as a hybrid of causality and invention.

With all these realizations listed, how can we define time? Is time just the marking of our sauntering around the sun? Is time something like the frames of a film progressing T^1 - T^2 - T^3 and so on? There are many eloquent descriptions of time, many of which seem quite plausible. Time is typically, however defined, thought to be definable in terms of the past, present, and future. However, the past, present, and future presuppose time as already existing. This is not helpful because these terms can only function as predicates regarding time's existence, while leaving the full determination of time still unresolved. In fact, as far as we can tell, the past and the present seem to only exist at the moment when they are available to us in the present. The past becomes memory, a distant fading shadow of ever more distant memories of the present. These memories remain hidden from actual existence and struggle to retain their relevance. The only evidence of their existing at all resides in their presentation as objectified, as Whitehead suggests, by their descendants.

If we look to what remains of the historic past we might yet discover a deeper insight into the character of the phenomena we call time. In his essay on History, Ralph Waldo Emerson says, "There is a relation between the hours of our life and the centuries of time. As the air I breathe is drawn from the great repositories of nature, as the light on my book is yielded by a star a hundred millions of miles distant, as the poise of my body depends on the equilibrium of centrifugal and centripetal forces, so the hours should be instructed by the ages, and the ages explained by the hours."⁷ As we take in the wisdom of Emerson, we experience the reality of time in each breath of air. Imagine the air that has blown to you from other times and spaces. It is so ubiquitous that we seldom think of it as it is. The air we breathe is a newly born traveler existing in constant fluctuation for countless ages; stretching backward far beyond the ages of men. The light that traverses the great expanses of space from distant stars and shines

continuously has a constant connection to our reality. Even Emerson himself is a sign post revealing that we can access relevant information from great thinkers in the past like a historic rolodex of wisdom, and explore the meaning of time and, perhaps, locate beings with shared perceptions and curiosities. In this regard, we have an ever flowing chalice to draw upon in our quest to know the mysterious “Holy Grail” of time. There is hope.

Act I: The Genesis of the Experience of Time

Long ago, various mystical traditions developed and gave rise to modern religion. All of these religious traditions, as we perceive them, entertain some theory of time and claim to have a history. One popular reference to time that many are familiar with occurs in the Old Testament book of Genesis. It is written, “In the beginning God created the heavens and the earth. Now the earth was formless and empty, darkness was over the surface of the deep, and the Spirit of God was hovering over the waters.”⁸ One may ask, “Why bring in the Bible?” How can religious fairy tales help us to understand the meaning of time? Regardless of one's religious convictions, this biblical passage reveals a temporally significant progression that is fundamentally related to time. It is temporally relevant that it is said, “In the beginning (meaning *when*) God created the heavens and the earth.”⁹ This instance may be merely metaphorical, as opposed to historical, but it is important to note that having a beginning presupposes an instance in time, a *then* moment. From the description of this beginning there are no specific limitations placed upon time. One can speculate whether or not this particular beginning is specifically *the* beginning for the heavens and the earth alone (meaning when the deity did the thing, the act of creation, that made the stuff, the entire known universe) or if this moment was also the inception of God as a being (in other words, God's birthday). The main thing to note is that when these past actions described in the text took place, it was a presumed to be a present moment, a supposed “beginning” to all

that we know. This beginning is a foothold for our perception of both “the beginning of time” and of the creator God, the creator of material things out of a void of nothingness. The God of Abraham is the beginning and the end for Jewish, Muslim, and Judeo-Christian time for most believers; Alpha and Omega and being of beings are one and the same. For the purpose of this work it is the ordering or the temporal progression of events as they occur in this narrative, that is relevant to understanding our perception of its meaning and, perhaps, the ordering is at least as important as the content. As a member of the Western, Christian dominated culture; the notion of this God exerts a long standing influence on my thought and perception which cannot be excluded. Given the nature of relationships in time and space and, additionally, the reciprocal influence of religious thought throughout the world, even among the non-religious, it is reasonable to assume that this and other creation narratives should be included in any meaningful discussion about our perception of time.

Act II: Olympus Illuminated

Early Greek philosophers also recognized the importance of time. The whole of western civilization has been formed along-side fundamental philosophical questions involving oriental concepts of time. The import of this history is itself likely to be both multifaceted and manifold. Heraclitus believed in a universal law that was based on change and strife. He said, “It is not possible to step in the same river twice.”¹⁰ The river stood as a symbolic representation for the whole of existence rushing past us *like* a river. It remains a powerful metaphor. Unlike philosophers before him, such as Parmenides, who claimed that the world was static and unchanging, Heraclitus observed a world that was constantly changing. His world was composed of pure fire, existing in many different forms. Behind this was the “hidden harmony”¹¹ of the *Logos*, “the law of change which is itself changeless, the law of generation which is itself

ungenerated, the law of decay which is itself immune to decay.”¹² Perhaps the *Logos* was time itself. Time was both the ever changing reality and the consuming fire. This reality gave birth to all things and destroyed them as well. This relationship is constructed much like the union of Gaia and Kronos in Greek creation mythology. Gaia, the Earth mother, gave birth to the children of their union and Kronos, the father who is both chaos and night, gobbled those up out of fear that they might, one day, overtake him. This is very consistent with the concept of God as the *Alpha* and the *Omega*. The Alpha and the Omega are terms which mean the beginning and the end. They are the first and the last letters of the Greek alphabet and are symbolic links between the power of the Gods and the power of time. More importantly, each of these symbolic metaphors, which are very similar, belongs to different cultures and different times, but transfers a similar meaning about the nature of the temporal world.

It is possible that ancient mathematicians also recognized a connection between the cosmic structure of the universe and the numbers that emerged through music, mathematical shapes, and the concept of time. The Pythagoreans believed that numbers were the underlying theme that linked all things and held them in common. They found evidence related to numeric qualities throughout the natural world. Over time they derived three means through which all things could be measured; the arithmetic mean, the geometric mean, and the harmonic mean. The Pythagoreans believed that there was a hidden harmony observable in the rotation of the heavenly spheres that was also present in the vibration of strings. The underlying unity that they were touching on was the time signatures observable in music, the movements in the divine heavens above, and the geometric similarity of physical bodies on earth. The procession of time was apparent in each of these phenomena. The common thread that bound them was that they could each be understood through the mathematics and number. This is important because it

reveals an early historic recognition of the relationship between both the physicality and temporality of the world that is knowable and, for these early humans, being is perceived as a seamless whole.

Act III: A Small Corner of the World and the Saddle Maker's Son

Nearly two millennia later, Immanuel Kant provides a subjective concept of time in the *Critique of Pure Reason*. This is part of what is known as the second Copernican turn; this was the turn from the external perspective held by the Ancients and the Moderns toward a world view that was based on the subjective conditions of human cognition. Kant explains his idea of time clearly stating, "I perceive that appearances follow one another."¹³ For Kant, all of our perceptions, and therefore our experiences, are in time and presented to cognition in a successive manner. We order time in such a way that one o'clock in the afternoon comes before two o'clock in the afternoon. It also comes after the noon hour. Accordingly, it is a necessary fact of our experience that one moment in time occurs either before or after another, at least insofar as we can make sense of it. Time itself is the condition for all our experience and even the intuition of space gives way to the time although the form of each is intuited *a priori*. Kant states that "the apprehension of the manifold is always successive"¹⁴ and therefore "the manifold of appearances is always generated in the mind successively."¹⁵ The manifold of appearances is the sum total of our processes and it includes all of our sensible experience and our comprehension of all the sensory data. Kant is careful to separate subjective succession, for example, our viewing a house in any particular manner, from objective succession, or of a ship sailing down a river. In the first event the viewer, or perceiver, is in control of which particular section of the house will viewed and in what order. In the second event the ship continues down the river and its position in the water alters as it moves farther away. In the later sense the temporal succession is objective

because it was a necessary order in the event. The other is termed subjective although one could argue, from a historical perspective, that the succession of the first event could never occur in any other order in that time. We will avoid this thinking which could lead us to the A series versus B series argument of McTaggart, which seems unproductive at this juncture.

Kant says, “The relation of cause to effect is the condition of the objective validity of our empirical judgment”¹⁶ and this implies that “the principle of the causal relation in the sequence of appearances is therefore also valid of all objects of experience.”¹⁷ For Kant, there must be rules that ground our experience in order for our minds to make sense of the objects *in* our experience and of the events that occur therein. We find these rules in judgments and in the categories, like those of causality. Kant has shown how former events necessarily precede later events and how they have a necessary relationship to one another through the succession of time. The succession of time reveals the relation of cause to effect, that is, to the sequence of time and experience and its objective validity. Every alteration takes place in time and every alteration takes place in conformity with the law of cause and effect within its succession. Thus Kant threatens the ground of experience; mine yours and ours.

The past, present, and future are already a temporal relation which is why Kant’s account of temporality is unsatisfactory. Additionally, Kant claims that time is merely an element of human intuition. In Kant’s theory, time only exists as the *a priori* condition for the possibility of experience and cannot exist, as far as we can know, in the external world. Kant claims that the boundaries of reason cannot extend beyond our possible experience. Subsequently, we cannot possess knowledge of things as they really are in themselves. We are stuck with mere appearances that are given to us in the sensible manifold. If this is true, then all of the history of the world is, in itself, unknown, and the experiences we have are reduced to appearances. Kant

neglects the alternative that our senses *give* us the actual world *as it actually is*, and the only limitations that we have are in perceiving those elements that are beyond our faculties. Some examples of this are that ultraviolet light cannot be seen with the naked eye, sounds beyond a certain range are inaudible to human ears, and certain gases have no odor for the human nose. Kant provides a number of useful insights with regard to time, but the neglected alternative cannot be overlooked so it is necessary to draw out the best of Kant and move forward in our search for answers.

Act IV: Pinocchio becomes a Real Boy

In contrast to Kant, Bergson discusses time in terms of duration. For Bergson, durational time is experienced in terms of intensive and extensive magnitudes. The extensive magnitude is often recognized as quantitative; like the time it takes for the moon to circle the earth or the earth's procession around the sun and all the related specified measurements. These physical facts do not exhaust the case. An intensive magnitude is best regarded as qualitative; like the how we recognize the meaning of having a sun and a moon, how it makes us feel about the world and our lives as the seasons change, etc. The depth on the intensive magnitude extends beyond imagination. For each individual, the experience of duration is unique. Every individual being occupies a certain time and space and the experiences within that time and space are one of a kind. They experiences are only as we perceive them to be. This is the heart of free will for Bergson. Bergson claims, "Duration thus assumes the illusory form of a homogeneous medium, and the connecting link between these two terms, space and duration, is simultaneity, which might be defined as the intersection of time and space."¹⁸ This means that duration is not homogeneous in all places and times. As an extensive magnitude, we understand that time in a black hole is not homogeneous, but that shows the extreme limit of extensive thinking. For

intensive magnitude Bergson asks us to recall a time when five minutes seemed to drag out forever, or when an hour flashed by in what felt like only a short time. Bergson insists, “Not all conscious states blend with another as raindrops on the water of a lake.”¹⁹ Bergson means that these experiences are all qualitative and therefore, beyond total measurement by either physical or mathematical means. This brings us to the contemporary disputes between physics and philosophy.

Act V: Slings and Arrows

Albert Einstein is world famous for his work on the theory of relativity. Einstein’s theory says, “the same laws of electrodynamics and optics will be valid for all frames of reference for which the laws of mechanics hold good which is known as the Principle of Relativity.”²⁰ Einstein also states, “Time is absolute, i.e., independent of the choice of the particular inertial frame; it is defined by more characteristics than logically necessary, although - as implied by mechanics - this should not lead to contradictions with experience.”²¹ Einstein is fully aware of the existences of time *per se* as it exists regardless of inertial frames. In order to make time work for special relativity, the notion of time had to be adjusted as Einstein states “To harmonize the relativity principle with the light principle, the assumption that an absolute time (agreeing for all inertial frames) exists, had to be abandoned.”²² This was the move that opened the door for many physicists to claim that time only exist as it is relative to inertial frames, but does not exist *per se*. These scientists forget that mathematics is a human construct. They also discount the fact that when isolate a piece of the universe in order to study it, we never really completely separate it from the world, except in our minds.

These scientists package time within the framework of a subjective location and claim that Einstein’s theory suggests that time is unreal. One only need to reflect on Bergson’s

suggestion that time is not homogeneous; therefore, the restriction to inertial frames does not disqualify time as being something real, in fact it locates human perception within the narrative of time. Additionally, it is important to note that a Bergsonian notion of time works well with the quantum theory of time in ways that Bergson never imagined. Quantum theories of time include a notion of “when” a thing is present in a relative location and they allow, as Bergson allows that time is not homogenous, that even universal laws and symmetries are malleable. Theoretical physicist Lee Smolin discusses this in his book *Time Reborn*, stating, “Time’s reality allows a new formulation of quantum theory that can also illuminate how laws evolve in time.”²³ The evolution of laws might help understand how a world like ours can come into being. If we consider this merger of Bergson’s concept of “duration, considered as a creative evolution, there is the perpetual creation of possibility and not only of reality,”²⁴ which allows for multiplicity and novelty to enter into our perception of time and quantum theory.

Denouement: The Tragic Absence of Place (or, You Can’t Go Home Again)

The importance of time, perception, and observation cannot be discounted with regard to quantum or temporal theories. Whitehead worked on his universal cosmology and he believes that the universe is a process of concrecence of actual entities, actual occasions, and eternal objects. The theory of actual entities is analogized as a cell theory. The actual entities range from the singular entity and form more complex actual entities when they gather in a society. The rules of the many and the few are the same; they are only relative to an actual entity. The actual world exists as a concrete physical world, but its primary nature is temporal because it is in constant creative flux. Whitehead says, “The universe includes a threefold creative act composed of (i) the one infinite conceptual realization, (ii) the multiple solidarity of free physical realizations in the temporal world, (iii) the ultimate unity of the multiplicity of actual fact with

the primordial conceptual fact.”²⁵ The universe is the one infinite conceptual realization and the primordial conceptual fact. All other beings are the multiple solidarity of free physical realizations in the temporal world that make up the multiplicity of actual facts of the universe. For Whitehead, God is the possibility of physical and mental actuality, but each actual entity has autonomy. Whitehead finishes *Process and Reality* by stating, “We find here the final application of the doctrine of objective immortality. Throughout the perishing occasions in the life of each temporal creature, the inward source of distaste or of refreshment, the judge arising out of the very nature of thing, redeemer or goddess of mischief is the transformation of itself, everlasting in the Being of God. In this way, the insistent craving is justified—the insistent craving, that zest for existence be refreshed by the ever-present unfading importance of our immediate action, which perish and yet live ever more.”²⁶ Whitehead provides the framework to explain how each moment has meaning and fulfillment regarding the aims of each entity. Whitehead is framing a temporal reality, and that reality can be understood qualitatively through the feelings and perspectives of each actual entity.

Each entity is a “*causa sui*”²⁷ or self-causing entity. The analogy can be recognized in human cell production and reproduction. Our cells reproduce constantly. As each cell participates in this process they take on as much information from the previous cell as available. During this process some of the data may be lost and novel data may be created. This process explains the novelty in the world in Whitehead’s strange sense. The cells contain within themselves the ability to reproduce new cells that are like them yet unique. Whitehead applies this framework to the reproduction of successive moments in time in the “actual world.”²⁸ Through this analogy we can see how perception is important, even at the cellular level. It is also clear that time is involved in our existence.

The Story of the Moral

The being of a thing is made intelligible to beings like us through time relations. Where being and time are concerned, one can relocate Heidegger who states, “Time is the condition of the possibility of care.”²⁹ Our history, the history of being, allows us to engage in the process of reflection through which care can be an option. This reflection provides us with the opportunity to be moral and change our behavior and our habits as we advance toward the future (although one can argue that Heidegger excludes such conclusions personally). Time does give us the opportunity to care. Thus, time is a necessary condition for the possibility of moral action. The mere existence of time provides our reason and our understanding the stage on which they can even be considered as functions. Without the reality of time we could not plan, contemplate, or do anything with a goal in mind. Imagination could not even exist because it requires us to draw from the past and the present in order to craft a creative thought. Thus, time is intrinsic to all action and all possibility; it is self-causing and can be described as both extensive and intensive. The self-causing entity has a reason for care for both itself and the others around it. This notion of care is also at the heart of Whiteheads cell theory and is an intersecting moment for these two philosophies.

After reviewing the available evidence on this journey it appears that the reality of time is something that we can assert as being real by using our perception but, beyond experience we cannot assert that time is real. Human experience is always immersed in perceptions, but there is no reason to think that perception denies the mind of access to reality. The mystery of time is one that can be addressed only with a pause to contemplate the present moment. During that pause we can consider the role that human perception plays in shaping our understanding of time; beyond this we have little to guarantee our knowledge at all. We perceive the process of “being”

as a temporal process and the access that we have to the world is sufficient to understand this truth. For those who will fret about the implications of treating subjectivity as central to our understanding of time, the reality of time is not diminished simply because time is relative to individuals, or individual spaces. The relative view is acceptable when considering time and the notion of “duration” based on the uniqueness of each individual experience of time. After careful consideration of the reality of time I can only conclude that time is *at least* experientially real. Logically, it must be the case that beings themselves are in time, as they exist, and that *being*, as limited in human perception, is interwoven with time. Time is, thus, experientially real and if it is not homogeneous, it is still impossible to measure accurately. This limit fits within all the reasonable existing theories, even the subjective. From this perspective, time is at the base of reality, intrinsic to our perception of the fabric of space, and constitutive of all things past, present, and future. Time remains the foundational prerequisite form of all reality *as we experience it*. If there is some *extra* reality that lies behind the perceptions and appearances that we see today, then we will have a robust conversation once it is exposed. In the meantime, we should consider the *idea* that time, as we perceive it, is the basis for all perceptions of space and, together, time and space are the conditions for the possibility of human experience. This idea should be considered as a companion to the inverse notion we privilege today; that is the privilege of space . The work I have described herein offers a reason to contemplate temporality as primary rather than blindly granting mathematical physics the primacy of defining the *real* relations of being in terms of space and material phenomena. As hopeful beings, we should remain open to the authority of historical references, philosophical inquiry, the useful tools of science, and metaphysics as we ponder the nature of time and our existence in the actual world in which we, for the time being, happily live out our lives.

End Notes

- ¹ Heidegger, Martin. *Being and Time* p.82
- ² *Being and time* p.3
- ³ *Being and time* p.34
- ⁴ Whitehead, Alfred N. *Process and Reality* p.120
- ⁵ *Process and Reality* p.120
- ⁶ *Process and Reality* p.121
- ⁷ Emerson, Ralph Waldo, *History*
- ⁸ *The Holy Bible*, “Genesis 1.1”
- ⁹ “Genesis 1.1”
- ¹⁰ Sherover, Charles M. *The Human Experience of Time* p.11
- ¹¹ *The Human Experience of Time* p.13
- ¹² *The Human Experience of Time* p.3
- ¹³ Kant, Immanuel. *The Critique of Pure Reason* B233
- ¹⁴ *The Critique of Pure Reason* B 235
- ¹⁵ *The Critique of Pure Reason* B 235
- ¹⁶ *The Critique of Pure Reason* A 202
- ¹⁷ *The Critique of Pure Reason* A 202
- ¹⁸ Bergson, Henri. *Time and Free Will*
- ¹⁹ Kleinherenbrink, Arjen. *Time, Duration, and Freedom- Bergson’s Critical Move Against Kant* p.224
- ²⁰ Einstein, Albert. *Fundamental ideas and problems of the theory of relativity*. P.483
- ²¹ *Fundamental ideas and problems of the theory of relativity*. P.483
- ²² *Fundamental ideas and problems of the theory of relativity*. P.484
- ²³ Smolin, Lee, *Time Reborn* p.140
- ²⁴ Canales, Jimena, *The Physicist & The Philosopher: Einstein, Bergson, and the Debate that Changed Our Understanding of Time* p.44
- ²⁵ *Process and Reality* p.346
- ²⁶ *Process and Reality* p.351
- ²⁷ Sherburne Donald, W. *A Key to Whitehead’s Process and Reality* p.16
- ²⁸ Sherburne Donald, W. *A Key to Whitehead’s Process and Reality* p. 207
- ²⁹ *Being and Time* p.41

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