2015

Tempora Mutantur: an examination of time in physics, biology, and human mental experience

Simes, Mark

http://hdl.handle.net/2144/15242

Boston University
Dissertation

TEMPORA MUTANTUR: AN EXAMINATION OF TIME
IN PHYSICS, BIOLOGY, AND HUMAN MENTAL EXPERIENCE

by

MARK SIMES

B.A., Boston University, 2006

Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
2015
The movement of mankind, proceeding from a countless number of human wills, occurs continuously.

– Tolstoy, War and Peace
TEMPORA MUTANTUR: AN EXAMINATION OF TIME
IN PHYSICS, BIOLOGY, AND HUMAN MENTAL EXPERIENCE

MARK SIMES

Boston University, University Professors Program, 2015

Major Professor:  Liah Greenfeld, University Professor of Anthropology, Political Science and Sociology

ABSTRACT

This dissertation seeks to examine the essential nature of time—both the concept in physics, biology, and philosophy, and the phenomenon in life and culture—with the ultimate goal of deepening our understanding of the empirical manifestation of time in human mental experience. It thus engages with both philosophy and with empirical science, natural as well as humanistic, in the paradigms of history, social theory, fundamental (or philosophical) anthropology, as well as with human neuroscience. The central argument is that while time is not an empirical phenomenon in physics – time itself is not an absolute quality of matter – one can make a certain argument for the real existence of time in biology, and still a different argument for a unique, linear phenomenon of time that derives from the specific human, cultural, experience. To make these arguments the dissertation devotes attention to the analysis of both the concept of time and the empirical phenomenon to which it refers successively in physics, biology, philosophy and history/sociology. Arriving at the conclusion that the linear concept of time (the causally significant relationship between the past, present and future) reflects a
phenomenon that is uniquely human and suggests the ways in which this experience is necessarily reflected in the brain.
# TABLE OF CONTENTS

ABSTRACT ............................................................................................................................................ x

THE PHYSICAL UNREALITY OF TIME ............................................................................................. 1

Time in Newton’s Universe .................................................................................................................. 5

Pre-Newtonian Development .............................................................................................................. 8

The Religious Explanation of Newton’s Time .................................................................................. 45

The Dissolution of Absolute Time .................................................................................................... 58

TIME IN BIOLOGY AND BIOLOGICAL TIME .............................................................................. 64

At the Nexus of Matter and Life ....................................................................................................... 66

Life is a Process .................................................................................................................................. 83

The Nature of Organic Time ............................................................................................................. 85

THE HISTORY OF TIME IN WESTERN THOUGHT ....................................................................... 107

In the Beginning God Created Heaven and Earth (Genesis 1:1) .............................................. 112

Plato, Aristotle, and the Problems of Time ....................................................................................... 114

St. Augustine of Hippo ....................................................................................................................... 127

Post Newtonian Philosophy of Time ............................................................................................... 137

Kant and the Transcendental Aesthetic ......................................................................................... 142

Bergson’s Entrance and Departure ................................................................................................. 152

HUMAN TIME .................................................................................................................................... 163

Bloch’s Time ....................................................................................................................................... 166

The Autonomy of Human Time .......................................................................................................... 184

Linear Trajectory of Time .................................................................................................................. 185

Human Time: Concept and Reality ................................................................................................. 190
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplicity and Interconnectedness of Times</td>
<td>193</td>
</tr>
<tr>
<td>Historical Causality: a Segue into Neuroscience</td>
<td>196</td>
</tr>
<tr>
<td><strong>THE EMPIRICAL ARGUMENT FOR ORGANIC AND HUMAN TIME</strong></td>
<td>205</td>
</tr>
<tr>
<td>Part I: Time in the Biological Paradigm</td>
<td>209</td>
</tr>
<tr>
<td>The State of the Art</td>
<td>209</td>
</tr>
<tr>
<td>Time Reimagined for Biology</td>
<td>225</td>
</tr>
<tr>
<td>Empirical Support for the Unique Characteristics of Organic Time</td>
<td>232</td>
</tr>
<tr>
<td>Part II: Human Time</td>
<td>242</td>
</tr>
<tr>
<td>The Problem of Definitions</td>
<td>244</td>
</tr>
<tr>
<td>Logical and Empirical Implications of Human Time</td>
<td>268</td>
</tr>
<tr>
<td>Neuropsychological Evidence in Support of Human Time</td>
<td>273</td>
</tr>
<tr>
<td>Neuroscientific Evidence in Support of Human Time</td>
<td>280</td>
</tr>
<tr>
<td><strong>BIBLIOGRAPHY</strong></td>
<td>290</td>
</tr>
<tr>
<td><strong>CURRICULUM VITAE</strong></td>
<td>298</td>
</tr>
</tbody>
</table>
THE PHYSICAL UNREALITY OF TIME

The science of physics, the first science, upon the model of which our modern scientific institution was founded, presupposes certain fundamental categories in its central analysis of matter and the dynamic interactions of material elements. One of those fundamental categories, addressed explicitly and succinctly in Newton’s formative text, *Principia*, is time. Since Newton’s original formulation, however, physical science has witnessed a dramatic change in the way the phenomenon of time is conceptualized. No longer is time viewed as Newton’s immutable and absolute expanse of eternity. Instead, reconceptualized by Einstein, time is bound up with space where its very parts exist relatively to one another dependent upon an observational frame of reference. Taken together, the mutation of this originally immutable concept and the relativity of its ostensible absoluteness—in an institution oriented to the understanding of objective and logically consistent reality—render the ontological status of physical time tenuous.

Like space, cause and, effect, time is a basic category of human understanding. But this does not mean that a corresponding substance in the material environment determines the nature of our concepts for such categories. Proposing a sociological theory of knowledge in his *Elementary Forms of Religious Life*, Durkheim suggested that the nature of the fundamental categories of thought might not be explained by some *res extensa*; rather, such fundamental categories may have their origins in the collective representations that are particular to individual societies. Such representations, being generated by the minds of men, acquire their meaningful characteristics alongside other arbitrary systems of representations and develop through their perpetuation and
institutionalization by the collectivity. Only by analyzing the specific context and institutional development of a collective representation can one begin to understand the ‘thing’ that it purports to represent and the role that its conceptualization plays in the collectivity’s experience.

Thus, with Durkheim’s proposition in mind, I intend to investigate the ultimate reality of time in the universe, analyzing how it is understood by physics and thereby illuminating the very nature of this fundamental concept in the scientific sphere of intellectual activity. For it seems that, unlike the category of space, it is no longer necessary to regard time as an intrinsic part of the physical reality; more may be learned about it by approaching the subject from a sociological point of view. This approach is even more warranted in light of the contributions of Einstein. Since the revolution of his relativistic theories, it is difficult to regard time as real in any material sense—it has no discernible, independent qualities. Instead, it is possible to consider time a peripheral concept in physics, merely a side effect resulting from a mathematical conception of the universe. Therefore I propose to undertake an examination of how time came to be conceptualized in physics originally, modified eventually, and understood at present, showing finally that when all of the facts are considered, time is not a physical phenomenon but indeed a sociological one.

Though my claim is strong, it is not revolutionary. A few authors in contemporary history and philosophy of science have touched upon the tacit implication that time may not be an essential characteristic of material phenomena. As such, the

---

method of investigation that I propose is not without precedent. Gerald Holton, in his
*Thematic Origins of Scientific Thought*, established the usefulness of examining scientific
developments not only through empirical facts and the analytical tools of the scientific
method but also by mapping the influence of a third dimension of extra-scientific *themata*
that exert a real force on the scientific imagination from outside the realm of purely
empirical/analytical investigations. Holton describes these influential themes as
“fundamental presuppositions, notions, terms, methodological judgments and decisions
…which are themselves neither directly evolved from nor resolvable into, objective
observation on the one hand, or logical, mathematical and other formal analytical
ratiocination on the other hand.”2 Not only is the examination of the thematic element in
the scientific process warranted, according to Holton, but such an analysis may very well
be necessary for a more complete understanding of the problems and solutions that
appear within the institution of science itself. For the thematic dimension plays an
important role in the formation of and attachment to scientific laws and hypotheses and,
indeed, Holton stresses that, “The strong hold that certain themes have on the mind of the
scientist helps to explain his commitment to some point of view that may in fact run
exactly counter to all accepted doctrine and to the clear evidence of the senses.”3

Holton’s approach is only superficially similar to the philosophical approach of
Durkheim who in his sociology of knowledge explicates the development of all organized
collective activity—of which science is as good an example as any—by virtue of its
foundation in and interaction with its concurrent cultural systems. More directly related

---

3 Ibid., 59
to Holton’s thematic element is a tradition in the philosophy of science which has sought
to explore and explain the foundations of modern physical science in relation to the
beliefs and ruminations of the individuals who contributed directly to the scientific
revolution of the seventeenth century and, later, to specific paradigm shifts in the science
once it was securely established. ¹ I will draw on the work of philosophers and historians
to substantiate my larger claim about the ontological status of time. For their work
chronicles many of the factors that Holton considers among his thematic axis of scientific
“proposition space”. Discussing the contributions that extra scientific themata made to
the foundation and development of the physical sciences, these philosophers and
historians have emphasized the epistemic shift promoted by the wider practice and
acceptance of scientific thought—and in a few cases have touched upon the meaningful
shift in such concepts as force, motion, space and time. None of them, however, in
outlining the themata that have contributed to the development of the institution of
science have made ontological claims about the reality itself that physical science seeks
to understand. Instead, what they discuss is the new roles that certain fundamental
concepts come to play in the emerging science. This description of change in attitude is
essentially different from the goal of this chapter, which is to examine and explain the
limits of empirical accessibility of time in the science of physics.

¹ Examples in this tradition are myriad. Of particular influence in the development of this
dissertation were: Michael Ben-Chaim, Experimental Philosophy and the Birth of Empirical
Science (Ashgate, 2004); Peter Galison, Einstein’s Clocks, Poincaré’s Maps: Empires of Time
(New York: W.W. Norton, 2003); Alexandre Koyré, From the Closed World to the Infinite
Universe (Baltimore: Johns Hopkins Press, 1957); Thomas Kuhn, The Structure of Scientific
Time in Newton’s Universe

Time in Newton’s Principia, is discussed in the opening Scholium where Newton endeavors to clarify and establish certain common conceptions so that they may become operationalized in his universal science of motion and separated from their everyday understanding. Of time, Newton writes, “Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration…” Space, he continues to establish, is similarly conceptualized as “Absolute…in its own nature, without relation to anything external, [and it] remains always similar and immovable.” Both of these ideas of time and space are distinguished from their relative interpretations, which are arrived at by measures that are “sensible” and “external” to the phenomena themselves. Notwithstanding his definitions in the Scholium, Newton freely admitted that space and time do not come under the observation of our senses. With this admission in mind, and in light of the revolution effectuated by Einstein who showed that these assumptions about absolute time do not hold in the cases of certain empirical phenomena thus rendering the concept untenable, a pertinent question arises about Newton’s absolute time: how and why did the father of modern, positivist, science incorporate a concept so unempirical into his mathematical principles, and more importantly, how and why did this conceptual incorporation remain unproblematic for the development of physical science for nearly 200 years following its establishment?

The answer to these questions is simultaneously logical and sociological, and respectively short and long. The short answer can be found in Newton’s explication that
the very concept of absolute motion, accessible empirically only through its perceived
causes and effects, necessarily establishes the existence of a uniform, constant space and
time through which bodies can be in motion. To be sure, these causes and effects of
motion can only be sensed and measured by means of relative distinctions or common
measurements (of space and time), but behind any common measurement there always
exists a correspondence between a body’s place, absolute homogeneous space, and
immutable logical time.

Upon philosophical examination – and with our modern relativist conceptions -
this answer is not particularly satisfactory, resembling an induction that justifies
consistency in the machination governing the movement of bodies. But the proof for
Newton was to be found in the consistency of the mathematical equations that described
the effects of forces on bodies in motion irrespective of any relative space or particular
time. For it was on the reduction of physical motion to a universal principle, expressed
mathematically, that Newton established the foundation of modern science. Because
Newton was able to imagine the mathematical expression of his ideas, physical science
was presented and preserved in a system of formal logic insulated from the influence of
cultural systems that are extraneous to it. Setting the universe in the formal logic of
mathematics, however, was not only dependent on, but also resulted in certain
metaphysical attitudes toward the nature of reality in the universe. The result of the latter
was a necessary adoption of an ideal and theoretically infinite concept of mathematical
time. The former, as we shall see, was the latest and most complete incarnation of the
metaphysical attitude professing the ordered perfection of a universe made in the image of the almighty Creator.

Richard Westfall, one of Newton’s biographers and author of *Science and Religion in 17th Century England* writes that, “….modern science was produced by a Christian society, it could not itself remain untouched by the religious beliefs of the men who conceived it. Christians of patent sincerity, with but few exceptions, the *virtuosi* saw in the discoveries of natural science confirmation of their religious beliefs. In the many books that they published to show how God has revealed himself in nature they effected a satisfying consolidation of science and religions. So strong was the influence of Christianity upon them that it helped to mold their conception of nature, softening the harsh mechanical outline with the comforting light of divine benevolence.”

Newton’s mechanical outline, as we have noted, was the foundation of what we consider to be our modern science. This is so because after Newton, with his principles and equations, the explanation of physical phenomena did not have to look outside of the analytical walls that his system so concretely circumscribed: his mathematical principles contained all of the tools that one might need for analyzing and establishing the logical consistency between relevant phenomena of motion. Thus, it may seem paradoxical when Westfall asserts the importance of Christian thought for the establishment of modern science because, through his accomplishment, Newton renders any appeal to Christian belief superfluous to the scientific system for posterity. And yet, while the formally logical structure of Newton’s science bequeathed to his intellectual descendants

---

the framework for constructing progressive knowledge concerning the physical nature of
the universe for nearly two hundred years, Westfall reminds us that it was not itself born
of the void.

Like the imagination of any individual, Newton’s was greatly influenced and even primed by the ideas that he, himself, inherited from the inquisitive pre-modern scientists who came before him. But as their science was pre-modern, their minds did not have the benefit of the analytical isolation that Newton’s system afforded. Thus, in their histories and work, we have the unique opportunity to examine the ways in which pre-modern scientific thought developed outside of the self-contained scientific genealogy of question and answer (or hypothesis and refutation) being related by direct logical descent; instead we must analyze pre-modern scientific “discoveries” in light of the dynamic influence that the cultural environment and reigning metaphysical conceptions exerted on the natural philosopher as he sought to explain his observations of the heavens and earth. In a quest to understand the scientific conception of time, therefore, we must arrive at Newton via the history of the scientific revolution from its pre-Newtonian origins to see how his intellectual inheritance might have resulted in such an absolute—and uncharacteristically unempirical—notion.

**Pre-Newtonian Development**

By the time that Newton entered Trinity College in 1661, 118 years had passed since the publication of Copernicus’ *De Revolutionibus Orbium Coelestium*. In that span, a handful of brilliant minds contributed to a tradition of natural philosophy that sought to describe the organization of the cosmos and, in doing so, would reorient humanity’s
conception of its place in the universe. Despite this incredible reorientation, the singular contributions of the natural philosophers remained individualized in a way that distinguishes them from the collective progression of knowledge in our modern science; in each case, the philosophers pursued questions of their own interest, with their own methodologies and lacked the foundation of a single, unifying logic—or first principles—that would bind together the bits of knowledge contained in their work and endow them with a universal consistency that is characteristic of the scientific institution. The thought of the 15th and 16th century virtuosi can be unified, however, by two significant threads: a commitment to the ordered nature of God’s universe and a desire to show the reflection of that order in the discovery of mathematically ideal relationships.

With the renewed emphasis on classical texts during the Italian Renaissance, European intellectuals began to incorporate and appropriate philosophical currents of antiquity that had lain dormant during the late Middle Ages. Before such a renaissance, philosophy concerning itself with descriptive accounts of the cosmos was dominated by both a strict religious interpretation of phenomena and Aristotelian deductions of knowledge within that religious framework. For centuries, scholasticism dominated the intellectual landscape. God was the unmoved mover, the first and ubiquitous cause of all change, and His will was present in every occurrence. The universe was undoubtedly organized according to His plan, and this plan was only understandable insofar as it revealed itself to sensible experience.

It was the rediscovery of the classics, in particular the revival and translation of Plato, however, that introduced an alternative philosophical approach to knowledge about
God’s universe and ushered in a period of idealist emphasis in the imagined organization of the cosmos. This Platonic revival stood in sharp contrast to the crude empiricism of the scholastic, Aristotelian approach. Of this divide Thomas Kuhn writes that, “Plato, who is the [humanist/idealists’] ultimate source, often seems to dismiss the objects of this world as mere imperfect shadows of an eternal world of ideal objects or ‘forms’ existing outside of space and time…. [the] mystical philosophy [of the neoplatonists], which many humanists took as a model, recognized only transcendent reality.”

To be sure, much of the renaissance creations in literature and art echo the themes of classical humanism showing the widespread contemplation of ideal forms; but the influence of this philosophical shift was not limited to the arts and, according to Kuhn and his predecessor, historian and philosopher E. A. Burtt, it had significant repercussions in man’s attitude toward theological and astronomical disciplines as well. Kuhn writes that, “…for all its mysticism, Neoplatonism contained elements that gave a significant new direction to the science of the Renaissance.” Burtt, in turn, describes how this new scientific direction took root from the Pythagorean conceptions that permeate Plato’s idealist philosophy.

In 1438, under the patronage of the Medici family, the Platonic Academy (of Florence) began translating Plato’s *oeuvre*—in addition to other Neoplatonic works—into Latin. The writings produced at the Academy were disseminated and incorporated into the curricula of many Italian universities, including the University of Bologna where, according to Burtt, Professor Dominico de Novara was the Platonic Academy’s “most

---

important representative”. De Novara’s import derives not only from his enthusiasm for the revival of Plato’s idealist philosophy (an enthusiasm prevalent among the Renaissance professoriate at the time) but also from the fact of his appointment as professor of astronomy and mathematics at the university where Nicolaus Copernicus would become his pupil and assistant. Burtt describes de Novara’s position toward the existing state of his disciplines, writing “…that he was a free critic of the Ptolemaic system of astronomy, partly because of some observations which did not agree closely enough with deductions from it, but more especially because he was caught in this Platonic-Pythagorean current and felt that the whole cumbersome [Ptolemaic] system violated the postulate that the astronomical universe is an orderly mathematical harmony.”

Thus, De Novara’s commitment to the Platonic-Pythagorean ideal of harmony in the universe came into conflict with the mathematical system that for more than a millennium had been employed to describe the organization and movement of the heavens.

Envisioning and describing the heavens mathematically was not unique to the natural philosophy of the Renaissance. The close tie between mathematics and astronomy had existed in antiquity and was maintained throughout the middle ages. “Typical lists of the mathematical sciences offered by Alfarabi and Roger Bacon,” writes Burt, “place them in the order: geometry, astronomy, arithmetic, music…. Astronomy, more than arithmetic, was like geometry. It was nothing essentially but the geometry of the heavens; men readily felt, therefore, that whatever was true in geometry must be

---

necessarily and fully true of astronomy.” The Ptolemaic system, placing earth at its center, was a ubiquitous example of the marriage between astronomy and geometry, having being employed to describe cosmological phenomena by a complicated array of geometrical relationships since the second century of the Common Era. It was precisely this system with which de Novara and Copernicus took issue.

Equating astronomy with the pure mathematical science of geometry has certain conceptual side effects, specifically in regard to whatever metaphysical commitments an astronomer might have to the ultimate organization of the cosmos. The most problematic of these effects is that the purely abstract realm of geometry introduces the possibility of relative points of reference; this is because geometric relationships can be described in a multitude of “true” ways depending upon the reference point taken. Ptolemy was certainly not ignorant of this fact. He dealt with this relativistic problem in his day by taking the position that “it is legitimate to interpret the facts of astronomy by the simplest geometrical scheme which will ‘save the phenomena’ no matter whose metaphysics might be upset.” But for Ptolemy—and for a millennium, his followers—one of the central phenomena that must be ‘saved’ was the stationary position of the earth. This was not necessarily a metaphysical stance for Ptolemy (though it eventually became one for Christian astronomers) but rather was an empirical feature of the system: on the one hand, a ‘fact’ arrived at by Aristotelian deduction and on the other hand, and artifact of the observational data acquired by men whose point of observation was obviously the earth. (In the former case, the astronomical tradition carried with it Aristotle’s deduction

---

8 Ibid., 32.
9 Ibid., 35, citing Ptolemy, *Mathematical Composition*, Book 13, Ch. 2.
that if movement were attributed to the earth, only a movement of enormous speed would explain its regular diurnal changes. This speed would be so great that the unity and integrity of the earth itself could not be maintained and the velocity of an earth in motion would consequently send its habitants flying off and itself disintegrate into space due to the centrifugal force.\(^{10}\)

By the fifteenth century CE, however, the Ptolemaic system based on this conception of *terra firma* had accumulated too many *ad hoc* introductions and dependencies to account for the descriptive inaccuracies in the planetary and celestial movements. The Ptoleic system of the 15\(^{th}\) century was a far cry from the simple and harmonious system insinuated by the idealist philosophy of de Novara and Copernicus and by their time the Ptolemaic system no longer ‘saved’ many phenomena that they observed in the heavenly movements. To help the modern reader understand the massive inconsistencies that the passage of time had introduced into the Ptolemaic system, Kuhn presents the analogy of a clock, “The motions of a system of epicycles and deferents [of the Ptolemic system] are not unlike those of the hands of a clock, and the apparent error of a clock increases with the passage of time. If a clock loses, say, 1 second per decade, its error may not be apparent at the end of a year or the end of ten. But the error can scarcely be evaded after a millennium, when it will have increased to almost 2 minutes. Since Copernicus and his contemporaries possessed astronomical data extending over a time span thirteen centuries longer than that covered by Ptolemy’s data, they could impose a far more sensitive check upon their systems. They were necessarily more aware

\(^{10}\) This criticism is weighed by Copernicus in Book VII of *De Revolutionibus Orbium Coelestium*
of the errors inherent in the ancient approach.”¹¹ The geocentric system, as it was, differed drastically from the simple mathematical harmony that the Neoplatonists believed to be representative of the natural order. And while de Novara raised awareness of the problem, Copernicus ultimately provided the solution.

Spurred by his dissatisfaction with the complexities of the Ptolemaic system and his firm belief in the mathematical harmony of the cosmos, Copernicus set about finding a new point of reference among the planetary spheres that would allow for the reformulation of the geometric relationships that reflected this conviction. What was new, and fundamental to the revolution of Copernicus, was the line of inquiry that asked whether or not the cosmological realm could be imagined according to a simpler set of mathematical principles which still accounted for all of the relevant phenomena. For the sensible phenomena themselves had not changed and neither had the assumption that the motion of objects in the heavens could be described geometrically. But the relationship between geometry and the supposed design of the unmoved mover had changed; His design must be one of more harmony and consistency than was found in the reigning explanation. The strength of this attitude in Copernicus and the divergence that it represents from the traditional cosmological order demonstrate the enormous potential of intellectual reorientation along thematic propositions. Thus, the winding road to Newton’s physics begins here.

In Copernicus’s prefatory letter to *De Revolutionibus Orbium Coelestium*, addressed to Pope Paul III, the theme of an orderly and harmonious universe is cited

¹¹ Kuhn, *Copernican Revolution*, 139.
repeatedly as an explanatory goal of his work that is both self-evident and ultimately reflective of the “good and orderly Creator.” Copernicus writes,

I should like your holiness to know that I was induced to think of a method of computing the motions of the spheres by nothing else than the knowledge that the Mathematicians are inconsistent in their investigations. For, first, the mathematicians are so unsure of the movements of the Sun and the Moon that they cannot even explain or observe the constant length of the seasonal year. Secondly, in determining the motions of these and of the other five planets, they do not even use the same principles and hypotheses as in their proofs of seeming revolutions and motions. Some use only concentric circles while others use eccentrics and epicycles. Yet even by these means they do not completely attain their ends… Nor have they been able thereby to discern or deduce the principal thing—namely the shape of the Universe and the unchangeable symmetry of its parts…I pondered long upon this uncertainty of mathematical tradition in establishing the motions of the systems of spheres. At last I began to chafe that philosophers could by no means agree on any one certain theory of the mechanism of the Universe, wrought for us by the supremely good and orderly Creator…

The idealism of the Platonic/Pythagorean philosophy, with its emphasis on geometric harmony at the foundation of all phenomena in the universe, was interpreted by Copernicus to evince the perfect design of the Almighty Creator. From his own writing, it is evident that the inconsistency in the traditional astronomic system is intolerable to Copernicus, inconsistency and therefore the lack of a more unified theory of movement and change in the universe. But, like the influence of Plato and the Pythagoreans, the concepts of movement and change come to Copernicus from historical circumstance too and contribute as much to the specific construction of his universal system as does his desire for a simpler, more harmonious mathematical explanation. For in his displacement of the earth from the center of the universe—a spot that it had occupied in the minds of theologians and astronomers alike since antiquity—Copernicus also demonstrated a

---

12 Copernicus, Letter to Pope Paul III, Preface to *De Revolutionibus Orbium Coelestium*
strong metaphysical stance in the principal phenomenon that his system chose to save:

Uniformity.

Copernicus chose to preserve the uniformity in the structure of the universe and of movement in it. Uniformity, it should be noted, is different from harmony and, as Burtt writes, this principle was religious in its origin. In his *Commentary on the Hypothesis Concerning Celestial Motion* Copernicus writes that, “The theories of Ptolemy…present no small difficulty. For these theories were not adequate unless certain equants were also conceived; it then appeared that a planet moved with uniform velocity neither on its deferent nor about the centre of its epicycle…Having become aware of these defects, I often considered whether there could perhaps be found a more reasonable arrangement of circles, from which every apparent inequality would be derived and in which everything would move uniformly about its proper centre, as the rule of absolute motion requires.” And later in his Preface to *De Revolutionibus*, “Thus assuming motions, which in my work I ascribe to the earth, by long and frequent observations I have at last discovered that, if the motions of the rest of the planets be brought into relation with the circulation of the Earth, and be reckoned in proportion to the orbit of each planet, not only do their phenomena presently ensue, but the order and magnitudes of all stars and spheres, nay the heavens themselves, become so bound together that nothing in any part thereof could be moved from its place without producing confusion of all of the other parts and of the Universe as a whole.”

---

Thus, the integrity of the universe as one whole, with uniform movement and change, orderly and mathematically harmonious serve both as the guiding light and the ultimate nature of the principal phenomena in Copernicus’ system. This orientation is brought about both by the Platonic-Pythagorean emphasis on ideal geometric concordance and the simultaneous religious interpretation of such an approach. God, the Almighty Creator and Unmoved Mover, organized the cosmos in the most orderly manner, “So we find underlying this ordination” Copernicus writes, “an admirable symmetry in the universe, and a clear bond of harmony in their motion and magnitude of the orbits such as can be discovered no other wise…. All these phenomena proceed from the same cause, namely Earth’s motion…So great is the divine work of the Great and Noble Creator!”

Following Copernicus, the amalgamation of Neo-Platonic harmony and divine ordination is illustrated, most explicitly, by the great champion of the Copernican system, Johannes Kepler. Educated as a mathematician, Kepler adopted many of the tenets of Copernicus’ mathematical foundations regarding the structure of the universe. “The specific reasons for his early adoption of the Copernican theory are in part obscure, but it is easy to show from his works that he felt vigorously all those general environmental influences that appealed so strongly to Copernicus,” writes Burtt. Kuhn, in the same vein, describes Kepler as “…an ardent Neo-Platonist. He believed that mathematically simple laws are the basis of all natural phenomena and that the sun is the physical cause

14 Copernicus, *De Revolutionibus*, Bk. 10.
of all celestial motions. Both his most lasting and his most evanescent contributions to astronomy display these two aspects of his frequently mystical Neo-Platonic faith.”

Indeed, Kepler’s emphasis on the placement of the sun did, at times, border on fanatical; it was always with religious zeal and justification that he asserted its central place in the planetary system. Both Burtt and Kuhn separately cite the same one of Kepler’s fragments to illustrate that, for Kepler, “the exalted position of the sun in the new system appears as the main and sufficient reason for its adoption.” “In the first place,” Kepler professes, “…of all the bodies in the universe the most excellent is the sun, whose whole essence is nothing else than the purest light...; which singly alone is the producer, conserver and warmer of all things…and which alone we should judge worthy of the Most High God, should he be pleased with a material domicile and choose a place in which to dwell with the blessed angels…. It is interesting to notice here, a fact alluded to by Kuhn, that the thematic lines of Kepler’s thinking led to both his most lasting and his most evanescent contributions to astronomy.

Kepler began his studies at the University of Tübingen with the goal of becoming a Lutheran clergyman. Like all university studies in that day, the emphasis was theological, but Kepler earned special recognition by focusing on mathematics and philosophy in general. Only coincidentally, however, did this lead to his entrance into astronomy; his ultimate relationship to the practice of this science is somewhat an accident of circumstance. Sir David Brewster (inventor of the Kaleidoscope and author of The Martyrs of Science or the Lives of Galileo Tycho Brahe and Kepler) indicates that

16 Kuhn, Copernican Revolution, 214.
17 Burtt, Metaphysical Foundations, 47.
Kepler had “no peculiar affection for astronomy” and only seemed to become interested in the subject via his master, a professor of mathematics at Tübingen, Michael Maestlin, who defended the Copernican system in a lecture that provided him with some notoriety. Brewster recounts that in 1594 the death of the incumbent chair in astronomy at Graz made vacant a fortuitous position fitting for a young mathematician of Kepler’s ability. Though he had “little knowledge of the science, and no passion for it whatever”, Kepler was forced by the authority of his professional tutors and their recommendation to the nobles of Styria to take the position. Thus at Graz, according to Brewster, Kepler first began to tackle the nagging problem of the planets.

Copernicus’ system, printed in Nuremberg in 1543 and again in Basel in 1566, was certainly in circulation among mathematicians of Kepler’s epoch. But the mathematical system that Copernicus used in describing the orbits and relationships of the planets did not satisfy Kepler for it still retained many complicated calculations reminiscent of the Ptolemaic organization. If the Copernican system were to be true—and based on Kepler’s firm belief in the mathematical simplicity of God’s universe and his religious/Platonic admiration of the sun’s centrality, it should be true—then, reasoned the mathematician, there must be many more mathematical harmonies contained in the system waiting to be discovered. Thus, Kepler dedicated much of his life’s work to the discovery of these harmonies, although only a small fraction of such discoveries would become lasting contributions to modern science.

---

18 Sir David Brewster Martyrs of Science (New York: Harber, 1841), 207.
19 Ibid., 208.
20 See Owen Gingerich, The Book That Nobody Read (New York: Penguin, 2005) where even Kepler’s own annotated copy is examined.
Frequently noted in retrospective accounts of Kepler’s contribution to astronomical science is his emphasis on the correspondence of his mathematical imagination to observational data. This, most certainly, is an artifact of Tycho Brahe’s influence but is also a direct result of Kepler’s own conviction that the truth of his religious conception revealed itself directly in the nature of God’s universe. His conviction, essentially thematic, is a teleology; this becomes evident when the mathematical activity of these early modern astronomers is viewed in light of their metaphysical convictions. Operating on the belief that that God has created a universe of geometric simplicity and harmony and then setting about to imagine the relationships that best exhibit those features, the only mathematical descriptions that are permissible are ones that conform to the original belief. Perhaps nowhere is this type of teleological reasoning more evident than in an example of Kepler’s early work. Brewster writes that in 1595 Kepler set out to determine the number, size and motion of the orbits of the planets. “He first tried if the size of the planet’s orbits, or the difference of their sizes, had any regular proportion to each other. Finding no proof of this, he inserted a new planet between Mars and Jupiter, and another between Venus and Mercury, which he supposed might be invisible from their smallness; but even with these assumptions the distances of the planets exhibited no regular progression. Kepler next tried if these distances varied as the cosines of the quadrant, and if their motion varied as the sun’s, the sine of 90 representing the motion at the sun and the sine of 0 that at the fixed stars; but in this trial he was also disappointed.”

21 Brewster, Martyrs, 191.
the emphasis on the harmony of the system and on the purported design of the Creator far outweigh any attachment to observational data – Kepler was inserting imaginary planets so that his model might approximate his idea of order in the universe!

When these efforts proved unproductive, his imagination turned to different directions: “Having spent the whole summer in these fruitless speculations, and praying constantly to his Maker for success, he was accidentally drawing a diagram in his lecture-room, in July 1595, when he observed the relation between the circle inscribed in a triangle and that described round it; and the ratio of these circles, which was that of 1 to 2, appeared to his eye to be identical with that of Jupiter’s and Saturn’s orbits. Hence he was led to compare the orbits of the other planets’ circles described in pentagons and hexagons. As this hypothesis was as inapplicable to the heavens as its predecessors, Kepler asked himself in despair, ‘What have plane figures to do with solid orbits? Solid bodies ought to be used for solid orbits.’ On the strength of this conceit, he supposed that the distances of the planets were regulated by the sizes of the five regular solids described within one another. ‘The Earth is the circle, the measurer of all. Round it describe a dodecahedron; the circle including this will be Mars. Round Mars describe a tetrahedron; the circle including this will be Jupiter. Describe a cube round Jupiter; the circle including this will be Saturn. Then inscribe in the Earth an icosahedron; the circle described in it will be Venus. Inscribe an octahedron in Venus; the circle inscribed in it will be Mercury.’ This discovery, as he considered it, harmonized in a very rude way with the measures of the planetary orbits given by Copernicus; but Kepler was so enamoured with it, that he ascribed the differences to errors of observation, and declared
that he would not renounce the glory of having made it for the whole Electorate of
Saxony.”

After this “discovery” Kepler was incited to write a letter to his former teacher,
Maestlin, “For a long time I wanted to become a theologian; for a long time I was
restless. Now, however, behold how through my effort God is being celebrated in
astronomy.”

Burtt writes that this discovery of the rough resemblance in planetary orbits
to the relationships of circles inscribed and described around the five regular solids,
“…yielded Kepler the most inordinate delight and [was that] to which he referred for
many years as his most important achievement.” Kepler himself wrote that, “The
intense pleasure I have received from this discovery can never be told in words. I
regretted no more the time wasted; I tired of no labour; I shunned no toil or reckoning,
days and nights spent in calculation, until I could see whether my hypothesis would agree
with the orbits of Copernicus or whether my joy was to vanish into air.”

Kepler’s description of this system was published at Tübingen in 1596 under the full title
“Forerunner of the Cosmological Essays, Which Contains the Secret of the Universe; on
the Marvelous Proportion of the Celestial Spheres, and on the True and Particular Causes
of the Number, Magnitude, and Periodic Motions of the Heavens; Established by Means
of the Five Regular Geometric Solids.”

---

22 Ibid., 192-193.
23 Kepler to Maestlin 3 October 1595; Kepler Gesammelte Werke, 13, 40: cited by Gingerich,
25 Ibid., 52; Burtt citing Oliver Lodge, *Pioneers of Science*, Ch. III
His commitment to this accomplishment was such that 15 years later, when the news that Galileo turned his telescope to Jupiter and found its 4 secondary “planets” (actually its moons), Kepler was agitated with mixed emotion. Confounded that this might contradict his *Mysterium Cosmographicum* Kepler is cited by Brewster as having written to Galileo, “I am so far from disbelieving the existence of the four circumjovial planets, that I long for a telescope, to anticipate you, if possible, in discovering two round Mars, as the proportion seems to require, *six* or *eight* round Saturn, and perhaps *one* each round Mercury and Venus.”

Throughout Kepler’s work, his conviction in nature’s simplicity and unity was commonplace. He would reiterate constantly that ‘*Natura simplicitatem amat.*’ ‘*Amat illa unitatem.*’ ‘*Numquam in ipsa quiquam otiosum aut superfluum existitit.*’ ‘*Natura semper quod potest per faciliora, non agit per ambages difficiles.*’ Ultimately, this attitude toward the nature of things, coincident with his faith in the mathematical harmony of the universe, would assume the place of ontological causality and cement the role of mathematical law for what would become the foundation of modern science. Holton writes that the source of Kepler’s harmonies “…lies in the same metaphysics which helped him over the failure of his physical dynamics of the solar system…*the association of quantity per se with Deity.* Moreover…Kepler held that man’s ability to discover harmonies, and therefore reality, in the chaos of events is due to a direct connection between ultimate reality; namely, God, and the mind of man.”

---

letter to Herwart, in 1599, wrote that, “Those laws lie within the power of understanding of the human mind; God wanted us to perceive them when he created us in his image in order that we may take part in His own thoughts….”

Thus the discovery of regularities in the universe as they correspond to observable phenomena becomes an end in and of itself because of the relationship that this activity establishes between the individual and God. (Though an analysis of the particularly Lutheran tone of Keppler’s assertions is not within the scope of the present dissertation, it reflects another source of extra-scientific factors influencing the philosopher and should not pass without notice.) God, the first mover, creator and organizer of all things, becomes not only the Neoplatonic god who forever geometrizes, but having created man in his image, reveals Himself through natural occurrences that man must separate out from chaos and understand according to His aesthetic order. The emphasis on the aesthetic aspect of this process is evident in Kepler whose mathematical acumen was constantly guided by his convictions; after all, in one instance of his work he attempted earnestly to extrapolate his third law of planetary motion to coincide with interval harmonies on the musical scale.

In addition to the third law—which is preserved without his aspirations for musical correspondence—modern science retains Kepler’s first two laws of planetary motion outlined in his *Astronomia Nova* which assert: 1.) That the orbit of every planet is an ellipse with the sun resting at either one of its two foci; and 2.) That a line drawn between the planet and the sun sweeps through equal areas of the ellipse in equal

---

29 Letter to Herwart April 9/10, 1599, cited by Holton p. 85
30 For more on the relationship between Kepler’s thought and Neoplatonism see Brendan Dooley, “Astrology and Science: A Renaissance Problem” in *The Ideals of Joseph Ben David*, (New Brunswick: Transaction, 2012), 37-41
intervals of time. These two discoveries of Kepler resolve the long term retrospective and predictive problems of consistently modeling the position of the planets that were characteristic in both the circular orbits of Ptolemy and Copernicus. At the same time, Kepler saved the phenomenon—or at least preserved the idea—of uniformity of motion by substituting it with the law of equal areas described in his second law. He laboriously worked over this mathematical system for the better part of 10 years and at one point in his manuscript implores his reader, “If thou art bored with this wearisome method of calculation, take pity on me, who had to go through with at least seventy repetitions of it, at a very great loss of time.”

Kepler was led to the discovery of these two laws by the same convictions that produced his Mysterium Cosmographicum and incited his quest for uncovering the musical harmony in the organization and movement of the cosmos. In fact, the preservation of uniformity of motion in the system—derived from a religious conception of movement and change—was of such an ontological priority that it brought Kepler chronologically first to the discovery of his second law from which the commonly named “first” law (of elliptical orbits) was, in a way, later deduced. Kuhn writes that before Kepler had discovered the elliptical orbital paths or had formulated his second law of areal velocity, he had developed an idea of an inverse proportionality between the speed of the planet along its orbit and its distance from the sun. The more distant from the sun the slower the planet would move through its orbit and, conversely, the closer it was to the sun the greater the orbital speed would be. This inverse speed law does not translate.

---

directly to the ultimate formulation of his second law of areal velocity but is similar enough in principle, Kuhn reports, that Kepler used both interchangeably throughout his life. The preceding inverse speed law, Kuhn surmises, “was very much ‘pulled from a hat’ by a strange intuition… of the forces that must govern a sun-dominated universe…. For all its visionary overtones the early Neo-Platonic speed law proved fundamental in Kepler’s most fruitful research.”

For in order to arrive at his first law of elliptical orbits, a speed function was necessary to supplement Brahe’s observational data with which Kepler was working—the empirical data did not provide a complete set of variables for modeling the dynamic, geometric system of orbits. Kuhn writes that, “…a speed law is required to compute orbital shape from naked-eye data. When analyzing Brahe’s observations, Kepler made constant use of his earlier Neo-Platonic guess.” Thus, a particular function of speed was imagined, or induced to the system, based on both the preconceived, idealist notion of uniformity of motion and for the sake of the mathematical modeling of the orbit of a planet in a heliocentric cosmography.

In the development of modern science, the impact of Kepler’s work went beyond the three laws of planetary motion and the remnants of his influence is illustrated by the very thought process which led him to the discovery of these laws described above. For, in the work of Kepler, a correspondence between observed fact, induced metaphysical harmony and the primacy of simple mathematical law reflecting that harmony is constantly sought, but it is only the precise alignment of all three that produces satisfactory results. What determines the point of alignment? Holton tells us that the

---

32 Kuhn, *Copernican Revolution*, 215.
activity of science is always influenced by both the axis of insulated scientific data and
theory as well as extra scientific currents, attitudes and beliefs. Kepler’s work,
specifically in its relationship with the precise observational data of Tycho Brahe is a
prime example of this relationship. Through Kepler we see worlds, the empirical and the
ideal (which is necessarily immaterial, extra-scientific, and therefore cultural) meeting
explicitly in the mind of an individual. The results of this meeting are twofold. In the
first place it produced three planetary laws of motion which are loosely preserved in
modern astronomical observations today. Burtt writes that the preservation of these laws,
however, results from the empirical aspect of Kepler’s models having “just enough in
common with the successful procedure of later science, so that out of a vast mass of
painfully and laboriously won geometrisms in nature, three chanced to become fruitful
foundations for the later stupendous scientific achievements of Newton.”

In the second place, the combination of real data and ideal mathematics shifted the ontological primacy
in the natural world away from the qualities of phenomena to their quantity. Burtt quotes
Kepler in saying that, “Just as the eye was made to see colours, and the ear to hear
sounds, so the human mind was made to understand, not whatever you please, but
quantity” and that “…there are more of these principles [concerning quantities and
requiring no other demonstration for their reality] in mathematics than in any other
theoretical sciences because of that very characteristic of the human understanding which
seems to be such from the law of creation, that nothing can be known completely except

quantities or by quantities. And so it happens that the conclusions of mathematics are most certain and indubitable.”

Thus the influence of Neo-Platonism begins to create something of a perfect circle itself. The aesthetic emphasis on harmony in mathematics is applied to matters of astronomical understanding as a result of the dissatisfactory mathematical complexity exhibited by the Ptolemaic system. Questions of astronomical dynamics and organization, however, cannot be asked in a vacuum and necessarily involve consulting the will of He who organizes. The idea of God’s universe begins to be imagined in the aesthetic framework of Neo-Platonic harmony, and since the soul in Christian theology was given to man in His image—His image being one of ideal perfection—the idea of man’s quantitative sensibility is equated with the direct sensibility of the reality of nature. The reality of God and the soul makes irrelevant the Platonic realm of ideals and instead establishes a connection between God and man through the sense and perception of nature. Quantity becomes the primary reality, because it is the way in which God’s universe is both organized and revealed to the senses. The philosophical implications of this transition are well documented in the decline of the influence of scholasticism on the natural philosophers. The stage continues to be set for the ascendancy of scientific reasoning and the emphatic role of mathematics in that reasoning by the historical development of attitudes toward the true nature of God’s universe. One more genius, Galileo, will contribute immensely to this philosophical development and the specific consequences of his development will lead directly to the problematic nature of time.

---

In the works of Galileo, Holton’s z-axis of thematic influence is met head-on. For it is in Galileo’s development of the science of local motion and the equation of that phenomenon with the motion of astronomical bodies that he bequeaths the fundamental concepts of space, time, motion and force to the physical sciences as mathematically defined, natural phenomena. Like Kepler, his contemporary and friend, Galileo was a priori convinced in the geometric basis of natural phenomenon, and also, like Kepler, this bias resulted from an essentially religious conception of the universe. Burtt quotes Galileo on the subject of his convictions, writing that, “As to the truth, of which mathematical demonstrations give us the knowledge, it is the same which the Divine Wisdom knoweth; but… the manner whereby God knoweth the infinite propositions, whereof we understand some few, is highly more excellent than ours, which proceedeth by ratiocination, and passeth from conclusion to conclusion, whereas his is done at a single thought or intuition…. The Divine wisdom, like light, penetrateth [the universe] in an instant, which is the same as to say, hath them always present.”35 Thus, Galileo too demonstrates an emphasis on the geometric foundation of natural phenomena via the design of His mighty wisdom. Though Galileo was less zealous than Keppler, his ideas proved to be much more controversial during his lifetime; although—and despite his famed controversy—he contributed more to the epistemological shift that emphasized the inherent mathematical structure of the universe, supported by positive empirical justification, than any thinker who came before him.

Despite the fact that Galileo was put on trial for, and found guilty of, heresy, one should not interpret his ideas as being at odds with the religious conception that was the impetus for much of Keppler’s work. Instead, Galileo’s conflict was an affront to the authority of Rome not only in the scriptural interpretation God’s universe but also—and more importantly—an affront to the reigning metaphysical view of Aristotelian scholasticism and the accepted place of man in this metaphysical scheme. In his defense of the Copernican heliocentric system, Galileo advocated the revelation of divine truth in the geometrical patterns of nature first, followed by the interpretation of scripture along those lines. Galileo wrote that, “Methinks that in the discussion of natural problems, we ought not to begin at the authority of places of scripture, but at sensible experiments and necessary demonstrations. For, from the Divine Word, the sacred scripture and nature did both alike proceed…Nature being inexorable and immutable, and never passing the bounds of the laws assigned her…” His point being that God does not, “… less admirably discover himself to us in Nature’s actions than in the Scripture’s sacred dictions.”36

This great challenge to papal authority reflected the enormous philosophical shift that Galileo’s work implied regarding the accepted view of the structure of the universe. In both the cases of Copernicus and Kepler, contributions to the understanding of the cosmos were made in the name of the Neoplatonic/Pythagorean world view that, since

the early Renaissance, found itself at odds with the Aristotelian/scholastic interpretation of natural phenomena. Nowhere was the scholastic approach to physical and metaphysical understanding more prominent than in the teachings and dogma of the 17th century Catholic Church. Additionally, at no time in its recent history was the Catholic Church so bent on asserting and preserving its authority over scriptural interpretation and terrestrial matters than during Galileo’s lifetime, having just seen The Reformation and Protestantism sweep across the European continent. Rome was anxious to preserve its influence at home in the Italian peninsula and, in the end, Galileo, unlike Copernicus and Kepler, was too close in geopolitical time and space for comfort.  

Furthering the distinction between Galileo and his predecessors was his extrapolation from the science of local motion to the laws that govern the cosmos. Galileo’s assimilation of the mundane with the celestial proved a great affront to scholastic doctrine, which asserted that these two worlds were naturally separate, qualitatively distinct spheres of existence. Therefore, Galileo’s confrontation with the Church was rooted in the emphasis that his project placed on mathematics as the foundation of natural phenomena in the cosmos and in terrestrial matters alike. Historians Burtt and Koyré have outlined in depth the significant epistemological shift that Galileo’s approach to the science of motion required over the common-sense empiricism of Aristotelian thought. For my purposes it is best to synthesize their

---

37 Edward Grant makes the argument that the Church’s blind attachment to Scholastic doctrine was stronger in Galileo’s time than in that of Copernicus. See, Edward Grant, God and Reason in the Middle Ages, (New York: Cambridge University Press, 2001), 303-307.
historical accounts illustrating Galileo’s integral contribution to natural philosophy that would eventually lead to a new, mathematical vision of time in the universe.

Koyré points out that the concept of motion, or change, implicit in the Copernican heliocentric scheme was already at odds with the Aristotelian notion of the phenomenon. Copernicus himself was aware of this to a certain extent; his admission of such a problem appears in Book VII of *De Revolutionibus Orbium Coelestium*. Aristotelian physics imagined movement not as a translation from one geometrically defined space to another as we do in modern physics, but rather as a transition of the moving body itself from one natural state or stage into another stage or state. It is for this reason that the movement of the earth in the cosmographical system seemed such an incredible claim—such violent and forceful change was impossible to conceive of both in its potency and in terms of the cataclysmic effects it would have on the earth itself. For, from Aristotle’s perspective, the movement of an object meant a change in that object away from or toward a different natural state. To counteract the cognitive dissonance that this imbalance implied a new philosophy had to be employed, one in which the natural order of the celestial realm was reimagined and the movement of the earth was included as a proper part of God’s design. Kepler contributed much to this effect by searching for numerous—although uncovering only a few—harmonious relationships in a universe where such movement was posited as the *true* organization of the cosmos. The search was religiously motivated and the discovery of such harmonies in the new scheme would serve to reinforce the convictions of his fundamentally religious ideals.
According to Koyré, however, Keppler’s thinking, though advanced for its epoch, remained rooted in certain scholastic conceptions. Perhaps the greatest illustration of Kepler’s scholasticism is his endeavor to seek out and describe the forces of movement or *anima motrix* that constantly had a hand in effectuating the change in his harmoniously dynamic system. If the earth was to be moved along with the planets, a functional equivalent of Aristotle’s unmoved mover must have his hand in the system at every moment. For Keppler, this role was played by the force emanating from the sun, the most glorious and worthy occupant of the center of God’s universe.\(^{38}\) Insofar as movement was imagined by Keppler, it was a phenomenon that pertained to the cosmological realm alone (i.e. it had nothing to do with local motion) and God’s hand was in it, quite literally, at every moment.\(^{39}\) Koyré writes that, “… the great Keppler, the founder of modern astronomy, the same man who proclaimed the unity of matter in the whole universe and stated that *ubi materia, ibi geometria,* [where there is matter, there is geometry] failed to establish the basis of modern physical science for one and only reason: he still believed that motion is, ontologically, on a higher level of being than rest.”\(^{40}\) Galileo’s philosophy, and his ultimate marriage of motion in the cosmological realm to motion on earth would radically change the idea of motion itself by treating it as a phenomenon governed not by real metaphysical forces, ontologically superior to being at rest, but essentially equivalent to rest, and mathematical in its essence, governed by the

\(^{38}\) See Kuhn, *Copernican Revolution*, 214.

\(^{39}\) In the Aristotilean framework, movement or change required a constant force. Every effect had an immediate cause and, therefore, conversely the absence of a force would result in the abrupt cessation of the movement.

ideal laws of geometry and number. Galileo’s main challenge to Aristotelian thought was his uniform mechanization of movement and change in God’s universe.

As for Copernicus and Kepler, this new metaphysical position, which is the latest incarnation of the Neo-Platonic/Pythagorean position, is a position *a priori* for Galileo too. Koyré writes that for Galileo, “*necesse determines esse*”, as such the mathematical descriptions that govern physical movement can be discovered without experiments, simply from analyzing the mathematical logic in which the blueprint of nature is already drawn. Galileo’s even wrote that, “Philosophy is written in that great book which ever lies before our eyes—I mean the universe—but we cannot understand it if we do not first learn the language and grasp the symbols in which it is written. This book is written in the mathematical language, and the symbols are triangles, circles, and other geometrical figures, without whose help it is impossible to comprehend a single word of it without which one wanders in vain through a dark labrynth.”

According to this belief, Galileo famously denies the necessity of making an experiment to prove his argument that a ball falling from the mast of a ship will land at the foot of the mast, rather than lag behind, falling some feet away due to the motion of the ship alone. In *Galileo, His Life and Work*, J.J. Fahie writes, “…Galileo declared that ignorance had been the best teacher he ever had, since in order to be able to demonstrate to his opponents the truth of his

---

conclusions, he had been forced to prove them by a variety of experiments, though to satisfy his own mind alone he had never felt it necessary to make any.”  

What a testimony to the Neo-Platonic commitments of Galileo this position constituted! In the Aristotelian framework, all of the conclusions arrived at were inductions from nature as experienced. Reiterated in the scholastic sense, God’s world is revealed to man through experience, but the underlying nature of this world and the specific role of His will in any experience lies beyond an individual’s understanding, constituting a part of the larger providential plan. Thus, the nature of any experience is presented as a function of Providence and can only begin to be interpreted after the fact. Galileo’s position, however, reverses the role of experience in understanding nature and makes it subservient to the geometrical laws by which nature is constituted. Experience, instead of being primary in explanation and understanding, acquires a different functional role in natural philosophy when it is considered a secondary effect of the primary geometrical structure of His world. The traditional Aristotelian understanding which took the form of why change occurred ex post facto, came to be replaced with the new approach of natural philosophy which, based on its a priori convictions, explained sensible phenomena in terms of how change proceeded—it always proceeded according to the regularities of geometry and quantity. To this effect Burtt writes that, “On the one hand we cannot deny that it is the senses which offer us the world to be explained; on the other we are equally certain that they do not give us the rational order which alone

supplies the desired explanation. The latter is always mathematical, to be reached only by the accepted methods of mathematical demonstration.” Burtt describes in detail the steps implicit in Galileo’s approach,

Facing the world of sensible experience, we isolate and examine as fully as possible a certain typical phenomenon, in order first to intuit those simple, absolute elements in terms of which the phenomenon can be most easily and completely translated into mathematical form… Have we performed this step properly, we need the sensible facts no more; the elements thus reached are their real constituents, and deductive demonstrations from them by pure mathematics (second step) must always be true of similar instances of the phenomenon, even though at times it should be impossible to confirm them empirically. This explains the bold tone of his more \textit{a priori} passages.\footnote{Ibid., 71.}

The senses themselves, therefore, do not provide man with the \textit{rational} order by which the universe is constituted. Instead they merely help to intuit or to confirm the mathematical relationships that are the absolute and true aspects of nature. The geometrical order of nature is thus emphasized \textit{a priori}—for a contemporary researcher to state this position would seem categorically unscientific. But Koyré echoes the account of Burtt and tells a similar story demonstrating Galileo’s divergence from the modern—materially based—scientific position, “For Galileo it was in curves and circles and triangles, in mathematical or even more precisely, in \textit{geometrical language}—not in the language of common sense or in that or pure symbols—that we must speak to Nature and receive her answers. Yet obviously the choice of the language, the decision to employ it, could not be determined by the experience which its use was to make possible. It had to come from other sources.”\footnote{Alexandre Koyré, “Galileo and Plato” in \textit{Metaphysics and Measurement}, (Cambridge, MA: Harvard University Press, 1968), 19.}
The “other source” that Koyré implies is the functional equivalent of Holton’s thematic axis acting on the mind of the natural philosopher. Though Koyré preceded Holton’s formulation of this intellectual dynamic, he is referring to exactly the same process. In fact, by making the point that the experience of the natural world cannot in and of itself give rise to the rational explanation of it, all three sources—Burtt, Koyré and Kuhn—agree that the advent and triumph of Neo-Platonic thought in mathematics and astronomy played a central role in producing the vision of a universe governed by an orderly set of geometrical relationships lain down by God’s providential plan. This particular historically circumscribed tradition of thought was common to Copernicus, Kepler, and Galileo (in addition to others such as Tycho Brahe and Giordano Bruno who, though influential, remain on the periphery of the present analysis). In Galileo the tradition differed in the extent to which its principles were mathematically operationalized and set into play on the terrestrial stage.

By extrapolating his philosophy to terrestrial, or local, motion, Galileo brought the idea of universal geometric principles down to our own world, uniting in a new way the laws of the cosmological realm with the laws that govern sensible objects on earth. This marriage contributed finally to what Koyré calls the “dissolution of the Cosmos,” a revolution in thought, he writes, “so profound and so far-reaching that mankind…for centuries did not grasp its bearing and its meaning which, even now, is often misvalued and misunderstood.” This dissolution, according to Koyré, “[meant] the destruction of the idea of a hierarchically-ordered finite world structure, of the idea of a qualitatively and ontologically differentiated world, and its replacement by that of an open, indefinite
and even infinite universe, united and governed by the same universal laws; a universe in which, in contradiction to the traditional conception with its distinction and opposition of the two worlds of Heaven and of Earth, all things are on the same level of Being. The laws of Heaven and the laws of Earth are merged together.”

This marriage of worlds, in the name of geometrical laws serving as the foundation of natural movement and change, not only posits that the metaphysical reality of every day experience is grounded in mathematics and geometry, but by equating the terrestrial with the cosmological, it also establishes boundless, universal laws in a ordered yet infinite system. Moreover in this unification, movement of the celestial bodies is equated with the movement of cannon balls and sailing ships. Galileo painstakingly emphasizes that movement itself is a conceptual state that a physical body can be in rather than a succession of qualitatively different states, or process, that an object moves through. Most importantly, Galileo’s conception of movement differs from the Aristotelian notion of movement as qualitative change in that it is reimagined as a phenomenon in and of itself that is quantifiable and about which mathematically consistent characteristics (i.e. laws) can be generalized.

Galileo’s reconceptualization of movement carried with it very significant side effects: the emphasis on movement as a property, resulting from forces on geometrical objects with certain physical characteristics, made space and time, as uniform media that physical bodies move through, necessarily recast as fundamental categories in the new science of local motion. Though the introduction of the spatio-temporal emphasis in

---

46 Ibid., 20.
Galileo’s science is logically implicit, Burtt draws attention to this categorical transition and writes, “the mathematical study of the how of motion inevitably thrusts into prominence the concepts of space and time…. It must be remembered that the qualitative, as opposed to the quantitative method in the physics of Aristotle and scholasticism…made space and time very unimportant….” From the Galilean perspective, “Physical space was assumed to be identical with the realm of geometry, and physical motion was acquiring the character of a pure mathematical concept. Hence in the metaphysics of Galileo, space (or distance) and time become fundamental categories.

The real world is the world of bodies in mathematically reducible motions and this means that the real world is a world of bodies moving in space and time.”

Burtt writes that the introduction of space and time as mathematical entities replaced the “teleological categories into which scholasticism had analysed change and movement” but I argue that the new quantifiable conceptions of space and time are equally as teleological. Examining the trajectory of extra scientific factors that have influenced the development of natural philosophy up to this point shows that they represent, in fact, a teleology in Galileo’s new science as well. The idea that movement can be abstracted from the bodies which it involves and described in terms of quantifiable space and time are founded completely in a geometric conception of the universe which, I have established along with the authority of the philosophers and historians of science here quoted, is a priori to the core—it is contingent upon the belief that the universe was structured in such a way by the Creator according to the ideas that the natural

---

47 Burtt, *Metaphysical Foundations*, 82-83; emphasis in the original.
48 Ibid., 83-84.
philosophers had about His nature and will. In addition to the *a priori* status of this fundamental idea, this particular approach to the understanding and study reality developed historically; it was not forced upon the natural philosophers by the reality itself. The strength of such foundational principals noted in the cases of Copernicus, Kepler, and Galileo not only causes certain relationships among facts in the universe to be posited in terms of strict geometric relationship to one another, but posited precisely in the imagined geometric relationships that best save the significant phenomena—*nota bene*: it is always the relative significance of certain phenomena to men and not anything inherently significant in the phenomena themselves. Once realized, these essentially creative descriptions of the relationships between relevant phenomena, expressed in the language of mathematics, reinforce the *a priori* position from which the inquiry began in the first place.

In distinction to the old scholastic teleology which placed the existence of God as both the cause and the effect in terms of qualitative experience of the world, man and God were distanced from one another by the new science, with the Creator now considered the architect of an infinite yet mechanically ordered universe, understandable only through abstract glimpses of His perfection by the discovery of mathematical laws. For Galileo and his Neo-Platonic predecessors, God remained the architect, as he was for the Scholastics, the point of divergence, however, can be found in the new assertion that the language of geometry (and not direct experience) was the language of His blueprint. As such, the belief in the fundamentally mathematical nature of the universe eventually resulted in the development of the mathematical notion of the fundamental categories of
space and time as homogeneous, infinite and quantifiable. The revolution in thought ushered in by the new, natural philosophy completely altered the nature of man’s knowledge of the cosmos, previously rich with sacred experience and actively guided by the hand of God, by breaking that old cosmological realm apart. What little room this left for the *experience* of God and the occurrence of miracles! Man, who once stood on the earth that God created for Him, necessarily connected to heaven, now occupied a small corner of the universe with the Almighty Creator watching from behind a curtain separated from us by space, the size of which no human intellect could fathom.

The conceptual revolution in the imagination of universal space, is the significant factor that Koyré highlights in his discussion of the dissolution of the cosmos. The geometrization of space in which bodies move in response to forces, and the implications of this notion, represented the most explicit affront to the dogmatic stance of the Catholic Church and their scholastic view of the universe. Burtt, by contrast, draws attention to the philosophical problem that this shift introduces with respect to time, lending considerable support to my claim that time enters the scientific discourse by means of historically contingent circumstances (i.e. culture) rather than by way of empirical observation and evidence.

With respect to time, there are features in Galileo’s work of particular significance for modern metaphysics. To discuss events in terms of space or distance was to assign a new importance and dignity to a characteristic that had been regarded as merely accidental by the scholastics and to give it a new definition for those whose physical thinking had been controlled by Aristotle—to be sure, an important transformation enough because it made the world of nature infinite instead of finite—but in the case of time the thought-revolution went

49 See, for example, Kuhn, *Copernican Revolution*, 231; and Koyré *From the Closed World to the Infinite Universe* (JHU Press, 1968).
much deeper. Not that a new definition of it was particularly needed—the conception of time as the measure of motion, common to practically all parties among previous philosophers, was sufficiently serviceable still—but the substitution of the entity for the old categories of potentiality and actuality involved a radically new view of the universe, a view such that the very existence of a being like man became one enormous puzzle. In the course of ancient philosophy previous to Aristotle, change (including, of course, motion) had been either denied, neglected, reluctantly admitted or apotheosized; it had not been rationally explained. Aristotle offered his analysis of events in terms of potentiality and actuality as a means of reducing change to intelligibility... When medieval philosophers thought of what we call the temporal process it was this continuous transformation of potentiality into actuality that they had in mind, a transformation which culminated in those ravishing moments when the overpowering visio Dei was vouchsafed to some pious and trembling mortal. God was that one who eternally exists, and ever draws into movement by his perfect beauty all that is potentially the bearer of a higher existence.... To put this in modern terms, the present exists unmoved and continually draws into itself the future. That this sounds absurd to our ears is because we have followed Galileo and banished man, with his memory and purpose, out of the real world. Consequently time seems to us nothing but a measurable continuum, the present moment alone exists and that moment itself is no temporal quantity but merely a dividing line between the infinite stretch of a vanished past and the equally infinite expanse of the untrodden future.... We are forced to view the movement of time as passing from the past into the future, the present being merely that moving limit between the two. Time as something lived we have banished from our metaphysics, hence it constitutes for modern philosophy an unsolved problem. The fact that man can think in the present of a past happening seems a strange matter to modern speculators, requiring to be accounted for, and even M. Bergson, doughty champion though he is of time lived, can present it only in terms of an ever self-multiplying snowball, a notion which would make a modern physicist gnash his teeth and a medieval scholastic gasp in amazement. We forget that we are no longer part of the real world of modern metaphysics and that time as a measurable continuum—the dividing line of the present moving in regular and solemn silence from the dead past into the unborn future—is a notion whose ultimate metaphysical validity is conditioned upon making our exclusion permanent. If we are a part of the world, then the t of physics must become but a partial element in real time, and a more inclusive philosophy thus rewon might again consider the evidence in favour of attributing movement to the future rather than to the present, while the idea of the past as dead and vanished might be consigned to oblivion with the other curious relics of an over-mechanical age.\footnote{Burtt, \textit{Metaphysical Foundations}, 84-86.}
In his description, Burtt outlines the radical shift that Galileo’s mechanics brought about with respect to time. On the one hand, like space, it had been essentially unproblematic in the scholastic conception of movement and change. On the other hand, it had occupied a conceptual relationship even closer to man and his experience because time in the scholastic framework was fundamentally empirical—it was “time lived” or experienced. Galileo’s mechanization of the universe, however, left man extracted from time when it was considered quantitatively, while making it an indispensible (and independent) feature of physical systems. For Burtt, this creates a major philosophical problem which until now remains unresolved, the assertion of which falls directly in line with my general claim that the treatment of time as a mathematical entity, belonging to the universe independent of sensible experience, is a sociologically generated concept. Implicit in Burtt’s argument—and explicit in mine—is the very fact that his outline of the metaphysical foundations of physics is rooted in the notion of time as lived through the historically causal trajectory of ideas that contributed to the foundations of modern science. A mathematical and impersonal time stands in opposition to this kind of historical explanation because it fails to support any causal link between the distant past and present events in mental experience—the scientific imagination included. For Burtt, the ontological status of time borne of Galileo’s science reflects the philosophical problem that an impersonal, mathematical time creates for him, Bergson and the like in understanding the questions of their epoch. Their problem stems from the authority with

51 In fact, as subsequent chapters of this dissertation will show, my account of time places an enormous causal emphasis on “the past”. The historical argument of the present chapter is based on the idea that the past is not dead and consigned into oblivion, but instead is the major causal factor in the nature of present and future ideas.
which physics would ultimately elevate “time-in-the-universe” to a fundamental category in a “real” world devoid of man; even though this very concept of time was derived from the historically conditioned—sociological and thus culturally created—conception of a mathematically constant, geometrically-organized image of reality, it was inherited and perpetuated by the founders of modern science as a necessary truth.

The modern problem of time–without-man versus time-as-lived should not be confused with the more specific problem that the mathematical treatment of time created for physical science itself: namely, that time, as it was borne from Galileo’s science, was a fundamental category that had no intrinsic qualities other than its mathematical assignment and, unlike the geometrization of extended matter, its mathematical assignments corresponded to no sensible referent. The mathematical treatment of time represented a new attitude toward an old concept spawned by a Platonic commitment to the organization of matter and its motion. This new attitude, a priori in nature, was produced historically and therefore did not represent the discovery of time as a physical dimension. Thus, time became a truly ideal category that could only be understood by what Newton referred to as “Absolute, true, and mathematical… of itself, and from its own nature.” Said another way, time’s ultimate nature could only be understood speculatively. Thus, as Newton, the founder of modern physics, struggled with the rationalization of an ideal, fundamental category in light of his positivist stance toward science, we see the appeal to religion as the justification and reconciliation of a physical system organized in infinite, immutable, space and time.
The Religious Explanation of Newton’s Time

The religious commitments of Isaac Newton, as well as of other English virtuosi of the 17th century, should not be underestimated. Richard Westfall, the distinguished biographer of Newton, emphasizes the role that religion played in the early days of the scientific revolution when he writes, “Unconsciously the virtuoso was reasoning in a circle, for his original conception of the natural order derived from his belief in the Creator’s goodness. Religion influenced the conclusions of science in its early days as much as science influenced religion.” And later, “[the virtuoso] proved the existence of God from assumptions in which the existence of God was already implicit.”52 While a parallel argument has been made to highlight such a teleology in the thought of the pre-modern natural philosophers discussed thus far, Westfall’s characterization is of special importance in the work of Isaac Newton where coincidentally we see the religious influence permeate the scientist’s work despite his disdain for “hypotheses”53 and then virtually disappear from scientific discourse once institutionalized around his mathematical principles.

During the gestation of physical science, Newton was involved in a dialogue with his contemporaries—and with himself to no small extent—concerning the mathematical principles of natural philosophy and the relevant phenomena of interest that should be expressed and preserved in mathematical representation. Before the definitive establishment of his system, which enshrined physical science in the airtight self-

---

52 Westfall, Science and Religion 50-51; emphasis in the original.
53 For Newton and his 17th century contemporaries, the word ‘hypothesis’ referred specifically to assumptions lacking in empirical foundation and was often used pejoratively.
containment of logical equations, certain dispositions had to be dealt with and extra scientific choices had to be made. Prominent among the relevant concerns were the place of God in the burgeoning mechanical image of the world; it is on this point that the young Newton asserted his adamant opposition to the dualist conception espoused by Descartes. Cartesian mechanics (and later, Cartesian philosophy) separated the realm of the spirit from the res extensa of geometrically organized matter. To this division Newton objected strongly, arguing that such a separation of spirit from nature led one dangerously close to an atheistic view of the universe. Describing Newton’s sentiments on the matter Westfall writes, “By the separation of body and spirit, Descartes denied the dependence of the material world on God. The ultimate cause of atheism, Newton asserted, is ‘this notion of bodies having, as it were, a complete, absolute and independent reality in themselves…”\(^54\) Westfall’s account of Newton’s early development highlights the significance of religion in Newton’s metaphysics and foreshadows the need for God’s incorporation into the physical system—and into the essence of things—that will ultimately be described. Preceding the victory of Newton’s physics in the history and establishment of modern science, however, this religious sentiment introduces a problematic dissonance between the emphasis on fundamental cause, the underlying nature of certain phenomena, and the rigors of positive empiricism. Indeed, Holton refers to this dissonance when he speaks about “some of the strange tension which pervades Principia and [Newton’s] other writing.”\(^55\)


\(^{55}\) Holton, Thematic Origins, 50.
subsequent disappearance of religious emphasis in the science of physics is directly related to the story of time in science.

I have already discussed the Pythagorean/Neoplatonic influence on the development of natural philosophy up to Newton. That tradition (namely, the claim that the understanding of the mathematical organization of the universe was the only path to uncovering the true organization of God’s realm, and the consequences that this claim had for the subjugation of Aristotelian scholasticism) was Newton’s intellectual inheritance. He was well aware of his place in this genealogy of thought and pointed to this awareness in his famous homage to the “giants” whose accomplishments formed the foundation of his own view of the natural world. Moreover, a key section in the first edition of *Principia* makes it clear that Newton knew that certain traditional “hypotheses” (i.e. assumptions) lay at the foundation of his science and without these assumptions philosophical reasoning about nature could not be done. These foundational assumptions constitute Newton’s *Regulae Philosophandi* and read:

I. Nature is essentially simple; therefore, we should not introduce more hypotheses than are sufficient and necessary for the explanation of observed facts. This is a hypothesis, or rule, of simplicity and *verae causae*.

II. Hence, as far as possible, similar effects must be assigned to the same cause. This is a principle of uniformity of nature.\(^{56}\)

As *Regulae*, these assumptions reflect the thematic principles of a well-established Neo-Platonic/mathematical view of the universe; the fact of their widespread acceptance by

\(^{56}\) Newton’s *Regulae Philosophandi* these first two rules appear in the first edition of *Principia* of 1687. By the third edition of 1726 they were expanded to included two additional rules for the formation of universals in natural philosophy and the logical refutation by empirical evidence of scientific propositions.
the natural philosophers of Newton’s epoch accounts for the straightforward acknowledgement given to them in the first edition. In subsequent editions of the *Principia*, however, Newton’s rules for reasoning in philosophy did not stay confined to these two. In response to criticism from and competition with the ideas of his contemporary Cartesians and Leibnizians, Newton felt the need for elaboration of the *Regulae* and through this elaboration we begin to observe the pervasive tension to which Holton refers in Newton’s writing.\(^{57}\)

In the third edition of *Principia*, Holton tells us, Newton chose to add two more rules for reasoning in natural philosophy. The third was a reformulation of the first two rules and is not of particular significance here. The fourth, however, was new, emphasizing the importance of positive proof in Newton’s philosophy and, according to Holton, was intended to bolster Newton’s work against “the hypotheses-laden missiles from the Cartesians and Leibnizians”.\(^{58}\) It read:

IV. Propositions in science obtained by wide induction are to be regarded as exactly or approximately true until phenomena or experiments show that they may be corrected or are liable to exceptions. This principle states that propositions induced on the basis of experiment should not be confuted merely by proposing contrary hypotheses.\(^{59}\)

This fourth rule underlined the reliance of Newton’s natural philosophy on deductive (i.e. positive, experimental) proof of widely induced propositions, arising from generally

\(^{57}\) On the philosophical tension between Newton and his contemporaries at it concerned space and time, see Disalle, “Newton’s Philosophical Analysis of Space and Time” in *The Cambridge Companion to Newton*, Cohen and Smith (eds.) (Cambridge: Cambridge University Press, 2002), 33-56.

\(^{58}\) Holton, *Thematic Origins*, 50.

consistent observations of empirical phenomena, and his dismissal of any reasoning that proceeded in the contrary direction. In response to the empirically unfounded, purely hypothetical, criticisms directed by his Cartesian and Liebnizian contemporaries, Newton frequently asserted the authority of his thought through its correspondence to positive empiricism. The emphasis and authoritative dependence on positivism, however, was not so easily won. In fact, his positivism would prove to be problematic for some of Newton’s most foundational assertions with respect to the cause of gravity, the place of God in the natural universe and, as I will demonstrate, for the conceptualization of absolute space and time.

The contradiction between Newton’s positivism and certain necessary assumptions is illustrated by the apparent drafting, and subsequent suppression, of a lengthy fifth rule never included in any edition of the *Principia*. Amazingly, the discovery of this fifth rule dates only the mid 20th century and is discussed in Koyré’s *Études Newtoniennes* of 1960; Holton seizes upon this discovery in his exposition of the thematic process of the scientific imagination—an exposition that supports my claim about the tenuous status of time in Newton’s mechanics. The first and last sentences of the 5th rule are the most telling for the present purpose and they read:

V. Whatever is not derived from things themselves, whether by the external senses or by internal cogitation, is to be taken for hypotheses. … And what neither can be demonstrated from the phenomena nor follows from them by argument based on induction, I hold as hypotheses.60

(It is important to reiterate that, for Newton, “hypotheses” meant assumptions, which were inadmissible in natural philosophy when they lacked demonstrable correspondence to empirical phenomena—Newton asserted this stipulation in the immediately preceding rule.)

The fact that this 5th rule appears in no edition of the *Principia* indicates to Holton that Newton knew this statement was at odds with many of the implicit assumptions of his mathematical principles; preferring not to contradict himself so openly, Newton ultimately suppressed the fifth rule from publication. On the specific contradictions that this rule would have created, Holton writes that despite his disdain for assumptions, “…Newton found one class of hypotheses to be impossible to avoid in his pursuit of natural philosophy—a class that shared with Cartesian hypotheses the characteristic of neither being demonstrable from the phenomena nor following from them by an argument based on induction…The necessity, at certain stages, of entertaining such unverifiable and unfalsifiable, yet not quite arbitrary, hypotheses…is an embarrassing conception which did not and does not fit into a purely positivistically oriented philosophy of science.”

Indeed, the thematic imagination is not a simple process and Newton’s omission of the fifth rule suggests to Holton that this genius was aware that an explicit opposition to hypotheses that cannot be derived from empirical or analytical properties of the phenomena themselves would render his own metaphysical foundations patently problematic.

---

Thus, Holton draws attention to the *Regulae* as an important demonstration of the extra scientific influence in Newton’s developing propositions because they demonstrate the process of the scientist’s thematic imagination both in the plain admission of their status as hypotheses and also in the iterations they underwent in subsequent editions of the *Principia*. By outlining the development of the *Regulae*, Holton illuminates the process by which Newton weighed and decided between thematic propositions in his science to augment or reconcile the relationship between empirically accessible phenomena and the extent to which the nature of things can be analytically reasoned from the data; for, the substantive content of the fifth rule presents an explicit problem to Newton in the case of gravity, where Newton was unable to assert its physical cause either by observation or by logical analysis. In the *General Scholium* appendix to the second edition of *Principia*, Newton writes, “I have not yet disclosed the cause of gravity, nor have I undertaken to explain it, since I could not understand it from the phenomena.” On the one hand, Newton’s omission is consistent with his methodological positivism and in line with his—unpublished—5th rule. On the other hand, Holton points out the deep-seated dissonance that this theoretical gap creates in the mind of the scientist. Illustrating this dissonance, Rupert Hall and Marie Boas Hall write that, “In one obvious sense, [the inability to disclose the cause of gravity] is true, and in that sense it knocks the bottom out of the aethereal hypothesis. In another sense it is false: Newton knew that God was the cause of gravity, as he was the cause of all natural forces…. That this statement could be both true and false was Newton’s dilemma: in

---

spite of his confident expectations, physics and metaphysics (or rather theology) did not smoothly combine. In the end, mechanism and Newton’s conception of God could not be reconciled…. Forced to choose, Newton preferred God to Leibniz. “63

The qualitative emptiness of time in Newton’s vision of the universe reveals that same complicated dissonance between the positivist requirements of his science and a concept of real physical time.64 Being deduced from the positive observations that imply absolute motion, the fundamental concepts of space and time are thrust into the forefront of Newton’s mathematical system by the same logical necessity that introduced them into Galileo’s. As I have argued, the absolute numerical conception of time that was integral to Newton’s mathematical description of the universe placed it beyond the realm of empirical accessibility and made it an ideal concept that could not be deduced from material facts themselves. Newton bridged this theoretical gap in the case of time, both implicitly and explicitly at different points in his work, however, by asserting his firm commitment to the presence of God in the grand universal scheme and His role in causing the physical phenomena occurring in it. Burtt takes account of this device and its significance with respect to the fundamental categories advanced in Newton’s Scholium where in the case of absolute time, Newton frequently affirms that it, like space, does not come under the observation of our senses.

That this empirical lacuna was an affront to Newton’s positive science is certain. For if he simply took the fundamental category of time for logical necessity, Burtt argues,

63 Ibid., cited in Holton, Thematic Origins, 52.
64 Holton includes the nature of space and time as thematic hypotheses in the list of “major problems which haunted [Newton]” but he does not explore space and time specifically.
it (along with space) would stand as “unimpeachable and would deserve inclusion among the definitions and axioms which furnish the foundation of his mechanics, in spite of the fact that they are quite inaccessible experimentally.” But Newton’s characterization of space and time did not stop at the mere mathematical employment of the concepts, as it did with gravity. In the case of space and time he went further and asserted them as absolute and fundamentally real aspects of the physical universe. The strength of Newton’s position on this matter is evidenced once again in his General Scholium. In it he writes,

“He endures for ever, and is everywhere present; and by existing always and everywhere, he constitutes duration and space….In Him are all things contained and moved…."

By outlining the religious foundations of his work, Newton sheds light on his metaphysical position regarding the nature of the fundamental categories themselves. Not only were space and time fundamental features of the physical world, they were the direct result of God’s everlasting and omnipotent nature. They were absolute in and of themselves because they were in and of Him. Thus, as a result of Newton’s religious commitment, the metaphysics that served as the foundation for his mathematical principles of natural philosophy make Newton’s time a necessarily real feature of the physical universe. Said another way, Newton’s absolute commitment to the reality and

---

65 Burtt, Metaphysical Foundations, 254.
66 Newton, Principia, II 311 ff., cited by Burtt, Metaphysical Foundations, 257, the emphasis is Burtt’s.
omnipresence of God in the universe imbued his concept of time with a strong ontological status, making it something more than simply time-as-measurement.

Since time could not be accessed empirically nor deduced from physical phenomena it was, instead, rationalized by the appeal to thematic propositions that, as Holton tells us, serve “as a bridge over the gap of ignorance.” While Holton’s exposition of the thematic imagination helps us understand both the need and the mechanism of extra scientific factors in Newtonian physics, the present analysis highlighting the specific—religious—bridge that Newton built, contributes to an understanding of the particular vision of time that Newton established, thereby underlining the strength of that vision as it was left to the inheritors of his science. To a degree of explicitness that far surpassed his tacit understanding of the cause of gravity, Newton asserted the absolute nature of time because his scientific imagination was so firmly rooted in Christian belief.

Evidence of the conflation of science and religion survives unambiguously in Newton’s writing as it relates to time (as seen in the Scholia) as well as implicitly in other propositions that follow logically from the formulation of absolute time derived from the nature of the Creator. In the history of physical science, the most significant side effect of this conflation between the thematic (e.g. religious) origin of time and its relationship to physical phenomena is demonstrated by the concept of simultaneity. The idea of simultaneity in classical mechanics follows logically from Newton’s vision of the universe where all physical bodies were contained in the infinite space imagined as God’s

67 Holton, Thematic Origins, 53.
sensorium. Burtt characterizes Newton’s postulation of the divine sensorium succinctly as, “that in which the intellect and will of God comprehend and guide the doings of the physical world.” And, in *Opticks*, Newton writes that God, “being in all places, is more able by his will to move the bodies within his boundless uniform sensorium, and thereby to form and reform parts of the universe, than we are by our will to move the parts of our own bodies.” Absolute space, and the movement of physical bodies within that space, is thus equated with the “eternal and infinite, omnipotent and omniscient” qualities of the Creator that Newton espouses in *Principia*. As such, physical events are imagined to take place on one universal stage directed by the will of God who “*endures for ever, and is everywhere present.*” It is from such premises that Burtt concludes, “The divine consciousness furnishes the ultimate centre of reference for absolute motion.” With one center of reference (God, or the divine consciousness) and the omnipotence of one will (God’s will) firmly established, it follows logically that physical events occur as the result of one force acting in multiple locations at the same moment in absolute time. Hence, simultaneity is not only a possible feature of Newton’s mechanics, the very concept is a logical derivation of the metaphysical features built-into Newton’s concept of time. Simultaneity in action at a distance is presented in such a way that implies only God could be responsible for its occurrence.

---

72 That force in Newtonian mechanics is gravity, in the proximate cause, and tacitly understood to be Providence in the ultimate analysis.
In 1692 Richard Bentley delivered the first Boyle Lecture where he set out to provide a popularized description of Newton’s system of the universe in order to demonstrate the existence of an intelligent creator. Before the publication of his lectures, Bentley turned to Newton for advice regarding his synthesis of certain points from the *Principia*. At one place in their correspondence, there arose the question of gravity’s innate relationship to matter and the idea that bodies can exert forces on one another without coming into physical contact (i.e. action at a distance). On this topic Newton wrote,

> That Gravity should be innate, inherent and essential to Matter, so that one Body may act upon another at a Distance thro’ a *Vacuum*, without the Mediation of anything else, by and through which their Action and Force may be conveyed from one to another, is to me so great an Absurdity, that I believe no man who has in philosophical Matters a competent Faculty of thinking, can ever fall into it. Gravity must be caused by an Agent acting constantly according to certain Laws; but whether this Agent be material or immaterial, I have left to the Consideration of my Readers.  

Surely, the possibility that the action of gravitational forces at a distance was the result of some undiscovered material agent or system was not only left open in Newton’s response to Bentley, it was also the object of his own aetherial model that would be added to the second edition of *Opticks* in 1717. Notwithstanding the retrospective light in which Newton might view his own aetherial hypothesis, it is clear from the letter to Bentley that the concept of simultaneity is contained in the idea of bodies separated in absolute space interacting with one another by means of forces according to one universal and absolute time.

73 Newton to Bentley, February 25, 1692/3
The laws and equations of Newton’s *Principia* also reflect the characteristics of such an immutable frame of reference. The fact that the laws of motion (particularly the third)\(^\text{74}\) and the mathematical expression of the law of gravitational attraction all lack a variable for time is indicative of the belief that the divine consciousness—the ultimate cause—acts everywhere simultaneously according to one unified system of cause and effect. The consistency of Newton’s universal model where movement is governed by the forces that bodies exert on one another both in collision and at a distance depends upon the instantaneous translation of cause and effect (i.e. of force) through space.

Without the idea of absolute time and simultaneity, the equations describing gravitational forces and actual movement become manifestly problematic. As such, the mathematical *Principles* themselves serve as abundant evidence of the conviction that Newton, his contemporaries, and disciples held in the particular monotheistic view of the universe that I’ve argued serves as the foundation for the scientific concept of time. However, the preservation and transmission of Newton’s concept of time in the language of mathematics shrouded the thematic, religious, and essentially sociological origin of the concept in the unquestionable authority of the scientific institution. Consequently, with the concept of absolute time incorporated into the foundation of the mathematical principles—principles that could be transmitted independently of the cultural environment and the thematic imaginations that spawned them—the idea of Providence,

\(^{74}\) Law III: To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts. — Whatever draws or presses another is as much drawn or pressed by that other. .... This law takes place also in attractions, as will be proved in the next scholium. Isaac Newton. Andrew Motte (*trans.*) *The Mathematical Principles of Natural Philosophy*, Vol. 1 (London, 1729), 20-21.
the pantokrator with His divine consciousness, could be dropped from the future annals of science.

**The Dissolution of Absolute Time**

My exposition would not be complete without addressing the contribution of Einstein, that genius of physics who transcended the concept of absolute time. Since the specific development and consequences of special and general relativity have been chronicled extensively—perhaps nowhere more thoroughly than in Holton’s expositions—it is not my task to detail these developments as I have done for the other scientific imaginations recounted thus far. The relevance of Einstein’s accomplishment lies in his destruction of the concept of absolute time which, when analyzed in light of what I have argued, serves as the final proof of the sociological derivation of the concept of time and its absence from the intrinsic characteristics of physical phenomena.

As Holton’s exposition of the thematic imagination implies, the thematic propositions themselves, being derived from the cultural environment rather than directly from the analysis of data, are quasi-scientific propositions; which is to say that due to their tenuous relationship to empirical phenomena, thematic propositions may eventually present problems to the logical consistency of the progressive accumulation of knowledge in science. Einstein drew attention to this pitfall when he discussed the formerly orthodox view of Newtonian time. In *Reality and Physics* he writes, “[A] lack of definiteness which, from the point of view of its empirical significance, adheres to the notion of time in classical mechanics was veiled by the axiomatic representation of space and time as given independently of our sense experiences. Such a use of notions—
independent of the empirical basis to which they owe their existence—does not necessarily damage science. One may, however, easily be led into the error of believing that these notions, whose origin is forgotten, are logically necessary and therefore unalterable, and this error may constitute a serious danger to the progress of science."\textsuperscript{75}

Thus, Einstein alludes to the potentially dogmatic attachment to propositions that are not empirically related to the phenomena of interest and, in a roundabout way, underlines the importance of organized skepticism in preventing such assumptions from hindering the advancement of scientific knowledge.

With respect to time, surmounting the ostensible absoluteness of the concept was Einstein’s great intellectual achievement. The rigor of his own solution derives from its logical relationship to empirical evidence; for Einstein, the principles of simultaneity—logically contained in the premise of absolute time—contradicted the empirically derived constancy of the maximum velocity of light. Thus, in his \textit{Autobiographical Notes} he wrote that, “One sees that in this paradox [of pursuing a beam of light at the speed $c$] the germ of the special relativity theory is already contained. Today everyone knows, of course, that all attempts to clarify this paradox satisfactorily were condemned to failure as long as the axiom of the absolute character of time, or of simultaneity, was rooted unrecognized in the unconscious.”\textsuperscript{76} While it has been the task of the previous section to outline how Newton’s notion of absolute time was derived and became rooted in the unconscious, it should be noted that, in the case of Einstein, an awareness of the


\textsuperscript{76} Einstein, \textit{Autobiographical Notes}, (Illinois, Open Court Publishing, 1979), 51.
sociological nature of time’s original conceptualization was inconsequential to his theoretical breakthrough. Einstein’s *unawareness*, therefore, demonstrates that thematic propositions can be contained and transmitted separately from the historical context of their origin thus exposing the dangerous potential for the passive preservation of unempirically generated concepts in science. But science need not be doomed by this potential pit fall. By constantly examining all aspects of our scientific analyses, particularly our assumptions, it is possible to avoid the inclusion of arbitrary concepts. In Einstein’s case, the axiomatic nature of time in physics was discernible only after the fact, but his imagination that reality might be organized differently than we expect allowed for the breakthrough that would make the assumptive nature of time apparent. Einstein’s negation of simultaneity and absolute time shows that, once the thematic concept is removed from the historical environment of its initial significance, the scientific imagination—usually only in the case of genius—is at liberty to ignore, discard, or change it.77 The fact that Einstein’s revolution constituted the destruction of the concept of absolute physical time proves that the concept was merely the product of sociological, which is to say historical, processes and thus disconnected from empirical data to an extent that ‘normal’ science is not likely to recognize. From Einstein’s theories of relativity we see that that the concept of time, originally generated by thematic principles, is changeable and therefore arbitrary.

77 See, for example, Liah Greenfeld’s negation of the dualist picture of reality in *Mind, Modernity, Madness: The Impact of Culture on Human Experience* (Cambridge: Harvard University Press, 2013), 51-58.
Only much later in his life did Einstein begin to grasp at a realization of the intellectual freedom that his own contributions implied. In *Autobiographical Notes* Einstein wrote that, “…even scholars of audacious spirit and fine instinct can be hindered in the interpretation of facts by philosophical prejudices. The prejudice—which has by no means disappeared—consists in the belief that facts by themselves can and should yield scientific knowledge without free conceptual construction. Such a misconception is possible only because one does not easily become aware of the free choice of such concepts, which, through success and long usage, appear to be immediately connected with the empirical material.”

I have demonstrated that the assumptions surrounding the concept of time in physics can be derived from Newton’s thematic proposition, religious in its origin, and is therefore not connected to the empirical material of physical systems. What had begun as a philosophical prejudice became accepted and treated as fact by the scientific institution (i.e. the entire edifice of modern science) as soon as the idea of absolute time was incorporated into the mathematical language of physics. By Einstein’s epoch, however, the environmental constraints of culture had changed and the metaphysical commitments that brought the concept of absolute time into being for physics no longer exerted an insurmountable influence over scientists in the way they had over Newton and his contemporaries. Thus, without the context that brings thematic principles to bear on the mind of the scientist, the scientific imagination is free to leave them and pursue alternative solutions. In the case of Einstein, the solution was a novel

---

78 The philosophical shift in Einstein’s thought from staunch positivism to a rationalist epistemology is outlined by Holton in his article “Mach, Einstein, and the Search for Relativity”, in *Thematic Origins*, 219.
79 Einstein, *Autobiographical Notes*, 47.
conception of the universe in which time no longer served as real, absolute feature of physical systems, but rather, depended upon the frame of reference of an observer thus creating infinitely many times, effectively relegating the concept to nothing more than an aspect of mathematical notation.

Despite the demotion of time in physics to a relative, purely mathematical entity, we popularly retain the impression that time is a feature of the universe, that it somehow constitutes a fundamental category of our experience and therefore exists in a manner outside of us. This vague retention is, in itself, indicative of the enormous significance that historically generated concepts exert over contemporary minds. Einstein himself attempted to account for the perseverance of popular attachment to Newton’s universal scheme. Towards the end of *Physics and Reality* he wrote that, “In spite of the fact that, today, we know positively that classical mechanics fails as a foundation dominating all physics, it still occupies the center of all of our thinking in physics. The reason for this lies in the fact that, regardless of important progress reached since the time of Newton, we have not yet arrived at a new foundation of physics concerning which we may be certain that the manifold of all investigated phenomena, and of successful partial theoretical systems, could be deduced logically from it.”\(^{80}\) Based on the logic of Einstein’s argument, it would seem that the Newtonian shift in epistemology with respect to time remains cemented in our thought because we have yet to find a system that more completely contributes to our understanding of the universe. The explanation of the popular belief in real physical time, however, cannot be completely accounted for by

---

\(^{80}\) Einstein, “Physics and Reality,” 301.
Einstein’s reasoning; necessarily it falls outside of the purview of material science. Having shown here that that time is not an empirically derived concept, we must now examine ideas about time closer to our every day experience. Newton’s idea of absolute time might suggest a concept that is much more in line with the perception of a singular time-as-lived and experienced by the individual mind. In this sense, Einstein is only half correct when he attributes the stagnation in knowledge to the lack of a more unified theory in physics. It would be better to underline the general importance of scientific knowledge in our contemporary epistemology and consequently to recognize the foundational significance that Newtonian physics plays in our understanding of the world as a whole. This too is a task for the sociologist and, while such an analysis is certainly related to the present argument, it lies outside of what has been the specific focus thus far.

It has been my goal in this chapter to shed light on the origin and development of the imagined physical reality of time, arrive at the conclusion that the notion itself can only be accounted for sociologically, and consequently argue that time is not an empirical characteristic of physical systems. I shall now proceed to the discussion of the implications of this conclusion for biology, philosophy and human neuroscience, with the goal of arriving ultimately at the empirical reality of time, which, with Einstein, we have lost.
TIME IN BIOLOGY AND BIOLOGICAL TIME

In the concluding chapter of *The Origin of the Species*, Darwin brought the subject of time into question by distinguishing between geological—or physical—time and *times* defined by the interactive relationships of contemporaneous species. “The whole history of the world, as at present known,” wrote Darwin, “…will hereafter be recognized as a mere fragment of time, compared with the ages which have elapsed since the first creature, the progenitor of innumerable extinct and living descendants, was created.”81 This statement follows a suggestive contradistinction between what Darwin called “actual time” and “organic change”; actual time might be measured by the march of earth’s rotations, revolutions, and geological transformations but organic change is multifarious and constitutes isolatable sets or *times* that appear to be independent of physical time itself. Thus, Darwin’s “whole history of the world” as it was known (transforming, in his day, from a biblically informed time scale to a geological one82) represented only a small piece of the complete concept of time because neither the relationships between, nor the characteristics of, certain organic phenomena can be determined by a geologically or astronomically defined time—organic change, or the process of life, creates times of its own.

It is highly unlikely that Darwin questioned the scientific legitimacy of absolute physical time in a way that could implicate him in the discussion of the first chapter of this dissertation. Not only is there no historical evidence of such skepticism on his part,

---

there is also no logical need for it in the development of his theory of natural selection—a theory whose success derives from its incredible consistency with the science of physics. What Darwin’s theory does introduce, however, is the autonomy of organic phenomena, of life itself, from the laws of the physical world in which it is contained; his emphasis on the uniqueness of organically defined ages (that is, epochs which can be delineated by the species that inhabit them) points to a characteristic feature of this autonomy. The “Recapitulation and Conclusion” of *The Origin of the Species* is full of thought provoking conjectures and implications that follow from his theory of natural selection, indicating an awareness in Darwin himself of the scientifically prolific capacity of his view of the living world. The context in which he arrives at the hetero-chronic nature of life, however, makes it seem as if he were lead to this particular thought accidentally.

The main objective of the passage in question was to draw attention to the fact that while natural selection points to an interactive relationship between a species and its environment, the environment cannot completely be represented by its physical characteristics; one must take into account what Darwin calls “the mutual relationship of organism to organism” (i.e. the presence of other species in the species’ environment). This mutual relationship between individuals of both the same and different species contributes greatly to the totality of selective pressures. The significant implication for Darwin is that these pressures, and the dynamic ecological systems that contain them, may not be causally related to physically delineated periods. “A number of species… kept in a body might remain for a long period unchanged,” Darwin wrote, “whilst within this same period, several of these species, by migrating into new countries and coming
into competition with foreign associates, might become modified; so that we must not overrate the accuracy of organic change as a measure of time.”

Already, in the short paragraph addressing these points, Darwin introduces concepts of “actual time”, “ages”, “organic change” and “the whole world history” to make his argument about the autonomy of the organic world in its physical environment—it seems as though the concept of absolute, homogenous time presented itself to Darwin as an impossible feature of life and thus as a potentially problematic concept for biological science and this intimation is captured by the deliberate diversity of terms he used to express these temporal concepts. Thus, Darwin fleetingly, and perhaps even despite himself, offered his readers the implication that organic forces and physical forces do not operate according to the same temporal principles. Having already argued against the idea that physical forces are temporal in any absolute or empirical sense, it will be the task of this chapter to answer the question as to how time can be an empirical phenomenon in organic reality, and then to examine organic time’s characteristics and its consequences for the science of biology.

At the Nexus of Matter and Life

In order to approach the unique status of time in the organic world, I must first address the relationship that organic phenomena have to the physical elements of which they are composed, for it is in the novel conceptualization of this relationship that the great philosophical revolution of Darwin’s theory resides. Having typically to pay very

---

84 I assert that this is the most likely interpretation of the passage because, as I will discuss subsequently in this chapter, the philosophy implicit in Darwin’s framework posits life as an emergent phenomenon whose fundamental characteristics are irreducible to its physic-elements.
little attention to Darwin’s philosophical contribution, contemporary biologists are apt to overlook many of the implications that his theory represents in the lineage of scientific knowledge; in fact, even many philosophers of science throughout the 20th century (i.e. Kuhn, Popper, Nagel) have demonstrated considerable difficulty in attempting to incorporate biology into their accounts of science, which are historically modeled on the nature of explanations in physics. But a clear understanding of Darwin’s—and thus biology’s—place in the development of science as an institution vis-à-vis physics is indispensible for the argument that I intend to make about the nature of time in organic reality.

Like all scientific endeavors, the birth and development of biology began from a desire to understand and explain certain phenomena—living phenomena—according to empirical and objectively verifiable standards. The empirical distinctions between organisms and inanimate matter, however, made the understanding and explanation of living phenomena patently problematic for the practitioners and admirers of science, which was built around the discovery of lawful consistencies and universal principles. Physics, having served as the model for science since the 17th century, informed the expectations of what causal relationships, and therefore explanations, should look like: mathematically describable interactions that occur according to laws of universal regularity. Life’s empirical characteristics, however, seemed incompatible with this

---

86 This understanding is necessarily influenced by Greenfeld’s exposition where she underlines the metaphysical implications of Darwin’s theory in the “Premises” of Mind, Modernity, Madness, 54-58.
rigorous method of understanding. Of the conundrum that living phenomena presented to science, Earnst Mayr writes, “To elucidate the nature of this entity called ‘life’ has been one of the major objectives of biology. The problem here is that ‘life’ suggests some ‘thing’—a substance or a force—and for centuries philosophers and biologists have tried to identify this life substance or vital force to no avail.”

Thus, the birth of biological science was preceded by the development of two separate philosophical camps engaged in the 19th century debate over the nature of life and living things.

One camp, the *mechanists*, modeled itself on the premises of physics and sought to explain organic phenomena in terms of the universal laws that govern physical and chemical interactions. Conversely, philosophers and naturalists of the *vitalist* camp opposed the mechanists by arguing that animate matter possessed some metaphysical quality, or *élan vital*, that accounted for the empirical differences between organic and material phenomena. Empirical lacunae in both philosophies made it impossible for biology to become an independent science.

Mayr characterizes the major problem in the vitalist approach as the unscientific nature of its assumptions. “…Vitalism was more and more often viewed as a metaphysical rather than a scientific concept,” he writes. “It was considered unscientific because the vitalists had no method to test it.” Conversely, the physicalist position, a 20th century outgrowth of the 19th century mechanist philosophy, proved its own shortcomings in the inability to logically account for the diversity and indeterminacy of

---


88 Mayr, *This is Biology*, 13.
organic phenomena. Even well into the 20th century, according to Mayr, when many biologists, “…particularly those working in physiology and other branches of functional biology, adopted physicalism and attempted to explain all biological processes in terms of movements and forces…[physicalism] left a vast number of phenomena in the living world totally unexplained.”89

In his final analysis, Mayr concludes that both the mechanist and vitalist approaches were partly correct and partly incorrect, asserting that a synthesis of the two schools of thought constitutes the best theoretical foundation for scientifically sound explanations of organic phenomena. Mayr dubs this synthetic position organicism, and, blends the previous positions by accepting “that processes at the molecular level could be explained exhaustively by physicochemical mechanisms but that such mechanisms played an increasingly smaller, if not negligible, role at higher levels of integration…” Mayr goes on to qualify that, “The unique characteristics of living organisms are not due to their composition but rather their organization…” Therefore, the unique characteristic of the organicist approach is that it, “…stresses particularly the characteristics of highly complex ordered systems and the historical nature of the evolved genetic programs in organisms.”90

It is significant that Mayr extends his account of the vitalist/materialist91 debate well into the middle part of the 20th century, resolving ultimately in the organicist position. For it wasn’t until then that vitalism became completely outmoded in scientific

89 Mayr, New Philosophy of Biology, 9; see also, Greenfeld Mind, Modernity, Madness, 56-58.
90 Mayr, This is Biology, 16-17.
91 Materialism being essentially characteristic of both the mechanist and physicalist positions.
circles; at the same time, with the advent of molecular biology and the discovery of the genome, physicalism has maintained a steady hold on the biological imagination. That this persistent philosophical rift lies historically on either side of the publication of Darwin’s *Origin of Species* illustrates the difficulties present in the scientific understanding of life. On the one hand, the debate between the mechanist and vitalist positions in the 19th century is reflective of the enormous difficulty that Darwin’s theory would have to overcome in order to establish biology as a scientifically legitimate discipline. On the other hand, the endurance of this debate into the better part of the 20th century (and even the vestiges of this debate, demonstrated by the reductionist mindset of many contemporary intellectuals93) is indicative of the extent to which Darwin’s theory itself is ignored as a resolution of this dichotomy in the philosophy of science. For even though Dobzhansky reminds us that “Nothing in biology makes sense except in the light of [Darwin’s theory] of evolution”,94 the epistemological contributions of Darwin are frequently overlooked or misunderstood.

Indeed, the organicist position that Mayr describes is predicated on Darwin’s particular view of life in the universe. But what is so unique about Darwin’s theory? What made it truly revolutionary? And how does it relate to the current philosophical stance of biology? As I pointed out above, explaining life, understanding its fundamental  

---

92 As evinced, for example, by the strictly mechanist outlook expressed in Watson’s book *DNA: The Secret of Life* and his persistent rejection of vitalism, the only other philosophical position available to him. 
nature in the most complete sense, was unaccomplished by either the materialist or vitalist position. As Greenfeld argues, the former was unsuccessful in providing a logical connection from physiological data to the phenomenon of life itself and the latter was scientifically untenable.\(^95\) Moreover, the analytical focus of both positions placed emphasis on explaining the transformation from inanimate matter to animate organisms, essentially begging the question: what qualities or laws caused inanimate matter to organize, produce, and expend energy in ways that were unanticipated by the laws of physics as they were known? *Darwin’s theory of evolution through descent with modification and natural selection transcended the materialist/vitalist debate by disregarding such questions and, instead, by taking life for granted, explained the law by which life abides rather than attempting to uncover laws to explain its existence.*\(^96\) What is often misunderstood about the *Origin of the Species* is that Darwin’s theory specifically addresses the source or mechanism of speciation, the diversity in *forms* of life, not the origin of life itself. In March of 1853 Darwin expressed his frustration with this common misunderstanding of his work in a letter to J.D. Hooker, “…I have long regretted that I truckled to public opinion, and used the Pentateuchal term ‘creation’, by which I really meant ‘appeared’ by some wholly unknown process. It is mere rubbish”, he continued, “thinking at present of the origin of life; one might as well think of the origin of matter.”\(^97\) This letter could just as well address the general misunderstanding of contemporary biology, for it is infrequently appreciated that Darwin avoided the

\(^95\) See Greenfeld, *Mind, Modernity, Madness*, 52-58
\(^96\) Ibid.
\(^97\) Charles Darwin to J.D. Hooker, March 29, 1863, Darwin Correspondence Database [http://www.darwinproject.ac.uk/entry-4065](http://www.darwinproject.ac.uk/entry-4065) (accessed August 4, 2014).
methodological impossibility of addressing ultimate origins in science by taking the reality of life for granted.

The most revolutionary aspect of his theory follows from this methodological approach: without reducing life it to its physicochemical elements (and by not resorting to metaphysical explanations) Darwin implicitly treated life as an emergent phenomenon—i.e., a reality *sui generis*—with its own law: the law of evolution by natural selection. Unlike the static laws of physics, Darwin’s law described a dynamic, interactive process between an organism (or a species) and its environment. Though this emergent reality of life had its own unique empirical characteristics, the material elements of life in every instance remained subject to the laws of physics and chemistry, thus, making Darwin’s vision of organic phenomena logically consistent with the existing canon of scientific knowledge. As a result of this astonishing consistency, Mayr’s organismism is able to reconcile the significance of physiological processes on the molecular level with questions at higher levels of analysis that relate to the interactive relationship between organisms and their dynamic environment. When viewed in this light, the philosophical foundation of the organicist position does not seem quite as new; it can be seen, instead, as an elaboration on the Darwinian framework, merely including more data (namely, of the cellular-molecular kind) that was not empirically accessible until the middle of the twentieth century.

Beyond its consistency with physical science, Darwin’s framework also provided a logical means for answering questions about ‘how’ and ‘why’ organisms are structured or function in such a way without resorting to the empirical inaccessibility of an
intelligent designer or an *élan vital*. The answers to these questions are found in actively selective pressures of the environment, which, according to Darwin’s theory, are directly correlated with what Mayr calls “the historical nature of the evolved genetic programs in organisms.” Remembering that speciation was the focus of Darwin’s analysis, the causal connection between environmental factors (or stimuli) and the existence or function of certain phenotypes becomes the focus of empirical analysis—an analysis in which hypotheses can be constructed and, more importantly, in the face of contradictory empirical evidence, such hypotheses can be refuted.

Thus, we see that two central features of Darwin’s theory form the foundation of the contemporary organismist position: the amenability of organic processes to physicochemical description based on the theory’s consistency with the laws of physics and the empirical emphasis of the interactive relationship between an organism and its environment envisioned in the theory of evolution through natural selection. When these two aspects of Darwin’s theory are taken for granted—as they are by every modern student of biology, for whom the organismist position comes packaged with an endless supply of supportive facts that make the theory itself seem obvious—one loses sight of the enormous philosophical implication on which biology’s functional explanations depend: the inexplicable emergence of a reality whose essential qualities are irreducible to and un-derivable from its constitutive elements.

One can catch a glimpse of this implication in Mayr’s description of the unique features of biological systems that justify biology’s independence from the sciences of physics and chemistry. Those features are the empirical characteristics of life that exhibit
processual autonomy, an incredible departure from the limits of cause and effect in
physics, and thus, have historically been some of the most problematic concepts in the
philosophical understanding of biology. Mayr lists them as:

- A capacity for evolution
- A capacity for self replication [...]
- A capacity for growth and differentiation via a genetic program
- A capacity for metabolism [...]
- A capacity for self regulation, to keep the complex system in steady state
  (homeostasis, feedback)
- A capacity (through perception and sense organs) for response to stimuli
  from the environment
- A capacity for change at two levels, that of the phenotype and that of the
  genotype

In short, Mayr writes, “All these characteristics of living organisms distinguish them
categorically from inanimate systems.” Organisms, he goes on to say, “…are not just
piles of characters or molecules, because their function depends entirely on their
organization, their mutual interrelations, interactions and interdependencies.”

It is thus the emergence of new systems of organizations, some of which plainly violate cardinal
laws of physics (the second law of thermodynamics in the case of metabolism, in
particular), that characterizes the living world and necessitates a novel approach in the
scientific explanation of life.

For Mayr, these unique characteristics of life are accounted for in the organicist
position by introducing the concept of emergence, allowing for the appearance of new
organizational structures or programs whose properties cannot be explained by its
elements alone. Of the relationship between this concept and the success of organicism,

---

98 Mayr, *This is Biology*, 19-23.
Mayr writes that, “... in a structured system, new properties emerge at higher levels of integration which could not have been predicted from a knowledge of the lower-level components...[and that]...by eventually incorporating the concepts of the genetic program and of emergence, organicism became antireductionist and yet remained mechanistic.”

Though his discussion of emergence and organicism may account for both the progression of biological knowledge and the unique autonomy of explanations in biology, I would like to make the case that Mayr’s discussion does not, in fact, provide the most complete interpretation of emergence nor does it portray the importance that this concept has for the very existence of biology; in other words, I claim that Mayr’s presentation of the concept falls short of capturing the epistemological foundation on which biological science really depends. This is because Mayr’s exposition falls into the category of a weak argument for emergence by focusing on properties, or novel organizations, occurring in systems already living (and therefore products of and subject to the laws of natural selection) whereas the implications of Darwin’s vision, and the cornerstone on which the aforementioned functional laws of biology depend, recognize the emergent reality of life itself as a reality of its own kind. The problem that I see in Mayr’s exposition is that emergence is treated as an effect of organic systems, rather than a distinguishing characteristic of organic reality. The elements of these systems, for Mayr, may not predict the processes in which they partake, nor may they be causally relevant at all levels of analysis, but nevertheless new and more complex arrangements that

99 Ibid., 19.
contribute to the fitness of an individual or species are produced by natural selection. Emergence, in this sense, refers to a phenotype, as is evinced from Mayr’s assertion that, “A modern evolutionist would say that the formation of a more complex system, representing the emergence of a new higher level, is strictly a matter of genetic variation and selection.” 100 Thus, for Mayr, emergence “…in no way conflicts with the principles of Darwinism.” But understanding emergence in this way reduces the concept to nothing more than an arbitrary distinction between the causally relevant connections that organic processes have to one another and the environment. Since all phenotypes are, in essence, inextricably linked to other organic phenomena within the organism and the species’ environment, Mayr’s interpretation begs the question: by what standards is a specific organic property or feature deemed emergent?

All organic phenomena develop and operate within the physical constraints of an environment and according to the same laws of life. It is specific life processes (i.e. phenotypes) that evolve or maintain homeostasis on whichever level of analysis one may choose to investigate. By stating that the organic reality is a reality within which new properties “emerge” at higher levels of integration, Mayr implies that there are levels of integration which cannot, at least theoretically, be explained by or derived from the physicochemical processes or ecological interactions upon which the property or organization depends. This is simply not true of biological systems. For one, this view has the potential to contradict the physicalist principles of reductionism upon which molecular and cellular biology are founded. Even more so, the notion that certain organic

100 Mayr, This is Biology, 20.
phenomena ‘emerge’ which are not the cumulative result of a genome/environment interaction, completely dependent upon the totality of physic-chemical processes of the organism, regardless of the complexity involved, runs counter to the causal continuity on which the existence of organic phenomena depends. The weak version of emergence implied by Mayr seems to implicitly contradict the analytical logic of biological science after Darwin and has no objective means of definition. In order to see biology as an independent science and life as an autonomous reality we must see it as emergent in the strong sense of the concept—i.e. one must identify a break in either logical or empirical continuity. It is only with respect to such a break that the concept of emergence in biology becomes analytically useful.

Mayr’s organicist position reflects the insufficient appreciation of the profundity of Darwin’s contribution to the development of the science of biology among the contemporary practitioners of this very science. As I have argued (along with Greenfeld), Darwin’s treatment of the phenomenon of life in relation to the world of inanimate matter implicitly reimagined the phenomenon itself as a reality whose essential nature is not explained by the elements that constitute it. Life is a reality in which new properties emerge which could not have been predicted from its lower level, material, components (see Mayr’s own list of the unique characteristics of organisms, above). Though Darwin never made his philosophical position in this respect explicit, his treatment of life represents an example of emergence in the strongest sense: Darwin
envisioned the reality of life as ontologically emergent in relationship to the reality of inanimate matter.\textsuperscript{101}

The most convincing argument in support of the emergent relationship between living phenomena and inanimate matter (organic vs. physical reality) was published in a 1968 Nature article titled “Life’s Irreducible Structure” by Michael Polanyi. In the article Polanyi argued that DNA, the passive mechanism of Darwinian evolution, is a structure whose informational significance only exists because its ordered, code-like structure is not “due to the forces of potential energy”. Polanyi tells us that it is the indeterminate nature of the base sequence that creates the informational essence of DNA in juxtaposition to the physicochemical probability that joins inorganic molecules in complex and regular arrangements throughout the physical universe. Thus, while the DNA structure occurs within the physical-chemical boundary conditions of its material constituents, the significance (both functionally and analytically) of any particular instance of DNA is extraneous to the laws of physics and chemistry; it is rather an informational structure in the process of life, determined not by physical laws. Furthermore, this structure can only be said to be informational with reference to the processes of life in which it is engaged.

By stepping back from the detailed, molecular and cellular focus of modern biology, Polanyi reminds us that the biological reality, as conceptualized by Darwin is a reality of its own kind whose laws are extraneous to the physicochemical boundary

conditions in which the process of life takes place. All organisms, according to Polanyi, exist as systems of dual control in which the structure of the organism is bound by the laws of physics and chemistry while at the same time the developmental processes, or morphogenesis, of the organism will organize its inanimate constituents in ways that both limit and defy the probabilities of inorganic, material interactions. Thus, the organicist analysis of Mayr is reducible down to the lowest level of physiological operation but never further—at a certain level of reduction, organic processes can only be explained from the top down rather than from the bottom up. Polanyi highlights the fact that the structural characteristics of living processes and their products are themselves the evidence of a supervening logic over inanimate matter, which in essence defines the biologist’s subject matter. For life abides by its own organizing principle, which is irreducible to but perfectly consistent with the laws of life’s boundary conditions of inanimate matter; understanding life on the species level through this autonomous and organizing principle was Darwin’s revolutionary contribution to science.\textsuperscript{102}

Liah Greenfeld has perhaps paid the closest attention to the feature of emergence in biological philosophy, stating explicitly that, “After Darwin, it became possible to envision the objective world not in terms of the materialist/idealist duality, but in terms of \textit{emergent phenomena}.\textsuperscript{103} Defining an emergent phenomenon as,

\begin{quote}
   …a complex phenomenon that cannot be reduced to the sum of its elements, a case in which a specific combination of elements, which no one element, and no law in accordance with which the elements function, renders likely, produces a certain new quality (in most important instances, a certain law or tendency) which
\end{quote}

\textsuperscript{102} Portions of the previous two paragraphs appear in my article “The Mind’s Irreducible Structure” \textit{Sociology Mind} Vol. 2 No. 3 July 2012.

\textsuperscript{103} Greenfeld, \textit{Mind, Modernity, Madness}, 58.
in a large measure determines the nature and the existence of the phenomenon, as well as of its elements. Life… is the original referent of this concept. Life is irreducible to the inanimate matter of which, and only of which, every living cell is composed; it is a quality—a tendency—beyond and apart from this matter, which exists in the boundary conditions provided by it, yet shapes it at the same time, insofar as this matter belongs to the living thing. The irreducibility of the emergent phenomenon implies that at the moment of emergence there occurs a break in continuity, a leap from one interconnected world or reality into another one, essentially disconnected from, yet fundamentally consistent with it, a transformation the mechanism of which, by definition, cannot be traced exclusively to the first reality, and is, at least in part, extraneous to it.

In the case of life, accepting a strong, or ontological emergence (the type of emergence implicit in Darwin’s philosophy) is the only means of accounting for the extraordinary empirical characteristics of life that were cited by Mayr above. The concept of emergence in this sense, remains agnostic to the origin of these new tendencies, takes them for granted and, most importantly, reconciles science to the fact that new empirical qualities or properties can appear that are neither characteristic of nor derived from the constitutive elements themselves. Making this epistemological feature of biological science explicit, as Greenfeld has done, can serve to resolve some of the fundamental distinctions between biology and physics for philosophers of science, who, as has already been mentioned, are ill-equipped to admit some of the unique features of biological explanation into their physics-centric vision of science.

It is apparent at different points in Mayr’s writing that unique features of biological explanation, when compared with physics, are not only legitimate but necessary. He writes,

I believe that a unification of science is indeed possible if we are willing to expand the concept of science to include the basic principles and concepts of not only the physical but also the biological sciences. Such a new philosophy of

104 Ibid.
science will need to adopt a greatly enlarged vocabulary—one that includes such words as biopopulation, teleonomy, and program. It will have to abandon its loyalty to a rigid essentialism and determinism in favor of a broader recognition of stochastic processes, a pluralism of causes and effects, the hierarchical organization of much of nature, the emergence of unanticipated properties at higher hierarchical levels, the internal cohesion of complex systems, and other concepts absent from—or at least neglected by—the classical philosophy of science.\textsuperscript{105}

To functionally explain the features of stochastic processes, teleonomy, and the plurality of causes and effects is to come to terms with their empirical reality; biology, it can be said, accomplished this acceptance, to a certain extent, as soon as it began producing objectively verifiable, progressive knowledge within the functional explanation of the Darwinian framework, taking the implicit, emergent foundation of biological philosophy for granted. Making the philosophical implications of biology’s foundation explicit, however, permits the institution of science as a whole to proceed beyond the break in continuity between inanimate and animate matter by recognizing that emergent phenomena may create new empirical realities with their own empirical characteristics. Darwin’s law did not need to make emergence explicit, but, by positing a unique functional law to account for the empirical features of life that are autonomous from, but consistent with, physical science, his framework nevertheless implies it.

In distinction to the emergence proposed by Mayr, the emergent phenomenon described by Greenfeld does not refer to a collection of phenotypes arising from organic processes (evolution included) already in action but rather casts light on the nature of the emergent phenomenon that is life itself. Through this perspective, science has the opportunity to describe empirical characteristics of life by juxtaposing them with the

\textsuperscript{105} Mayr, \textit{New Philosophy of Biology}, 21.
empirical characteristics that can be discerned from inanimate matter. This is a different activity from the functional explanations within biology that form the backbone of Mayr’s theoretical apparatus. But the conclusions of both inquiries must remain logically consistent with one another, differing only in the respect that describing the new, emergent features of life itself can only hope to answer the questions “what?” and “how?”, while the functional analysis of biological phenomena very often—and legitimately so—seeks to answer the question “why?”; in the more unified science that such a holistic perspective exemplifies, it is my assertion that understanding both the essential and functional features of the phenomena in which the scientist becomes interested makes him better at answering all three.

Therefore, with the concept of emergence clearly in mind, I am in a position to describe the principal feature that characterizes the emergent reality of life in distinction to the reality of inanimate matter. Through Greenfeld’s exposition of life as science’s original referent of emergence, I arrive at the conclusion that it, in distinction to the subject matter of physical science, coincides with a temporal dimension from which it cannot be separated. Greenfeld, in fact, alludes to this distinction, “If we define matter as it is defined in physics, clearly, the theory of natural selection implies that the phenomenon of life is only partly material, that there is more to it than matter. Matter is essentially a spatial phenomenon; it is defined by taking place in space. There is much that is spatial in every living organism, but the great biological law is historical, evolution by natural selection occurs in time.”106 Much like Darwin’s problematization of time in

106 Greenfeld, *Mind, Modernity, Madness*, 57
his “Recapitulation and Conclusion,” the causal historicity of evolution hints at a specific nature or quality of time inherent in the organic reality that distinguishes it from the physical world where, as I have shown in the first chapter, there is no empirical justification for treating time as an independent factor. It is thus Darwin’s problem between the indeterminacy of geological time and the specificity of organic history that I will resolve as I elucidate the temporal phenomenon that is characteristics of life. For on the basis of considering life itself a phenomenon that is emergent from its material constituents, one has the possibility of examining the new, essential characteristics brought into being that define the phenomenon itself: in the case of organic phenomena, that new, essential characteristic is life’s processual nature.

**Life is a Process**

Life is a process. By definition, processes occur *in time* and the distinguishing characteristic of organic phenomena resides in the duration and perpetuation of life’s processes. Within the framework of this duration, the sequence of events, the inextricable link between a past and a present, constitutes the primary evolutionary force. From the most primitive organism to the most complex biological society, successive forms of life are explained as the products of complex relationships that contribute to the maintenance or disruption of these forms’ persistence or demise.\(^{107}\) Thus, time, when understood as a sequence where there exists a real dependence of the present on the past, or, in reconstruction, as a set of necessary logical steps brought about by self perpetuating causes, can be considered an essential characteristic of the organic reality.

\(^{107}\) In fact, one could argue that the disruption of certain life processes (i.e. in death) usually provides biological science with more reliable evidence from the positivist view.
The claim about the nature of time in the organic reality should be approached as preliminary in the sense that properties of this time are not immediately understandable; they do not correspond exactly to our common intuition of time in general. For now, I want to make plain the starting point of my argument, which can be summarized as thus: 1.) Life itself is a process; 2.) biological science understands and explains organic phenomena as an interactive product of life’s processes and its dynamic environment; 3.) all processes are historical; 4.) as such, life and its functional explanations are essentially dependent upon causal relationships in a temporal dimension (i.e. the dependence of a particular present on a particular past). With these premises in mind, a more complete analysis of the nature and specificity of the temporal phenomenon unique to organic reality is possible and can be deduced from the Darwinian framework of biology and the empirical characteristics of the organic processes that that science explains. This section will be dedicated to such an exploration and analysis.

It is necessary from the outset to distinguish between two referents of “time” as it relates to the organic world. In the first case, I mean to distinguish and describe the nature of time as an empirical phenomenon whose fundamental structure (the dependence of the present on the past) is the essence of causality active in organic reality; this I will call ‘organic time’. In the second case, I must draw attention to the difference between this phenomenon (which always exists as an extended present in the life of an individual organism or population without us) and the concept of ‘biological time’ used in an explanatory activity (science) performed by us to map out causal connections between phenomena in organic reality. The significant difference between these two referents is
that organic time is independent from biological science, it is a feature of life. It refers to life’s objectively demonstrable temporal reality that is accessible by biological science through the material traces that the process of life leaves, while biological-time, itself a concept, is dependent on the rest of biology’s cognitive apparatus. Certainly, biological time always seeks to align itself as accurately as possible with organic time, but it can only do so to the extent that organic processes of the past make themselves knowable to the scientist; furthermore, my argument will imply that this alignment is more precisely achieved through an explicit understanding and appreciation for the qualities that make each referent different. With this distinction in mind, the reader is less apt to confuse the nature of my argument, which necessarily must address both referents in their turn.

The Nature of Organic Time

I will begin my exploration with a claim, the elucidation and defense of which will be my task throughout this section: organic-time is a specific, absolute, empirical phenomenon, which may be logically delineated, whose characteristics and causal significance are limited by the presence of variables which have the capacity to influence organic processes on either the molecular-cellular, individual or the species level.

Organic time’s specificity derives from the fact that it is not a side effect of the physical elements of which the organic reality is constituted. But, as a result of the interaction between organisms and their material environment, such inanimate, timeless elements can become a part of organic time when they are incorporated into organic processes. Take, for instance, the production of carbon dioxide waste that results from the metabolism of carbohydrates in the Kreb’s cycle. An individual carbon dioxide
molecule is part of organic time while it is connected to the process from which it arises until the moment that it is expelled from the organism into the environment; during this period, it is an element of the organic process, a product, and a relevant factor for homeostatic mechanisms. Once it has left the organism and enters the inanimate atmosphere, however, it is no longer a variable in any physiological sequence; even though it may be re-incorporated into organic processes through the photosynthetic activity of a plant, for example. Between these two distinct physiological processes it is timeless and the possibly measurable (relative) interim is of no significance to its role in either of the two organic events. Thus, the molecule in question passes in and out of the temporal dimension of organic reality. The temporal phenomenon belongs only to the organic realm despite the fact that organic phenomena themselves are constituted by physical elements which possess no temporal dimension on their own.  

The process of life occurs on several levels. The fundamental level, on which the rest of life depends, is that of certain physicochemical events occurring in particular sequences. In biology, biology specific organic sequences may be defined either by the elements (integrons, to use Mayr’s term) or the steps that characterize them or by their products and the vital functions that they perform. Above a certain minimum, the matrix of life’s sequences, or chain of events, is responsible for the self-regulation, self-perpetuation and self-replication of an organism. It is in the sequential dependence of the steps themselves, however, that the empirical relationship between the present and the past emerges. Time, when it is understood as the appearance of this dependent

---

108 The lack of an empirically justified temporal dimension in physical reality is discussed at length in the preceding chapter of my dissertation.
relationship between the past and the present in the case of logically dependent sequences, is an essential characteristic of all living phenomena.

The elucidation of the genome as an informational molecular sequence, whose serial structure creates a linear dependence of the aforementioned type, illustrates the temporal relationship on the most basic organic level. In terms of its function, genetic information controls the assembly line construction of amino acids into proteins; through the translation of mRNA in the ribosomes, proteins acquire their essential three-dimensional structure as a result of the order in which the amino acid chains are constructed and interact with the burgeoning molecule. The sequential nature of the code and the step-by-step processing in the ribosomes highlights the absolute dependence that the present step has on its immediate past in life’s most basic synthetic activity.\(^\text{109}\) This relationship between the past and the present, however, is not limited to the linear transcription and translation of the genetic code. In fact, the activities of the genetic code are controlled by other dynamic mechanisms in the cell that operate similarly by sequential processes.

Every physiological process requires a specific set of conditions and a catalyst for the activation of their mechanism. Whereas processes can be investigated from their products to their substrates in microbiology (a result of the top down logic that defines the organic reality), it can equally be stated that any particular stage in the productive

\(^{109}\) See for example, Watson’s example of the production of hemoglobin described in *DNA: The Secret of Life*. 
process is the direct result of the active variables in the immediately preceding stage.\footnote{To be sure, many processes in physiology can be considered passive in the respect that the expenditure of energy is not necessary for their effectuation, but these passive processes no less fit the bill of an orderly sequential connection between condition, cause and effect, and thus the word “active” should be understood to include both energy dependent and metabolically independent processes.}

As is the case with both of the processes mentioned thus far, every intracellular mechanism and product represents an empirical example of time in organic reality on the smallest possible scale: *organic time is fundamentally the sequential organization of chemical interactions/reactions that constitute the vital processes on life’s most elementary level.*

Moving beyond the granularity of individual protein synthesis, isolated metabolic cycles and other functions of intracellular maintenance, the fundamentally sequential characteristic of the organic temporal relationship does not change. Colonies or populations of cells perform a host of systemic functions for the organism and the specific stages—as well as, ultimately, the products—of those functions depend entirely on the complex matrix of lower level processes whose effects become the elements of higher level, sequence dependent mechanisms. At any level of analysis, despite the complexity involved, conditions must always be fulfilled which allow a cause to become active and produce a certain effect (in other words, some events must necessarily happen before others). The introduction of complexity into the organic system does not change the sequential nature of the system itself; it merely makes the outcome a matter of probability rather than the operation of a simple input $\rightarrow$ output function. In fact, positioning complexity alone as a distinguishing feature of organic phenomena leads to
one of the great misunderstandings of the scientific relationship between matter and life. This misunderstanding is made clear, and complexity as an explanatory concept is made irrelevant, when one remembers that the outcome of even ‘simple’ functions, being of their own kind vis-à-vis their inanimate constituents, are no less stochastic on the molecular level. By focusing on the complexity of chemical mechanisms (i.e. focusing on the nature of the events, instead of their order) necessarily highlights the material and not organic characteristics of life’s mechanisms. Alternately, when one takes into account the importance of time, or the sequence of events in those mechanisms, the unpredictable nature of life’s products, its diversity and its aberrations can be accounted for both logically and empirically. The necessary historical dependence between past and present events is both empirically demonstrable and logically indispensable for the scientist of organic reality.

To say that the postulate of time-dependence in organic phenomena is both warranted empirically by the facts and indispensable for the scientist seems to imply a tautology in which the processes explain their products from the bottom up but are only knowable to the scientist from the top down. Indeed, it has been objected that the relationship between processes and products, or stages and sequences is a teleological one where the sequential dependence is predicated on the outcome, which, in the final analysis, is itself a product of the sequence. Without resorting to the existence of a metaphysical telos, however, these objections can be put aside. Any biologist—or any positivist scientist, for that matter—must readily concede that organic reality is, in fact, characterized by the cyclical nature of its processes. This incredible fact—being patently
problematic for traditional philosophers of science because of the contrast it presents to any phenomenon in the physical reality—is brought into being by the self-reproducing, self-creating and self-causing nature of life. Reproduction is perhaps life’s most distinguishing characteristic, the continued repetition of which makes life’s sequences definable by their ends and allows processes to be understood in terms of their products. This, in fact, is implied in the concept of “emergent phenomenon.” Such functional activity of definition and understanding in biological science is only possible because of the organic reality’s emergent nature—and this nature, above all, implies the temporal dimension. Life goes on through the repetition and replication of its many processes; life continually exhibits repeated self-causation through time. Since all organisms interact with their environment in ways that either permit the duration of existing vital processes, change these processes, or cease them altogether, the scientist can make logically refutable hypotheses about the events that contributed causally (in the sense in which Mayr discusses proximate causes) to one of these three possible outcomes; this is the logic implied in Darwin’s law of evolution through natural selection. The feature of the organic reality that Darwin’s law captures, making such hypotheses logically refutable, is the real dependence of present conditions or facts (events) on the specific sequential interactions that precede them. Thus, all biological understanding is historical, reflecting the time-dependent nature of organic processes themselves.

The implications of duration and historicity for the science of biology and for the organic reality as-it-is are indeed nuanced and resonate with the suggestive distinctions that Darwin made about time in his recapitulation and conclusion of *The Origin of*
Species. Our contemporary knowledge of biological structure and function of the genome coupled with the claim that I am advancing here allows us to investigate this historicity logically and empirically and grasp the important role that time has in both its ontological and analytical referents for organic phenomena. For in the organic reality itself, the genome is the vehicle of reproduction and, to the organisms that it informs, the blueprint for the repetition of vital processes. For the scientist, however, the genome can be viewed as an archive of sorts, a collection of the mutations and adaptations of an organism or species placed on a conceptually evolutionary scale. It is possible to claim that the genome connects all living species in one way or another, but this connection supposes an overarching or universally active role for time that may not be empirically demonstrable by the observed sequences of present organic processes. Time, as such, may exist only in the mind of the biologist. In other words, phylogenetic time, which is linear, has no causal significance when one seeks to explain any organism or group in its contemporary environment. On the ontogenetic level—or in each segment of this historical, linear time—organic time-as-lived collapses into circular time, which, in distinction to evolutionary, or phylogenetic time, can be empirically observed; on the ontogenetic level time is circular and, as such, strictly limited in its causal significance.

Consider, for example, that even though *canis lupus* has ancestral, and therefore genetic, ties to a common progenitor, it is the activity of only the living *canis lupus* genome in the present that interacts with the environment and maintains the vital

processes of the organism. When the individual dies, so too does the individual genome. The reproduction of a similar, yet distinct, genome engages in its own set of sequentially dependent interactions with different elements of the environment and undergoes a unique (insofar as it is never identical) trajectory of development, reproduction and death. If we take the organic present to be constituted by the presence of variables that contribute to vital (ordered) processes, then it becomes clear that the ancestral connection, in this respect, is, after a generation or two, a purely conceptual one. For death, the cessation of a set of life’s processes, is an empirical feature of the organic reality too and when a genome ceases to interact with its environment, its “present” is no more. It is true that certain genetic (i.e. evolutionary) events in the past are responsible for the descendent genotypes and phenotypes of “the present” but these connections are only significant for the scientist; for life itself, these events are nothing more than beats in the unpredictable rhythm of life’s drum. Understanding death, the cessation of individual processes as an empirical fact distinct from the reproduction of present sequences (to which a deceased individual may have contributed in the past) casts light onto the genome as both the instructor of presently ongoing processes, on the one hand, and the preserved trace of processes that are no longer active, on the other. Insofar as organic time refers to the immediate dependence between the present and the past, the causal role that any event may exert in the organic process exists in quite a limited fashion; each step in an organic sequence moves it further from events that preceded it until the causal connection between events in a more remote past and present fades away. The distinctions between different parts of organic time—past and present, conceptual and
real—can be clarified, perhaps unexpectedly, by explaining organic time’s causal role as a function of space.

Defining organic time as a necessary relationship between the past and the present in ordered sequences of events necessarily limits the scope of this time (as an extended present) and denies it the future. For the dependence reflects the actual interaction of life’s constitutive elements. When one understands that the ordered sequence of chemical events in time constitutes the essential characteristic of vital processes, it follows that the matrix of active elements is limited by space. Said another way, the extent to which variables (organic and inorganic) may be considered elements in organic processes, and thus become connected to one another through organic time, is limited by the spatial proximity that allows the molecular elements of physiological processes to exert a force on one another. Thus, the spatial relationship is a condition for interaction, while the interaction itself represents one or many steps in an organic process. Recognizing the spatial component of organic processes is essential for distinguishing the relative import between an element and a given stage in which that element plays a part in an organic sequence. Consequently, space is a limiting factor in the role that any element may play in an instant of organic time and, as such, is a limiting factor in the span of specific organic times.

The discussion of the relationship between space and time in the organic world brings us back to the threshold of the distinction between material and living phenomena. Being made up of inanimate parts, animate processes are always subject to the boundary
conditions of their elements. While the theoretical limit of biological reductionism is represented by the moment of emergence, the empirical limit coincides with the spatial delineations of each temporary segment. *It is space that defines the biological present.* And that’s why each stage in the organic processes corresponds to a specific material state. The molecular environment influences organic sequences by virtue of the spatial relationship that allows for certain physicochemical forces to take part in the system, each sequence resulting in the material products which become conditions for new sequences.

Moving conceptually up the biological hierarchy from the molecular/cellular to the systems and eventually the individual or species level, the spatial limitations of relevant time (temporal sequences) are proportionally commensurate with the size of the units of the analytical focus (i.e. both the material products and the process to which it relates). Physical space is absolute but its relevance for organic processes is relative in the sense that only actual spatial interactions of molecules *in an organism* are organically, and thus biologically, significant. Therefore, space is a secondary, concomitant and limiting feature of organic time and consequently of organic reality in regards to time. It is only in spatial/material elements that life *exists as embodied*, and without such embodiment organic processes cease.

The relationship between space and time in the organic reality manifests itself most significantly in the translation of material elements of the environment into

---

112 These boundary conditions imply that all the organic processes are necessarily logically consistent with the laws of physical reality. This consistency between organic processes and physical laws is a theoretical proposition implied in the framework of emergence; different from this theoretical proposition is the empirical proposition about the spatial conditions which serve as the boundary, or point of delineation, between the past and the present in organic reality.

113 See Greenfeld, *Mind, Modernity, Madness*, 63-64.
embodied artifacts or elements of organic processes. This ontogenetic translation is always initiated within the limits of spatial proximity described above and then mediated by a cascade of processes within the organism. Despite the initial connection to material elements in space, the duration of the resulting processes is primarily a function of the organism and independent from the essence of the original stimulus. In fact, it is possible, and must happen quite often in the case of more complex, open systems (take nervous systems, for example), that long after the initial, material stimulus disappears the duration or after-effects of resultant processes influences other processes within the organism that were originally unaffected by or unrelated to the stimulus in the first place. Empirically, the processes initiated further down that cascade may not be direct derivations of the original stimulus though historically they may be conditionally related (think of a flesh wound that becomes infected days or weeks later). The biologist, arriving on the scene long after past conditions have played their part, conceptually reconstructs the historical causes that have contributed to the present while the organism, by contrast, is locked into the extended organic present where each successive moment arises out of the conditions of its immediate environment and homeostatic integrity. The organic present does not solidify into an empirically relevant, ‘active’ past, but rather morphs continually into a set of operational, self-sustaining, cyclical processes. Certainly, it is the traces left behind by these processes that inform the biologist on any systems or evolutionary level, but the connections that may be drawn on this level are derived from a concept of time that is independent of space and thus distinguished from

114 This analogy is borrowed from Marc Bloch’s *The Historian’s Craft* where he uses it to describe the necessarily circumstantial view of both scientific and historical analysis.
the organic time that has been described thus far; instead, this evolutionary time is a hypothetical, linear, phylogenetic time that exists only in the mind of the biologist. On the ontogenetic level, organic time (which is the time that goes on in any segment of historical time) is circular, remaining actively involved in its own perpetuation or that of the organism and necessarily delimited by the actual space in which the process takes place. It is only this spatially delimited time that is empirically demonstrable.

Once again, importance of taking the reality life for granted in Darwin’s explanation of the organic world is highlighted. Every analytical endeavor in biology starts from the scrutiny of organic processes as they exist and explains the form and function of those processes from the top down. The laws that guide the explanatory mechanism of biology always have a process, or an instance of organic time, in their purview and seek to uncover the causal relationship between its constitutive elements and the environment in which it operates. For this reason—the constant empirical focus on a process—time is a fundamental concept in biological science; but rather than being introduced into the explanation by the scientist (as is the case for physics), time in biological reasoning is derived from the empirical characteristics of the phenomenon itself. Despite this derivation, however, biological time does remain distinguished from organic time to a certain extent by virtue of the fact that it is an analytically significant application of a concept whose goal is to most accurately capture the empirical traces of the latter, which exists independently. Therefore, it is important to draw attention the main to distinction between the two referents of the word “time” in biology: biological
time is relative, imposed by the scientist for the purposes of comparative analysis, whereas organic time, being a product of the living process itself, is absolute.

The concept of evolution is the representative example of how differently time is conceived of in biology when compared with time’s empirical manifestation in organic reality. Being a historical discipline, evolutionary biology, on its most general scale, allows the scientist to describe periods characterized by certain environmental features that explain either the proliferation of or selection against specific populations. The degree of consistency of environmental features in a period may result in relatively expansive ages of genetic equilibrium or widely distributed examples of genomic change, but these ages, circumscribed by the researcher and not by something inherently syncopated in the organic reality itself, serve arbitrary conceptual purposes for scientific analysis. This is because organic time does not operate on a universal time scale with successive ages rolling one into another brought about by widespread geological or meteorological changes. Instead, organic times exist in the small-scale, spatially delineated dependencies between the past and the present interactions of sequentially organized elements. The biologist must come to terms with the fact that, despite his strongest preconceived notions, there is no one, universal time that belongs to organic reality, but always numerous, coexisting, overlapping, and crisscrossing times. To be sure, the specificities of processes that exist in organic time are influenced by boundary

\[115\] The fact that certain species span different periods (i.e. the modern American horseshoe crab evolving ~135 million years ago and remaining largely unchanged) show that organic processes are not absolutely a function of environmentally delineated periods but rather that periods are delineated based on relatively adjudicated scales of organic change. See John T. Tanacredi, Mark L. Botton & David Smith (2009). *Biology and Conservation of Horseshoe Crabs*. Dordrecht: Springer.
conditions set by geological and meteorological changes, among other environmental factors. In these changing environmental conditions, many organic times end and certain new times or processes are born, but organic time as an empirical phenomenon is dependent only on life’s duration in general. For the mere existence of organic time, the particular periods of equilibrium or evolutionary change are irrelevant. This is because equilibrium is a relative concept in biology whereas change or the stochastic nature of all organic processes on the individual level is, in fact, one of its inherent, empirical features.  

Due to the vast dynamism of the environment in which organisms operate, no two instances of organic time are ever identical. Particular sequences interact with different sets of molecules in conjunction with other organic sequences whose combination make up the sum total of the vital processes of an individual organism. Thus the history of organic time is unique to each individual, constituting, in essence, an endless proliferation of organic times that become empirically distinct from one another through the limitations of space, death and reproductive or interactive incompatibility. The real organic times in which these interactions are organized on the individual level are absolute in the sense that each segment has certain specific qualities completely independent from an unobtrusive observer (i.e. an observer who does not become a participant in the process).

Biological, or evolutionary, time, on the other hand, readily seeks causal connections with concepts of equilibrium, selective pressure and adaptation to explain the comparative differences between isolated examples of distinct organic times. The relativity of evolutionary accounts can be seen in the employment of explanations that answer questions about the nature of organic processes that may not be absolutely connected by the spatial limitations placed on the organic time of the subject in question. In this way, the conceptual connections made by biological explanations legitimately eschew the singular causes that are responsible in individual instances of absolute, organic time by treating populations as collective representatives (or ideal types, to borrow a word from the humanities) embodying a genetic or phenotypic average.

With respect to cause, biological time and organic time diverge in another significant manner; one that highlights the true, circular nature of organic time and thus underlines not only the legitimacy, but also the importance of teleological systems in organic reality. Teleology and the roles of cause and effect in organic systems have been debated repeatedly throughout the history of biology: the former concept was often grounds for accusations of *vitalism* by the materialist philosophers of science, while the latter two concepts were denied the prestige of universal applicability that scientific laws, modeled on the science of physics, are expected to provide. Mayr confronts these two subjects, deftly unpacking most of the philosophical baggage that has accompanied the concepts in formal philosophy while justifying their applications in biological analysis. It is not my intention to remake Mayr’s arguments here, but instead to place some of his most salient points in company with the understanding of time that I have been
developing to demonstrate that, in many respects, our approaches reinforce one another. Ultimately, it is my assertion that focusing on the nature of organic time renders teleology and causality in organic reality unproblematic, while allowing us to understand their biological significance in a novel way.

I have had already had occasion to point out the circular nature of organic time in distinction to the linear trajectory of evolutionary or phylogenetic explanation. Organic time, the empirically observable relationship between elements in a sequence, delineated by space, and constituting an extended present where both environmental and embodied conditions provide for the perpetuation of vital processes, exists in a circle. The idea of this circle is a metaphor, of course, employed in order to convey the idea that on the individual, species, and phenomenological level of life itself, organic time can be imagined as a contiguous present (constituted by interconnected sets of individual organic times), perpetually active in sustaining and producing unique forms of life that then go on to produce descendants of their own. Organic time, in general, is cyclical and unremitting in the sense that the phenomenon of life is constantly connected to itself and this connection does not, even for a moment, disappear or break once life has emerged. Unlike its individual forms, life’s existence in time is not punctuated. This does not mean, however, that organic time on the individual or the species level cannot stop. Obviously, individual times end very often, and absolutely, in the instance of death and extinction. The contributions of that extinct individual or species’ genome to the environment, however, occurs within the unbroken boundary of organic time, and may be distally connected to other organic times through either its offspring or through the
positive role that its death plays in the survival of other individuals or species (think of the millions of individual krill that must die when ingested by blue whales, and the millions more that must reproduce, or must have reproduced, to ensure their titanic numbers; or, on the species level, the extinction of a group which opens up a new environmental niche for other species). Whether that connection is empirical, or conceptual, (i.e. ontogenetic or phylogenetic), however, is determined by the nature of the relationship between cause and effect in the specific processes in question.

Ontogenetically, every instance of organic time is causally connected to the processes that precede and therefore produce it. Life creates, sustains and perpetuates itself and, in this respect, the emergence of life presents science with its singular example of ultimate causality. Yet, the connection that this ultimate cause has to life’s empirical effects exists for organic reality in a counterintuitive way. On the phenomenological level, organic time is unbroken; for this reason, (i.e. the self creating, self perpetuating characteristic of life in general) life’s ultimate cause, or telos, is empirically manifest in the active operation of all individual organic times. Said another way, it is in accordance with the logic of life’s telos that individual instances of organic time exist: organic times reflect life’s teleological propensity for self-preservation and self-replication. Therefore, teleological connection is an essential quality of organic systems in time. Remembering that, on the ontogenetic level, organic time remains actively involved in its own perpetuation and that it is only the organic present in space which is empirically demonstrable, it can be said that this circular, self-perpetuating

117 The extent to which ultimate causality exists physics, for example, is debatable. Newton himself was quite honest about this fact. See first chapter, the cause of gravity.
nature of organic reality makes teleology an empirical characteristic of organic time in all of its present instantiations. Consequently, the vast majority of proximate causes in ontogenetic processes operate on the principle this teleology. What this necessarily implies, however, is that the circular structure of organic time, upon which life’s existence, in any form, depends places the cause of any particular sequence a step ahead of the specific operations that are active in bringing it about.

In the case of evolutionary explanations, this teleological transposition of cause and effect is not so. This is because, despite their teleological existence all proximate causes in organic processes are understood through the lens of life’s ultimate end (survival) in conjunction with the active variables of an environment which together explain the particular forms and specific functions of each instance or set of organic times in a historical way. Addressing this complicated relationship between teleology, ultimate and proximate causes Mayr writes,

Let me consider a few of the proximate and ultimate causes (Mayr 1961), to bring out some of the difficulties more clearly. The functioning of these [organic] systems is the subject matter of regulatory biology, which analyzes proximate causes. Biological systems are complicated steady-state systems, replete with feedback devices. There is a high premium on homeostasis, on the maintenance of the milieu interieur. Since most of the processes performed by these systems are programmed, it is legitimate to call them teleonomic processes. They are “end-directed” even though very often the “end” is the maintenance of the status quo. There is nothing metaphysical in any of this because, so far as these processes are accessible to analysis, they represent chains of causally interrelated stimuli and reactions, of inputs and of outputs. The ultimate causes for the

---

118 In particular Mayr is talking about the regulatory function of the heart and the kidneys, but his statement is generalizable to any complex organic process.

119 As part of his initiative to strip illegitimate philosophical prejudices calls them teleonomic programs, but for my purposes, due to the teleological nature of organic time itself, it is not necessary to invent or preserve jargon.
efficiency and seeming purposefulness of these living systems were explained by Darwin in 1859. The adaptiveness of these systems is the result of millions of generations of natural selection.”

In this passage, Mayr makes the case for the existence of teleological processes in biological systems and the essential role that they play in the survival of individual organisms. The conceptual complexity, for Mayr, arises in the conflation of proximate causes and the distal, evolutionary events that brought specific teleological systems about. He goes on to say that, “Proximate and ultimate causes must be carefully separated in the discussion of teleological systems (Mayr 1961). A system is capable of performing teleonomic processes because it was programmed to function in this manner. The origin of the program that is responsible for the adaptiveness of the system is an entirely independent matter.” Framed in the present discussion, Mayr’s ultimate assertion can be reinterpreted thus: the nature of the causal relationship supposed to have brought about a particular organic time (in evolution) is categorically different from that which drives any present, empirical instance of it. According to my claim, this is because all evolutionary explanations are historical and linear where, in distinction to the circular relationship between effect and cause in organic time, the causes of natural selection always precede their effect.

Consider the two theoretical possibilities that may represent evolutionary events in organic time: 1.) a feature of the environment may cause the interruption of a particular organic process (possibly resulting in the death/eradication of an individual genome); or 2.) due to the natural propensity for life to reproduce its specific forms in variation, a new

---

120 Mayr, New Philosophy of Biology, 53.
program appears for which little or no negative selection takes place. In the first case, it is the environment that is the active element (the cause) and the disruption or death that constitutes a positivistic effect; the causal relationship between these two events cannot be transposed in time due to both the absolute cessation of the organic process in question and the random (thus non-teleological) agency of the environment. In the second case, no positivistic cause can be imagined other than life’s empirical propensity for diversity in the reproduction of its own processes—a feature of its telos.\textsuperscript{121} The ‘accidental’ appearance of a new organic time, (in the instance of a new genetic program, for example; and ‘accidental’ is all that such an appearance, in isolation, may be considered) becomes a singular teleological cause (its own) in empirically demonstrable, organic time while simultaneously, as soon as having appeared, it constitutes a theoretically historical individual in the linear, phylogenetic framework. When either event occurs outside of the spatial limitations placed on the organic present accessible to an observer, all knowledge about its cause is predicated on circumstantial evidence, i.e. on facts whose causal connection is logically constructed and not empirical due to their occurrence in the organic past. The conceptual (as distinguished from empirical) nature of such evolutionary causes are evident in Mayr’s discussion when he writes, “I doubt that there is a scientist who would question the ultimate causality of all biological phenomena—that is, that a causal explanation can be given for past biological events. Yet such an explanation will often have to be so unspecific and so purely formal that its explanatory value can certainly be challenged. In dealing with a complex system, an explanation can

\textsuperscript{121} Even sexual selection is derived from this teleological propensity.
hardly be considered very illuminating that states: ‘Phenomenon A is caused by a complex set of interacting factors, one of which is B.’ Yet often this is about all one can say.”

Although, once again, emphasizing the complexity of an organic system leads the biologist away from the essential distinction between ontological and evolutionary causes, which, instead can be found in the differential relationship between cause and effect with respect to time. Taking Mayr’s own definition of cause as, “…a nonsufficient condition without which an event would not have happened, or as a member of a set of jointly sufficient reasons without which the event would not happen” and placing it in light of the teleological structure of cause in organic time, it becomes apparent that every point in organic time \( p \) is a nonsufficient condition without which the subsequent moment of organic time \( c \) could not happen. But, \( c \), the teleological cause, is always a state or a set of jointly sufficient reasons without which point \( p \) never would have occurred. A third possibility lies in the addition of an environmental agent \( x \), but this agent can only be considered causal to the extent that it interrupts the inverse relationship between cause/moment \( c \) and its preceding condition, point \( p \). In this case \( x \) as a cause stands categorically apart by virtue of being absolutely historical, for it stops organic time in its tracks and prevents any further operation in that particular sequence.

This confusing relationship between proximate and ultimate causes results from the categorical difference between biological and organic time and the respective relationship that cause has to its effects in each domain. Mayr points out that, “…many heated arguments about the “cause” of a certain biological phenomenon could have been

---

122 Mayr, New Philosophy of Biology, 29.
avoided if the two opponents had realized that one of them was concerned with proximate and the other with ultimate causes.”

Focusing on the teleological nature of organic time and the historical essence of biological explanation allows one to be more keenly aware of the distinction and relationship between the two. For even though the concept of time in biology is empirically justified by the temporal dimension that organic reality exhibits, it is employed by the scientist according to its own causal structure; one that enters the scene by virtue of the cognitive apparatus that is the scientific mind.

\[\text{Ibid., 28.}\]
THE HISTORY OF TIME IN WESTERN THOUGHT

At the outset of the Greek mythological tradition, the world was imagined as Chaos. According to Hesiod’s *Theogony*, out of Chaos came Earth, from Earth separated Tantaros and along side both emerged Eros, that “fairest among the deathless gods, who unnerves the limbs and overcomes the mind and wise counsels of all gods and all men within them.” After these, only black Night, Heaven, and the Sea were produced without what Hesiod calls that Erotic “sweet union of love.” The aforementioned divine forces are the protogenoi, or those from whom all gods descended, and henceforward nearly all the mythological agents were brought about by the burning and unpredictable influence of Eros acting between and upon them. In both Homeric and Hesiodic mythology, the protogenoi are the foundational forces of reality; interestingly, a personification of time is not included in their company. In fact, it is only from the creative force of Eros bringing together Heaven and Earth that the titans are born: out of twelve, Kronos, the titan who may most closely be associated with the idea or personification of time, is born last.

The relationship between Kronos and time is not made explicit in either Hesiod’s *Theogony* or Homer’s epic poems—nowhere in these works are specifically temporal qualities or duties attributed to Kronos. In later writings of antiquity, however, the conflation between Κρόνος (the god of Hesiod) and χρόνος (the Attic word for time) is made apparent. Perhaps the most prominent among such opinions is that of Socrates who justifies the interpretation of Kronos as the personification of time in the Platonic

---

dialogue *Cratylus* addressing the “correctness” or naturalness of names. In the dialogue, Socrates rhetorically asks his interlocutor, "Well, don't you think he who gave to the ancestors of the other gods the names ‘Rhea’ and ‘Kronos’ had the same thought as Heraclitus? Do you think he gave both of them the names of streams merely by chance?” By specifically referencing the theme of temporality in Heraclitus, Socrates’s etymological interpretation of the gods’ names demonstrates the philosopher’s own credence in the connection between Kronos and time—the association between the names and the thing itself is *natural* and not arbitrary. In later antiquity, Cicero expresses a similar association in *De Natura Deorum* where the Roman writes, “By Saturnus (Kronos) again they denoted that being who maintains the course and revolution of the seasons and periods of time, the deity so designated in Greek, for Saturnus’ Greek name is Kronos, which is the same as khronos, a space of time. The Latin designation ‘Saturnus’ on the other hand is due to the fact that he is ‘saturated’ or ‘satiated with years’ (anni); the fable is that he was in the habit of devouring his sons—meaning that Time devours the ages and gorges himself insatiably with the years that are past.”

There are disagreements on the validity of this conflation, however, and they stem from the orthographic distinction between Κρόνος, the god and χρόνος, time. Plutarch seems to imply that the association between the god and the concept is a mistaken one. But being removed from the original environment in which the *Theogony* asserted its epistemological influence even more so than Plato and Cicero, it is unclear on what

---

125 Plato, *Cratylus*, 420b.
126 Cicero, *De Natura Deorum*, 2.64, *trans.* H. Rackham.
127 Plutarch, *Questiones Romanae*, 12.
grounds, aside from the orthographical, his distinction can be made. Spelling was far from standard in the Homeric and Hesiodic age and, as Socrates intimated, S.G.F. Brandon points out that the similarity in the two words Κρόνος and χρόνος is striking.\textsuperscript{128}

In his discussion of “Time as Deity”, Brandon paints an inconclusive picture of the concept of time in the early Greek mythology. He notes that while Hesiod neither explicitly relates Kronos to time nor does he describe its origin, other early thinkers such as Pheracydes (c. 550 BC), Pindar (518-438 BC) and Anaximander (c. 550 BC) addressed the existence and origin of time explicitly but not consistently. “The degree of personification in these conceptions of Time,” concludes Brandon, “is admittedly rather vague, and from them no clear image of time emerges.”\textsuperscript{129}

Two significant implications can be drawn from the complex and dynamic reality described in the mythologies of pre-Socratic Greece: the first concerns the question of origin and relates directly to the present discussion of time; the second, more generally, speaks to time’s conceptual dependence on a particular metaphysical system. In the first case, it is suggestive that no unified, consistent vision or personification of time emerges out of the pre-Socratic mythologies. I intend to make it apparent that such a heterogeneous conceptualization is categorically opposed to the unified impression of a singular time that our modern ontology has inherited (an impression akin to Newton’s absolute time—that which even Einstein admitted we preserve as the popular conception). In the second case, the dichotomy between these two empirical facts (the vague and indeterminate concept of time in Greek mythology and the singular, absolute

\textsuperscript{128} S. G. F. Brandon, \textit{History, Time and Deity}, (New York: Barnes and Noble, 1965), 47.
\textsuperscript{129} Ibid.
conception of time that emerges in Plato and is preserved all the way through to modern, Western thought) is indicative of a more general characterization not entirely absent from the discussion of the transition from mythos to logos: that the polytheistic worldview of pre-Socratic Greece provided its subscribers with a characteristically disordered view of reality. This “disorder” resulted from the active roles that constantly warring, competing, copulating and desirous gods played in the causal chain of events and contrasts drastically with our own idea of a singularly unified, ordered universe. To this point, classicist Richard D. McKirahan writes, “The anthropomorphic gods control the events in the world that fall into their various departments. Since the gods are competitive and jealous of their prerogatives, and since their departments are not wholly separate, the world does not have a perfect order.”

By about the 6th century BC, however, the metaphysical disorder of polytheistic Greece begins to assume a diminished role in the explanations of reality. Bertrand Russell famously marks the transition to a more “logical” (and therefore less mythological) thought structure by the appearance of the unique, singular concepts of being and causality exhibited in the work of a certain Miletian scholar. Russell writes that, “Western philosophy begins with Thales” and Liah Greenfeld too points to the fact that a colossal change in consciousness must have occurred to account for the introduction of such logical principles by Thales. Commonly, this change in consciousness, this transition from mythos to logos, is considered ‘the Greek miracle’ for

132 Greenfeld, Mind, Modernity, Madness, 39.
the explanation as to why it occurred at the specific time and place that it did has eluded scholars of the period. But the very fact that a transition, or a change occurred at all is suggestive of a hypothesis that is not readily accepted by modern academics regardless of their disciplinary affiliations; the hypothesis is that perhaps, like the argument advanced in the first chapter of this dissertation with respect to a particular conceptualization of time, formal logic too is not a necessary corollary of human reason (i.e. occurring naturally in every mind by virtue of it belonging to the species of *homo sapiens*) but rather a mode of thought that is culturally and therefore historically contingent.

Durkheim made such a drastic hypothesis in the introduction to his *Elementary Forms of Religious Life* that has gone largely ignored even though many of its fundamental implications stand clearly at the root of controversy in many examples of anthropological case studies.\(^\text{133}\)\(^\text{134}\) Along the lines of Durkheim’s far-reaching hypothesis, Greenfeld, in her most recent book, has eluded to a sociological explanation that accounts for the occurrence of the Greek’s “miraculous” transition by their significant proximity to the Babylonian redaction of the Hebrew Bible of the 6\(^{th}\) century.\(^\text{135}\) The metaphysical structure of Judaic monotheism, according to Greenfeld, provided the conceptual framework for an absolutely ordered universe; one in which contradiction cannot exist or be tolerated. The exposure to such a system of beliefs may explain the historical accident

\(^{133}\) See Durkheim, “Introduction” to the *Elementary Forms of Religious Life*.

\(^{134}\) See, for example, David E. Cooper’s article “Alternative Logic in ‘Primitive Thought’” in *Man, New Series*, Vol. 10, No. 2 (Jun., 1975), 238-256, touches upon the controversies and confusions on the subject of logical thought in the work of Levi-Strauss, Beattie, Horton among others.

\(^{135}\) There seems to be ample indirect agreement for this argument. Many historians of antiquity often point out the proximity and exchange between Mediterranean and near East civilizations. See, for example, McKirahan, *Philosophy Before Socrates*, 19.
in which the Greeks went on to operationalize such non-contradictory principles that make arguments arguable, leading eventually to the formalization of logic in the work of Aristotle two centuries later.\textsuperscript{136} It is certainly not within the scope of the present dissertation to prove or disprove the foundations of such a claim, but its theoretical implications appear consistent with the historical evidence that surrounds the concept of time in the West and allow us to understand the development of the concept in a new light. For it is unmistakable that by the time of Socrates, the polytheistic agents who once controlled and determined the configurations of reality are impotent. The names and personas of the gods remain merely as rhetorical devices and whatever their allegorical role may be in the structure of the cosmological scheme or in the life of man, their caprices pale in comparison to the logical rigidity of Socrates’s universe. It is in this universe that the question of time becomes simultaneously unavoidable and problematic; it is quite possible that this fact stems from the very first line of the Hebrew Bible.

**In the Beginning God Created Heaven and Earth (Genesis 1:1)**

The first sentence of the Old Testament opens with the Hebrew word *bereshit* meaning literally “in the beginning”. Taken alone, there is nothing necessarily significant or problematic about this word, but the meaning of words is shaped by their context and in the context of the foundational text of monotheism, the text that espouses one world, with one God, one creation with one beginning, *bereshit* can refer to nothing other than the beginning. In the face of such a awesome concept, (seemingly absent from the Greek concept of Chaos and origin story) the human mind might be tempted to wonder “what, if

\textsuperscript{136} Greenfeld, *Mind, Modernity, Madness*, 39-40
anything, came before the beginning?” In fact, we need not speculate about the effect of this sentence on its interpreters, it is known that skepticism frequently surrounded this idea, for numerous warnings against the danger of doubtful questions can be found in both the Mishnah and the Midrash. The most prominent effect of this conceptually singular beginning however, is to be found in the logical problems it creates for those who attempt to reconcile its implications. The problems brought about by ‘the beginning’ appear in sources that may be heuristically divided into three main sets: the first set is composed of the rabbinic tradition whose specific subject matter—aside from corroborating the existence of such problems—is largely irrelevant to the present dissertation; the third set of sources, if I am to number them in order of historical appearance, consists of the medieval Christian scholastics for whom Saint Augustine will serve as the prime example later in this chapter; while the second set of sources (second since they chronologically precede the third), are the philosophical writings of Plato and Aristotle which completely expose the logical problems that the concept of one, singular time lays at the foundation Western philosophy. Admittedly, the connections that I assert—guided by Greenfeld’s aforementioned hypothesis about the relationship of Greek logos to Jewish monotheism—between the principles of monotheism, the story of Genesis and the writings of Plato and Aristotle appear radical; my discussion uncovers a dependent relationship from Greek logos—and thought about time, in particular—to the monotheistic text and not, as is the case in the study of the New Testament, the other way around. That the worldview contained in monotheism pervades the thought of Plato and
Aristotle, however, is unmistakable when one considers their discussion of time, its nature, and its position in the ontological scheme.

**Plato, Aristotle, and the Problems of Time**

Are we right, then, in describing the heaven as one, or would it be more correct to speak of heavens as many of infinite in number? One it must be termed, if it is to be framed after its Pattern. For that which embraces all intelligible Living Creatures could never be second, with another beside it; for if so, there must needs exist yet another Living Creature, which should embrace them both, and of which they two would each be a part; in which case this Universe could no longer be rightly described as modeled on these two, but rather on that third Creature which contains them both. …For this reason its Maker made neither two Universes nor an infinite number, but there is and will continue to be this one generated Heaven, unique of its kind. – Plato, *Timeaus*.

The foundation of Western philosophy rests on the idea of the universe outlined so emphatically in the dialogue *Timeaus*: one cosmological system, ordered in its essence, constituted according to the ideals and forms of its *maker*. It is in the context of this fundamentally unified view of reality that the question of universals becomes pertinent and from this unifying concept that formal logic comes into existence. Plato’s story of the creation, however, exposes some unsettling problems implied in this worldview, not the least of which concern the creation, existence and nature of time. For, from where did the universe come? In what way and for what reason was it constituted? And if it did, in fact, come to be at the hands of a maker does this not imply that there was a moment when it was not yet made? Surely there can be no time before time, or else a discussion of the temporal would devolve into the implication of ‘two times’ thus an infinite number of ‘times’ nested one inside another like the heavens of heaven that

---

137 *Timeaus*, Loeb, p. ~57
Plato dismisses as an impossibility in the epigraph above. To resolve the impossibility of this contradiction, Plato fits time into his larger universal scheme by asserting that it is a substantive, unique feature of the universe, a sensible reflection of the true, ideal eternity, which exists ultimately unified in form. Of the relationship between time and eternity Plato writes,

When the father creator saw the creature which he had made moving and living, the created image of the eternal gods, he rejoiced, and in his joy determined to make the copy still more like the original; and as this was eternal, he sought to make the universe eternal, so far as might be. Now the nature of the ideal being was everlasting, but to bestow this attribute in its fullness upon a creature was impossible. Wherefore he resolved to have a moving image of eternity, and when he set in order the heaven, he made this image eternal but moving according to number, while eternity itself rests in unity; and this image we call time.\textsuperscript{138}

A striking feature of this passage is Plato’s reference to a “father creator.” Certainly this singular idea distinguishes itself from the numerous creative forces at play in the polytheistic tradition and resounds much more closely the tone of the original creation described in Genesis. Of course, Plato goes on to develop this idea in his own way, inventing what is frequently cited as his idealist influence on the writers of the New Testament. But already in \textit{Timeaus}, in the case of time, Plato is brought up against the discrepancy between time as a created thing and the “everlasting” nature of “the ideal being” who created it. Thus, the ideal, (e.g. eternity in the case of time), is the ultimate form of existence and all phenomena (of which time is an example) exist in reflection of their corresponding truths. The forms in Plato’s ontology “rest in unity” and constitute not only the ultimate reality but also the total envelope of reality outside of which nothing can exist—the universe is predicated on their unified and ultimate status, full stop.

\textsuperscript{138} Timeaus, Loeb, p. ~77
Characterizing this scheme, A. Cornelius Benjamin writes that, “The essence of Plato’s view is that an ordinary object of every day experience consists of two ‘parts,’ one called variously its ‘form,’ its ‘Idea,’ its ‘essence,’ and the other its ‘matter,’ its ‘individuality,’ its ‘sensible manifestation.’… Forms are absolute, eternal and unchanging; particular objects appear and disappear, undergo changes, and therefore reside in the world of time and space.”

According to Benjamin, Plato’s theory of the universe, in attempting to resolve the problems of pre-Socratics concerned with the division between the reality of being and change, on the one hand, and the opposition of the one to the many, on the other, creates a system in which two realms, that of the forms and that of the particular reflections, “…fit together without contradiction and thus constitute a universe rather than a pluriverse.”

Therefore, in the case of time, the particular, sensible manifestation of it, having a motion according to number, is a reflection of the ideal (and real) existence of eternity in one, ordered world.

There is a problem with Plato’s universal ontology, however, and it is that the ontology itself gives rise to sort of contradiction where the forms and their reflection, taken together, create a duality within a universality in the Western worldview. For most realms of thought, this duality, within which our most fundamental belief compels us to stay, is largely unproblematic. In fact, to the modern heritors of Plato, this contradictory belief in the duality of our universe has become so entrenched as to carry with it a necessary practicality: a mental voyage beyond the singularity of forms in the universe.

140 Ibid., 12.
results in the dissolution of our logic (and therefore our science) while disregarding the reality of phenomena (i.e. the material reflection of forms) forces one to the untenable position of solipsism. But in the case of time and eternity, the universal duality forces one to the metaphysical position that time, in its reflection of eternity, is a singular object with definite, objective qualities that make it not only commonly identifiable but logically separate from any particular instance of it; said another way, when time reflects the unified essence of eternity, time must be a whole to its parts in which the parts or instances contain characteristics that are derived from the whole. The universe requires that there be one and only one Time. This unified and objectified view of time-writ-large makes patently problematic the possibility of multiple, co-existing and causally independent times (e.g. the organic-times that were discussed in the previous chapter): such a multivariate concept seems to be irreconcilable with the universal principle.

Thus it is within the iron cage of the universal principle, demonstrated first and most explicitly by Plato, that our Western inquiries into the nature and qualities of time have proceeded, destined to vie again and again with the contradictory philosophies of a unified eternity versus sensibly disjointed movement and change; an unknowable infinity against apparent beginnings and ends; and knowledge of an inactive past combined with the expectation of an non-existent future. It is within all of these contradictions that Aristotle, the great formalizer of logic according to the universal principle, begins his inquiry into time’s essence, seeking to arrive at an understanding through categorical deduction and empirical intuition of time’s qualities.

141 Greenfeld, Mind, Modernity, Madness, 38.
Although first addressed as a quantity, continuous and relative, in the *Organon*,
Aristotle’s most thorough treatment of time appears in *Physics* immediately following
Book III’s problematization of the infinite. Differing from the metaphysical idealization
of eternity upon which Plato’s time is modeled, Aristotle asserts that time must be infinite
because of its status as a thing (ὄντα) counted in number; since number can be increased
*ad infinitum*, time, in a real sense, must also be infinite. Furthermore, time, like spatial
magnitude, can be divided *ad infinitum*. Thus, there is a necessary relationship between
time and the infinite, for though Aristotle arrives at the conclusion that the infinite does
not exist as a substance, it must exist as “the essential attribute of some entity” in order
to prevent something like time from falling into contradiction by having a beginning or
an end.

Just as it was in the rabbinical tradition, the conceptual beginning and end of time
will prove to be an uncomfortable problem for Western philosophy; Plato’s solution was
to cede, in a way, that time had a beginning but that that beginning results from its
imperfect (and created) reflection of a more perfect eternity outside of which no
beginning or end exists. But this attitude toward time represents a choice—decidedly
illogical—that explicitly avoids the problem of a time before which time itself would
have been created. Aristotle attempts to resolve this same problem without resorting to
such a metaphysical (and murky) belief system; by logically deducing an infinite
\[142\] Aristotle, *Organon*, Bk. VI.
Bk. III.
\[144\] Aristotle, *Physics*, Bk. III, Ch. IV, ed. T.E. Page et al. and trans. Wicksteed and Cornford,
characteristic of time from both its relationship with number and by its unbounded
existence when compared to space, the problem of beginning and end disappears for
Aristotle, and time itself resembles more closely the concept of an infinite eternity upon
which Plato asserted that it was modeled. Thus, for Aristotle, time comes to play a
unique role in the physical ontology. It is in this sense that Ross writes, “Number has a
minimum but no maximum; space a maximum but no minimum”—in Aristotle’s physics,
time has neither.

Beginnings and ends are not the only contradictory features of time that Aristotle
must address. “Time does not exist as an infinite given whole,” Ross points out, “since it
is not the nature of its parts to coexist…” Despite this obvious qualification, Aristotle
maintains that time is a unified, objective entity insofar as— unlike number—its parts are
infinitely divisible but not discrete. This unity of time juxtaposed with the apparent
distinction between instants or “nows” that make up time (Aristotle calls them νόμος
meaning “now” or times “just at hand” ) presents a complicated dynamic that must be
resolved. Indeed, when Aristotle begins his exploration into the essence of time, he sets
off from such “considerations [that] might make one suspect either that there is really no
such things as time, or at least that it has only an equivocal and obscure existence.”
Prominent among these considerations is the contradiction between the unity of time and
its separate “nows”.

145 Ross, Aristotle, 86-87.
146 Ibid.
(1) Some of it is past and no longer exists, and the rest is future and does not yet exist; and all the time, whether in its limitless totality or any given length of time we take, is entirely made up of the no-longer and the not-yet; and how can we conceive of that which is composed of non-existents sharing in existence in any way?

(2) Moreover, if anything divisible exists, then, so long as it is in existence, either all of its parts or some of them must exist. Now time is divisible into parts, and some of these were in the past and some will be in the future, but none of them exists. The present ‘now’ is not part of time at all, for a part measures the whole, and the whole must be made up of part, but we cannot say that time is made up of ‘nows.’

(3) Nor is it easy to see whether the ‘now’ that appears to divide the past and the future (a) is always one and the same or (b) is continuously changing. 147

Thus the concept of time and the division of it into distinct yet continuous parts is rife with contradictions. A “now” obviously refers to a part of time, but how can time itself be made up of qualitatively differing segments of “now”? On the other hand, if the “nows” are not distinct, then they themselves are unbound and indiscernible, effectively collapsing time down upon itself, causing, as Aristotle says, “…what happened ten thousand years ago…[to be] simultaneous with what is happening to-day [for] nothing would be before or after anything else.”

Aristotle’s commitment to the unity of time despite the apparent discreteness of its instances becomes apparent in his discussion of time’s relationship to movement and change. For Aristotle, time cannot be disconnected from his ideas of kinesis; although, time should not be understood as being identical with it for both movement and change are to be found in particular objects whereas time is universal, having no particular object but itself. “When any particular thing changes or moves,” writes the philosopher, “the movement or change is in the moving or changing thing itself or takes place only

---

147 Aristotle, Physics (Loeb), Bk. IV, Ch. X, 372.
where that thing is . . . .” Time, in distinction, “is current everywhere alike and is in
relation with everything.” Thus, time is not to be found in particular ‘nows’, but rather
‘nows’ must be conceptualized to fit into a time that is “identical everywhere
simultaneously.” The “nows” of Aristotle’s time in this respect become a part of time,
but in such a way that the whole cannot be completely constructed or known by its parts.

To resolve this uncomfortable position, Aristotle searches for a more complete
understanding of time in its correspondence to movement (kinesis). This exploration
constitutes the backbone of his conceptualization of time and, in aligning it essentially
with movement and change, time becomes inextricably tied with the physical universe
and its objective appearance to us from the outside through this sensible manifestation:
Aristotle deduces that it is only through movement that we become aware of time. He
writes that, “…we are not aware of time when we do not distinguish any change (the
mind appearing to abide in a single indivisible and undifferentiated state), whereas if we
perceive and distinguish changes, then we say that time has elapsed.” Through this
relationship it becomes evident to the philosopher that “time cannot be distinguished
from motion and change.” (It is important to note here that despite Aristotle’s mention of
the soul/mind [ψυχή] he implies no metaphysics—at least not as it would be defined in
the tradition relating to a Cartesian separation between mind and body. The individual
ψυχή in Aristotle’s physics is the seat of sensible movement; by virtue of sensing the
objective movement in the universe the soul/mind itself is moved. The connection

148 Ibid., 377.
149 Aristotle, Physics, Bk IV Ch XII p. 397
between the outside world and the world of the mind is essentially physical in this respect.\footnote{Ross writes that “A notion like that of Descartes’, that the existence of the soul is the first certainty and the existence of matter a latter inference, would have struck Aristotle as absurd. The whole self, soul and body alike, is something given and not questioned. But so too is the physical world. Aristotle sometimes uses language that is suggestive of idealism, but in the main he might perhaps be called a naïve realist….the underlying view is not that the object is constituted by thought, but that the mind is a ‘place of forms’ or form of forms,’ a thing which until it apprehends some universal is a mere potentiality, characterized by the apprehension, so that it may be said to have become one with its object. This is not idealism but extreme realism, allowing for no modification, still less construction, of the object by mind.” Ross, Aristotle, 138.} Thus being aware of motion, for Aristotle, implies being aware of time.

This concomitance of movement and time draws attention to the concept of magnitude that, for Aristotle, relates time and change to one another most concretely.

Following his demonstration that these two are not identical phenomena, Aristotle brings his reader to the conclusion that all movement, change and rest occur \textit{with time} insofar as time is the “calculable measure or dimension of motion with respect to before-and-afterness”\footnote{Aristotle, \textit{Physics} (Loeb), Bk. III, Ch. XI.}. This countable feature of time (i.e. magnitude) being indissociable from the qualitative changes of motion serves as Aristotle’s principal concept of the temporal. What’s more, even though this primary definition of time is established, the philosopher is careful to prevent time from being washed away as merely an apparent feature of movement. He points out that while “…time is not movement, but that by which movement can be numerically estimated…we are to note that time is the countable thing that we are counting, not the numbers we count in—which two things are different.” And in a later discussion, “… ‘before’ and ‘after’ are objectively involved in motion, and these, qua capable of numeration, constitute time.” Thus, time’s objectivity as an
The analogy of movement in this case serves to position the problematic “nows” of Aristotle’s time as the demarcation points of before-and-afterness. Aristotle writes that “...as time follows the analogy of movement, so does the ‘now’ of time follow the analogy of the moving body since it is by the moving body that we come to know the before and after in movement, and it is in virtue of the countableness of its before and afters that the “now” exists.” Thus “now” as a concept belongs to time since it is only by means of movement that we sense the “now” in its relationship to before and afterness; furthermore, it is only through the comparison of “nows” that we perceive time as passing. To be sure, this implies, as Aristotle points out, that, “There is a sense... in which what we mean when we say “now” is always the same, and a sense in which it is not, just as is the case with anything in motion.” But this should not trouble us as a contradiction because much like an object in motion belongs to movement in any particular instantiation of the object’s state, “nows” belong to time as a continuously changing limit between before and afterness. The “now” for Aristotle follows the analogy of the moving body and is concurrently juxtaposed with the analogy of points on a line. For in the instance of a continuous line, a bisection may be demarcated by a single point that represents both the beginning and end of its congruent segments, but the “now” as a limit is never static like the point. The hypothetical stasis of a “now” would imply a pause in time, and for Aristotle this is an impossibility—time is continuous. Thus the concept of a “now” is a mere abstraction for Aristotle, for both time and motion are
characterized by their constant continuity, and in this way the individual “now” or segment of time demarcated is not time itself but is identical to it. Time is an external, infinite and continuous reality that, though sensible, retains objective qualities (in relation to motion) to which our concepts merely approximate.

Furthermore with respect to “nows” and the objective unity of time that they abstractly represent, Aristotle asks whether each of the “nows” can refer to different times, being constituted by different movements occurring concurrently yet independently. His answer is firmly in the negative, stating that “…it is the same lapse of time that is counted by two ‘nows’ everywhere at once, whatever the units of movement of change…just as if there were dogs and horses, seven of each, the number would be the same, but the units numbered different. So too of all movement-changes determined simultaneously the time is the same.”152 This conclusion is made possible by two commitments of the philosopher. The first is the implicit foundation exposed in all of Aristotle’s conclusions thus far: the unity of time as an objective, singular phenomenon, pertaining to movement and change—a natural feature of the physical universe; the second commitment is the privileged place of number in Aristotle’s ontological scheme: time is the countable aspect of before and afterness in movement and time considered numerically, according to Aristotle, “is concrete, not abstract.”153 Finally, he reiterates this same point as his discussion of time comes to a close in Chapter XIV when he writes that even though, “the movements or changes are different and stand apart, …the time is the same everywhere, because the numeration, if made simultaneously and up to the same

152 Aristotle, Physics (Loeb), Bk. III, Ch. XIV.
153 Aristotle, Physics (Loeb), Bk. III, Ch. XIII.
figure, is one and the same.” Characterizing Aristotle’s argument about the singular reality of time A. Cornelius Benjamin writes that, “Both time and motion, therefore, as processes, imply something which proceeds; this itself must be unchanging.”

Before we can leave Aristotle’s notion of time as the sensible before-and-afterness of motion, countable in number and continuous in its essence, we must deal with his ultimate, and perhaps his most problematic, question about time: whether or not time would exist if there were no consciousness. For time as an objective reality is the countable aspect of movement and change—the philosopher himself admits that it would be impossible for a thing to be counted if we were to omit the thing (e.g. consciousness) that does the counting. Without explicitly stating as much, his arguments have straddled the problem of time-as-objective reality and time-as-subjective impression variously throughout his discussion. As I have pointed out, he consistently argues in favor of the objective and external reality of time in the universe. Thus it is interesting that Aristotle’s rigid empiricism brings him so far at one point as to say that without consciousness number could not exist because it is only consciousness as intellect that can employ number in any sense, while also citing the countable-ness of time as an argument for its concrete objectivity. But in the end, Aristotle cannot conceive of a timeless universe nor a universe with multiple, concurrent yet discrete times and in positing the kinesis of our world to be an inherent feature, independent of our sensibility to it (a materialist perspective of the universe which remains the backbone of nearly all Western philosophy), he asserts that time must objectively exist, “if we may suppose that

154 Aristotle, *Physics* (Loeb), Bk. III, Ch. XIV.
movement could thus objectively exist without there being any consciousness”. For “‘before’ and ‘after’,” he writes, “are objectively involved in motion, and these, qua capable of numeration, constitute time.”\textsuperscript{156}

Rather than resolving the problematic origin or creation of time, however, Aristotle’s association of time with movement shifts the burden of beginnings to the origin of \textit{kinesis}. After working through a series of complex relationships between movement and time with respect to the potential and actual qualities of movement in Book VI,\textsuperscript{157} Aristotle is brought to the problem of the Prime Mover. In line with the infinite nature of time, Ross tells us that, for Aristotle, “There always has been and always will be motion.” and “Whatever is moved is moved by something.” Thus, if time is both infinite and indissociable from motion, then motion must always have existed. More explicitly than time, however, the phenomenon of motion requires a cause, something responsible for any particular object’s movement and change. What’s more is that motion is a spatial phenomenon for Aristotle, and space, unlike time, is not infinite. Therefore, at the circumference of the universe, Aristotle posits a primary force, the source of movement’s first cause in the corporeal universe. It is here where the philosopher begins to develop his idea of the primary and unmoved mover ($\pi\rho\tau\omicron\nu\ kiv\omicron\nu\ \kiv\eta\omicron\nu$) in his \textit{Physics}. This concept, in the end, cannot avoid the strong resemblance to Plato’s demiurge in its incorporeal and unextended essence. Aristotle posits a physical force outside of the physical universe, a cause unrelated to any cause but itself and a being which is not substance yet interacts with substance and in positing as

\textsuperscript{156} Aristotle, \textit{Physics} (Loeb) Bk. IV, Ch. XIV.

\textsuperscript{157} For a concise synthesis of the propositions therein see Ross, “Continuity” in \textit{Aristotle}, 92.
much, the philosopher falls into the same logical problem implied in imagining a time before time. Ross points out that the postulation of the Prime Mover in Aristotle’s physics “leaves us with two unanswered problems. (1) How can the incorporeal and unextended first mover nevertheless be at the circumference of the universe? And (2) how can an incorporeal being impart movement?” With the indication that Aristotle goes on to address these problems in his metaphysics, Ross concludes that, in the end, “[the introduction of the Prime Mover] raises difficulties no less than those which it removes.”

St. Augustine of Hippo

They endeavor to comprehend eternal things, but their heart still flies about in the past and future motions of created things, and is still unstable. Who shall hold it and fix it so that it may come to rest for a little; and then, by degrees, glimpse the glory of that eternity which abides forever; and then, comparing eternity with the temporal process in which nothing abides, they may see that they are incommensurable? Confessions, Chapter XI

Saint Augustine of Hippo reprises the question of eternity versus the temporal nature of created things within the context of the biblical story of creation in Genesis. In fact, his extended and complex exploration of time in Confessions results directly from the clash between his logical sense that an absolute beginning presents problems for the place of God in the ontological scheme of the universe and his faith in the eternal nature of the Father Creator. “Let me hear and understand how thou in the beginning has made haven and earth,” Augustine’s monologue entreats. Indeed, the themes that surround Augustine’s questions derive from the scriptural account of The Beginning, its truth, and

158 Ross, Aristotle, 95-96.
the logical problems that Aristotle made plain in such a unified temporal order. As a sensitive Aristotelian, Augustine perceived these problems acutely and suffered a crisis of conscience as they confronted the capacities of his faith. Thus, a significant portion of his *Confessions* grapples with the idea of time and the Saint’s inability to reconcile its logical implications. “Who is able to comprehend the will, the power and the truth of God?” the theologian supplicates rhetorically, and begins his own humble approach at The Beginning.

It is not surprising that Augustine’s principle questions about time echo those that have already been seen in Plato and Aristotle. In the case of the Saint, however, the fact that Genesis is the source of his difficulties is unquestionable. Augustine alludes to the errant nature of men who wonder, “How could God have existed before time and, if he did, then why did He ‘wait’ to bring about his creation?” Augustine knows that this perilous investigation should be tempered by faith and from the outset of his exploration he admits that such questions of infidels result not only in contradiction, but highlight the distinction between the omniscience and omnipotence of the Almighty God and the ignorance of mere men. Nevertheless, these questions are his questions too; for this reason he includes his struggle with time amongst his *confessions* and seeks to reconcile his understanding of time with his faith.

The ultimate source of Augustine’s resolution is revealed early in his exploration (much like the logic of Aquinas, Augustine’s conclusion is given in his premises), and it is reminiscent of Plato’s eternal demiurge and Aristotle’s infinitely abiding Prime Mover. He addresses God the Father, the Creator of the Old Testament, “In the eminence of thy
ever-present eternity, thou precedest all times past, and extendest beyond all future
times…All thy years stand together as one, since they are abiding. Nor do thy years past
exclude the years to come because thy years are all abiding…Thou madest all time and
before all times thou art, and there was never a time when there was no time.”

Like the descriptions of Plato and Aristotle, the Saint’s account is rife with contradiction and he is
not unaware of this fact. Time, for Augustine, is a creature (i.e. a thing created) of God
and before it was created there was no time at all. “There was no time, therefore, when
though hadst not made anything, because thou hadst made time itself,” he writes. His
answer to the problem of the beginning, thus, is that time is a characteristic of God’s
universe, created by Him and in His eternal reflection. This resolution of faith logically
implies that God exists outside of time; an idea that the Saint confesses is torturously
unfathomable. The only resolution to it is to believe that, in fact, before time there was
nothing except God who is eternal and in whom everything abides forever. Augustine’s
faith in this account is his confirmation; and, for him, it is only this faith that can resolve
the logical questions that the story of Genesis raises. For a believer in the unfathomable
Creator, questions about God’s activity before the creation or any movement in His will
are futile and must remain a mystery. Elsewhere, in the City of God, Augustine
reiterates his position most forcefully. “I own that I do not know what ages passed before
the human race was created,” he affirms, “yet I have no doubt that no created thing is co-
 eternal with the Creator….From this belief I am not frightened by philosophical

---

160 Augustine, Confessions (Loeb), Bk. XI, Ch. XIII, 235-237.
arguments….” Yet his *Confessions* make it plain that he has considered such philosophical arguments carefully, and that this consideration was a great source of his suffering.

Time, as God’s creation, presents an enormous problem for the theologian who thirsts to know the power and nature of it. In Chapter XIII of his Confessions he writes:

But if the roving thought of someone should wander over the images of past time, and wonder that thou, the Almighty God, the All-creating and All-sustaining, the Architect of heaven and earth, didst for ages unnumbered abstain from so great a work before thou didst actually do it, let him awake and consider that he wonders at illusions. For in what temporal medium could the unnumbered ages that thou didst not make pass by, since thou art the Author and Creator of all the ages? Or what periods of time would those be that were not made by thee? Or how could they have already passed away if they had not already been? Since, therefore, thou art the Creator of all times, if there was any time *before* thou madest heaven and earth, why is it said that thou wast abstaining from working? For thou madest that very time itself, and periods could not pass by *before* thou madest the whole temporal procession. But if there was no time *before* heaven and earth, how, then, can it be asked, “What wast thou doing then?” For there was no “then” when there was no time.\(^\text{162}\)

From this reasoning he cannot prevent himself from entering into a logical analysis of time as a created thing seeking to resolve the contradictions against which he warns others before in this mortal life before he “shall flow together into God, purged and molten in the fire of His love.”

Augustine begins his analysis by affirming that time *is an empirical reality*. “Is it not true that in conversation we refer to nothing more familiarly or knowingly than time? And surely we understand it when we speak of it…If one asks me, I know what it is.”

Yet, he writes, “If [however] I wish to explain it to him who asks me, I do not know.

Yet, I say with confidence that I know that if nothing passes away, there would be no past

---

\(^{161}\) Saint Augustine, *City of God*, Ch. 16 and 17.

\(^{162}\) Augustine, *Confessions* (Loeb), Bk. XI, Ch. XIII, 235.
time and if nothing were still coming, there would be no future time; and if there were nothing at all, there would be no present time." It is clear that his reasoning comes up against itself again and again. The problem of what time is, and how God might stand in relation to it is immediately apparent from “The Beginning” and seemingly unresolvable.

Augustine’s analysis recapitulates much of Aristotle’s conception of time as something sensible and measurable through movement and change while amalgamating the concept of time with his religious framework and, as a result, echoes Plato’s idea of the temporal as the substantive image of the Creator’s eternal essence to an extent that furthers the argument for their common derivation from the monotheism of the Old Testament. As a synthesis of Plato and Aristotle’s perspectives, however, Augustine’s conception of time inherits the logical problems of both. Faith in the eternal and omnipresent nature of God resolves the problem of origination and beginnings for believers, but it also explicitly represents two worlds in one: the eternal and the temporal as irreconcilable features of God’s universe. In the case of Plato’s thought, I have already drawn attention to the complicated implications that this view has for time, making the logical characterization of time as an objective, external and unified feature of the universe inherently problematic. Furthermore, persistence in the conception of time as an external “thing” (albeit the creation of God) in the realm of the mundane conserves the difficulties of Aristotle’s thought that recognize the contradictory existence of past, present and future as parts of time where the whole seems to exist without its parts being all three in existence at any instant. It is on this point that Augustine spends a

163 Augustine, *Confessions* (Outler), Bk. XI, Ch. XIV.
considerable amount of his exposition, and attempts to go beyond Aristotle’s understanding in reconciling the past, present and future. In the end he too, like the philosopher, arrives at a resolution that seems to imply more problems than it solves.

Augustine struggles with his impression that the past and the present should be given similar ontological status. The past’s true existence—its reality—resides in men’s minds. But this past, though existing presently in the minds of men, stands apart from what is present: it is discernable through its own qualities of past-ness. In a way, it has the properties of both being and non-being and it is this contradiction that the theologian attempts to reconcile. “These things [past and present] could in no way be discerned if they did not exist,” he affirms, “There are therefore time present and times past.” Yet, time past is no more and is confoundingly characterized by the fact that it ceases to be. Furthermore, one must account for the future, which itself seems almost never to be in existence though, in another sense, it constantly arrives. According to Augustine, without this arrival of “things future” then time would not be time for nothing would ever pass from the present into the past: “…if the present were always present, and did not pass into past time, it obviously would not be time but eternity.” he remarks.

Much like Aristotle’s examination of the ‘nows’, Augustine tries to discern the limits and the relationship between past present and future. He asks how these times may be delineated, since they clearly are, and he wonders how they may all be a part of time, since they are the parts by virtue of which time is distinguished from eternity. The

---

164 Augustine, *Confessions* (Outler), Bk. XI, Ch. XVII.
Saint’s account of this problem is so telling in its complexity that it is worth quoting at length:

Is a hundred years when present a long time? But, first, see whether a hundred years can be present at once. For if the first year in the century is current, then it is present time, and the other ninety and nine are still future. Therefore, they are not yet. But, then, if the second year is current, one year is already past, the second present, and all the rest are future. And thus, if we fix on any middle year of this century as present, those before it are past, those after it are future. Therefore, a hundred years cannot be present all at once.

Let us see, then, whether the year that is now current can be present. For if its first month is current, then the rest are future; if the second, the first is already past, and the remainder are not yet. Therefore, the current year is not present all at once. And if it is not present as a whole, then the year is not present. For it takes twelve months to make the year, from which each individual month which is current is itself present one at a time, but the rest are either past or future. Thus it comes out that time present, which we found was the only time that could be called “long,” has been cut down to the space of scarcely a single day. But let us examine even that, for one day is never present as a whole. For it is made up of twenty-four hours, divided between night and day. The first of these hours has the rest of them as future, and the last of them has the rest as past; but any of those between has those that preceded it as past and those that succeed it as future. And that one hour itself passes away in fleeting fractions. The part of it that has fled is past; what remains is still future. If any fraction of time be conceived that cannot now be divided even into the most minute momentary point, this alone is what we may call time present. But this flies so rapidly from future to past that it cannot be extended by any delay. For if it is extended, it is then divided into past and future. But the present has no extension whatever.165

Thus, Augustine deduces too that time is infinitely divisible and that in this infinite division the past and the future never exist alongside the present but continuously just before and just after it. Nevertheless, the past, being characterized by the fact that it has ceased to be and the future by the fact that it is not yet, somehow come together in our minds and constitute a duration or a period that, according to Augustine, “we do perceive.” “Who is there who will tell me that there are not three times,” asks the theologian, “…time past, time present, and time future? Who can say that there is only

165 Augustine, Confessions (Outler), Bk. XI, Ch. XV.
time present because the other two do not exist? ...And those who tell of things past could not speak of them as if they were true, if they did not see them in their minds.”

The answer to this problem of past, present and being lies for Augustine in the phenomenon of memory: the knowledge that exists in the mind not as the events or things themselves—which have already ceased to be—but comes to us in the present through “…words constructed from the images of the perceptions which were formed in the mind like footprints in their passage through the senses.”

The problem of the future, on the other hand, is resolved by recognizing the mind’s tendency to think about future actions before these actions have come to pass into the present. In this sense, Augustine’s conception of the relationship between the future and the present is very similar to Aristotle’s account of becoming and, in light of the Providential plan, may be considered less problematic than the previous philosopher’s resolution between the present and the past. With the consideration that nothing is future to God, and all things created are created by Him and in Him, the ontological status of things that “will be” is resolved for the believer by his faith. It is not for man to participate in this type of knowing; as such, Augustine resolves that he cannot pursue it in his understanding. Thus the Father’s knowledge of the future and His revelation of it to the prophets is placed outside of the realm of man though it remains within the reality of the God’s universe. It is for this reason that Augustine admits of the future, “This way of thine [knowledge] is too far

166 Augustine, Confessions (Outler), Bk, XI, Ch. XVII.
167 Augustine, Confessions (Outler), Bk, XI, Ch. XVIII.
from my sight; it is too great for me, I cannot attain to it."\textsuperscript{168} The past and the present, however, cannot be resolved in such an external way and brings Augustine to bear on the question of the mind in temporal experience.

If time, for Augustine, is our access to the present, our knowledge of the past, and our expectation of the future, then his account places man at the center of the philosophical question of time by highlighting the fact that it is \textit{in us} that time assumes its peculiar qualities. To this effect, he writes, “Perhaps it might be said rightly that there are three times: a time present of things past; a time present of things present; and a time present of things future. For these three do coexist somehow in the soul, for otherwise I could not see them. The time present of things past is memory; the time present of things present is called direct experience; the time present of things future is expectation.”\textsuperscript{169} This approach seems to imply, however, that time is disjointed in us through memory and expectation, while outside of us it remains everywhere unified in God. At a point of confusion and frustration in his analysis of time, the Saint calls upon his mind, exhorting, “It is in you, O mind of mine \textit{anime meus}, that I measure the periods of time. Do not shout me down that it exists; do not overwhelm yourself with the turbulent flood of your impressions. In you, as I have said, I measure the periods of time.” Augustine emphasizes that it is through his mind, his \textit{anime}—thus, his soul—that time is sensed. Moreover, this reproach to his soul grounds his experience in the religious significance implied in the Christian relationship between man’s soul and God. Time, for Augustine,

\begin{footnotes}
\item[168] Augustine, \textit{Confessions} (Outler) Bk. XI, Ch. XIX, the editor also notes that this lines echoes Psalm 139:6.
\item[169] Augustine, \textit{Confessions} (Outler), Bk. XI, Ch. XX.
\end{footnotes}
is both God’s creature in the outside world, and the Saint’s own experience inside himself. Augustine even goes so far, in fact, as to recognize that this internal, spiritual reality is the empirical limit of his knowledge. “In you [anime meus], as I have said, I measure the periods of time. I measure as time present the impression that things make on you as they pass by and what remains after they have passed by—*I do not measure the things themselves which have passed by and left their impression on you.*”

Nothing may be past or future to God, in which all things abide forever, but for man—and consequently for the theologian—only the present fleeting experience of continual becoming exists. All other things, past and future, exist in God and man is left in this temporary world to search for the truth in his own soul. Augustine resigns himself to these irreconcilable facets of time deciding that either time is really all of these things that appear to him, or else he does not, in fact, sense time at all.

By the end of his analysis, Augustine admits that he still does not know what time is, but confesses that he still yearns to understand it. It is through faith and supplication that he seeks this knowledge from God asking Him to “heal his eyes” so that the confessor might “enjoy God’s light” and begin to see what “chasm there is in [God’s] secret.” But this chasm remains profound, and time retains its complexity. Having barely added to Aristotle’s logical analysis by incorporating an explicitly religious framework—one in which the Prime Mover (i.e. the Christian God) has an emotional significance rather than a logical one—Augustine resolves himself to his faith in one Almighty and all knowing, eternal Creator. For posterity, Augustine bundles the

---

170 Augustine, *Confessions* (Outler), Bk. XI, Ch. XXVII.
171 Augustine, *Confessions* (Outler), Bk. XI, Ch. XXXI.
contradictions of time into a religious view of the universe that legitimates the Platonic duality and concurrently grapples with the implications that this duality has for change and being, past and future, death and eternity. Suspending all critical judgment, the Saint writes, “Let all those therefore see, that there could be no time without a created world, and let them cease to speak vanity… Let them also…understand that thou, the eternal Creator of all times, art before all times and that no times are coeternal with thee; nor is any creature, even if there is a creature above time.” God is the Creator of the universe, the Creator of time, the Creator of bodies, and the Creator of souls. The universe, its bodies and our souls are in a constant state of becoming according to the will of God and this becoming is witnessed by man as the fleeting moments that make up this temporary life. This view of time would implicitly persist in Western thought for more than a thousand years, the questions and problems of time laying dormant, until Galileo arrived to strip the temporal universe of the scholastic significance of its qualities and make time the empty container through which bodies moved mechanistically and mathematically through space.

**Post Newtonian Philosophy of Time**

The first chapter of this dissertation has recounted the indelible effect that the natural philosophers had on not only the scientific, but also our popular conception of time. Time, after Newton, was imagined as a physically extending, mathematical, ubiquitous quality of the material universe having been incorporated into the equations of Newton’s principles effectively stripped of the *thematie* (i.e. socio-cultural; e.g. religious)

---

172 Augustine, *Confessions* (Outler), Bk. XI, Ch. XXX.
context that encapsulated its original integration into science. Following this incorporation, solidified in the subsequent publications of Newton’s *Principia*, the discourse regarding time in the West bifurcated: one direction, a philosophical discussion, formed in reaction to the implications that Newton’s physics had for the relationship between fundamental categories of thought and the nature of God; while another discussion concerned itself chiefly with the scientific operationalization of Newtonian concepts and, finding the mathematical employment of time logically effective, remained unproblematic until Einstein dismantled the universal notion of absolute time in the early 20th century. Even today, the implications of Einstein’s contribution remain largely limited to the scientific discourse of physics and astronomy while the philosophical discussion (having become increasingly secularized through the 19th and 20th centuries) carried on its independent, speculative discussion about the nature of time, arrested by the same problems that had been encountered by Plato, Aristotle and Augustine.

In contemporary thought, these two discourses remain largely unconnected, but it is important to remember that they, in fact, began as one: the modern philosophical discussion of time has its origins in its response to Newton’s scientific revolution. Leibniz, the 17th century philosopher and mathematician, holds a prominent place in the history of philosophy owing, among other contributions, to his antagonistic critique of Newton’s conception of absolute space and time as they relate to the nature of the Divinity. Outlining his objections most explicitly in a correspondence to Newton’s
defender Samuel Clarke, Leibniz, repeatedly asserts that Newton’s concepts of absolute space and time are logically incompatible with the reigning theology.

42 I have still other reasons against this strange fancy that space is a property of God. If it is so, then space enters into the essence of God. But space has parts; so on this theory there would be parts in the essence of God. *Spectatum admissi!* [A phrase taken from the Latin poet Horace, meaning roughly ‘Look at what a fool he’s making of himself!’]

43 And again: spaces are sometimes empty, sometimes full. So God’s essence will have parts that are sometimes empty and sometimes full, meaning that God’s essence will be perpetually changing.…Such a *God with parts* will be very like the Stoics’ God, which was *the whole universe considered as a divine animal.*

44 If infinite space is God’s immensity, infinite time will be God’s eternity. So we’ll have to say that whatever is in space is in God’s immensity and consequently in his essence, and that whatever is in time is also in God’s essence. Strange expressions, which show that Clarke is misusing language.

45 Here is another sample of the trouble Clarke is in. God’s immensity makes him present in all spaces. But given that God is in space, how could it be that space is in God, or that space is a property of God? We’ve heard of a property being in the thing that has it, but not of a thing being in the property that it has! Similarly, God exists in each time—so how can time be in God, and how can time be a property of God? The barbarisms keep coming! 173

For Leibniz, absolute space and time as abiding *things* contradict the infinite and eternal nature of God himself, for, if absolute, then they represent things that are eternal and immense alongside which God, the Creator of all things, must exist either as a like entity or, even more absurd, as things within which God must exist. These deductive conclusions echo the problems that manifest in Augustine’s *Confessions* and represent logical impossibilities for Leibniz too; nothing is as immense and eternal as God, for He is before all. Thus, the propositions of absolute space and time reduce to be what Jeffrey McDonough characterizes as theologically misleading at the least, or heretical at their

---

worst. In addition to the contradictory nature of Newton’s hypotheses, ideas of absolute space and time seem to deny Leibniz the employment of one of his religiously generated philosophical positions, the principle of sufficient reason. According to the principle of sufficient reason, God created the universe in the most perfect way. (This, of course, is also the assumption of the Bible.) As such, space and time are relative to one another in their dependence upon the objects of God’s creation. Making space and time qualitatively empty mathematical concepts, as Newton’s physics essentially does, renders the actual organization of the cosmos unnecessary or random in either its spatial orientation or temporal beginning.

Thus, the implications of Newton’s physics for the fundamental categories of space and time create explicit contradictions with the theological commitments of some—though not all—of his contemporaries. (Interesting, since, as has been discussed already, and as Holton noted, Newton’s own theological commitments produced his particular views of space and time.) Rather than accept Newton’s implications for their scientific usefulness, his opponent, Leibniz, undertakes the task of reimagining the fundamental concepts of space and time speculatively, aligning them more consistently with his understanding of God’s nature and His relationship to both the physical and the metaphysical universe. What is significant to note about the details of Leibniz’s schema regarding time is that by opposing Newton, Leibniz hypothesizes that space and time are

––––––––––––––––––––––––––––––––––––––––––––––

relative, ideal concepts dependent upon the actual bodies and events in God’s universe. This reflects somewhat the scholastic position that understands time as ontologically intertwined with qualitative movement and change—it should not be understood as having anything explicitly in common with Einstein’s relativity. But this view also requires an idealized concept of universal time in which all instances of actual time, reflected in movement and change, occur in the monadic scheme. To this effect, Bertrand Russel characterizes Leibniz’s thought writing, “Time… is metaphysically necessary, and the same in all possible worlds; whereas the existence of time is contingent, since it depends upon God’s free resolve to create the world.”\footnote{175} In the end, Leibniz’s elaborate conception of time suffers many of the same problems of confusion as other religious accounts that preceded it.\footnote{176} For the present purposes, Leibniz’s critique of Newton shows that the post-Enlightenment philosophical discussion of time has its origins in both its metaphysical orientation and the opposition of that orientation to the fundamental implications of physical science. In no small way, this historical origin that shapes discussion of time in contemporary philosophy serves to reinforce the claims made in the first chapter regarding the thematic origin of the concept in the development of natural philosophy. Leibniz’s persistent focus on the metaphysical relationship that time has in its sensible manifestation to that of its divine ideality sets the stage for the philosophy of Kant who seeks to resolve the logical problems of time inherent in Western thinking from the 6th century B.C. with his examination of the faculty of reason.

Kant and the Transcendental Aesthetic

Kant’s discussion of time appears in the “Transcendental Aesthetic” of his *Critique of Pure Reason*. In the *Critique*, Kant aims to establish a science of reason in which one might logically and empirically understand the essence of human thought in and of itself. The philosopher’s impetus in this project is an explicit response to the recent ascendancy of *objective* science—so characterized by its focus on external and extended *objects*—brought about by the natural, and especially *experimental* philosophers of the 17th century.177 Kant departs from the burgeoning science of physics, however, by reorienting the analytical focus from the external objects to the essential nature of the thinking mechanism, reason, which is the seat of all sensation and conceptual knowledge about objective reality.

In the introduction to the “Transcendental Aesthetic,” Kant provides definitions for the categorization of external objects and the way in which human reason acquires knowledge of such objective existences. According to his framework, the matter of certain phenomena produces subjectively sensuous, yet *objectively empirical, intuitions* in our minds and these intuitions give rise to thought which results in the conceptualization of things thereby representing the objective phenomena qua matter of the outside world. All experience occurs in the mind according to certain *a priori form*, and, for Kant, some aspects of this form cannot be derived from the matter or the sensuous experience itself. Rather, the form is *prior* to the experience and frames it.

---

Certain forms, or structures, of reason are thus *a priori*. Highlighting the importance of this type of knowledge in his schema, the philosopher writes,

In the science of the transcendental aesthetic accordingly, we shall first isolate sensibility of the sensuous faculty, by separating from it all that is annexed to its perceptions by the conceptions of understanding, so that nothing be left but empirical intuition. In the next place we shall take away from this intuition all that belongs to sensation, so that nothing may remain but pure intuition, and the mere form of phenomena, which is all that the sensibility can afford *a priori*. From this investigation it will be found that there are two pure forms of sensuous intuition, as principles of knowledge *a priori*, namely, *space and time*.178

In the case of space, Kant argues that an *a priori* conception of it is necessary to intuit any phenomena as being outside of us. Space cannot be discerned from experience and in this sense it is not perceived through our senses but rather is understood by virtue of its unique ontological status (i.e. it’s *a priori* status) within the structure of our reason. He responds both to Newton’s absolute conception and to Leibniz’s relativist notion of space when he writes, “Space does not represent any property of objects as things in themselves, nor does it represent them in their relations to each other; in other words, space does not represent to us any determination of objects such as attaches to the objects themselves, and would remain, even though all subjective conditions of the intuition were abstracted. For neither absolute nor relative determinations of objects can be intuited prior to the experience of the things to which they belong, and therefore not *à priori*.“179

With respect to time, he similarly removes from the notion its previous ontological position as a substance “out there” in the universe and places the central issue of time’s

---

existence, its nature and our knowledge of it, squarely within the mind of the individual. Let us see what resolutions, if any, this produces.

“Time is not an empirical conception,” Kant writes, “For neither coexistence nor succession would be perceived by us, if the representation of time did not exist as a foundation a priori. Without this presupposition, we could not represent to ourselves that things exist together at one and the same time, or at different times, that is contemporaneously, or in succession.” Like in the case of space, Kant argues that time is a fundamental category of all thought, a priori in nature without which the plurality (or even a duality) of intuitions could not exist. Only in time is the reality of all phenomena made possible, Kant asserts; time is the universal condition of phenomenological possibility, and, as such, time cannot be annulled from our thought without annihilating thought itself. Furthermore, the concepts of movement and change are only possible through the representation of time, making time logically prior to both. This point emphasizes the distinction for Kant between empirical and a priori knowledge and time’s status as the latter: the phenomena of movement and change both require objects or matter that move and change and thus can only be perceived and understood empirically, while time, as a condition for movement and change, exists as a pure intuition of the structure of our thought. But it is not just in respect to the sensible universe—that is, the external objective world—that time is an essential condition, time is also an indispensible
feature of reason in the case of other types of *a priori* knowledge, namely knowledge that Kant labels as *synthetic a priori*.\(^{181}\)

In regards to synthetic, *a priori* knowledge, Kant draws attention first to the impossibility of contradiction in the universe and later to the ideas of cause and effect, showing that both contradiction and cause/effect depend upon pure, *a priori* knowledge of the temporal dimension. Kant extrapolates, “It is only in time that it is possible to meet with two contradictorily opposed determinations in one thing, that is, after each other. Thus our conception of time explains the possibility of so much synthetical knowledge *a priori*… which is not a little fruitful.”\(^{182}\) Time, for Kant, like space, is a fundamental category of human reason, acquired *a priori*, serving as the mold in which all synthetic propositions and sensuous intuition take shape.

Treating time as a pure form of sensuous intuition, however, implies that time is not only a reality whose ontological status resides *inside* of us, but like all sensuous intuitions, it also has a considerable subjective component. Indeed, Kant is forced to reconcile this position which, for the other thinkers reviewed here, has appeared differently as the dichotomy between time as a objective feature of the universe and one’s subjective experience of it. Whereas for the ancients this problem manifested itself as the irreconcilability between the objective instances of time being the parts of a whole which never completely exists, Kant’s position reframes the discourse in the context of his

\(^{181}\) Pure mathematics, according to Kant, is an example of knowledge that can be both synthetic (i.e. pure intuitions relating to one another and readily applicable to objects in the world) and *à priori* in nature. The abstract axioms of geometry, for example, can be arrived at by virtue of reason alone, according to Kant, based on the *à priori* intuitions of space. The goal of Kant’s metaphysics was to explain the possibility of such synthetic *à priori* knowledge.

\(^{182}\) *Kant, Critique of Pure Reason*, 29.
conception of time as neither absolute nor relative, but an internal form of reason whose subjective experience is concurrently representative of a universal and objective category of thought. The problem still remains, however, for Kant to resolve the unity of time when it exists as the sensuous form of intuition scattered amongst individual instances of reason.

In the metaphysical exposition of time, Kant tells the reader that, “Different times are merely parts of one and the same time…” and that, “the proposition that different times cannot be coexistent, could not be derived from a general conception…[but] is contained immediately in the intuition and representation of time.”\(^{183}\) Hence, the *unity* of time is an indispensable feature of the category, but it is not entirely clear whether this unity is either a.) logically or empirically warranted by his “scientific” examination of reason or b.) thematically significant in the same way that Holton describes the significance of the absolute nature of time for Newton.

In the first case, Kant describes the categories as being fundamental to all thought and the backbone of reason. As such, all objects are intuited in time and their actual intuition, though sensuously subjective, provides sufficient empirical evidence (for Kant) to uphold the objective reality of time as a singular category. According to this logic, the ubiquity of time (or, in other words, in the universal necessity of it as a foundation for reason) necessarily implies that time is the same everywhere in its essential qualities because it is *prior* to any empirical intuition which may occur in it. Conceptions of time, on the other hand, (which are different from the category of time itself) are

\(^{183}\) Ibid.
transcendental ideas that result from the cognizance of the category’s existence and reason’s capacity to make synthetic propositions about it. By differentiating the concepts about the category from the category itself, Kant attempts to resolve the problem of eternity and continuity in time that has irked other philosophical minds by explaining how reason naturally surpasses itself when it ruminates on certain qualities of space and time. Kant’s exposition of this dialectic, despite his earnest attempt to avoid the metaphysical quandaries of his predecessors, will lead the great rationalist philosopher to thematic propositions in his own unique way.

Justifying his method of transcendental idealism as the most complete account of the faculty of reason when analyzed in its totality, Kant explains the existence of transcendental ideas as emanating from the essential qualities of the fundamental categories when these categories are operationalized (i.e. made explicit) in reason. A natural consequence of reason turning inward on itself, according to Kant is that, being derived only from the pure categories themselves (and not any empirical phenomenon intuited in them) the conceptions of pure thought take reason beyond its own empirical limits. In Book I “Of the Conceptions of Pure Reason”, Kant writes, “…pure conceptions of reason…are transcendental ideas…. they regard all empirical cognition as determined by means of an absolute totality of conditions. They are not mere fictions, but natural and necessary products of reason and have hence a necessary relation to the whole sphere of the exercise of the understanding. And finally, they are transcendent, and overstep the limits of all experience, in which, consequently no object can ever be
presented that would be perfectly adequate to a transcendental idea.”¹⁸⁴ Thus, the transcendental ideality of the fundamental categories as concepts explains, for Kant, the persistence of the dichotomy between the real and ideal conceptions of reality in Western philosophy that began with Plato’s ontological view. Kant seeks to resolve the problem by reorienting the epistemic focus within the empirical limits of reason despite the speculative, transcendental tendencies of pure thought. Kant’s rationalism is a naïve prisoner to the same universal view of Plato’s dualist ontology, and though Kant intends to remain focused on the empirical limits of reason, the logical problems inherent in his worldview can only be reconciled by the appeal to something outside of pure reason.

In pure reason, when the categories and the ideas or conceptions of the categories are taken alone, they necessarily result in contradiction. It is for this reason that time presents (along with space) the first conflict of the transcendental ideal in Kant’s system and stands almost unavoidably as the first antinomy of reason. Before I proceed to the logical dialectic that the fundamental category of time presents to pure reason, however, it is important to note that Kant’s system of transcendental ideas, before devolving into the contradiction of the antinomies, do combine in such a way that reinforces the philosopher’s emphasis on the unity of reality. This unity corresponds to the relationship between things that exist and the subject (i.e. objective existence and reason are the inseparable predicates of all knowledge), the relation of objects to phenomena (and other objects, conceivably not dependent upon the subject or reason but knowable only through

¹⁸⁴ Ibid., 205.
it) and, what Kant calls “the relation to all things in general.” According to Kant’s scheme, “it is obvious, that there exists among the transcendental ideas a certain connection and unity, and that pure reason by means of them, collects all its cognitions into one system. From the cognition of self to the cognition of the world and through these to the Supreme Being, the progression is so natural, that it seems to resemble the logical march of reason from the premises to the conclusion.” (He was very perceptive: it does.) In a footnote corresponding to his assertion, Kant explains that these considerations have been the primary focus of metaphysics in the Western tradition. The revolution of his ontological view, however, reverses the traditional relationship from the analysis that begins with the outer-world and moves inward to our knowledge of it to one that focuses on the essence of our psychology and from the principles of reason therein contained extrapolates to the cosmological and theological realms. The reorientation of this system in Kant’s thought constitutes his self proclaimed “Copernican Revolution” in epistemology by purportedly deducing the unity of relationships between being, subject, object and universe in a more satisfactory way.

Time, appearing together with space as the first antinomy of pure reason, illustrates the consequences of Kant’s epistemic reversal in both the tendency for pure reason to betray itself by exceeding its own empirical limits in the case of transcendental ideals and in the persistent need to appeal to metaphysics in explaining and/or limiting such transcendence therefore grounding reason in its real world setting. The “First Conflict of the Transcendental Ideas” presents absolutely opposing theses concerning

185 Ibid., 209.
186 Ibid., 211.
time and the nature of the universe that result from the synthetic, conceptual employment of pure, *a priori* time. The first thesis reasons that, “The world has a beginning in time, and is also limited in regard to space.” The antithesis states that, “The world has no beginning and no limits in space, but is, in relation to both time and space, infinite.” These theses, taken together force reason into the derivation of such unempirical and contradictory concepts as unknowable infinity and beginnings or ends in eternity.\(^\text{187}\)

Thus, Kant defends his argument that the transcendently ideal nature of the categories must be true by showing that concepts about them (which, are separate from the intuition) have the capacity to logically nullify our empirical knowledge of their reality. For, taking transcendental idealism into account allows one to understand that both of theses of the antinomies must be regarded as false. To treat either of them as true would not only require a choice between them that cannot be logically or empirically warranted (they are equally plausible logically—or equally implausible, however one chooses to see it) and to treat both of them as being true devolves into blatant contradiction. Furthermore, as antinomies of *pure* reason derive from the tendency of pure reason to surpass itself, neither possibility is accessible empirically. According to Kant, however, the very existence of such modes of thought can only arise from reason’s capacity to transcend itself through the conceptualization of the fundamental categories of space and time as *they really are*. Allen Wood writes of Kant’s first antinomy that, “…to assume they [space and time] must exist either as infinite wholes or finite wholes is to assume that they are not merely appearances but *things in themselves*, whose determinations must

\(^{187}\) Ibid., 241.  
\(^{188}\) Ibid., 244.
exist independently of the manner in which they can be given to our intuition. But if transcendental idealism is true, this assumption is false." ¹⁸⁹ Time, for Kant, therefore, does not exist as a thing in itself. He writes forcefully in the “Transcendental Aesthetic” that “Time, no doubt, is something real, that is, it is the real form of our internal intuition” all the while stressing elsewhere that, “[time]… in itself, independently of the mind or subject, is nothing.” ¹⁹⁰ The philosopher grants that the concept of time presents reason with an irresolvable problem from which our thought has never been able to truly emancipate itself. But transcendental idealism only explains the existence of the problem by cementing its origin within the fundamental structure of pure reason. Kant must turn elsewhere in an attempt to solve it.

The solution to the irresolvable contradictions arising from pure speculative reason arrives in Kant’s subsequent work, the Critique of Practical Reason. The goal of the second critique is to build upon the Critique of Pure Reason by asserting and explaining the empirical faculties of reason that prevent it from overstepping itself. Kant writes that, “It would certainly be more satisfying to our speculative reason to solve those problems [in which the transcendental ideals—of time, for example—take reason beyond its empirical limits] for itself without this circuit and to have put them aside as insight for practical use; but,” he admits, “as matters stand, our faculty of speculation is not so well off.” Thus, reason must have recourse to mechanisms that prevent it from falling into absolute contradiction and allow it to be grounded in objective reality despite the fact that

¹⁹⁰ Kant, Critique of Pure Reason, 31.
such reality is only knowable empirically through the mind. *It is here that Kant deduces the necessity for the establishment of the moral law and the belief in God as the transcendental being that embodies the ultimate, universal relationship of “all things in general.”* Thus, in the end, Kant’s exposition of time and his position on the faculty of reason in general is both empirical and metaphysical. In regard to the relationship between Kant’s philosophy and religion Phillip Rossi writes, “Kant's treatment of the concept of God and religion in his critical philosophy…does not consist merely in this negative result that we must block reason from taking us along the theoretical paths that rationalist metaphysics had claimed will lead to a proof of God's existence. He argues that once we have disciplined human reason to stay off that theoretical path, we are then in a position to make an affirmation of God on the basis of what he terms the practical, i.e., moral, use of reason. As he writes in the Preface to the second edition of the *Critique of Pure Reason* (1787), ‘I had to deny knowledge in order to make room for faith.’”¹⁹¹ Thus, the resolution of the philosopher mirrors the conclusion of Augustine to an astonishing degree—in the end, Kant too chose faith and suspended his critical judgment.

**Bergson’s Entrance and Departure**

The influence of Kant on the direction of philosophy in its separation from natural science was, and still remains in many academic circles, colossal. For the purposes of the present discussion it is enough to understand his essential view of time as an internal reality emanating from the fundamental, *a priori* structure of reason and to see that his

---

view stands in distinction not only to the traditional understanding of time in Western philosophy as a necessary feature of the universe, ontologically residing outside of us, but also to the treatment of it by natural philosophy which, after Newton, cemented that external, physical time as an absolute and mathematical quality encompassing all of extended matter. In the century following Kant’s *Critiques*, Neo-Kantians carried the internal, *a priori* conception of time in their work, which occurred in isolation from whatever was happening in the physical sciences, thus in a discourse that had very little connection to empirical reality outside of the mind and, until the end of the 19th century, remained wholly speculative with respect to an understanding of mental reality itself. Two interesting intellectual developments were fermenting around the turn of the 20th century, however, that would briefly bring the philosophical question of time back in contact with the scientific treatment of it. Those concurrent developments were a burgeoning interest in the structure and function of the human brain as it relates to the psychic qualities of the mind, on the one hand, and the revolution of Einstein’s theory of relativity, on the other.

The intellectual legacy most representative of the philosophical and empirical convergence on the concept of time during this period belongs to Henri Bergson. Bergson’s philosophy begins from an amalgamation of traditional philosophical problems (problems that Bergson sees in Kant’s account of the fundamental categories and his subsequent derivation of freedom and the moral law) and the contemporary interest in the relationship between the sensory organs and objective reality; Bergson’s philosophy ends, in a certain respect, with his extrapolation of his earlier ideas to an assertion of
problems with Einstein’s theory of general relativity exhibited in Bergson’s essay *Durée et Simultanéité* and the notorious debate between the two that ensued.

Bergson’s deviation from Kant, and thus his central contribution to the philosophical discussion, is illustrated in the opening to his classic, *Time and Free Will* (*Les Données Immédiates de la Conscience*); there Bergson writes, “The problem which I have chosen is one which is common to metaphysics and psychology, the problem of free will. What I attempt to prove is that all discussion between the determinists and their opponents implies a previous confusion of duration with extensity, of succession with simultaneity, of quality with quantity: this confusion once dispelled, we may perhaps witness the disappearance of the objections raised against free will, of the definitions given to it, and, in a certain sense, of the problem of free will itself.”192 The problem of free will described by Bergson is not a subject of central interest here, but the means by which Bergson arrives at the solution to his problem is: by reexamining the purported relationships between space and time laid down by Kant, Bergson offers a novel account of the temporal concept that, in my mind, represents the final world in the philosophy of time.

Bergson’s main idea is that time in the Kantian scheme is considered a homogeneous medium, an empty container of thought in which all intuitions find their form according to the objective, yet internal reality of temporal succession. When the implications of time as a homogeneous medium, according to Bergson, are logically examined, time collapses into space and our understanding of time as a unified reality,

---

separate from space occurs merely in the form of an analogy to extensity and is therefore incomplete.

Now let us notice that when we speak of time, we generally think of a homogenous medium in which our conscious states are ranged alongside one another as in space, so as to form a discrete multiplicity. Would not time thus understood, be to the multiplicity of our psychic states what intensity is to certain of them—a sign, a symbol distinct from true duration? Let us ask consciousness to isolate itself from the external world, and, by a vigorous effort of abstraction, to become itself again. We shall then put this question to it: does the multiplicity of our conscious states bear the slightest resemblance to the multiplicity of the units of a number? Has true duration anything to do with space?

He answers this question by resorting to the a priori qualities of number that he has demonstrated in an earlier chapter and decides,

Certainly, our analysis of the idea of number could not but make us doubt this analogy, to say no more. For if time, as the reflective consciousness represents it, is a medium in which our conscious states form a discrete series so as to admit of being counted, and if on the other hand our conception of number ends in spreading out in space everything which can be directly counted, it is to be presumed that time, understood in the sense of a medium in which we make distinctions and count, is nothing but space. That which goes to confirm this opinion is that we are compelled to borrow from space the images by which we describe what the reflective consciousness feels about time and even about succession; it follows that pure duration must be something different. 193

So what is pure duration according to Bergson? In the conclusion to Time and Free Will he summarizes that, like Kant’s conception, duration exists within us, but unlike Kant’s objectification of a singular, uniform time, Bergson denotes the characteristic feature of duration is its multiplicity. “What is duration within us?,” he asks, “A qualitative multiplicity, with no likeness to number; an organic evolution which is yet not an increasing quantity; a pure heterogeneity within which there are no distinct

193 Ibid.
qualities. In a word, the moments of inner duration are not external to one another.”

This definition of pure duration is suggestive of many things. The first is that duration, as opposed to time, consists of *multiplicities*. Time, on the other hand, is our concept of duration and when treated as one, unified thing, it collapses into space because only space has the quality of being homogeneous and objective in the strictest sense. Duration, however, is the phenomenon that arises from the flow and intermingling proper to sensations, thought, and consciousness. Thus, similarly to Kant’s characterization of time, duration without consciousness is nothing.

In fact, Bergson draws attention to the distinction between “time” and duration when he argues that physical science is equipped to deal only with the misconception of time that results in its equation to space. Bergson tells his reader that, “Treatises on mechanics are careful to announce that they do not intend to define duration itself but only the equality of two durations…. In other words, we are to note the exact moment at which the motion begins, i.e. the coincidence of an external change with one of our psychic states; we are to note the moment at which the motions ends… finally we are to measure the space traversed, the only thing, in fact, which is really measurable. Hence there is no question here of duration, but only of space and simultaneities.” And later, “That the interval of duration itself cannot be taken into account by science is proved by the fact that, if all the motions of the universe took place twice or thrice as quickly, there would be nothing to alter either in our formulae or in the figures which are to be found in them.” This is because in the realm of space there exists only positions and no duration.

---

194 Ibid.
Certainly it seems to us that objects “endure” but this appearance is an artifact of the mind constantly affirming and reaffirming its sensuous intuition of an object’s empirical qualities. “Space contains only parts of space, and at whatever point of space we consider the moving body, we shall get only a position. If consciousness is aware of anything more than positions, the reason is that it keeps the successive positions in mind and synthesizes them.”

Duration is a characteristic of consciousness and that which is not consciousness cannot be considered to partake in it.

Pure duration, on the other hand, a property of minds, is described by Bergson at one point as “… nothing else but the melting of states of consciousness into one another…” In the first chapter of this dissertation, I had occasion to cite E. A. Burtt’s characterization of Bergson’s thought in reference to his ideas of time-lived as “an ever self-multiplying snowball” and therefore “a notion which would make a modern physicist gnash his teeth and a medieval scholastic gasp in amazement.” It is worth remembering Burtt’s assessment here to demonstrate both Bergson’s reiteration of certain themes encountered in Augustine’s impassioned analysis of time and the incredible distance that his “melting of conscious states into one another” represents from the point of view of physical science. Nevertheless, Bergson’s exposition of duration as a feature of consciousness includes a quality never before encountered in the major philosophical or physical analyses of temporal phenomena: namely, the multiplicitous and heterogeneous quality of duration.

---

195 Ibid.
196 Ibid.
The qualitative multiplicity of duration stands in contrast to the quantitative multiplicity—and thus objective, conceptual singularity—that inheres in space. Consciousness, according to Bergson, may possess multiple co-existing and non-contradictory feelings or intuitions and it is the intermixing and interweaving of these psychic states that contribute to the intensity or magnitude of mental experiences. The Stanford Encyclopedia of Philosophy describes Bergson’s idea of multiplicity as being represented by, “…a heterogeneity of feelings…, and yet no one would be able to juxtapose them or say that one negates the other. There is no negation in the duration…the feelings are continuous with one another; they interpenetrate one another, and there is even an opposition between inferior needs and superior needs. A qualitative multiplicity is therefore heterogeneous (or singularized), continuous (or interpenetrating), oppositional (or dualistic) at the extremes, and progressive (or temporal, an irreversible flow, which is not given all at once).”

It is from the nature of this multiplicity that Bergson derives his solution to the problem of free will as an inherent feature of reason (arguing that Kant’s scheme of one, singular time, without the possibility of such multiplicity leads, in fact, to a sort of empirical determinism). What strikes one as the most surprising in Bergson’s assertion, however, is the implication that multiplicity has for the principle of no contradiction, and thus for the idea of a fundamentally logical universe. Since there can be no contradiction in the duration (i.e. the multiplicity of thoughts, impressions, feelings, etc. cannot negate one another) one is tempted to

---

question the place of rationality in reason as well as the possibility of intelligibility between consciousnesses. Bergson, in fact, responds to this problem by showing that minds do ground themselves in the reality of the objective world, and thus our frequent misinterpretation of the duration through the expression of it as being analogous to space.

“It is therefore obvious that, if it did not betake itself to a symbolical substitute [namely, by the analogy to objectified space], our consciousness would never regard time as a homogeneous medium, in which the terms of a succession remain outside one another.”

But this solution posits a strange, metaphysical (and unempirical) relationship between the internal consciousness of the individual, the external world, and the internal consciousness of those external to the individual (i.e. of others). This—almost mystical—relationship is captured in Bergson’s description of the dynamic between the multiplicity inherent in duration and the singularity that we expect from the objective world:

In a word, our ego comes in contact with the external world at its surface; our successive sensations, although dissolving into one another, retain something [what exactly?] of the mutual externality which belongs to their objective causes; and thus our superficial psychic life comes to be pictured without any great effort as set out in a homogeneous medium. But the symbolical character of such a picture becomes more striking as we advance further into the depths of consciousness: the deep-seated self which ponders and decides, which heats up and blazes up, is a self whose states and changes permeate one another and undergo a deep alteration as soon as we separate them from one another in order to set them out in space. But as this deeper self forms one and the same person with the superficial ego, the two seem to endure in the same way...Thus the mutual externality which material objects gain from their juxtaposition in homogeneous space reverberates and spreads into the depths of consciousness: little by little our sensations are distinguished from one another like the eternal causes which gave rise to them, and our feelings or ideas come to be separated like the sensations with which they are contemporaneous.199

---

199 Bergson, *Time and Free Will.*
Here, Bergson falls victim to the limitations of the mind-body problem. External reality in his description seems to possess some qualities in and of itself—the qualities that are objective and capable of imparting some of themselves to our sensuous representations; while, simultaneously, an independent recourse to objectivity is denied to consciousness by the multiplicity, and what Bergson later calls the mobility of duration. Duration being characterized by multiplicity and belonging to consciousness makes the objectification of physical reality and the reality of a plane on which consciousnesses can meet patently problematic.

It remains to note the debate between Bergson and Einstein in reference to the theory of relativity in order to show just how far removed the philosophical and the scientific discussion had become from one another. Bergson’s Duration and Simultaneity (as the work’s subtitle in the original French, À propos de la théorie d’Einstein, makes plain) was written to engage the philosopher’s own analysis of duration and reveal the misconception of the relationship between space and time contained in both our common understanding and the scientific operationalization of temporal phenomena. Einstein, on the other hand, reproached Bergson for his lack of appreciation of the “physical nature” of the phenomena in question. In a letter to André Metz from July 2, 1924, the physicist wrote, “It is regrettable that Bergson should be so thoroughly mistaken, and that his error is really of a purely physical nature, apart from any disagreement between philosophical schools…. Bergson forgets that simultaneity... of two events which affect one and the
same being is something absolute, independent of the system chosen.” It seems as though the two authorities had categorically misunderstood one another, primarily on the grounds of simultaneity. Simultaneity for Bergson referred to the coincidence of events in the external reality with the conscious states of an individual observer. For Einstein, on the other hand, simultaneity had nothing to do with an observer at all, but rather could only occur as a real phenomenon in a physical system that was united through instantaneous cause and effect regardless of the distance between two points in space. Simultaneity for Einstein, in other words, could only occur if time were a feature independent of space. This doesn’t seem too far off from Bergson’s assertion that time and space are essentially separate phenomena, but Bergson asserts that time is dependent upon an observer by virtue of the observer having consciousness. Einstein makes time dependent on the observer with respect to the observer’s position in space. To make sense of Bergson’s argument one must imagine a universe in which there is no time, no succession except for that which resides in the mind; and to make sense of Einstein’s position one must imagine a universe in which there are no minds, just events occurring in dynamic systems which are relative to one another in their temporal (i.e. sequential) organization. By bringing attention to this debate, I do not intend to indicate that Einstein had produced a better account of the same concept; on the contrary, I have already discussed the philosophical implications of Einstein’s relativity showing that his general theory rendered the ontological status of time in the physical universe unequivocally tenuous. Rather, the central features of the dialectic between Bergson and Einstein speak

---

to the inability of Bergson’s own philosophical system of duration and simultaneity to provide for a clear, logical relationship between perception and the objective world, and the lack of interest that Einstein had in deducing qualities of our mental reality from the characteristics of physics. The two authoritative institutions on the understanding of time in Western thought, the scientific and the philosophical, revealed themselves, in the end, to be completely unintelligible to one another.
HUMAN TIME

In the preceding pages I have analyzed the nature of time and the understanding that our primary institutions of knowledge, science and philosophy, have of it. For the science of physics, time turned out to be nothing but a sociologically generated concept included in its mathematical descriptions by way of the human observer understood either (incorrectly) as a fundamental feature of the universe itself, or as a point of reference from which relative speeds and one particular sequence of physical events can be described. By contrast, in the organic realm, time emerges as a real, empirical phenomenon through the absolute dependence of organisms, or life in general, on complex yet particular sequences of physicochemical events. Another “time” enters the biological scheme—evolutionary time—but this is distinguished from the circular, absolute nature of organic time because it is imposed on the organic reality by the mind of the biologist, and, consequently, is linear and relative. The analysis of biological time, in either the real or conceptual cases, demonstrated that it is not time in the singular but times that exist empirically and that such coexisting times may be causally interwoven, crisscrossing, or mutually exclusive. The times or absolute sequences of individual organic events may influence millions of other organic times or they may occur in isolation, causally disconnected from millions of others despite externally derived measures of their contemporaneity. Thus, the empirical manifestation of organic times contradicts the prevailing Western philosophical position that our world and our understanding exist in the frame of one absolute time marching neatly and consistently from a uniformly analyzable past into a uniformly understandable future.
From the picture that has been painted thus far, a complex pattern between the role of the human mind and the empirical reality of time begins to appear. On the one hand, the sociological explanation of time in physics (and its subsequent banishment) shows that time is not an inherent property of matter; consequently, it only comes into being in the organic realm as a side effect of the emergent quality, namely the processual nature, of life. On the other hand, reflection on this empirical manifestation of time in biology (i.e. its actual qualities) showed that organic-time is cyclical and teleological, whereas the conceptual application of time in both physics and biology—and thus its explanatory power—consistently appears to be linear. Remembering that the concept of time in both the cases of physics and biology entered science through the mind of the scientist, i.e. through man, it is possible that the particular concept be overturned when it does not adequately capture the relationships between empirical phenomena that it was meant to describe. Hence, physics saw the replacement of the Newtonian idea of absolute time with Einstein’s relativity. What is remarkably common to all previous instantiations of the idea, however, is the linear quality that each instance of the concept exhibited. Even Einstein noted that despite the contradiction that Newtonian time presents, its unified linear framework is still retained as the common notion.

Both Western philosophy and science have continually sought to understand the relationship between “reality”, time and the mind. However, when one takes the perspective that time, in science, is most often projected onto reality as a linear construct by means of the mind, it is possible to imagine that the linear qualities of time might be found in the temporal characteristics of mental life itself. Even more, the linear
dependence of causal explanation in science seems to be at odds with the cyclical and teleological organic processes of the brain that must be supporting such thought. Thus, an adequate examination of time and our mental experience of it must account not only for the peculiar consistencies of the phenomenon itself but also for its apparent discrepancies from the material and organic realities to which it is undoubtedly related.

Locating the existence of time within the mind of the individual is not a new approach. Kant’s “revolution” in this domain has already been described. Bergson too considered time, or duration, among the fundamental features of human thought. The last chapter demonstrated that the philosophies of Kant and Bergson were incapable of transcending the dualist framework that separates the idealistic stuff of thought (or reason in Kant’s case) from the real, i.e. material, subject matter of science. As a result, Kant could only reconcile the existence of reason through faith in the transcendental and Bergson’s theories were destined to remain purely speculative. What makes my interpretation of time and its relationship to empirical science not only new, but plausible, is its foundation in a tradition that recognizes the empirical reality and the autonomy of the human mind and seeks to explain its structure and function in a universally generalizable way. This approach, much like the approach that allowed me to demonstrate the appearance of time as a new phenomenon in the organic realm, involves recognizing the mind as an emergent phenomenon, autonomous from, irreducible to, yet operating consistently with the biological substrates of the brain that supports it.\textsuperscript{201} This mentalist framework, developed by Liah Greenfeld avoids the logical conundrum of the

\textsuperscript{201} See Greenfeld, “The Mind as an Emergent Phenomenon” in Mind, Modernity, Madness.
mind/body problem by substituting the conventional ontology for a tripartite layered view of empirical reality; taking the reality of the mind for granted and seeking to explain its dependence on and causal influence over the matter, this framework allows for the logical deduction of the mind’s qualities from the empirical exigencies of its environment without having to address the mind’s actual origin.\footnote{It is imperative to remember that no science ever explains origins. (See footnote 93 from Chapter 2 of this dissertation where Darwin reiterates the fact in regard to his own theory in a letter to J.D. Hooker.)}

By this route, I begin to approach the central purpose of my dissertation: to demonstrate that time is an empirical reality of central importance in human mental life, that its ontological status and particular qualities are unique, and that it can—and must—be studied according to the rigors of science. The goal of the remainder of this dissertation, therefore, is to lay the foundation for understanding what time is as a matter of empirical fact and to make the case that this novel understanding is a valuable contribution to the progress of a uniquely human science—i.e. a scientific discipline whose subject matter is humanity. By the end I hope to have convinced the reader that the consideration of time, and its centrality in our mental experience, makes plain the necessity of a branch of neuroscience that pertains to humans alone. In fact, I intend to demonstrate that the study of time will lead us directly to the empirical point of connection between the human mind and the brain.

**Bloch’s Time**

Time is of central importance to the humanities. It is implied in every human narrative, both fictional and factual, and no community, society or civilization can be
delineated without reference to its development through time. Despite its centrality, however, the humanities’ general understanding of time is nebulous. There is the vague intimation that time is indicative of or represented by perpetual change but there is no agreement on what exactly it is that changes; as a result, it is not clear how the present relates to the past and, quite contrary to any scientific method, a considerable effort is spent discussing the implications of social studies for the future. A few careful methodologists and theorists, however, have considered time explicitly and the role that it plays in the human, cultural reality; to lay the foundation for my own interpretation, I will begin with an exposition of their ideas.

In his apology for the discipline of history, Marc Bloch states unequivocally that time “is the very plasma in which [human] events are immersed, and the field in which they become intelligible.”\(^\text{203}\) While it may seem obvious that a historian’s methodological treatise would concern itself explicitly with time, Bloch’s *Craft* makes it clear that a simplistic understanding of his discipline’s focus on abstract time (i.e. dates) to which an intellectual “fetish” of the past can be directed betrays the science of history completely. “It is difficult to imagine that any of the sciences could treat time as a mere abstraction.” Bloch writes, “Yet for a great number of those who, for their own purposes, chop it up into arbitrarily homogenous segments, time is nothing more than a measurement.”

Bloch’s history, on the other hand, implies a more profound conception of time, one that is derived from the discipline’s unique focus on *man*. Thus, in his weighty characterization of time as “the plasma in which events are immersed”, I insert the

qualification “human” to correspond with Bloch’s emphasis on the centrality of this element in history’s analytical focus. “Behind the features of landscape, behind tools or machinery, behind what appear to be the most formalized written documents, and behind institutions, which seem almost entirely detached from their founders,” writes Bloch, “there are men, and it is men that history seeks to grasp.” In order to adequately grasp its subject, history must not treat man in isolation. Rather, the historian must recognize that men’s “thoughts breathe freely the air of the climate of the time.” And it is for this reason that Bloch defines history’s focus as “the story of men in time.”

Bloch’s analogy of time to a ‘climate’ of thought highlights the catholic relationship between a temporal dimension and the contents of men’s minds; for it is only in time that men’s actions, thoughts and feelings take shape and become intelligible. They do so by virtue of the coincident and/or successive relationships that such historical facts or phenomena (e.g. actions, thoughts, feelings, behaviors, etc.) have to one another. Thus, pointing out the historicity of facts denotes a qualification that has much broader implications than a simple lack of coincidence with the present. In fact, the historicity that Bloch highlights elevates the data of his science to a category of their own.

Considering historical facts as facts that are merely not contemporary, Bloch argues, presents the risk of confusing his historical facts with facts of an entirely different nature. For example, the geologist certainly concerns himself with the “past” when considering the oceanic deposits found in the vineyards of Chablis; likewise for the evolutionary biologist who studies the skeletal remains of the wooly mammoth. Both the geologist

---

204 Ibid.
205 Ibid., emphasis mine.
and biologist will draw conclusions about their relevant pasts by re-imagining the material variables and causal relationships in the environment that may have produced the empirical trace in question. In a sense, both of these hard sciences deal with “historical” realities. Bloch concedes this but adds the following qualification, “It is true that our language, fundamentally conservative, freely retains the name of history for any study of a change taking place in time. The custom is harmless, for it deceives no one. In that sense, there is a history of the solar system, because the stars which compose it have not always been as we now see them. It belongs to the province of astronomy. There is a history of volcanic eruptions which is, I am sure, of most lively interest as regards the composition of the earth.” But Bloch differentiates theses “histories” from the practice he has set out to describe. The history of the solar system and the history of earth’s geology do “…not concern the history of historians,” according to Bloch. Instead, “What…seems to dictate the intervention of history… is the appearance of the human element.” Thus the justification of a separate discipline is not the fact that its data is qualified by its distinction from the present, but rather that it has man as its central datum, that its subject matter is humanity. Reiterating his point, Bloch writes that, “The good historian is like the giant of the fairy tale. He knows that wherever he catches the scent of human flesh, there his quandary lies.”

The implication of Bloch’s exposition is that the subjects of his history, subjects that are delineated by their human element, are immersed in a medium that cannot be causally charted according to any physical or organic chain of events. Distinct from the

---

materialist researcher, the historian finds a peculiar government in the United States of America that resulted from idealistic disagreements among the English in the 18\textsuperscript{th} century; he finds Sunday church goers who share a 2,000 year old belief in the life and resurrection of Jesus Christ; he finds Renaissance astronomers reviving Pythagorean ideals after the widespread translation of ancient Greek texts. Historical facts, the traces of men’s actions, thoughts, and beliefs seem to operate according to a logic that is unique and self-contained with regard to their material and biological conditions. For Marc Bloch, that logic is the essence of historical time, “a concrete and living reality with an irreversible onward rush.”\footnote{Ibid., 27}

Bloch is not alone in privileging history as the key to knowledge in questions of humanity. Durkheim, the founder of a sociological school of thought, which Bloch treats with great deference, asserts that human institutions (the eminently social conglomeration of facts and collective representations that both guide and are evinced by men’s actions) cannot be understood apart from their moment in time. “History alone enables us to break down an institution into its component parts, because it shows those parts to us as they are born in time, one after the other…. by situating each part of the institution within the totality of circumstances in which it was born, history puts into our hands the only tools we have for identifying the causes that have brought it into being. Thus, whenever we set out to explain something human at a specific moment in time—be it a religious belief, a moral rule, a legal principle, an aesthetic technique, or an economic system…we must seek to account for the features that define it at that period of its existence and then
show how it has gradually developed, gained in complexity, and become what it is at the moment under consideration.”

Thus, Durkheim too makes it plain that “the study of men in time” is the means by which all questions in the humanities must be approached, for the appartenance of a social fact to a particular place in historical time is the principle feature that allows for its understanding or explanation.

Similar to the assertions of Durkheim and Bloch, Max Weber highlights the correspondence of sociology with the explanatory interests of history, thus emphasizing the importance of a unique temporal dimension in human affairs as well. Weber prominently characterizes his sociology as a science focused on the interpretive understanding of the subjective meanings that particular actors attach to their thoughts and behaviors thereby providing a causal explanation of the course and consequences of such meaningful action. While the implications of subjective meaning as the focus of an objective science are discussed in both the methodologies of Durkheim and Bloch, Weber makes it signally clear that understanding the subjective aspect behind individual actors is the objective goal of his human science. In doing so, Weber’s methodological discussion underlines the inseparable connection that his science of meanings has to the empirical focus of history.

In the “Conceptual Exposition” that opens Weber’s *Economy and Society* he writes that, “…both for sociology in the present sense, and for history, the object of

---

cognition is the subjective-meaning complex of action.”210 History and sociology may be distinguished from one another in certain respects according to Weber, but essentially the sociologist and historian must consider the same data and should rely on one another’s scholarship in their understanding of individual actions and events. Weber specifies that, “…history…is oriented to the causal analysis and explanation of individual actions, structures and personalities possessing cultural significance. The empirical material which underlies the concepts of sociology consists to a very large extent, though by no means exclusively, of the same concrete processes of action which are dealt with by historians….“ Weber goes on to point out that, “In all cases…sociological analysis both abstracts from reality and at the same time helps us to understand it, in that it shows with what degree of approximation a concrete historical phenomenon can be subsumed under one or more of these [sociological] concepts.”211 Thus, for Weber, the division between sociology and history is largely a superficial one; in fact, he even uses the words interchangeably.

When all three (Durkheim, Weber and Bloch) are taken together, a common thread begins to emerge between these thinkers: namely, their emphasis on the uniqueness of the human element in their analyses and the important role that a temporal quality (characterized as historical time) plays in answering questions within this unique reality. Liah Greenfeld has noticed the concordance of these themes and draws attention to it in each of her major works. Elsewhere, in an article outlining the principle aims of sociological study, Greenfeld describes the connection between Durkheim, Weber and

211 Ibid., 19-20 (emphasis in the original).
Bloch at length.\textsuperscript{212} Durkheim and Weber, she demonstrates through textual evidence, were both focused on the subjectively meaningful nature of human social reality. She argues that they were unfortunately limited by the disciplinary vocabularies of their time and, as a result, their common choice of the name “sociology” betrayed the empirical delineation that both strove to make evident in their writing. Society in general is not the characteristic feature of their science, according to Greenfeld, but rather Weber and Durkheim sought to delineate the qualitatively unique type of society that is characteristic only of humanity. Drawing attention to the numerous passages that emphasize the particular scope of their analyses, Greenfeld shows instead that Durkheim and Weber’s sociology is oriented toward a study of the “cultural, symbolic and more generally mental” aspects of reality. “The specifically human reality that Durkheim and Weber focused on, the subject of sociological thought” writes Greenfeld, “was the human mind.”\textsuperscript{213} Without this specification, the qualification of society—a biological corollary of most higher organisms—does nothing to denote the unique qualities that separate \textit{homo sapiens} from the rest of the animal kingdom and, instead, leads to the misunderstanding that it is \textit{homo sapiens in groups} that represents the subject matter of social science. Weber’s methodological individualism demonstrates explicitly that the group is not the primary source of empirical data in his science. He explains that, “… for the subjective interpretation of action…collectivities must be treated as \textit{solely} the

\textsuperscript{212} Greenfeld, “‘Main Currents’ and Sociological Thought,” Brian-Paul Frost and Daniel J. Mahoney (eds.), \textit{Political Reason in the Age of Ideology: Essays in Honor of Raymond Aron}, (New Brunswick: Transaction, 2007) 125-143.

\textsuperscript{213} Ibid., 132.
resultants and modes of organization of the particular acts of individual persons, since these alone can be treated as agents in a course of subjectively understandable action.”\textsuperscript{214}

Even Durkheim’s discussion of society as an eminently collective reality reminds the reader that “individuals [are] the only active elements in it.”\textsuperscript{215}

In the Introduction to \textit{Mind, Modernity, Madness}, Greenfeld reiterates the fundamental point of convergence between Durkheim Weber and Bloch and notes the particular relationship that their thought has to time,

Durkheim, Weber, and Bloch (I list them chronologically) are unassailable authorities in the social sciences. But, quite apart from the fact that their major theories, all of which treated social… phenomena of great importance…have not been superseded… I rely on them because all three also thought of a unified science of man (or human sciences), and defined it, whether they referred to it as “sociology,” as did Durkheim, “history,” as did Bloch, or sometimes “history” and sometimes “sociology,” as did Weber, as the mental science. This may be lost in translation when Durkheim’s use of the word \textit{mental} in French is rendered \textit{social} in English, or glossed over in the case of Weber’s insistence on subjective meaning as the defining feature of social action. But in Bloch’s explicit formulation it cannot be missed. “In the last analysis,” he says, “it is human consciousness which is the subject-matter of history. The interrelations, confusions, and infections of human consciousness are, for history, reality itself.”\textsuperscript{216}

Thus, the writings of these three theoretical giants provide not only a wealth of resources for methodological orientation in the \textit{human} sciences but also emphasize an undeniable relationship between the mental quality of their central subject matter and a unique temporal dimension that is human, historical time.

Before I can proceed to a discussion of what exactly historical time may be, it is necessary to address the manner in which the particular tradition represented by

\textsuperscript{214} Basic Sociological Terms p. 13 emphasis in the original
\textsuperscript{216} Greenfeld, \textit{Mind, Modernity, Madness}, 7; quoting Bloch, \textit{Historian’s Craft}, 151.
Durkheim, Weber, and Bloch allows for the inclusion of such an analysis (i.e. of the human social reality and its unique temporal dimension) into the canon of scientific studies. (This, also, is in a way what my dissertation is about: an example of this scientific study and the causal relationships that this particular perspective has the capacity to uncover, evinced by the discussions of chapters 1 and 3.) It is clear from their methodological works that the establishment of such a human science is a goal that was common to all three. Therefore, much can be gleaned in this respect from Durkheim, Weber and Bloch individually. The scientific implications of their ideas converge to reveal an enormous potential, however, when their concepts are unified and refined in Greenfeld’s mentalist framework. Like the founders of her tradition, Greenfeld recognizes the ontological significance of the human social reality and describes its internal relationships in a logically consistent manner that seeks to align itself systematically with the hard sciences. What specifically allows for the inclusion of Greenfeld’s framework into the logical structure of science is the postulation that this unique human social reality is an emergent phenomenon distinguished by the fundamentally symbolic nature of its processes, which are causally irreducible to the conditions of the biological substratum from which they emerge even though they are all the time operating with and dependent upon it. (Chapter two of the present dissertation has already discussed the scientific utility of viewing reality as a set of causally heterogeneous, yet interrelated layers—showing that, in fact, this approach was implied

217 For more about the relationship between science as a patterned activity and the aims of Durkheim and Weber to participate in such an activity while analyzing humanity, see Eric Malczewski, “This is Social Science: a ‘Patterned Activity’ Oriented Toward Obtaining Objective Knowledge of Human Society” in Journal of Classical Sociology, 2013.
in Darwin’s *Origin of the Species.*) This new ontology recognizing the causal autonomy of the human social reality makes way for a humanities-driven study of consciousness that fuses consistently with experimentally driven neuroscience. For this reason, a brief summary of Greenfeld’s framework is necessary in order to illustrate the manner in which subjects of humanity, and therefore the specific analysis of human, historical time can be operationalized scientifically.

In “*The Mind as an Emergent Phenomenon*”, Greenfeld presents a theory for the scientific study of the unique human social reality that reformulates the foundational implications of Durkheim, Weber and Bloch and builds upon them in a significant way. Greenfeld’s major contribution to this tradition is a conceptual one that recognizes human social reality as a *cultural reality emergent from, dependent upon and logically consistent with the parameters of the biological constitution of homo sapiens*. By adopting this theoretical position one can imagine, as Greenfeld does, *culture* as a vast collection of symbolic, collective representations that are constantly being transmitted, interpreted and remade *in the minds of individual human beings*. Thus, culture is a reality that is both internally represented by individuals (individual minds are the only active element in it) yet it is derived from and transmitted by means of external stimuli (culture comes to individuals from the outside—i.e. it does not spontaneously appear *de novo* in each human individual, it arrives through socialization).\(^{218}\) The unique facet that Greenfeld highlights in the nature of such external stimuli is that, in distinction to the stimuli that are traditionally understood to affect biological systems, *cultural stimuli are not material*.

---

\(^{218}\) Greenfeld describes culture, and therefore the distinguishing characteristic of humanity, as acquired, *Mind, Modernity, Madness*, 25.
Rather, the stuff that culture is made of is *symbolic*, having no direct or necessary relationship to its referent in the material environment. In regard to symbols, Greenfeld elaborates that “…they represent phenomena of which they are not a part – …they are arbitrary, dependent on choice. The meaning (the significance) of a symbol is not given in the phenomenon it is signifying—its referent, or genetically; it is given to it by the context in which it is used…this context [is] mostly the context of other symbols.”

Greenfeld explains that her conceptualization of culture, or the symbolic environment, is analogous to the main philosophical theme implicit in Darwin’s conception of life: an emergent reality that is causally autonomous and historically subsequent to the layer of reality that serves as its constitutive elements (e.g. organic life emerges from and acts autonomously within the boundary conditions of matter and culture emerges from and is causally autonomous within the biological processes that support it). Like life, culture too is responsible for the organization of its elements into arrangements that are highly improbable (and complex processes which in the conventional framework have proven to be inexplicable) in light of their own qualities when analyzed independently. Thus, Greenfeld echoes Durkheim’s hypostatization of society as reality *sui generis* by asserting that the cultural reality has an operative logic all its own—one that is a function of the essentially symbolic nature of it. This does not mean that the symbolic reality operates independently of biological or physical reality; at every moment, the processing of symbols is necessarily supported by the biological reality of individual brains. Like the dependence of life on its material/spatial elements,

---

219 Ibid., 63.
Greenfeld explains, the symbolic, cultural process, “…happens…by means of the organic process and the corresponding material structure of the brain…. the use of every symbol, the perception of its significance, its maintenance and transformation is supported by the mechanisms of the individual brain and reflected in some, not necessarily specific, physicochemical neuronal activity. This is thus a mental process. And it is this symbolic (therefore, historical) and mental process… that we experience as the mind.”220

Similar to Bloch and Weber, Greenfeld emphasizes that the subject of analysis in this framework is ultimately the subject of human consciousness. Her framework establishes a conceptual link between the collective essence of symbols and their active existence in individual instantiations by recognizing that culture and the mind represent the same process operating on two different analytical levels. Culture is the symbolic environment into which all baby homo sapiens are born whereas the mind is the individual internalization, manipulation and recreation of symbols derived from that environment. In the same way that Weber indicated the impossibility of explaining the collective types without the agency of individuals, and Durkheim stressed the collective reality of society where individuals are the only active element in it, it is impossible, according to Greenfeld, to consider the mind without culture or culture without minds. Taking the perspective that the mind and culture are one and the same symbolic process operating on two different levels—autonomous from the point of view of physical or biological causality—not only creates the possibility of examining the relationships between the symbols that make up any particular instantiation of culture but also allows

220 Ibid., 63-64.
one to effectuate an objective analysis of the symbolic processes exhibited by an individual mind. Focusing on the symbolic nature of human cultural reality, in fact, allows one to form logically refutable hypotheses about the actions, thoughts, and behaviors of humans—about human minds—without having to resort to illogical jumps from organic or physical causes to human, mental phenomena all the while remaining within a framework that is perfectly consistent with them. (It is worth noting here that, in light of the conclusions from my previous chapters, such physical or biological causes explaining the existence and mental experience of time that will serve as the focus of the rest of this chapter would seem impossible: time is not a quality of matter and therefore not “sensible” from the physical world; and though time is a property of organic systems it is cyclical and teleological, two qualities which are absent from our linear experience of it.)

The explanatory thrust of the mentalist theory rests upon an understanding of the defining and functional characteristics of symbols themselves—*their fundamental arbitrariness*. Being essentially arbitrary, symbols are qualitatively distinguished from all known stimuli in the organic reality. In organic systems, the spatiotemporal features of the system’s elements determine the operative relationships of cause and effect at every level. With respect to an organism and its environment, all causal/effectual signs correspond directly (i.e. spatially) to a material configuration. Symbols, by contrast, derive their operative characteristic—*their meaning*—from the context in which they appear. Since, more often than not, the context is determined by other symbols (rather than material or organic factors) the configurations of symbolic systems exhibit a
substantial independence from the material—and thus the spatial environment—in which they exist. For this reason, Greenfeld points out, “The significance of symbols constantly changes. Unlike signs, which could be very many, but whose number is essentially limited by their referents in the environment, symbols are endlessly proliferating…Unlike signs which exist in sets, [symbols], from the first formed systems, ever changing and becoming more complex and connected by constantly transforming ties of interdependence. Symbols, in other words, constitute a world of their own, an autonomous, self creative world in which things are happening according to laws of causation that do not apply anywhere else.”

The unique fluidity of the symbolic environment is emphasized further by the comparison with the operative features of organic processes that are outlined in chapter two of this dissertation. Signs, though connected to temporally bound organic sequences, are necessarily spatial phenomena; this fact accounts for organic times’ constant dependency on space. The symbols that constitute culture and the mind, on the other hand, are unlike the physicochemical constituents that undergird all organic processes—they have no such spatial relationship. The significance of this discrepancy cannot be overemphasized—it leads directly to the importance of time in the symbolic environment. Greenfeld expounds that,

“Unlike the organic reality which provides the boundary conditions for it, and in which every stage and level of the organic process occurring in time corresponds to a specific, definite, and peculiar to that particular stage state of matter occurring in space, the symbolic reality [i.e. culture] is essentially historical. It is

---

221 Ibid.
222 See my discussion of the relationship between time and space in organic processes in Chapter 2.
a process that occurs without any specific reflection in substance. This process, like every process, occurs in time; but in distinction to the organic process, its relation to space is tenuous. It creates material by-products and leaves material side effects, but all this is only after the fact—there is no material aspect to its actual happening.  

The relationship between an essentially historical time and the focus of a human science, with its emphasis on consciousness, becomes abundantly clear in Greenfeld’s formulation of the functional characteristics of symbols and the implications that they have as the distinguishing quality of the cultural/mental reality. Being the central explanatory concept of the science, symbols can be understood logically by mapping the contextual and therefore associative patterns of particular symbolic facts in real historical examples making the science itself empirical. Said another way, the symbols that constitute a distinctive mental (and therefore a cultural) reality are understandable to the objective observer by situating them within the unique systematic context of other symbols in which they appear, thus resounding Durkheim’s insistence that the explanation of social facts must be found in other social facts, Weber’s emphasis that the causes of social action are to be looked for in meaningful reality itself, and Bloch’s declaration that historical phenomena can never be understood apart from their moment in time. Through the lens of the mentalist framework, it is possible to define human time as a phenomenon resulting from the dynamic interaction of symbols (meanings)—and therefore symbolic contexts—with one another that characterizes the cultural process. Historical time is created by the constant change, the irreversible onward rush, of symbols, whose meaning fluctuates by virtue of their associative relationships, as they are

---

223 Greenfeld, *Mind, Modernity, Madness*, 64, (emphasis mine).
interpreted, transformed and transmitted by individual minds; these incessant changes in the symbolic, and therefore essentially meaningful, reality constitute time, making it the very medium in which human, cultural—and therefore mental—facts exist and take shape.

Being fundamentally characteristic of the symbolic process, time, thus defined, resembles Bergson’s conceptualization of la durée in a number of significant ways. The first is its aforementioned independence from extension, or space. Another similarity is time’s dependence upon consciousness. Since symbols require individual minds for their processing, the temporal phenomenon created by the symbolic process cannot exist outside of them—human time is a purely mental phenomenon. Differing from Kant’s idea of homogeneous time as an empty container of pure thought, however, the constant variability of symbolic organizations that constitute time result in its enormous heterogeneity. Put another way, the unique symbolic arrangement that makes up any manifestation of human time in culture and in minds imbues each instance of it with particular qualities. The multivariate qualities of time arise out of the associative potential that symbols have with more than one contextual system, thus allowing for the coexistence of multiple “times” within an individual, community, society, epoch, et cetera. The multiplicity of symbols, therefore, can account for Bergson’s assertion that there can be no contradiction, no negation, in the duration.

In other respects, the new, cultural understanding of time that I propose differs profoundly from the accounts of Kant and Bergson. The principal distinction in the concept of time that I advance here is that it is derived logically from the abundance of
empirical, symbolic facts in the human cultural environment and, as such, is refutable should contradictory evidence about the fundamental nature of such stimuli be uncovered. Additionally, if the symbolic nature of the facts themselves is taken for granted, there exists the possibility of logically refuting the characterizations that I make about human time using the evidence from within the cultural environment. Simply by following Durkheim and Greenfeld in adopting the perspective that the cultural environment is *sui generis and real*, I am in a position to avoid the metaphysical difficulties of Kant’s claims and the dualistic quagmire of Bergson’s. My conceptualization of human, cultural time, in contrast to the philosophical discourse, is logical and empirical (and logically and empirically testable)—therefore scientific; what legitimates its inclusion in the scientific institution, much like the mentalist framework from which it stems, is its consistent amenability to biological and physical levels of analysis.

By taking into account the symbolic nature of the cultural process and the inseparability of culture and the mind, I hope to arrive at a scientifically viable conception of human “*time as lived*”\(^{224}\) capable of logically and empirically accounting for particular instances in the process that makes itself apparent in humanity on both the collective and the individual level. In a way, this explanatory conceptualization of time is analogous to Newton’s concept of gravity, both as a relative force exerting itself variably on facts external to an observer and as an absolute phenomenon exhibited by the way in which facts of the human social reality interact with one another. *To objectively prove*

\(^{224}\) Called for by E.A. Burtt in his *Metaphysical Foundations of Physical Science*, 86, and cited in the first chapter of this dissertation.
that either gravity or human, historical time exist ontologically is a difficult task. Like gravity, historical time is a relational concept whose validity will ultimately be evaluated by its explanatory utility. On the other hand, and unlike gravity, historical time is an inescapable aspect of all psychological experience. Though the subjective awareness of time may vary in degree, there is no possibility of conscious experience outside of it. This is because all of our conscious knowledge is explicit and therefore necessarily experienced through the employment of symbols. It may seem counterintuitive that the objective existence of this most intimate aspect of our experience is so difficult to account for, but this is unfortunately the case for mental life in general. By definition, mental life is subjective. As such, I must rely on the adequate derivation of the concept of time and the concept’s ability to logically account for the problems of time (exposed in the previous chapter) in a more universal way—this is the scientific mission that will guide my analysis for the remainder of the work.

**The Autonomy of Human Time**

Isolating the processual nature of the symbolic reality and juxtaposing it with the spatial dependence of organic processes allows one to see the qualitative uniqueness of historical, human time at its base. The comparison of historical time with the physicochemical sequences of organic reality permitted me to highlight the independence of the symbolic reality from matter and, as a consequence, the complex fluidity inherent in symbolic systems of meaning. Now, I will develop this understanding into an analysis.

---

of human time’s empirical manifestation, exploring the way in which the symbolic reality interacts with itself and thereby uncovering the specific features that result from its autonomous logic. Again, a set of comparisons is the most helpful in deducing the temporal characteristics of the cultural process particularly in light of the longstanding philosophies through which time has been understood, and the temporal reality of organic time which must be involved in its actual processing in a supportive way. In the end, I hope to have shown that the cultural account resolves key philosophical and scientific problems concerning time that were insurmountable in preexisting frameworks.

Linear Trajectory of Time

As I demonstrated in Chapter 2, the governing logic of organic processes is end-driven where each effectual relationship can only be explained with respect to the cause that follows it (i.e. functionally in terms of its telos). In symbolic reality, by contrast, the indeterminacy of symbols makes it impossible to postulate an analogous “end” or teleological propensity. Symbols, though self-generating—and self-transforming in a particular sense, by virtue of their combinatorial dynamics—are not self-preserving or repeating. The symbol, at its base, is determined by its context and this context is never static. In the organic realm, the self-repeating, self-replicating process of the genome occurs within the larger context of the environment, to be sure, but the functional characteristics of the genome must generally conform to life’s teleological propensity for self preservation and such functional characteristics are largely determined before the moment of transmission. Symbols, or systems of symbols, on the other hand, have the potential to be interpreted and reinterpreted continuously throughout the lifetime of the
individual and variously by different sets of individuals within the same cultural epoch. It is true that statistical homogeneities occur in the cultural process on the collective level: the conceptual classifications of such homogeneities are the scientific contribution of sociology and the consistency of the homogeneities in action are responsible for the existence and preservation of social institutions that characterize specific societies across generations. In this respect, the enormous diversity of cultural configurations highlights the dependency between sociology and history (or any other human science and history) where the empirical trajectory of meanings can only be observed in clear traces left by individual actors of the past. Unlike individual genomes that can be conceptually grouped into species in the organic environment, however, symbols are transmitted indirectly and therefore their causal role is more dependent upon the context in which they are perceived than the agent of their transmission. For this reason, symbols diversify continuously throughout the cultural processes in a manner that renders it virtually impossible to anticipate any configuration of meanings in the future. Though it is frequently used to describe the combination of statistical homogeneity and indeterminacy in organic species, the word *stochastic*, deriving from the Greek root στόχος, meaning an aim or a target, is a poor characterization of the change that occurs in the symbolic environment. The historical analysis of culture reveals the transmission and development of meanings to be probabilistic in a way that tempts an analogy to biological evolution, but, unlike individual organisms, the particular symbols that make up culture do not appear to be imbued with the characteristic of self-preservation—they persist only so long as the contextual environment and individual wills allow them to. Due to the lack of
any teleological propensity, the cultural process appears comparatively unstable when imagined through an “evolutionary” analogy.\textsuperscript{226}

Instead, the interactive dynamic of symbols in the human, cultural reality is such that that \textit{change in the process occurs according to a linear trajectory that results from the causal relationship between symbols and context}. The introduction of a symbol into the environment (of the mind) is always perceived and interpreted based on a particular context. The new symbol, once interpreted, changes the totality of possible contexts at the very moment of its perception and reorients the potential avenues of association for other symbols in the environment. When a new symbol is perceived, its interactive potentialities with other symbols are on the one hand, \textit{conditioned by} the context that exists just before its perception and, on the other hand \textit{irreversibly conditioning} the association of symbols that may occur immediately after its perception (i.e. in the future). As a result, the configuration of symbolic systems in the cultural process (on the individual or the collective level) is never the same, nor is it ever deterministic.\textsuperscript{227} \textit{The existence of symbols themselves, due to their arbitrary, contextual and therefore associative nature, create an absolute relationship between the past, the present and the future in minds where they are actively processed without actually determining what the specifically meaningful relationship between symbols will or should be.}

\textsuperscript{226} Therefore contradicting Dawkins’ concept of the cultural meme.
\textsuperscript{227} Because of their dependence upon context, a function of their essentially arbitrary nature, symbols are quite flexibly associative; as a consequence, the symbolic reality lacks any force of determinism. Cultures and the minds that they occupy are always free. See the subject of free will in Greenfeld, \textit{Mind, Modernity, Madness}, 102.
From an analytical perspective, this “irreversible onward rush” of causal relationships between symbols, their context, and the individual minds in which they are interpreted, is what the human sciences should seek to capture and reconstruct. Thus, Durkheim asserted that the sole path to understanding the meaningful reality of any given human “present” is to reconstruct the development of institutions (we can now consider them patterned arrangements of symbols) as they are born in time. Similarly, on the individual level, Bloch writes that, “Historical facts are, in essence, psychological facts. Normally, therefore, they find their antecedents in other psychological facts.”228 It is true that the arbitrary nature of symbols implies that culture and the minds that it occupies are indeterminate; which means that, like all sciences, the human one can only know its facts once they have already made themselves observable (in the past) and can never be certainly predictive. The unpredictability of future moments in human time results from the mind’s active agency in the symbolic process—at every moment in the process it is essentially free. The particular associative arrangements that serve as the defining or meaning-giving principle, and the individual freedom inherent in the arbitrary nature of symbols, account for the potentially creative and incredibly diverse instances of minds and cultures across distances and generations; these features also combine to render the imposition of experimental conditions largely ineffective for analyses. Notwithstanding the inherent freedom in the process, however, culture and the mind do seem to be prisoner to the unique structure of time in which this process takes place: the unbreakable, linear bond between the past, the present and an unpredictable future. It is

228 Bloch, Historian’s Craft, 194, (emphasis mine).
also through this relationship that that time acquires its particular explanatory characteristic.

The historicity of the cultural process is created by the past conditioning the present, and the present laying the foundation, to a certain extent, (being the necessary though not sufficient condition) for the future. Until now, it has been important to point out the plasticity of the symbolic environment in order to stress its basic distinction from the rigidity of signs that make up organic reality. Examining the relationship between the past and the present, however, shows that the plastic quality of the symbolic environment does not exist without limits. In regard to this connection between the present and the past, Bloch points out that, “A society that could be completely molded by its immediately preceding period would have to have a structure so malleable as to be virtually invertebrate.” To the contrary, he reminds his reader that historical facts (i.e. symbols) have a peculiar “inertia” to them that renders it impossible to understand the data of the present without knowing something about the antecedents from which they derive. “To neglect to organize rationally what comes to us as raw material is in the long run only to deny time—hence history itself.” Bloch writes, “For can we understand [for instance] this or that period of Latin if we detach it from the earlier development of the language? This form of ownership, or those beliefs were not, of course, absolute beginnings. Inasmuch as their development proceeds from the most ancient to the most recent times, human phenomena are governed primarily by chains of similar phenomena.

To classify them according to kind is to lay bare the principal effective lines of force.”

For the cultural reality, those principal lines of force are the causal dependencies of the present meanings and contexts upon the past—the force itself is time.

*Human Time: Concept and Reality*

The relationship between the present and the past is so strong that Bloch argues, “the lines of connection work both ways.” The reverse assembly between the present and the past, of course, only pertains to the *understanding* of the past by means of the present, thus it is purely conceptual—but in this way it too reflects the real, linear progression of historical time. Bloch asserts that “whether consciously or no, it is always by borrowing from our daily experiences and by shading them, where necessary, with new tints that we derive the elements which help us to restore the past.” For the understanding of historical time and the explanation of the phenomena that occur in it most often begin from observations of the present state of the subject in question. Comparison furnishes all sciences with the means of description and classification; in questions of human time, according to Bloch, comparison through time leads to the nexus of change that the historian is seeking to explain. “In the film in which he is examining,” writes Bloch, “only the last picture remains quite clear. In order to reconstruct the faded features of the others, it behooves him first to unwind the spool in the opposite direction from that in which the pictures were taken.” With this analogy, Bloch captures the essence of the

---

230 Ibid., 147.
231 Ibid., 46.
linear progression of historical time pointing out that the causal explanation of facts is often revealed in reverse.

The discussion of time then, appears to split for the cultural reality as it did for biology: on the one hand, time is an explanatory, hypothesis-driven, concept seeking to align itself as closely as possible with the actual causal progression of facts in the cultural process; on the other hand, time refers to a phenomenon that is actually happening, constituted by the constant, dynamic, yet linear interactions between symbols, contexts and minds—it is this, real, passage of time which we all feel. In both the case of the phenomenon and in the case of the concept, an absolute line of dependence from the past, to the present, to the future reveals a unique, linear trajectory of time. What is striking about this linear characteristic is its consistency with the logical pattern of all other temporal notions in science and philosophy. The absence of time in material reality and the teleological propensity of organic processes make it impossible that this linear trajectory comes to the mind by virtue of these realities themselves. Instead, the linear trajectory inherent in the scientific explanation of phenomena results from the fact that scientific explanation is a cultural, that is to say, a mental and symbolic activity. In this way, Kant was right when he asserted that time was the very structure of our thought and that without minds it could not exist, only he was not aware of the symbolic source of that structure. Moreover, taking the reality of organic processes into account reveals some invalidity in Kant’s axiom: linear time is, in fact, the structure of our thought, but time also exists in the organic world—ostensibly without us—though in a different way. The progressive bond between the past, present, and future in our minds is so strong that
it could only be overcome with enormous effort to arrive at the teleological understanding of organic time. (Even still, the thought of a present organic state depending equally on past conditions and the cause of a future developmental trajectory reverberates with a tinge of scientific heresy.) But the empirical manifestation of time in organic processes warrants such an interpretation; furthermore, the independence of organic time from mental processes implies that one sort of time (e.g. the organic one) is perfectly capable of existing outside of reason. Thus, it is possible to deduce that the linear progression of time is definitive of reason because it is a uniquely human characteristic resulting from the symbolic nature of mental processes. In distinction to Kant, there is no need for us to resort to metaphysical justification for the existence of reason or its temporal quality—time, the medium of the symbolic process, enters the mind through culture, the symbolic transmission of human ways of life.

Once again, recognizing the causal progression of historical time as it actually happens and understanding the explanatory method that can be applied to it hinges upon the perspective that recognizes the cultural reality as a symbolic process. Remembering that culture and the mind are one and the same symbolic process operating on two different levels, it is possible to deduce certain conclusions about the structure of historical time that were unimaginable in the previous philosophical accounts that focused on either one universal, metaphysical time or implicitly searched for a material explanation of time on the level of individual experience.
Multiplicity and Interconnectedness of Times

In addition to the unique, linear structure of human time, the fluidity of symbolic processes on both the individual and the collective level creates the potential for an enormous diversity in causal and effectual relationships of historical times that may be interwoven, crisscrossing or mutually exclusive. Like the empirical manifestation of multiplicity in organic times, it is only the actual interactions bringing two (or more) individual minds into contact that constitute a causally significant moment. Such interactions, observable only in the past, may be abstracted on the collective level according to certain, conceptual, common denominators (e.g. the Renaissance, Modernity, Japan’s Tokugawa period) but in this sense they represent types that approximate the individual instantiations that actively exist in human minds—the only place where symbolic time actually happens. The circumstances under which specific ideas come to reside in each individual and the manner in which they are interpreted—guiding action, in the Weberian sense—are unique to each individual and develop uniquely as each individual continues to perceive and interpret symbols as a constant participant in the cultural process.

Unlike the spatially delineated times of organic reality, real interaction between minds can cross great distances, generations, and even civilizations. This does not mean that present minds are able to affect the past—the cultural past, like the past in any science, is a system that forever remains closed. Despite the fact that the past can never be changed (its processes have solidified and ceased in a certain respect), no empirically
accessible past is too remote to lose the capacity to affect the present.\textsuperscript{232} “Observation proves,” Bloch writes, “…that the mighty convulsions of the vast, continuing development [of history] are perfectly capable of extending from the beginning of time to the present.”\textsuperscript{233} Thus, a certain type of “time-travel” in the human mental reality is possible because symbolic processes of the past can be preserved in traces of culture that exist outside of the individual mind that produced it and revived by minds of the present that pick such traces back up, thereby introducing them back into the cultural process.

Saint Augustine, in his \textit{Confessions}, wondered how the past and its “non-being” could come into contact with or exist alongside the actual present. His singular impression of time and ultimate agency of God in his worldview left this feature of time, the active relationship between the present and the past, mysterious. Recognizing the causal significance of “historical tracks” as symbols in the cultural process eliminates this mystery by explaining how the past’s empirical “traces” come into contact with and influence individual minds through the interconnectedness of human time. \textit{Hamlet}, for example, is a vestige of Shakespeare’s mind and differing from the significance of fossils for organic processes in biology, its significance in human time is twofold: it is a datum indicative of the climate of Shakespeare’s cultural context that also has the capacity to become causally responsible for certain thoughts and symbolic rearrangements in the modern mind that picks it up. The same can be said for a reader’s interaction with the bible (as was the case for Saint Augustine), a listener of Mozart’s \textit{Requiem} or even a

\begin{footnotesize}
\begin{enumerate}
\item The past is only empirically accessible in so far as it has left or been preserved in traces that are discoverable.
\item Bloch, \textit{Historian’s Craft}, 41.
\end{enumerate}
\end{footnotesize}
physicist revisiting Newton’s equations in *Principia*. It is true that the artifacts themselves can only be *understood or explained* in reference to the particular time (i.e. cultural context) in which they were created—this understanding is the goal of the human science. When they are brought into contact with minds that are separated from them by generations, however, they reenter the cultural process becoming a part of new times that are determined by *unique, contextually bound, unrepeatable, subsequent moments* in the individuals interpreting them. Old meanings and associations contained in those great minds that are far removed and long gone may color such moments, but the present, by virtue of its distinct context, always acquires a shade of its own.

It does not take exposure to the work of genius to enact such a distanced effect; think of the tsunami of causes in the symbolic environment that can be traced back to minds with which an individual has no physical or biological connection. The “inertia” of certain cultural artifacts is imbued by the minds that preserve and recycle them. It is for this reason that Bloch writes, “The historian never escapes from time. But, in an inevitable oscillation… he sometimes considers the great waves of related phenomena which run over long periods, and sometimes the specific moments in which these currents are channeled into the powerful vortex of direct experience.”\(^{234}\)

Human *time-as-lived* is a symbolic process, and, as such, each instance of it has its own unique physiognomy when compared to other moments in the process. Cultural time does not correspond to any particular configuration of space, nor does it fit into the arbitrary homogenous segments attributed to it by measures of clocks or calendars. Each

---

\(^{234}\) Ibid., 156.
individual time is characterized by its own matrix of historically contingent causes and effects that manifest as direct, mental experience. The multiplicity of times, originally postulated by Bergson, therefore can be accounted for not only on the collective level by outlining the statistical homogeneities between symbolic systems (i.e. the extent to which observable facts approximate to Weber’s ideal types), but also on the individual level by examining the role that this dynamic, symbolic process plays in individual psychology. Being spatially independent, there is nothing inherently illogical about the combination, coexistence, or concomitance of symbols in culture or the mind—in fact, many contradictory systems are encountered frequently in daily mental processes.\cite{235} For animals, this is not so; time, for them, is inextricably bound up with space. It is possible that space is the only universal category with qualities that are essentially logical in an Aristotelian sense; as a result, animals are able to operate in and interact with it. Minds on the other hand, can manipulate their experience of time, travel back in it through imagination and direct the future of it with our interpretations and expectations, all because of the freedom and explicitness of symbols.

**Historical Causality: a Segue into Neuroscience**

Taking culture and the mind into consideration as empirical realities defined by their symbolic and processual nature, occurring in time whose trajectory is uniquely linear, allows one to draw the lines that connect causes with effects in the analysis of human affairs. While it is useful to imagine time as an explanatory construct on the

\cite{235} For a discussion of the constant choice that individual minds make between operative logics see Greenfeld, *Mind, Modernity, Madness*, 101-104.
collective level for history and sociology, it is on the individual level that time is actually happening and, in this way, time as a causal phenomenon has its most profound effects.

The incredible diversity of cultures across distances and throughout generations of human history is a fact that eludes biological explanation. An “organic” rationalization of such diversity would necessarily require that the material factors causally responsible for the existence of certain collective representations (to use Durkheim’s concept), the subjective meaning complex’s relationship to a particular action (to use Weber’s), or the climate that encapsulates men’s thoughts (in the words of Bloch) be accounted for. Many prominent social scientists put forth such material explanations on the collective level under the misconception that human cultural realities are subject to the laws of evolution by natural selection.236 (From the point of view of the environment, such an explanation of humanity might be called material determinism; from the point of view of genetics, a type of individualistic racism.) Without such extreme—although nevertheless logically implicit—assumptions, the same material explanations are sought on the level of individual psychology within the context of gene-environment interactions that might account for the cognitive development and particular psychological manifestations (i.e. thoughts) of individual minds. While, the materialist, gene-environment approach adequately accounts for the way in which material features of the environment (as signs) spatially interact with genetically modulated neural networks/processes in complex nervous systems of all other higher organisms, the application of this logic—borrowed directly from biological science—in the paradigm of human psychology is categorically

236 For example: Stephen Pinker, Daniel Dennett, Richard Dawkins.
problematic. It is problematic because the symbolic “stuff” that serves as the basis for human thought and action is not spatial but historical in its essence. All the while occurring within the biological conditions of the human brain, the meaningful content of human thought and the empirical examples of human action can only be understood through their causal trajectory in time and not organically. The meaningful, symbolic nature of our environment categorically distinguishes human mental processes from those of animals. Animals certainly have the capacity for very complex cognitive functions (e.g. learning, memory, attention, imagination), but science must recognize that their “minds” are empirically accessible only in so far as their logical interactions with the material environment result in material/organic traces within their teleologically oriented vital processes. Particular causes and effects in human psychology cannot be explained through such teleological reasoning or evolutionary adaptiveness.

When analyzing the symbolic processes that constitute human thought on the individual level, the environment must be re-imagined as the vast symbolic reservoir of culture on the collective level in order to exert any explanatory power regarding the contents of individual’s minds. By taking the meaningful, symbolic context into account we can explain the course and outcome of thoughts, feelings, and behaviors on both the individual and collective level. The French Revolution, for example, was not incited by changes in climate or a necessary violent reaction to the scarcity of Parisian baguettes, nor was it the result of some teleologically predetermined expiration of monarchical governance. As for individuals, the advent of modern society made Shakespeare at least

\[237 \text{ See Greenfeld “Capacities of the Animal Brain” in Mind, Modernity, Madness, , 75.}\]
as much as Shakespeare shaped its language; even in science, the genius of Einstein’s relativity was primed by the European railroad network and the very important difference between local and standard times that formed a relevant part of his man-made (i.e. cultural) environment. Misleadingly, our social science operates under the belief that revolutions are materially motivated or that brilliant minds are somehow genetically predestined, but, in reality, it is each example’s particular moment in human time that contributes the most to its explanation. Once this change in perspective is accomplished, it is possible to imagine that specific psychological causes do not emanate from genetic sequences or from material characteristics of the environment, but rather are the direct result of time—the actual, dynamic, interactive process of culture and the mind—as defined above.

Even though the indeterminacy of effect that follows any cause, combined with the fluid role of the symbolic cause itself, creates the potential for an enormous diversity in minds through time, no psychological fact can be understood apart from its development in both the collective’s and individual’s history. Despite their inherent freedom, instances of thought, whether internal and private or externalized and observable, are inextricable from their environmental, cultural context. This absolutely dependent relationship between an individual psychology and time makes it such that the causes and effects on the individual level cannot be understood in isolation from one another nor from the culture—the particular symbolic environment—in which their

---

238 See for example Greenfeld’s discussion of Shakespeare’s role in the development of language for our modern existential experience in “The Cradle of Madness” in *Mind, Modernity, Madness*, 311.

interactions actually took place. Such interactions in the cultural/mental environment on the individual level *happen* according to time, thus making historical causality the driving force of change in humanity. This historical causality, although paramount, is not strictly limited to the purview of the humanities, it must be reflected in some way on the biological level because it is the brain that is supporting such processes at every moment that they are happening.

There is nothing inherently spatial in a symbolic stimulus itself, but in its transmission—through speech, writing, images, music, et cetera—the symbol “enters” the body of an individual by virtue of its neurological sensation and perception at which point it is translated into an array of biological processes. The symbol all the time retains its meaningful nature, and in this way is causal (at least potentially) on the cultural/mental level, but it is simultaneously causal in a different respect: it effectuates changes in neuropsychological processes. It is here, in this dual-causal role where culture, the mind and the brain intersect.

It is true that symbolic reality operates according to its own mechanisms of causality, but the processes of culture/the mind cannot exist without the parallel support of the human brain where they actually happen. Symbolic stimuli, like material stimuli, initiate neurological processes that have cascading effects on other biological systems and cause each successive “organic” moment in the organism to play an important conditioning role in the sequence of new symbolic events. Unlike material stimuli of the external environment, however, cultural processes “enter” the organism and self-perpetuate internally through the associative propensities of symbolic systems—this self-
perpetuation and endless creativity is what rolls out in front of us, through time, as the mind. Once this human, mental process begins (probably, as Greenfeld suggests, with the acquisition of language) the cultural and the biological realities work in tandem, where the teleological propensity of organic processes continually drives the organism back towards homeostasis while the symbolic, cultural environment, happening in its own linear trajectory of time, ceaselessly acts on the human organism re-initiating biological processes and causing organically mediated cascades of material processes and events. At every moment, the cultural process is embodied on the individual level according to the unique causal structure of linear time. This linear manifestation of historical time in individual minds points to a principal distinction between time in the symbolic, meaningful reality and the organic, physicochemical reality of the human brain. Effectively operating with to two different temporal structures (i.e. the teleological/organic, and the linear/symbolic) the human brain exhibits complex patterns of activity that are unique to it and definitive of it. In other words, if the cultural environment is responsible for the particular psychology of the individual then, according to its own temporal logic, it will result in unanticipated directions of neuropsychological processes that support and respond to such external stimuli.

Like symbols, the modus operandi of neurons is associative; complex networks and systems develop within the global context of the ontogenetic requirements of the organism and their interactive relationship with the environment. Since the human environment is overwhelmingly symbolic, it is plausible that many neurological processes, probably those that are the most plastic, develop as a direct effect of cultural
causes. (Other networks and processes, which are the least variable, probably support vital functions of the organism. Although the existence of these deep brain processes are explained biologically, they nevertheless are capable of being acted on by higher level, culturally mediated processes giving the symbolic environment the capacity to produce quite visceral effects.) Keeping in mind the constant variability in symbolic processes, the diversity of neurological effects exhibited by the same symbol or system of symbols may be greater than neuroscience currently expects—showing that in human psychology statistical consistency in both the neurological representation and the symbol’s explicit employment are necessary to account for the unity of mental experience. Cognitive development, in this way, can be imagined as happening in tandem with the process of acculturation giving psychological science the possibility of explaining the relative consistency and the absolute diversity of minds in society on both the mental and the neuropsychological level.240

The absolute diversity of minds on the individual level is a feature that can be accounted for logically in the cultural framework and empirically through neurological observation. Since time actually happens on the individual level as the dynamic

---

240 An important qualification to this discussion must be inserted here: human mental processes take place within the boundary conditions of biological processes. (In the same way that organic processes occur within the boundary conditions of material reality – i.e. physical laws.) The biological processes of the human brain are determined by the interaction between genetic causes and environmental conditions. If you change the dynamics of the biology that acts as a necessary condition for the cultural process then you necessarily change the functional dynamics of symbolic interaction in that individual instance. Particular biological processes, like all complex processes, may deviate into the realm of the pathological and in this way may cause functional anomalies in the dependent cultural phenomena. At present, organic deviations or anomalies of this kind are not within the scope of my discussion. It is important to recognize their existence, however, so as not to betray an important empirical aspect of human biology and, at the same time, to understand the connection and the autonomy in biological and cultural levels of analysis.
interaction between symbols and a unique context that morphs continually from the past, to the present, to the future, no symbol is ever, theoretically, the same. On the collective level this feature of the system translates to the existence of multiple coexisting times (the destruction of Kant’s one, universal time), while on the individual level this “irreversible onward rush” accounts for the multiplicity and variability in mental experience (similar to Bergson’s *durée*). Empirically, one might expect to find an analogous diversity in neuropsychological representation for the “same” symbol at various times in an individual’s mental life. And why not? Change in the stimulus would necessarily be reflected by degrees of variation in the neurological representation of it. This would be true for any interaction between a material stimulus and nervous system. What it would imply in the case of human mental facts, however, is that a stimulus as simple as “an apple” (the thing itself, the word, a picture, its taste, etc.) is largely determined neurologically by the linear sequence of symbolic contexts in which the stimulus is experienced. It may be (and should be according to my conceptualization of time) that no one-to-one correspondence exists between a substance and its mental/neurological representation in our brains. If this is, in fact, the case then it would prove our psychological life to be more dependent on symbolic reality than ever before imagined.

Additionally, such conclusions at the temporal nexus of culture and biology would prove not only the interrelatedness of the two “layers” of reality but would also show that my conceptualization of human *time as lived* (and therefore Greenfeld’s conceptualization of culture) is empirically demonstrable on a level of analysis by which it is not itself determined. In other words, showing that cultural causes have biological
effects according to the temporal logic of the symbolic environment would prove that the concept of time that I have laid out in this chapter is not tautological but describes a force that corresponds to an empirical reality. It will be the task of the next chapter to see if this concept is, in fact, scientifically useful.
THE EMPIRICAL ARGUMENT FOR ORGANIC AND HUMAN TIME

The purpose of this chapter is to evaluate the novel claims that I have made about time, as regards life and as regards humanity, against empirical evidence. Such empirical evidence is drawn from existing studies in cognitive neuroscience, which ask questions about the relationship between time and its neural representation in memory and cognition. My goal in this chapter is twofold: to show the extent to which the claims I made about biological time correspond with the findings in animal models; and to probe the extent to which the claims I made about the symbolic nature of human time allow us to understand aspects of the neuroscientific literature in the application to humanity both empirically and conceptually.

Having not had a laboratory of my own, nor access to advanced imaging technologies, I am dependent upon the studies of others to provide data that may confirm or contradict aspects of my argument. Many throughout my career have considered this a disadvantage, one that relegates my work to the halls of philosophy rather than science; this is a label that I have learned to take in stride. After all, science was birthed from philosophy and only recently began to differentiate itself by the type of knowledge it produces (e.g. objectively verifiable and universal versus speculative and context/framework dependent). Science differentiates itself from philosophy and produces objective, progressive knowledge by means of the intellectual attitude it adopts toward its subject matter, which is to say that it is not differentiated by any technique (laboratory or other) apart from the conceptual application of the scientific method, or in other words, the scientifically oriented mind. The logical and positivist norms of science
serve as the arbiter of facts that become accepted in the progress of the institution while, in the mind of the individual scientist, a great deal of philosophical thought, or speculation, must take place. In the preceding pages, I have taken up an enormous philosophical problem: the ontological status and essential characteristics of time, asking where it comes from, what its features are, of what is it causal, and in what way might it be an effect. Despite the historically philosophical bent of this subject, I hope that I have made it clear to the reader that the ultimate goal of my dissertation is a scientific one—that is, one that is oriented towards producing objective knowledge about the subject of interest consistent with the state of the art of other sciences and supported by empirical evidence. The fact that the empirical evidence I will make use of in this chapter is not “my own” does have one small limitation; namely, that I could not orient the various experimental designs to cater originally to my specific questions. This does not mean, however, that the results obtained are irrelevant for my purposes. Instead, analyzing the studies from the outside allows one to see not only the empirical results (always remembering that facts are facts and, one way or another, they must be accounted for) but also to discern the theoretical approach and assumptions of the researcher, which are not a little significant. The scientist would do well to heed Bloch’s advice to historians: that all data should be continually cross-examined and that the researcher must remain on the lookout for the unintentional evidence and the unexpected significance that may appear in his empirical results. As I have shown in the first chapter of the present work, scientific thought, like all mental activity, leaves unintentional traces indicative of certain biases of the thinker. Thus, in a discipline as novel and prolific as cognitive neuroscience in the
21st century, it is paramount to take both the assumptions and the results of research into account thereby paying equal attention to what we find and considering it along side what we still don’t know. For, despite the incredible advances that have been made in neuroscientific investigation in recent decades, our general understanding of how the brain relates to cognition and how thought relates to the brain (i.e. the relationship between the mind and the brain) is nebulous at best—fundamentally, it has not advanced beyond the postulate of William James at the turn of the 20th century who asserted that the only objective knowledge produced in a science of the mind is that psychological states are concomitant with specific brain states; of the nature of such psychological states, James wrote, science can explain very little and must cede the task to metaphysics, a discipline that has no place in the discourse of science.

In the final analysis, I disagree with James’ characterization of the objectively indiscernible nature of psychological states and in the fourth chapter of the present work I set out to elucidate the temporal process from which the meaningful qualities of thought emerge in a way that allows us to link the levels of analysis from the top-down—i.e. from psychological states, or thought, to the activity of the brain—without having to appeal to any metaphysical device. This approach (based on the theoretical framework of The Mind as an Emergent Phenomenon put forth by Liah Greenfeld) is new in that it highlights the ontological significance of the symbolic, meaningful, nature of human thought and causally privileges this cultural, symbolic process on the individual level in its relationship to the human brain, which, at every second, is supporting but not necessarily causing such explicit, psychological processes. Instead, like life, the
symbolic reality of human mental phenomena is self-generating and self-proliferating, producing by virtue of these tendencies *a uniquely linear trajectory of experience that we call time*. Thus, I arrive at the testable hypothesis of my dissertation: that time is a general concept referring to two ontologically distinct realities in the organic realm and in the realm of human mental phenomena. In the first, organic, case time is the absolute sequential relationship between the spatial configurations of life’s elements (which are also its material conditions) and goal-oriented (i.e. teleological) causes that provide for the maintenance and perpetuation of a genome; therefore, on the individual level, organic time is circular so long as it is active. In the second, cultural, symbolic, or *human* case, time is the absolute, closed relationship between the present and the past, and the conditioning, though not determining, relationship between the present and the future. In the configurations of symbolic systems that constitute the meaningful aspect of human mental life on the individual level, this time exists as a mental process while, on the collective level, it manifests empirically in distinguishable traces of human history. In both the organic and the cultural cases, time is not unified or singular, but instead is a collection of infinitely varied and empirically distinguishable times, each with its own unique characteristics and causal relationships.

In using contemporary neuroscientific research to substantiate my claims I do not intend to criticize the studies that have been performed. Rather, I approach the state of the art with a different hypothetical perspective of what time *is* and ask the question, “does my framework resolve questions posed by the data or reorient the original experimental question in a significant way?” The goal is not only to bring our
understanding of the essential nature of time and its role in different aspects of reality to light but also to elucidate the actual relationship between the human mind and the brain through a clearer understanding of the temporal dimension though empirical evidence.

**Part I: Time in the Biological Paradigm**

*The State of the Art*

Neuroscientific research in the animal framework has significantly elucidated the structural and functional mechanisms of memory in which the subject of time is necessarily implied. Only recently, however, has the role of time itself become an explicit area of investigation in cognitive models of memory. The recent neuroscientific investigations into the mechanisms that encode and represent a temporal dimension stem historically from a categorical limitation of the animal paradigm in comparison to human cognitive experimentation: namely that the researcher does not have direct insight into the quality of psychological states of animal subjects. Unlike human subjects, animals cannot give a direct report of their mental experience and, according to Eichenbaum and Fortin, this obvious drawback gave rise to a subset of criticisms purporting that animals were, in fact, incapable of the declarative, episodic aspects of memory laid out in Tulving’s 2002 description of explicit human memory processes.\(^{241}\) In 2002, Tulving defined episodic memory as *explicit* knowledge of the past displayed by an individual’s

---

capacity to “re-live” experiences or access knowledge about stimuli not immediately present in the subject’s environment. Despite the fact that even in the human case evaluating memory empirically according to this definition requires an element of trust in the accurate reporting of the individual (furthermore, the extent to which it can be evaluated \textit{a posteriori} is potentially problematic in real life settings), it has been noted that this definition is not particularly helpful in the neurobiological investigation of memory in animals.\footnote{Ibid.} Thus, researchers of the non-human subjects have designed their studies to uncover what the fundamental features of memory might be, in general, and to investigate the extent to which these fundamental features can be isolated empirically in the cognitive processes of animals. The ultimate goal is to operationalize the basic characteristics of memory processes and then to extrapolate such models to analogous cognitive processes in humans.

Tulving’s original 1972 conceptualization of declarative memory has proven more helpful in this task by postulating that spatial and temporal aspects of the environment frame a definitive context in the formation of memory episodes; because this earlier definition situated episodic memory in the context of specific temporal and spatial parameters, researchers in animal memory have employed it to logically separate episodic memory from semantic memory, or general knowledge, which is independent of the particular circumstance in which it was acquired. Indeed, shortly after Tulving highlighted the spatial and temporal nature of episodic memory, distinguishing it from what Eichenbaum and Fortin describe as the “conceptual [therefore non-spatial?] and
timeless organization of semantic memory”, O’Keefe and Nadal showed in their 1978 study that rats with selective hippocampal damage exhibited pronounced deficits in spatial learning tasks. Since then, a wealth of research has demonstrated the role of the hippocampus in encoding spatial stimuli, a notion that resulted ultimately in the discovery of specialized place cells within the hippocampus that are selectively activated in the presence of particular spatial stimuli. While such neurocognitive research in the domain of memory has proven an essential role for the hippocampus in encoding place, recent inquiry has sought to elucidate mechanisms for the second categorical feature of Tulving’s conceptualization of episodic memory by probing the ways in which an animal may be encoding aspects of time.

This temporally focused line of questioning proved tricky at the outset due to the potential confound between spatial and temporal encoding in the traditionally utilized “what, where and when” tasks. Synthesizing Morris’ 2001 examination of the psychological and neurocognitive aspects of episodic memory in rats, Eichenbaum and Fortin write that, “…if animals with hippocampal damage show a deficit in performance on a ‘what, when, and where’ task, this deficit can readily be interpreted as secondary to an impairment in spatial cognition. That is, if an animal cannot perceive or remember space, one can hardly expect the animal to locate temporally tagged events. Unfortunately, this potential confound calls into question the usefulness of investigating episodic memory with any task that requires remembering a location.”\footnote{243 Ibid.} Indeed, the emphasis on spatial location in these standard memory tasks made it difficult to logically
tease apart the functions of place and time in the memory processes of animals and researchers were forced to seek an alternate route if the role of time was to be isolated experimentally. It is here where fundamental aspects of time that I have set out to investigate in my dissertation become relevant to the neuroscientific investigation of memory.

In an effort to avoid the empirical conflation of spatial and temporal cues, researchers began to focus on the animal’s capacity for the encoding and retrieval of memories in other sensory domains that did not rely on aspects of place. To remove the primary salience of spatial cues in the experimental environment, Bunsey and Eichenbaum (among others) employed an odor-based delay non-match to sample task (DNMS) that allowed for an investigation into the hippocampal role in associative memory and disambiguation in rats. In the DNMS task, subjects are trained in odor/reward pairings and then tested on their memory for the correct pairings as well as the syllogistic relationship of stimuli (i.e. to associatively infer that because A goes with B, and B goes with C then A also goes with C.) Rats with selective damage to the hippocampal structure are able to successfully learn the associative pairings but unable to make the correct associations in the face of randomly ordered, extended trials, and equally unable to make the transitive inference that would allow them to perform the syllogistic associations of the testing phase. These early DNMS tests also demonstrated

the capacity for normal subjects to manipulate the associative relationships in a symmetrical manner, which is to say that the association between pairs was not dependent upon the order in which the stimulus or test odors are presented nor are the correct associations dependent upon the order in a series of other paired presentations. Turning this experimental paradigm toward the question of time more directly, Fortin, Agster and Eichenbaum (among others) developed a modification of the DNMS task that focused specifically on the capacity for subjects to represent and respond to order in a sequence by training the rats to dig for a reward based on the order in which particular odor stimuli were presented. In this modified task, the subject was given a choice to dig between two odors from a previously learned sequence and was rewarded by choosing the odor that appeared earlier in the presentation phase. This experiment provided valuable evidence in favor of episodic representation in the animal paradigm. By highlighting the order of events in a sequence Fortin, Agster, and Eichenbaum’s study indicated that the animal is able to conceive of particular events in relation to past and future placement of other events even though not all stimulus aspects of the sequence are simultaneously present. Not only were the rats able to construct and respond to the sequential order of events in the experiment, but the study showed that the hippocampus is integrally involved in associating learned pairs across trials and therefore for disambiguating stimuli across temporal gaps. Furthermore, these findings are consistent with a neurocognitive model explaining how the hippocampus might create such

In a 1998 article Wallenstein, Eichenbaum, and Hasselmo explored the mechanisms by which the hippocampus represents spatially and temporally arranged stimuli and then associates aspects of the animals environment that are discontinuous in both respects. In particular, they asked, “What…is special in the neural structure of the hippocampal system that enables this [associative] contribution to learning?” For contiguous events, or stimuli presented in close spatial or temporal proximity, it seemed plausible that a simple Hebbian learning scheme (mediated by LTP) bound together the myriad neuronal activations incited by the animal’s environment. When stimulus events are separated by a gap greater than the ~100ms activation window in which LTP occurs, however, a different associative mechanism was required. Therefore, Wallenstein et al. proposed (and then tested) a physiological mechanism by which patterns of activation in CA3 region of the hippocampus emerge out of a broader context of environmentally stimulated “noise”. In their scheme, the activation patterns of CA3 serve to physiologically bind together stimuli in the environment that share common contextual or qualitative features despite the fact that they may be separated from one another in space and time. This common “context” is encoded by means of the robust network of recurrent connections in the hippocampus whose activity, though incited by and connected to afferent networks signaling stimuli from the external environment, operates

---

largely in self-contained feedback patterns with other hippocampal cells. When the animal is exploring an environment, the activation patterns of stimulus events fire in conjunction with the background noise of normal hippocampal activity (resulting from regular environmental cues) and, over time, the background activation modulates its organization to the particular learning task of salient features in the subject’s environment. According to the model, therefore, the background activation, in conjunction with stimulus events, forms a sort of physiological context in which the neuronal associations become networked and strengthened when the environmental cues and task stimuli remain qualitatively similar though not necessarily contiguous in either place or temporal position. Describing this context-encoding mechanism the authors write, “In these computational models, context-sensitive cell firing serves to ‘glue’ together subsequent items in a sequence, even when the time period between them is an order of magnitude longer than the time frame from LTP induction (~100ms). This is because the $i^{th}$ and the $(i+1)^{th}$ items in a sequence are associated with each other indirectly through their mutual association with one or more context-sensitive cells that fire at that particular portion of the full sequence. Indeed, because many of the context fields overlap, items with a very large temporal disparity (that is, several orders of magnitude greater than the time frame for LTP induction) can also be associated using this general mechanism, where one context-sensitive cell potentiates the firing of a second one. Thus, context fields can be thought of as a biophysical realization within CA3 of earlier behavioral theories positing a role for the hippocampus in associating temporally
Though the potential confound between spatial cues and temporal processing persisted in the experimental paradigm of Wallenstein et al., their computational model provided a mechanism in which patterns of an environmentally derived sequence may be represented physiologically in the organism allowing for the association of discontinuous events. To be sure that the salience of “events” constituted a logical distinction from “place”, Wood, Dudchenko and Eichenbaum published the results of a variation on the DNMS task the following year in which subjects were tested in rich spatial environments; alternating the locations where stages of the recognition task were administered, the study demonstrated that the hippocampus was integral in encoding features of the task disassociated from place. This particular study uncovered hippocampal cells that fired differentially according to place while others remained consistently associated with specific odor stimuli and others still that fired consistently in either the match or non-match scenarios. “Of the 127 cells analyzed,” they write, “… 51 (40.2%) had solely non-spatial correlates, which is reflected in a statistically significant main effect for odor, trial type, or approach in the absence of a significant main effect or interaction involving cup position. Nearly all of these cells encoded just one of these non-spatial properties. A further 40 cells (31.5%) had a spatial correlate, reflected in a statistically significant main effect or interaction involving cup location. Only 14 of the spatial cells were pure location cells. The remaining 26 spatial cells, as well as two non-spatial cells, encoded

\[249\] Wallenstein et al., *Trends Neurosci.*, 319-320.
combinations of multiple variables.”250 While previous studies had shown a significant role for the hippocampus in encoding non-spatial stimuli, Wood et al. point out that theirs was the first to manipulate the spatial location of the recognition task while the animal was present, thus creating a variable spatial data point against which non-spatial constants could be evaluated. The authors conclude that their results point to the existence of a rich contextual map represented in the hippocampus corresponding to specific episodes constructed by events and odors in addition to, but disassociated from, place.

With abundant evidence for the hippocampal role in associating discontiguous events across different conceptual modalities (e.g. place, event, and stimulus type), one can safely say that neuroscientific research has settled the question as to whether or not animals have the capacity for episodic memory as distinguished from semantic knowledge. Not only did Wood et al.’s manipulation of place in comparison to other non-spatial stimuli demonstrate the salience of events in memory processing, but also Fortin, Agster and Eichenbaum’s exploration for the specific role of the hippocampus in remembering the sequential order of events, point to the existence of an explicit “replay” of episodes in tasks that require association and disambiguation of past events. In a development similar to the relationship between place cells and the neural processing of space, the computational model advanced by Hasselmo et al. accounts for the mechanism by which time, when specifically understood as sequence of events, is translated into a

---

biophysical representation within the organism. Thus, a particular emphasis on sequence (represented by numerous studies not recounted here)\textsuperscript{251} comes to represent one of the fundamental characteristics of time—as disassociated from place—in the neurocognitive investigation of animal memory.

MacDonald et al.’s landmark 2001 study investigation the essential role of time in episodic memory sought to increase the granularity of the temporal concept, by asking not only how the hippocampus effectuates such a sequential organization of events and later associates (or disambiguates) unique episodes separated by temporal gaps in the subject’s experience, but also how the hippocampus responds to time, defined by moments, as the medium in which events in a sequence take place.\textsuperscript{252} To tackle these questions, MacDonald et al. subjected rats to the DNMS task where the sample and reward aspects were separated by a constant 10s delay. During this “identital, empty delay” hippocampal activity was monitored and showed a regular, “temporally defined” firing sequence in which the peak firing for each cell corresponded uniquely to specific moments in the delay period. Investigating whether or not this phenomenon was preserved in altered conditions, the study then manipulated the delay period in an attempt to render time itself—or temporal cues—an independent variable. In theory, manipulating the duration of the “empty delay” would allow researchers to investigate the physiological behavior of hippocampal neurons in response to time as such either

\textsuperscript{251} Staresina and Davachi, 2009; Hales et al., 2009; Hales and Brewer, 2010 (all cited by MacDonald et al., 2011).

absolutely or relative to the specific trial features of the task. Thus, the MacDonald study takes the concept of time one step beyond the salience of sequence and attempts to demonstrate more broadly how neuronal activity encodes variable aspects of time as represented by successive moments rather than successive stimuli.

Significantly, MacDonald et al. found that 53% of the neurons monitored during the constant 10s delay fired selectively at specific moments in the delay and that 28% of the neurons that were active fired at successive, non-overlapping times during the delay period. Assuming that these neurons constitute a cascade in the network of a learned context relative to the task/environment, the study controlled for spatially relevant factors such as location of the subject, head direction, and running speed finding that “even when the influences of location, direction, speed, velocity and their interactions are removed, temporal modulation for each neuron still selectively peaks at specific moments and the temporal organization of these timing signals is preserved across the ensemble and bridges the delay period.”

The factor of space, however, could not be entirely eliminated from the explanation of observed firing patterns. Through a series of statistical analyses, the study found that most of the hippocampal activity could be accounted for by a combination of time and space. When MacDonald examined the activation patterns individually with respect to time and then to space as the primary (but not only) variable, the role of time in the sequential order of particular neuronal activation was informative for 75% of the cells activated during the delay while the role of space as the primary variable was 80% informative—a near split. When each variable was used independently

253 MacDonald et al., Neuron (2011): 739.
(i.e. using time or space exclusively to explain the model) 27% of the observed hippocampal activity was best accounted for “because including both as covariates did not significantly improve the model.” The results of these analyses, according to the researchers, show that the hippocampus is equally involved in encoding aspects of space and time across the population of neurons sampled.

Next, MacDonald and his team investigated whether or not time cells encode absolute or relative time when the delay period is altered. To do this, the task was administered with the normal 10s delay inserted between sample and match presentation changed to a sudden, unprecedented doubling of the delay duration. 80 neurons, 34% of the total neurons recorded, exhibited action potentials above the experimental threshold of significance in at least one of the trials and these 80 neurons were analyzed to determine whether the firing pattern differed across delay durations. Twenty-nine neurons (37% of the total neurons analyzed) maintained a consistent firing pattern across varied delay durations thus prompting MacDonald to interpret these cells as encoding “absolute time”. Only 5 neurons rescaled their activity while 51 (63% of the analyzed population) “…altered their firing patterns to changes in the delay in a manner not explained by absolute or relative timing…”254. These 63% are interpreted by the researchers to be engaged in a process of “retiming”, construed by MacDonald as a process analogous to the phenomenon of spatial “remapping” cited in Leutgeb’s 2005

254 Ibid., 743 (emphasis mine).
study regarding place cells. Demonstrating that the observed retiming was not due to a preservation or deterioration of task performance, nor to changes in the subject’s location during delay periods, MacDonald concludes that retiming occurs due to the alteration of a neurologically significant temporal parameter that corresponds to changes in interaction with the environment—in short, the delay. “The majority [of hippocampal neurons sampled] form qualitatively distinct representations when the critical temporal cue was altered, and most of these maintain new patterns when the delay is shortened to the original length.”

It is clear from the concluding discussion of MacDonald et al. that the authors believe hippocampal activity to be encoding “time” in the same way that place cells encode “space”. MacDonald writes, “The present observations indicate that hippocampal neurons also encode specific times between non-spatial events and disambiguate non-spatial sequences, extending the observation of time cells to filling gaps within a specific non-spatial memory.” Additionally, the introduction of such concepts as absolute and relative time (N.B. neither of which are defined explicitly in reference to any theoretical framework) in the discussion point to the assumption that absolute time is concretely represented and passing in the environment according to its own definite regularities of which an organism may be sensitive and that this absolute time is distinguished from a relative timing mechanism—occurring ostensibly within the organism—that

---

comparatively measures the time that passes between salient events. One major question that remains unclear, however—and one that would greatly disambiguate the concept of time from that of space—is how absolute “time”, or the standard intervals of relative time, might be given to the organism by the environment. In the experimental paradigm, two features of the task administration are imagined to be representative of time: the first is the sequence of events (constituted by the sample presentation and the go/no-go test to gain reward); the second is the delay inserted between salient events in the task. When the delay period is constant, the study found that certain hippocampal neurons fire in a manner that corresponds to specific “moments” in the delay. When the delay period is varied, however, the study found that certain cells initiate neuronal cascades that are consistent with the initial phase of the task (e.g. particular odor presented in the sample) but once the “normal” 10s duration has elapsed these cascades begin to “re-time” according to a logic that is not well understood relative to external cues of the environment. Investigating the hippocampal response of the subject in what the study calls an “empty delay” begs the question as to why a delay characterized by its emptiness, or lack of stimuli, would itself cause a change in hippocampal activity. Since the only change in the environment is a change in time (i.e. duration), the authors interpret the differential firing patterns as a neurological response to the variable of time as such. But this is based on an implicit assumption of what time is, how it is constituted by “moments” and the premise that “empty” moments are somehow significant to organisms. Analogous questions in the context of spatial representation do not present with the same complications: not only does space have its own qualities of which most
animals are constantly aware (e.g. bodily orientation in relation to the earth’s gravitational center, topographical characteristics of the surface on which the organism is placed, many species even have the capacity to detect characteristics or changes in local electromagnetic fields) but the overwhelming majority of salient relationships in an animal’s environment are spatially organized due to their material constitution—the very idea behind hippocampal place cells is that they link together higher level cortical representations of such material stimuli to give the subject an idea of its place in relation to such stimuli taken collectively. I contend that time, on the other hand, has no material qualities and, as such, cannot be derived from the physical environment itself. Time, instead, is an emergent characteristic of life and therefore only arises out of the properties of the organism. Time is not encoded in the same way as space because it is not “out there” in the environment to be deciphered. MacDonald’s study, if it treats “moments” as a variable with intrinsic significance, runs the danger of conflating regular, internally regulated neuronal activity with the uniform ticking of the scientist’s clock. In fact, only in this sense would the concepts of absolute and relative time seem to have explanatory value for both assume a regularity of moments in time corresponding either to time-writ-large, in the absolute case, or regular, measurable, intervals that have elapsed between presentation and performance phases of the DNMS task.

Shapiro’s preview of the MacDonald experiment seems to indicate that such a

---

conceptual conflation is indeed taking place. Extrapolating the findings of the MacDonald study, Shapiro conjectures that “Perhaps the hippocampus maps a Minkowski space in which all coordinates specify space and time.” In fact, writes Shapiro, “…[MacDonald’s] results imply that the hippocampus encodes event sequences that link one item to another through space and time. Even when the outside world appears static, hippocampal representations continue to evolve.” 259 Here, the phrase “appears static” is suggestive, as if Shapiro means to imply that the outside world is changing—however imperceptibly to the scientist—but indeed this change is translated from the environment into activity of the hippocampus. Of course, the observed patterns of hippocampal activity are empirical facts—facts that must be accounted for logically in the functional relationship between an organism and stimuli in its environment. According to the findings of the first two chapters of the present dissertation, however, the implicit account offered by MacDonald and Shapiro—that the organism is encoding moments or time, as such—would seem unfounded: time is not a qualitative feature of the material environment therefore it is not a part of the animal’s “outside world”. Instead, time is a characteristic feature of organic reality, constituted by the sequential nature of organic processes within an individual organism, of which the firing of hippocampal neurons serve as a categorical example. Let us then reframe the questions and results of the study of time cells according to the novel principles of my framework.

Reimagining biological time alongside the studies outlined above serves two purposes: the first purpose is to offer neuroscientific research an explicit theoretical framework about time though which it may interpret its empirical results; the second is to evaluate the claims that I have made about time in light of the available empirical evidence. As I have already had the occasion to point out in this dissertation, relatively little philosophizing has gone on in biology since Darwin—owing probably to the genius of its founder, biological science has been exceptionally productive without it. When it comes to the incorporation of extra-biological concepts such as time, however, (or learning and memory, for example) clear physiological mechanisms must be accounted for that explain or justify the extension of such hypothetical concepts to organic reality. In order to establish their biological legitimacy, our concepts must concretely define their corresponding phenomena while our emotional attachment to them remains low; in other words, like all hypotheses, concepts must be formulated so that they remain refutable in the face of empirical evidence. I have endeavored to maintain such a scientific perspective in my conceptual framework concerning the nature of time and its empirical manifestations; it is by means of the second purpose of this section that one might adjudicate the success or failure of my attempts. Ultimately, I hope to show to the reader that reframing the empirical results of neuroscientific inquiry about time and memory according to the novel framework that I have developed in this dissertation not only

---

260 In the case of learning and memory, for example, functional and behavioral frameworks were brought together by the work of Kandel and Squire, see *Memory: From Mind to Molecules* (New York: Holt, 2003).
brings the empirical data into a more logically cohesive picture of time for the study of animals but also provides a significant amount of support for my claims about the nature and scientific understanding of time in biology.

According to the conclusions of my first chapter, time is not a quality of matter and therefore is not itself present in the material environment of organisms, as neuroscience would seem to assume. Instead, time in the organic realm is an emergent phenomenon brought about by the sequential organization of material elements within the organism and it is this processual organization of matter that constitutes the essential separation between living and non-living, material reality. In organic time thus imagined, the temporal structure of life’s processes is circular where every step in the process (on every level of complexity) is both the functional cause of its preceding steps and the necessary condition for future steps; organic time is connected only to itself and this circular connection is reflected by the ultimate cause: the survival of the individual organism and the perpetuation of the species genome. It is from such ultimate causes that biology derives a functional explanation for any moment or conglomeration of moments in the life process. With these initial conclusions in mind, one can understand the structure and function of complex nervous systems as the product and evidence of organic time on both the individual and the species level. For not only has the duration of living processes produced complex nervous systems through the process of natural selection, but the processes of the nervous system themselves are occurring at the nexus of external, environmental variables and the internal, homeostatic needs of the organism. As such, experimentation into the relationship between the hippocampus and time (or
more broadly, the hippocampus and episodic memory) should provide a significant source of empirical evidence to support or refute my framework. The main claims that I will investigate with respect to the aforementioned evidence in the animal paradigm are the salience of the difference between organic time and evolutionary time for biological experimentation, the distinction between space and time in the organic reality, the teleological propensity of life’s processes and finally the relationship between memory, time and the brain.

The concluding argument of my discussion on the nature of organic time and time in biology highlighted the difference between the circular, teleological, nature of organic time and the linear construct of evolutionary time that is projected onto the science of biology by the mind of the researcher. To begin to disambiguate some of the conceptual confusion in the aforementioned studies in the cognitive neuroscience of memory and the perception of time, it is helpful to remember the distinction between real organic time and the ways in which this idea may be scientifically interpreted. Biological experimentation differs largely from evolutionary theory in that, occupying itself mostly with the relationship between independent variables and organic systems in vivo, experimentation deals directly with the processes of real organic time as they are happening; which is to say, that manipulations in the experimental paradigm occur in conjunction with the teleological causes that perpetuate within the organism, while evolutionary explanations are constructed most often by accumulating historical, circumstantial evidence, amassed long after the environment has played its role in the actual happening of organic time. The main difference in these two approaches is that
cause in the evolutionary framework is usually imagined as external (i.e. environmental) variables effectuating change within the organism while, in the process of organic time that I propose, the cause of any state in a living system is most adequately explained by knowledge of the statistical regularity of vital processes of the organism or the species itself. The biological explanations that have the most truth content are logically consistent in both domains. Confusing one with the other in empirical research, *in vivo*, however, may overestimate the causal role of the environment and consequently ignore the stochastic yet teleological propensities of cellular and molecular mechanisms in the system or subject in question. For evolutionary theory posits a binary relationship between an organism and its environment, but as I have already argued, this logical relationship manifests merely in the abstract on the analytical level of systems or populations as living vs. not living or adapted vs. extinct. Life, exhibiting its temporal dimension as a collection of processes that are constantly happening on many different levels of analysis (the smallest being the cellular-molecular level), rarely provides the scientist with such clear cut empirical results; thus, the biological positivist is forced to reconcile himself to the discovery of statistical tendencies. It is this reliance on uncovering the statistical tendencies of a system that underscores the need for a clear distinction between the nature of correlation and causation in biological study.

Researchers safely assume that a causal hypothesis is being confirmed by their experiments when the mechanism by which material variables from the environment are translated into a complex cascade of processes in the organism is well understood. In the instance of the odor DNMS task, for example, the mechanisms of the sensory perception
of odor have all been previously elucidated along with the connective pathways in the nervous system and their interactions with such structures implicated in memory as the hippocampus.\textsuperscript{261} As a result of this detailed physiological knowledge, researchers can then ask, or hypothesize, not only about the role of a particular part of the system involved in the memory, association, or disambiguation of the stimulus but can also explore the mechanistic relationships between different aspects of the system that support such a capacity. This is because all of the experimentation that occurs in biology occurs implicitly within the framework of evolutionary theory, which conceives of individuals in a logically interactive relationship with the material constituents of their environment. Thus, the manipulation of material variables and their translation into embodied, mechanistic effects in the processes of the organism is what characterizes the empirical method in biological science. This method rarely makes the environmental, material variable the ultimate cause, but because the processual mechanism is known or assumed, the correlation to internal states that such external variables display serves to reinforce the functional explanation hypothesized. The study of Wallenstein et al., elucidating the biophysical realization of a behavioral theory for the association of discontinuous stimuli and events is a perfect example of the combination of such scientific reasoning. Environmental variables are manipulated such that they might shed light onto the functional organization of the nervous system with which they interact; in the final analysis, however, the explanation of the neurological system is to be found in the structure and function of the organism itself, not the environment, which serves merely as

\textsuperscript{261} For review, see Eichenbaum et al., “Functional Organization of the Hippocampal Memory System.” \textit{PNAS} 93 no. 24 (1996): 13500-13507.
the organic system’s operative catalyst.

At the outset, the study of Wallenstein et al. hypothesized that the hippocampus provides a vital functional capacity for associating discontiguous stimuli in both spatial and temporal paradigms. Keeping in mind the distinction between cause and correlation, let us examine how this capacity may be effectuated in the spatial paradigm in comparison to what such findings may tell us about the temporal. For, the crux of understanding the associative mechanism of the hippocampus completely—and consequently the empirical basis for investigating the relationship between time and the brain in all of the subsequent studies—lies in understanding the distinction between the causal role of space and time in organic reality as it relates to the idea of association or disambiguation of discontiguous events.

In the second chapter of this dissertation, I argued that, in organic reality, space and time are intimately related although empirically distinct in their expressions and effects. Life, being embodied at every step of its processes, is dependent upon matter, which serves as the boundary conditions for its operative relationships, and organic time arises from the absolute, sequential organization of life’s material elements, but is not derived from them. In this way, organic time becomes a descriptive quality of material elements that are involved in organic processes while space limits the extent to which any material element may be engaged in an organic process. In other words, the causal/effectual relationships of organic time are limited, but not created, by the laws of
Since Material interactions are the only empirically accessible interactions between an organism and its environment, biological science is forced to concede that all of the stimuli in an organism’s environment have an essentially spatial component. Material stimuli either enter or are translated into the processes of the organism through direct physical contact with the sentient subject—and it is in this spatial manner that interactions between the organism and its external environment become embodied. The embodiment process \((\text{which is another way of characterizing an essential function of nervous systems})\) remains material, but only partially so, with the essential addition of a temporal dimension to its causal and effectual relationships. In other words, once a material variable in the external environment “interacts” with the organic processes of the organism, its role in the process will be determined not only by its own physical characteristics but also largely by the structure and function of the organic process in action.

In this way, my framework places the explanatory value of the phenomenon of organic time inside of the organism; at the same time, scientifically speaking, it is nevertheless true that the organism cannot be explained biologically without taking into account its interactions with the environment. From the point of view of the scientist, an organism’s interactions with the outside world are imagined as events that are constituted by changes (or experimental manipulations) in the environment, while, concurrently, it must be remembered that these external “events” do not really contain temporal information in and of themselves. Events in the environment can only be empirically

\[262\] See chapter two where I discuss the relationship between space and time in organic reality.
linked to one another by virtue of an observer—e.g. in the mind of the scientist or biophysically in the nervous system of the organism. *In both cases, the cause of the associative relationship is not in the stimuli themselves but rather is bestowed upon them logically by virtue of their interaction and representation within the nervous system.* The stimuli, taken alone, do not share any event-like or temporally associative qualities. Scientists, the observers who explain, do so with their logically (and therefore temporally) organized thought process, creating, from their point of view, the temporal relationship of events organized linearly (i.e. past $\rightarrow$ present $\rightarrow$ future). The animal subjects in question are observers in their own way and it is in reference to them that stimuli acquire their signifying quality. From the organic point of view—as far as we can tell—information acquired from the environment must be incorporated into teleological propensities for survival and reproduction of the individual organism. The environment must be managed in some way that allows for the continuation and perpetuation the life process.

_Empirical Support for the Unique Characteristics of Organic Time_

The role of embodiment in the association of discontinuous stimuli is, I would argue, the essential finding of Wallenstein’s study. In uncovering the functional existence of context cells in the hippocampus, cells that fire in conjunction with stimuli that share common perceptual features though they may not be presented simultaneously, Wallenstein et al. demonstrate an internal property of the hippocampal system that plays a _causal_ role in establishing sequential relationships between external stimuli for the organism. I point out that the causal role is played by the hippocampus because without
the living organism (and its already established processes) the material stimuli of the environment have no definite sequential relationship to one another. The stimuli, therefore, acquire their association in time by virtue of the hippocampus, and not the other way around. Of course, experimentally, the stimuli are designed and arranged by the researcher for whom they exist in logical (temporally linear) relationships. But this intentional organization of stimuli is designed according to the conceptual principles of time that are derived from biological thought—not the actual, teleological propensity of organic time which finds its causes within the organism itself among random and dynamic natural environments. Since, in a way, the explanation for such association, may be seen as twofold (i.e. on the one hand contained within the organism, and does not originate from the environment; while on the other hand only manifests empirically to the scientist as the interaction between an organism and its material environment) the search for an organically independent concept of time must answer the question: to what extent do animals respond to/encode/retrieve/manipulate anything that is non-spatial?

From early on, researchers noted the potential confound between time and place in “what, where and when” tasks (e.g. in the Morris water maze), pointing out that if an animal could not remember spatial location then this deficit could result in a secondary impairment for remembering temporally tagged events. To overcome this limitation, the new experimental paradigm of DNMS was employed to deemphasize the salience of location and to shift the independent stimulus variable to a specific sensory modality: smell. That this change in the perceptual nature of the stimuli allows researchers to

isolate a uniquely temporal dynamic, however, is uncertain. The sensation and perception of odor, like all biological sensations and perceptions, are, to a very large extent, mediated spatially. Thus, while changing the empirical paradigm to a test of odor as opposed to place deemphasizes the salience of location, it continues to highlight the effects of spatially defined material elements on nervous systems. Decreasing the complexity of spatial stimuli involved in registering place, a categorical feature defined by a collection of material elements in the animal's spatial environment, increases the granularity of the simple stimulus variable of odor, thus allowing the researchers to examine more closely the extent to which sequential processes (in neuronal cascades) are incited by specific material stimuli. In such a paradigm, space nevertheless remains an integral part of the empirical interaction, revealed by a particular, logically defined, or materially embodied, order of neuronal activation. Space, or matter, therefore cannot be empirically separated from time with regard to the organism because the sequential organizations of matter in the process (remembering that neurons are organized spatially too) are what organic moments are actually made of.

As for the disambiguation between “when” and “where”, space and place are dangerously similar concepts, matter being defined by the fact that it takes up space and place being the specific location in space gleaned by an organism from the overall picture of material stimuli in its environment. Place can only be experimentally isolated from other perceptual categories by virtue of this recognition. Conflating the ideas of space and place, neuroscience sought to separate both of these ideas from time proper, but in the end—perhaps precisely because of this conflation—the isolation of pure time was
experimentally impossible. In nearly all cases, the aforementioned research uncovers the linearly sequential relationship of stimuli given to the organism according to the structure of the experimental design, in which all of the relevant stimuli are represented physiologically according to the characteristics of their material constitution. What can be gleaned from this unconditionally sequential nature of material configurations in organic processes, however, is that animals may very well be the only ones for whom time and space are inextricably linked in an absolute—and therefore non-relative—way. Later studies, building off of the associative activity of the hippocampus, indeed emphasized sequence as the defining characteristic of a temporal concept in the neuroscientific investigation. But the issue remained as to whether or not a purely temporal concept was, in fact, being isolated. In my framework, time and space are both logically and empirically inseparable in the relationship between the organic past and the organic present. Material elements of the environment become a part of sequentially organized organic time as soon as they come into contact with the perceptive faculties of the organism, contributing their effects to the already ongoing process. This reasoning seems to be supported by the fact that MacDonald et al. found an overwhelming correlation between the explanatory power of temporal and spatial variables in the sequential order of neuronal activation following a particular stimulus. In the absence of logically defined stimuli (i.e. an empty delay), however, the descriptive concept of time-as-sequence breaks down. When MacDonald’s experiment introduced an unprecedented doubling of the delay, the researchers observed a hippocampal activation pattern that was both unexpected and inexplicable by any salient external variable (either time, nebulously
defined, or space, since there was intentionally no change in material stimulus). The researchers attributed the neurological phenomenon to a temporally analogous form of hippocampal “remapping” that they called “retiming”. With the understanding that time, unlike spatial characteristics, is not a part of the external environment, however, the idea of “retiming” begs the question, in what way, if any, can time alone be logically or empirically informative in the study of neurological processes?

MacDonald et al. attempted to answer this question in their research by analyzing the hippocampal response to time (as an independent variable) during the manipulation of the empty delay. In the initial, normal stages of the delay, neuronal activity was reasonably constant with certain neurons firing at specific moments during the normal period of the delay. It is important to note here that moments, as such, were defined in reference to the arbitrary metric of the scientist’s clock. Even if one accepts the vague concept of “absolute time” mentioned in the study, it is doubtful that the researchers would attribute clock-time sensitivity to their subjects. Without such an external standard, however, the idea of a moment for the subject (i.e. for the rat) remains perilously undefined. If the biologist, like Aristotle, privileges time as a reality external to the subject, then he too may be left wondering ad infinitum what these moments are made of. The concept of organic-time being advanced here, however, offers a solution to this problem: according to the logic of my argument, organic “moments” can be defined as the specific configurations of cellular and molecular variables (i.e. the actual neuronal firing) within the organism that occur as a result of the external stimulus but according to the internal processual properties of, in this case, the cortico-hippocampal network. This
conceptualization places time within the individual and makes individual instances of organic times numerous, overlapping, coexistent, and crisscrossing on whatever level of analysis they may be circumscribed. What is significant about the empirical exploration of episodic memory in animals is that the hippocampus is shown to represent such material/spatial relationships analogously through the organized processes of its circuitry. In this way, outlined in its functional detail by the study of Wallenstein et al, neuronal cascades become sequentially organized in response to certain material characteristics but also by virtue of the associative nature of neurons themselves. Thus, time and space as independent variables will always correlate empirically in relationships between the past and the present because of the material constitution of any given moment/interaction in the process.

When it comes to the hippocampal activity corresponding to the unprecedented extension of the delay in MacDonald’s experiment, on the other hand, the empirical results seem to require an additional consideration since the recourse to spatial/material variables is unavailable. The neural activity during the “normal” delay period supports the relationship between space and time from the past to the present that I have described in organic processes, showing that animals respond to space and its particular qualities in a sequentially organized manner. Once the delay passes beyond the previously experienced length, we would like to know by what principles the novel activity within the hippocampus is governed. I argue that this activity is best explained the only pure temporal—i.e. nonspatial—feature of organic time: its teleological propensity for causes in the future, which constantly bring the moments of organic processes in line with the
homeostatic and survival requirements of the individual or species genome.

Due to the teleological propensities of vital processes, any cause in an organic system is a small step ahead of the conditions that are active at any given moment. On the systems level, teleological interactions are constantly manifesting in the continued survival of the individual. It is easy to imagine the effect of hunger on the individual, or the instinct to flee a predator, for example. Such functional explanations abound in biological descriptions that treat the individual or the group as the unit of analysis, and I have had occasion already to point to the necessity of a causally relevant future in the concept of organic time. What is being shown here, in the results of MacDonald’s study, is the activity of this future on the cellular and molecular level in hippocampal networks. Without any material stimuli to encode in an empty delay, the best explanation for retiming comes from the interaction of systems within the organism itself. This circularity of cause and effect also seems to account for the consistency of animal behavior that makes them susceptible to biological experimentation in the first place: if a rat is hungry, for example, it digs for food. Behaviors are always connected to needs which serve the teleological propensities of the ultimate cause.264

It has always been assumed that animals have general expectations of their environment and the variables in it; recent neurocognitive research has pointed to the pre-play of hippocampal neurons as a mechanistic actualization of such a capacity. Dragoi and Tonegawa describe studies in which rats, exploring a novel spatial environment,

---

264 This is not so in the human case. We could expect activity to be much less organized and predictable because it is related to thought, which happens linearly and “unpredictably” in relation to its material and organic boundary conditions across populations of individuals.
exhibit hippocampal activity that mirrors patterns observed during rest or sleep and is distinguished from the “replay” of previously learned spatial representations.\textsuperscript{265} The theoretical explanation of such activity on the cellular level can be accounted for the by continuous and novel association of cellular activity of the central nervous system that results in what Greenfeld describes as the imaginative capacities of animals in her account of the animal brain.\textsuperscript{266} Taking the current proposal of the future’s role in organic time into consideration, such a capacity, (e.g. to “imagine” by neurologically priming the memory space in which non-present spatial/material experience will be encoded) requires that one take the survival and/or homeostatic needs of the organism into account for a biologically legitimate explanation of the phenomenon. In this way, MacDonald’s discovery of hippocampal “retiming” seems to empirically justify the biological legitimacy of the ultimately causal future by inadvertently uncovering the proximate causes of internally generated and temporally regulated neuronal sequences.

What makes this idea of the causal role of the organic future truly amazing, is that it remains connected to the embodied “pasts” of the organism, not only in its capacity to modify, but also to be influenced by their traces. Hence, in MacDonald’s case of the extended delay, one sees the expected pattern of activation relative to the exposure phase initiate but then deteriorate or morph into sequences that exhibit and maintain their own, new logic. Evidence for this is found in MacDonald’s own demonstration that a minority


\textsuperscript{266} Greenfeld, “Capacities of the Animal Brain” in \textit{Mind, Modernity, Madness},
of neurons sustained stable firing patterns in the instances of extended delay periods. Showing, as MacDonald concludes himself that, “...retiming is not attributable to differences in behavior during delays of different lengths but rather is caused by altering a highly salient temporal parameter that characterizes the delay event... the majority [of neurons] form qualitatively distinct representations...and most of these maintain the new patterns when the delay is shortened to the original length.”\footnote{MacDonald et al, Neuron (2011): 743.} If the causal role of time is to be found within the organism itself, owing to the lack of material indices by which it may be gleaned from the external environment, then the most logical explanation for the observed change in the hippocampal activity is legitimately derived from the connective priming of neuronal cascades representing what can only be imagined as the organic future vis-à-vis the subject’s interactions with its material environment. This relationship, the constant interplay between the past, present (in a primarily spatial sense) and future (in a purely temporal sense) in the lives of animals is what makes them products both of their genes and of their environment; they are imbued with instincts that most often manifest as teleological causes, but also engage constantly in direct, environmental learning which, becoming embodied, interacts, augments or interferes with their teleological propensities. Organic time, in this sense, remains absolutely connected to itself in a circular, bi-directional manner so long as it persists. Perhaps in no system is this multifarious, temporal dynamic more apparent than in the structure and function of complex nervous systems.

Finally, I propose that the concepts of space and time in organic reality are

\footnote{MacDonald et al, Neuron (2011): 743.}
logically and empirically inseparable in the relationships that govern the past and the present in organic time. Organic time, as a real phenomenon, has a significant spatial component to it in the sense that every instance of this time is embodied so long as it exists, and therefore, it is incredibly difficult to imagine the autonomy of the temporal dimension which lies just to future of any present interaction with the material environment. Perhaps, in the end, it is more logically useful to view these relationships, in time, as configurations of causes and effects that result from the interaction between an individual organism and its dynamic material environment on either the ultimate, teleological level in which future causes account for life’s maintenance and perpetuation, or on the proximate level of an extended present, in which the causes and effects that might be active at any given organic moment bridge the embodied steps just before and just after the sequential instance in question. Scientific investigation on this latter level must always be conscious of the scientist’s limited capacity to effectuate controlled manipulations in the present material state of an organism which itself is always subject to ultimately causal logic of organic time—the causal capacity of the future.

The empirical dynamic between organic time, as I have conceptualized it, and the central nervous system, or, more specifically, organic time and memory, therefore, assumes a new, interactive status where organic time is a both a descriptive and a causal phenomenon in the structure and function of the physiological activity of memory, and thereby justified in its ontological status on both accounts. Memories are not only acquired in time by virtue of the primarily temporal (i.e. sequential) organization of an individual’s organic processes, but specific material interactions that result in
sequentially organized learning and memory events contribute to the unique trajectories of infinitely varied organic times responsible for the diversity of biological systems. The particular changes observed in the hippocampal structure appear to be accounted for most consistently when the organic reality of the temporal dimension is understood as an intrinsic feature of the organism and not an encoded characteristic of the environment.

**Part II: Human Time**

The examination of a real, unique human time in the context of the empirical evidence of cognitive neuroscience deviates somewhat from the preceding exposition of organic time within the framework of animal studies; this is because organic time and human time are two ontologically distinct phenomena and therefore, the evidence that explains their respective structures, functions, causes, and effects is different. The main difference in the data demonstrating these two temporal phenomena relates to the feature of animal experimentation that shaped biological research from early on: animals cannot give us direct reports of their experience, therefore, concepts such as “learning”, “memory”, “time”, and “space” must be rigorously delineated and operationalized so that the role each plays in animal cognition may be demonstrated clearly. Despite attempts to isolate these concepts in animal studies, all empirical evidence points to an inextricable relationship between space, learning, and memory in absolutely sequential, embodied, organic time. As regards humans, however, this inextricable relationship between time and space (or matter) does not exist; even though the processes of the mind and culture (which both happen in time and are constitutive of our unique sense of it) are supported by the processes of the brain and thereby embodied neurologically, the concomitant
relationship between human time and the material characteristics of the environment does not hold in the same way. The processes and the products of the mind and culture are autonomous and not causally related to any material phenomenon. Furthermore, we do not need an external justification of time as such, we \textit{know} that it exists for us—it is a fundamental feature of our mental experience.

This does not mean that human time can be wholly taken for granted (that is, presented without analysis or justification), nor does it mean that it happens independently from biological (and therefore partially material) phenomena. Instead, the relationship between human time and organic time in the human brain—or, said another way, the organic mediation between symbolic and material processes—is organized in a manner not previously conceptualized by biological science. The explanation for human time and the form of causality characteristic of it are to be found in the human cultural reality and reflected in the effects that cultural causes have on the biological substrates of the human brain.

The argument that I intend to make about human time is not metaphysical or speculative, but one that seeks to articulate the concept of time for human cognitive neuroscience by asking the question that follows from all of the evidence and conclusions presented thus far: if we understand our absolutely linear experience of time to be characteristic of the mental, symbolic process and not derived from or created by the material reality (in which time as a real phenomenon does not exist) nor derived from or created by the inherently teleological, and absolutely embodied present of organic time, being instead a phenomenon through which we organize our knowledge of reality,
supported by and therefore reflected in some way in the organic and physical domain whenever the mind is active, can we reframe our analyses of this human, neuropsychological phenomenon in a scientifically useful and empirically justified way? To begin to answer this question let us first address how time has traditionally been conceptualized in human psychology and neuroscience.

_The Problem of Definitions_

In a chapter preceding his discussion of memory in the *Principles of Psychology*, William James provides the most thorough analysis of the human sense and perception of time for the discipline of psychology. Time, for James, like all of the psychological phenomena he addressed, acquired its salient features from the physiological mechanisms of the brain that represents it; all human mental experience emanated from specific brain states, according to the logic of the psychologist, and time was no different. Examining the subject from this perspective, James was led to the formulation of some interesting implications and other open-ended, if not unsatisfying, hypotheses.

On the one hand, James asserted that his brain-based hypotheses about time stood in explicit opposition to the Kantian intuition of objective, continuous and infinite, universal time. James argued that the subjective nature of our experience of time emanated from the phase changes and fluctuations of brain processes that make up a collection of instants of the “specious present”; in such a framework, grounded in the idea that the presence of neuronal activity is what gives rise to sentience, the physiological characteristics of the brain themselves become the cause of our vaguely

---

bounded perception of the present moment. Only by amalgamating such moments and *representing them symbolically* can one arrive at the experience of shorter or longer *durations*, according to James. Duration, therefore, is not caused by the intuition of time *qua* time, but rather is the object of the intuition resulting from the ever-present causes of sensation and perception. The specific train of his thought in this regard was not made explicit, but perhaps James arrived at the conclusion that, “Kant’s notion of an *intuition* of objective time as an infinite necessary continuum has nothing to support it” after considering the enormous diversity that such an empirical position must imply on the biological level for individual minds.\(^{269}\) This idea would seem to imply, however subtly, that a singular, objective, unified concept of time could not make sense for James; indeed, he would insinuate something akin to multiple, coexisting *times* in later works.

Unfortunately for psychology, however, James doesn’t follow this conclusion through in his *Principles* to the point that I have made repeatedly throughout this dissertation—that a universal conception of absolute time is unwarranted in any science, and it is empirically justified to consider the unique causal structure of individual *times* in both biological and human analyses. Instead, James’ psychological analysis preserves Kant’s problem of time *inside* the mind of the individual, rejecting Kant only partially by moving the causal mechanism to the fluctuating change of activity in the brain (a

\(^{269}\) Although this may seem a surprising deduction for a thinker of the mid to late 19th century, questions of time were certainly “in the air”, so to speak. Even though he may be imagined as a near contemporary of two major turn of the century figures concerned explicitly with time: Einstein would have been only 11 at the time of James’ publication, and although Bergson published his *Time and Free Will* in 1889, James began his inquiries much earlier (in the 1870s) and the two philosophers did not become familiar with one another until the beginning of the 20th century – James doesn’t quote Bergson’s views on time until his 1909 lectures on *A Pluralistic Universe*. 
perspective that, in certain, monistic philosophical circles, may not be wholly incompatible with Kant’s).

For James, it seems to have been enough to paint Kart’s universal time as illogical, but he fell short of logically or empirically refuting it. Thus, despite his assertion regarding the constant biological variation in its cause, James’ discussion rests on an implicitly metaphysical assumption that time nevertheless has certain objective characteristics resulting in a perceived duration of the specious present. James writes of the specious present that, “we must suppose that this amount of duration is pictured fairly steadily in each passing instant of consciousness by virtue of some fairly constant feature in the brain-process to which the consciousness is tied. This feature of the brain-process, whatever it be, must be the cause of our perceiving the fact of time at all…. the specious present, the intuited duration, stands permanent, like the rainbow on the waterfall, with its own quality unchanged by the events that stream through it.”

Without recourse to a framework for time outside of the individual or a unifying device for time inside the individual mind, James had no theoretical foundation on which he could base the actual objective features of human time—the linear relationship between the past, present and future of every symbolic process and the constant awareness of this relationship. In the end, James ties time to consciousness, whatever that may be.

Very little introspection is required to prove to an individual that they have a consciousness of time and thereby “access” to times past. Unlike studies with animals, human cognitive neuroscience begins from the question how phenomenologically the

---

270 James, *Principles*, 630 (emphasis in original).
psychological experience of time unfurls, and does not question that the perception of
time, as such, exists. Pursuing the former, (by means of introspection and reason alone—
tools that admittedly got him quite far) James deduced that Bloch’s “irreversible onward
rush” of psychological time could not be derived from the events in the environment
itself. “A succession of feelings,” he wrote, “in and of itself, is not a feeling of
succession. And since, to our successive feelings, a feeling of their own succession is
added, that must be treated as an additional fact requiring its own special elucidation,
which this talk about outer time relations stamping copies of themselves within leaves all
untouched.”271 The past, he asserts, can only be known as past alongside the present in
our thoughts; it must be conjured up as its own category and placed alongside another in
order to assume its distinguishing feature. To acquire or maintain such a categorically
discriminating feature in time, a layer of information must be added—a peculiar feature
of past-ness must be perceived. Remembering that James’ fundamental hypothesis
causally privileges the activity of the brain, one can see how he was lead directly to the
threshold of the mind-body problem, for his conclusions beg the question, how, if at all,
the brain possesses such an explicit indication or conception of the varying degrees of
past, present or future. Thus, many passages throughout his chapter on the psychological
perception of time allude to time’s symbolic representation and the manipulation of these
symbols in the mind of the individual, but an explanation for the function, or a search for
the source, of such symbols is notoriously absent from his science.

271 James, Principles, 628.
If the prevailing neuroscientific concept of time can be gleaned from the contemporary animal studies (discussed in the previous section of this dissertation) where time is imagined as either a sensible feature of the environment or a ubiquitous dimension of experience arising out of the structure and function of nervous systems, then we may consider James’ contributions to the understanding of time for contemporary psychology basically nil. The singular, universal, and objective notion of time, when considered from a Newtonian (i.e. external) or Kantian (i.e. intrinsic) perspective, that seemed to be losing ground in James’ individual, biologicistic approach is—unjustifiably—alive and well in the minds of today’s neuroscientists. The emphasis on another layer of temporal information being added to sense and perception (e.g. in the case of past-ness or succession), be it symbolic or of another as yet unknown type, is also relatively absent from contemporary thought on the subject. Such facts point to the thematic nature of concepts in neuroscience and underscore the absence of a better notion of time that conforms both to our experience and to our understanding. Einstein alluded to the popular preservation of the Newtonian idea of an absolute physical time in *Physics and Reality* and the biases implicit in contemporary biological research seem to reinforce his point. James, of course, did not realize the explicitly thematic nature of the concept of time in science in general, and therefore could not anticipate the extent to which it would be preserved in the future of psychology. But his later ruminations on the subject did highlight his belief in the need for a revision of fundamental concepts and, consequently, James became a staunch advocate for a resurgence of philosophical thinking in science to aid in refining such problematic concepts. James’ advocacy in this domain, however,
appeared in a decidedly more philosophical venue and perhaps for this reason the
biological and psychological communities were able to easily disregard it.\textsuperscript{272} Although,
James’ ruminations on the subject of time should not be ignored, for he raises interesting
problems regarding the traditional inquiry of time—as he did with many of his
conceptual analyses for human psychological phenomena—and underscores time’s
crucial problems far better than those who would succeed him.

From the perspective of intellectual history in general, James’ scrupulous analysis
is one among many examples of the extent to which the question of time pressed on the
minds of philosophical and scientific investigators of the late 19\textsuperscript{th} century. Taking into
account James’ chronological proximity to such thinkers as Bergson, Mach, and
Poincaré, one might say that discussions about time had not been as widespread in the
intellectual landscape since the debate of Newton and Leibniz. In science, the issue of
time was subsequently laid to rest by Einstein’s relativity which rendered it dependent on
space; while in philosophy, the questions of time that persisted had little influence on
thought outside of cloistered existence of academic circles (the influence of Heidigger’s
esoteric work \textit{Being and Time}, for example, can be seen in mid-century works of
continental philosophy but is entirely absent from scientific discussions of time and
temporal phenomena). It is not surprising then, that throughout much of the 20th century,
psychological investigations into the subject were sporadic and theoretically ungrounded,
lacking either a profound appreciation for the implications of Einstein’s relativity or
sufficient exposure to philosophical discussions of time.

\textsuperscript{272} See for example, James’ lecture on the contribution of Bergson’s philosophy to science in \textit{A
Pluralistic Universe}.\textsuperscript{272}
The disjuncture in psychology’s understanding of time is evident in a 1960 article appearing in *The Journal of Child Psychology and Psychiatry* titled “The Growth of the Concept of Time: A Comparative Study”, which synthesizes research in developmental psychology from the 1920s to the 1950s.²⁷³ Seeking to understand how children acquire a concept of time, the article cites studies that emphasize such different aspects of the problem as, “…knowledge of time words, telling the time, and the ability to appreciate universal time.” Notwithstanding the impossibility of physical simultaneity, without any justification of universal time—just an assumption—and seemingly uninfluenced by any Bergsonian conception of what time or duration might be for individual psychology, the article indicates that, “The senior author (K.L.) was particularly interested in the development of the appreciation of (a) simultaneity, (b) the equality of synchronous intervals, and (c) the order of events.” And further that another central, “… problem of interest was that of the growth of the awareness of interior time—the estimate of the time of an action in which the subject is personally involved and of the relationship of such growth to the ability to use objective time.” Nowhere in the article is there a reference to the deductions of William James nor the implications of the physical conceptions of time; without reference to these—or any—theoretical foundation one might do just as well to interpret the necessarily varied (and therefore non-universal) results of such studies in the vein of ethnographic or cultural anthropology rather than an biologically based psychology. The ostensible *modus operandi*, however, was that of biological science.

Later, in the 1970s, psychology witnessed somewhat of a renaissance in its consideration of time due to the meteoric rise of the cognitive neuroscience of memory. Endel Tulving’s 1972 work, which delineated two central categories of declarative memory (episodic and semantic), played a central role in this development and, by establishing episodic memory’s conceptual dependence on the “what, where and when” qualities of its acquisition, Tulving assumed an authoritative position, de facto, on the subject of time.\textsuperscript{274} Though his framework made time implicitly significant for memory studies from its inception, it was in 2002 that Tulving published two articles dealing specifically with time’s conceptualization, drawing his discipline’s attention to its unique status in human conscious experience, and theorizing explicitly about time’s nature, structure, function, and origin.\textsuperscript{275}

The first of Tulving’s 2002 articles addressed time specifically in relation to the phenomenon of episodic memory. Tulving defined episodic memory as a complex memory system that allows individuals to re-experience past experiences and, by virtue of this definition, placed an emphasis on past-ness (i.e. the episode’s distinction in time) as a characteristic feature of the memory process. Before remarking that, “[Episodic memory’s] unique relationship to time, surprisingly, is not widely known. Nor is it… adequately appreciated”, Tulving introduced his subject by extolling the time warping capacity of the human brain, repeatedly drawing the reader’s attention to the mind’s

ability to “turn time’s arrow into a loop” when remembering things past. Although this idea of time’s bent arrow serves a mostly rhetorical purpose for Tulving’s exposition, it reveals, at the same time, significant *thematic* biases. Thus, he writes,

> With one singular exception, Time’s arrow is naturally straight. Unidirectionality of time is one of nature’s fundamental laws. It has relentlessly governed all happenings in the universe – cosmic, geological, physical, biological, psychological – as long as the universe has existed. Galaxies and stars are born and they die, living creatures are young before they grow old, causes always precede effects, there is no return to yesterday, and so on and on. Time’s flow is irreversible.

> The singular exception is provided by the human ability to remember past happenings. When one thinks today about what one did yesterday, time’s arrow is bent into a loop. The rememberer has mentally traveled back into her past and thus violated the law of the irreversibility of the flow of time. She has not accomplished the feat in physical reality, of course, but rather in the reality of the mind, which, as everyone knows, is at least as important for human beings as is the physical reality. When Mother Nature watches her favorite creatures turning one of her immutable laws on its head, she must be pleased with her own creativity.\(^{276}\)

In this introductory passage, the stylistic objective of the phrasing—being written by a man of science—is apparent enough. Just below the surface of his prose, however, lie the assumptive qualities that Tulving bestows on the structure and source of time. To begin with, the author asserts that time’s singular direction is a fundamental law of nature, resulting ostensibly from the physical characteristics of the universe. Conversely, the unique mental experience of episodic memory—our ability to “travel back in time”, as Tulving remarks - presents an exception to this “universal law.” Even though we do not accomplish the feat in physical reality, he admits, Mother Nature’s (i.e. evolution’s) development of such a capacity to turn “one of her [own] immutable laws on its head” is

\(^{276}\) Tulving, “Episodic Memory: From Mind to Brain,” 2.
Tulving’s characterization of time and the human mental capacity to manipulate it, however, presents a significant logical problem for the understanding of time and memory’s relationship to it. The two implicit notions that time is real and has qualities derived from the physical laws of nature while, on the other hand, different laws of nature violate the fundamental laws from which time’s very constitution is derived, do not combine to provide a logically coherent understanding of the *same phenomenon*. If the objective of introducing time in such a manner were merely a matter of style, then Tulving’s paradox could be forgiven; but the goal, as Tulving asserts, is to understand the actual relationship between human mental experience and temporal phenomena. This goal cannot be accomplished with such a logically incongruent ideas about the phenomenon in question.\(^{277}\)

Although the main purpose of Tulving’s article is to provide a high-level summary of the research on episodic memory spanning the previous 30 years, the author takes special care to assert that the exploration of his hypothetical memory system may bring us closer to understanding the relationship between time and our mental processes. (N.B. Throughout the review Tulving is clear in reminding the reader that the system of episodic memory is only a hypothesis, showing by contrast how firm his assumptions are about the nature of time.) In the end, he concedes that the description of bending time’s

---

\(^{277}\) For my own part, sensitivity to the dual status of time as an apparent fundamental feature of the universe and the implications from Einstein’s relativity that time itself can have no actual qualities is what lead to the first chapter’s illustration of time’s thematic status in science, in general. Only then could I begin to account for a “time-like” (and therefore not entirely spatial) phenomenon in the organic realm.
arrow is too romantic to be scientifically valuable but then immediately provides a
cursory functional explanation of the brain’s relationship to time patently disregarding all
of the special qualities of time that are made apparent in the psychological literature he
cites—to say nothing of our direct experience.

Finally, what about time’s arrow that is bent into a loop by episodic
memory? Does episodic memory, or the fact that healthy humans can think about
their own past, violate the law of unidirectionality of time? Is it really a marvel of
nature? Surely this story line is too dramatic, even absurd. An event happens, a
person experiences it, memory traces are laid down representing the event, the
past vanishes and is replaced by the present. The memory traces of the event
continue to exist in the present, they are retrieved, and the person remembers the
event. This, in a nutshell, has been the understanding of how memory works. It is
simple and straightforward; there is no need or room for magic, or marvel. There
is certainly no violation of any law of time.278

On the surface, Tulving’s functional explanation for our experience of time may satisfy
the thinker who has the perspective that a.) “events” have intrinsic, constitutional
properties and b.) those properties are material at their base. In fact, the same succinct
characterization—that environmental stimuli are perceived by nervous systems which,
according to their structure and function, embody the signs acquired from the
environment such that they are potentially reactivated and interactive within the
homeostatic needs of the organism—applies to the operational definition of episodic
memory described in the animal studies above. In both cases, however, the animal and
the human, this conceptualization only works when time is imagined as a real,
environmental phenomenon with its own, independent qualities and, even then, this
conceptualization cannot account for the human capacity to “re-live experiences” at will.
Moreover, one still fails to account for one of James’ nagging problems, namely, how the

brain might acquire and represent different qualities of time (e.g. past-ness, succession, future) at all. Thus, Tulving appears to abandon some of the most salient temporal aspects of our memory experience: its immediate empirical reality (to us), its subjectivity, and its manipulability, due to the perceived conflict of such characteristics with the materialist requirements of science. What makes this final characterization even more problematic for Tulving, is that he arrives at this conclusion despite the repeated citation of the subjective and malleable features of time in mental experience as some of the defining features of human episodic memory.

The need for an operable concept of time for psychology and cognitive neuroscience is made all the more apparent by Tulving’s second 2002 article dealing specifically with the subjective experience of time, or what Tulving calls chronesthesia. Taken at face value, the conceptual delineation of chronesthesia is dependent upon two other ideas, the elucidation of which would be essential to an adequate understanding of the phenomenon: namely, subjective (vs. objective) experience and time. Instead of breaking down the obvious dependencies of his new concept, however, Tulving begins his argument for chronesthesia by describing it within the context of other traditionally accepted, conceptually formulated, cognitive systems. Hence, chronesthesia is, according to Tulving, just one example of many general capacities of the evolved brain that allows for a certain cognitive/behavioral manifestation pertaining to the subjective awareness of time. Cognitive scientists parse many such conceptual capacities in the human brain that they consider conditional systems within the organism produced by the natural process of evolution. Such capacities are conditional in the sense that they are necessary though not
sufficient for the particular functional expressions that they support and understanding this explicit distinction, according to Tulving, is essential to the understanding of chronesthesia.

To help his reader grasp the nature of such cognitive capacities, Tulving offers the examples of vision and hearing, and of learning and memory alongside his elaboration of chronesthesia. For Tulving, all of the above constitute capacitive systems of the human brain of seemingly qualitative equivalence from a biological standpoint. And while the correspondence of vision and hearing to an underlying biological structure or process is well understood, learning and memory, Tulving points out, are processes that represent a more nebulous relationship between the brain and the mind (considering that Kandel’s *Memory: From Mind to Molecules* was published in 2000, Tulving’s intention in this respect is somewhat unclear—if his opinion still stands, then we are in fundamental disagreement on this point). His main idea in these analogies is that certain modes of consciousness, of which chronesthesia is a particular type, are empirically accessible capacities, subject to scientific analysis and explanation. Though the capacitive systems of consciousness can be spoken of only metaphorically (since they are by nature more complex than vision or hearing and, consequently, their correspondence to an underlying organic process is not well understood), they are indeed widely discussed in what Tulving describes as the accepted disciplinary practice of faith [*sic!*] that such capacitive systems exist, and can/will be found, on the neurological level.  

It is necessary to reiterate here that I do not contest the fact that all mental activity

---

279 Tulving, “Chronesthesia,” 312.
must be represented somehow on the neurological level. I approach my subject from the perspective that the mind is obviously dependent upon, though not determined by the brain. What I argue in the case of Tulving’s approach, however, is that his list of capacities is, in fact, a list of concepts whose scientific utility—and thereby their correspondence to objective, empirical reality—stands or falls according to the rigor of their definitions. Unfortunately, when one analyzes Tulving’s explanation of chronesthesia from a strictly biological viewpoint, one is forced to face the same fundamental problem about time that plagued the previously discussed animal studies: time’s absence from the physical characteristics of the environment.

This particular absence manifests itself in the following logical problem for a biologically based inquiry: if chronesthesia is a type of consciousness dealing specifically with the subjective experience of time, then certain qualities of time must be present that not only objectively account for the existence of such a consciousness but also that are represented subjectively to individuals who manifest an awareness of it. An account of this empirical requirement seems absent from Tulving’s description. Contrary to any plausible evolutionary explanation he writes that consciousness “as capacity is not directed at anything”, and furthermore that consciousness is differentiated from awareness in his scheme because awareness is always an awareness of, and consequently directed at, some type of environmental stimulus. “To be aware of something”, Tulving expands, “means to have a particular subjective experience that is determined by both the current (particular) stimulation from external and internal sources. In other words an awareness presumes consciousness but consciousness is a necessary but not sufficient
condition of awareness.” As Tulving continues his case for chronesthesia, therefore, he
gives his readers a slightly more confusing iteration of the difference between capacitive
and functional manifestation, complicated by the addition of a particular stimulus to
which the capacity is not directed, but the awareness necessarily is. If one were to relate
this framework to the capacity of object vision, for example, it would follow that the very
existence of the capacity, (having been produced by the process of natural selection) is
dependent upon features of the material environment which makes things visible, namely
an object’s physical properties of reflecting light. In the case of hearing, the existence of
the organism’s capacity would be dependent on the vibration of air. Tulving’s
“awareness” in these two domains would then depend upon not only the organic capacity,
but also on specific instances of lit objects or sensible vibration in the local environment.
To be sure, consciousness is a much more nebulous concept for science than vision or
hearing—especially from the point of view of a specific evolutionary development that
produced it—nevertheless Tulving establishes chronesthesia as an analogous type of
sensitive capacity that may be directed at the presence of, or change in, temporal
phenomena without justification or definition of what exactly temporal phenomena are
made.

Tulving’s attempt to distinguish chronesthesia from autonoetic consciousness (yet
another capacity of consciousness that allows one to have “an awareness of self in time”)
introduces an additional vague concept, “the self”, in such a manner that makes it
logically indistinguishable from time at all, causing both “subjective experience” and
“time”—the fundamental ingredients of the phenomenon of chronesthesia—to be
proposed and operationalized in an absolutely meaningless way.

The concept that is most closely related to chronesthesia is autonoetic consciousness (or autonoesis), already mentioned above. It is defined as a form of consciousness that allows individuals to apprehend their subjective experiences throughout time, and to perceive the present moment as both a continuation of their past and as a prelude to their future…. Because the essence of what I attribute here to chronesthesia has previously been associated with autonoesis, one may wonder whether yet another esoteric concept such as chronesthesia is needed. I think that it is. Although both autonoesis and chronesthesia imply awareness of self in time, the emphasis on self versus time is different in the two concepts: in autonoesis the emphasis is on awareness of the self, albeit in subjective time, where as in chronesthesia the emphasis is on awareness of subjective time, albeit in relation to the self. The distinction may be subtle but it is necessary, because time can be dealt with, and usually is dealt with, independently of the self, and self can be dealt with independently of time, as shown by behavioral…and functional neuroimaging… research on self-recognition and self-face recognition.\textsuperscript{280}

The mind-bending logic of Tulving’s passage requires that for both autonoetic consciousness and chronesthesia, subjective time and the self be always essentially concomitant yet functionally distinguishable. Since experience in both cases (either of time or of the self) is defined by its subjectivity to the individual, adjudicating the balance of the relationship that Tulving posits as the distinguishing feature between the two would require a third mechanism (a super-ego, perhaps?) or an observer with access to a standard of measure of absolute time. For time, as an object to which a “capacity” may turn its awareness, can never be sensed without a self, and the self, though ostensibly distinct from the temporal phenomenon, can never exist outside of the reality of time, especially if time is a fundamental principle of reality. Perhaps the two are dissociable in this latter scenario when time is imagined objectively—and remembering Tulving’s assumptions from the previous article, this is indeed how he represents time to himself, as

\textsuperscript{280} Tulving, “Chronesthesia,” 315.
a fundamentally physical universal category—but how a mind might turn its conscious
capacity toward this reality and not have a subjective experience of it (i.e. and only have
an experience of time as such) is problematic. And here again psychology arrives at the
inability to distinguish knowledge about time (all the while undefined) from the
subjective experience of it.

Armed with a consummate empirical example of the confusing relationship
between temporal knowledge and temporal experience, Tulving introduces the case of an
amnesic patient known in the literature as K.C. K.C. exhibits what Tulving characterizes
as global episodic amnesia despite otherwise normal cognitive capacities in language,
semantic knowledge, literacy, noetic consciousness, and working memory. The unique
feature of K.C.’s presentation, according to Tulving, is that he exhibits a detailed
knowledge of time and temporal relationships while he lacks any trace of autonoetic
consciousness due to his inability to remember episodes occurring even a few minutes
into the past. Moreover, he is equally incapable of imagining himself in the future.
Describing K.C.’s presentation, Tulving writes, “…When asked, he cannot tell the
questioner what he is going to do later on that day, or the day after, or at any time in the
rest of his life, any more than he can say what he did the day before or what events have
happened in his life.” And of K.C.’s knowledge of time, “He knows and can talk about
what most other people know about physical [sic!] time, its units, its structure, and its
measurement by clocks and calendars. But such knowledge of time in and of itself does
not allow him to remember events as having happened at a particular time.” Noting

specifically that a knowledge of time is “necessary but not sufficient” for temporal experience, Tulving hypothesizes that K.C.’s capacity for chronesthesia is limited by his physical trauma but is at a loss to explain the confluence of his persistent knowledge of time and his incapacity to experience it.

Tulving’s operationalization of time in relation to episodic memory and his conceptualization of chronesthesia—our subjective experience of it—clearly demonstrates the challenge of developing concepts for human psychology that withstand the rigors of scientific scrutiny (that is, logical coherence with other scientific theories, universal applicability, and objective correspondence to empirical reality). Episodic memory, in its distinction from other types of memory and by virtue of its declarative status, is a hypothetical memory system deduced from the experience of memory itself. Justifying such a concept scientifically requires that it be logically dissociable from other phenomena that it is not and functionally explained with respect to other parts of reality with which the system interacts (again, the concepts of learning and memory and their relationship with material signs of the environment are excellent examples of success in this domain). When one is not careful with the development or employment of concepts, however, specifically in their definition and delineation, one runs the risk of indissoluble dependencies and indefensible assumptions. Time, until it is defined, cannot serve as a descriptive feature of memory and, so far, neuropsychological models of episodic memory have not been able to elucidate an objective, cohesive picture of the phenomenon. Additionally, Tulving’s discussion of chronesthesia, as it stands, cannot be very useful for neuroscience. As a concept, chronesthesia is parasitic on too many
undefined terms—specifically consciousness and time (e.g. it is a particular type of consciousness related to the subjective experience of time as it relates to the self). Moreover, chronesthesia’s conceptual delineation from other types of consciousness, without recourse to actual temporal features of the environment outside of us, is empirically untenable.

Conceptual problems exist in every science, but this problem is particularly prominent in the empirical investigations of human neuroscience concerning time and temporally related phenomena. Without a solid conceptual apparatus through which to understand time from the top down, and without having produced a functional account of the phenomenon from the bottom up, neuroscience remains at an impasse in its ability to analyze the actual relationship between time and the human brain in such areas as memory, for example, which are necessarily related to it. Thus, as recently as 2009, some researchers have openly doubted the general usefulness of the concept of time for human neuroscience at all.

In a dissertation chapter titled “Downgrading the Importance of Time” Demis Hassabis cites some of the most authoritative time studies relative to memory research showing that empirical results in this domain are not always consistent with one another nor do they combine to contribute to a coherent, general understanding of temporal phenomena. According to Hassabis’ summary, there is a twofold understanding of time in cognitive neuroscience (quite different from the ontological separation of organic time and human time that I propose). In the first case, Hassabis writes, much research

has centered on a concept of “micro-time”, constituted by the “moment by moment” sequence of an actual event. Sensitivity to this micro-time is shared by humans and animals alike and exists by virtue of “the physical laws of nature…. for example, one must open a door before going through it, and [micro-time] might be reliant on the special anatomical properties of the hippocampus.” Secondary to micro-time is a concept of “macro-time” that may only pertain to human thought and experience. The concept of macro-time has developed in the literature by virtue of the introspection and direct report of experimental subjects and is distinguished not only by its manipulability in the mind (Hassabis cites Ferbinteanu et al. 2006 in this respect) but also by its ostensible subjectivity (and here, Tulving 2002 Chronesthesia). The themes that underlie the summary of these two concepts are familiar refrains in the general understanding of time as it pertains to human mental experience and cognitive science. Thus, they present the same fundamental problems that I have reiterated throughout this chapter: in light of the arguments made in the case of animal studies, as well as the absence of a real temporal dimension in the physical characteristics of nature, it would seem impossible that “micro-time” could be absolutely objective, in and of itself, since the reality of all sequential relationships requires and observer, human or non-human. Focusing on the subjective feature of macro-time doesn’t seem to adequately justify the empirical difference between the two concepts either. In fact, it is precisely the explanatory power of this second macro-time that Hassabis questions for human neuroscience.

Having performed studies on the neurocognitive representation of imagined, fictitious scenarios and mental time travel (e.g. remembered past episodes and imagined
futures), Hassabis doubts that a distinct temporal quality of the imagined content is either an analytically significant variable for neuroscience or empirically justifiable. From the neurological standpoint, Hassabis notes that, “Near total overlap has been found in brain regions supporting past episodic memory recall and episodic future thinking (Addis et al. 2007; Szpunar et al. 2007).” And furthermore he cites 7 studies from the past 15 years demonstrating that, “…memories from distinct time periods have failed to show consistent neural correlations in response to [time] modulation.”

What is striking about Hassabis’ empirical results and his conclusion that time may not be a meaningful variable in neuropsychological explanation, is that the distinct parts of human time lack clear neurological markers yet we can’t help but know that they exist—we have constant direct experience of the present, knowledge of the past and its past-ness, and explicit mental representations of the imagined future. The absence of a known neurological distinction in these qualitatively different mental processes, to which Hassabis draws our attention, highlights one of the central conundrums for the neuroscientific investigation of human time as it highlights the central conundrum for the neuroscientific investigation of the mind in general.

Therefore, I argue that rather than “downgrading the importance of time,” Hassabis inadvertently underscores the importance of an operable concept of time in human neuroscience by demonstrating that such a notion is completely lacking and, as such, the results inferred from its investigation can hardly inform neuroscience— specifically in questions to which the idea of time is necessarily tied (e.g. declarative, episodic memory)—and its relationship to our mental experience. Hassabis demonstrates
this need despite himself by showing that the reigning ideas of time, or time as an independent variable, do not seem to contribute substantially to the observation of the neurological underpinning of imagined fictitious episodes. Remarking in his dissertation (among other places)\textsuperscript{283} that strikingly similar cortical networks are activated in imagined experiences as those that are observed in active episodic recall, Hassabis puts forth the hypothesis that the operative neuropsychological process in both cases is one of “construction” as opposed to a temporally delineated reactivation.\textsuperscript{284} In his analysis, construction allows for an explanation of the neurological and mental phenomenon without having to resort to the sticky business of time and its qualitative distinctions (e.g. past, present, future). Time, according to this reasoning, can be excluded as a significant variable since including it reveals no empirical distinction on the neurological level. In my opinion, however, this exclusion does not solve the problem of time; it merely chooses to ignore it. The “construction” that Hassabis hypothesizes in time’s place is nevertheless a process where certain causes precede certain effects. These causes and effects, no matter how they are manifested neurologically, must correspond to thoughts, which succeed and depend on one another logically to form any sort of coherent structure. Much like Tulving’s introduction of the self, Hassabis’ dubiousness of time begs the question: how might we consider certain human mental processes (e.g. episodic construction) to be outside of or unrelated to time?


When we dissect Hassabis’ assumptions about temporal phenomena we find another set of time-related problems that plague psychology, cognitive science, and human neuroscience—the empirical status of time’s parts: the past, the present, and the future. As evinced by his discussion of “micro-time” Hassabis seems to accept the ubiquitous reality of an intrinsic flow of events recorded in the brains of humans and animals alike. Citing others in the discipline, he refers to the concept of “micro-time” and contrasts it with what may be considered a uniquely human perception of time distinguished by its explicit subjectivity. Subjective, human time, for Hassabis, isn’t an informative variable for imagined experience because there is no neurological difference between “the future” and imagined a-temporal stimuli. What is interesting is that Hassabis cites the same neurologically undistinguished quality for past information all the while accepting the intrinsic reality of micro-time and its representation by means of the hippocampus. Taken together with his position on future, imagined time, this implies logically that, unlike the future, Hassabis regards the past as real in an external sense while the imagined future does not share the same empirical status. Despite the fact that both are neurologically represented, and allegedly indistinguishable, this reasoning would seem to imply that some parts of time (e.g. the past) are privileged as being “more real” than others (e.g. the future). Without a clear concept of where time comes from and how it operates, neuroscience cannot escape the dualist paradox of only being able to explain time by virtue of the environment, and therefore unable to understand either the past’s difference (or commonality) to imagination and the future.

The involuntary demonstration by Hassabis of the absolute necessity for a new
The concept of time in human neuroscience (despite his argument that it doesn’t seem to be warranted based on the neurological overlap in representations of past, present or future), as well as certain intimations that can be gleaned from Tulving’s expositions (namely that we know we have a subjective experience of time and that empirically certain aspects of this experience seem to be dissociable from our knowledge of it) serve as perfectly representative examples of the conceptual confusion that is rampant in our contemporary understanding of time in human cognitive neuroscience. The demonstration of such problems, however, should not persuade us to dismiss the work of the authors who attempted to conceptualize time and address its relationship to various cognitive processes; each one of them highlights fundamental questions about human mental experience that are directly related to the understanding of time. By considering these works carefully one can see that the main problems of time requiring solution are: 1.) the objective qualities of time; 2.) the empirical status of its component parts; 3.) its causal structure and function; 4.) our subjective experience of it; and 5.) the relationship that it has to the brain that supports it. I believe that these problems can be addressed in a logical, and objective manner with the universally applicable conceptualization of human time that I am offering in this dissertation. It will be the goal of the rest of this chapter, therefore, to show that all of these puzzling pieces fit neatly together with my concept of time as a uniquely human mental—and therefore symbolic—phenomenon on both the conceptual and the empirical level.
Logical and Empirical Implications of Human Time

The empirical results and conclusions of Hassabis regarding the overlap of neurological representation of the past, present, and future, irrespective of the temporal qualities of psychological experience, permit us to examine the ontological status of time’s categories and to determine their relationships to one another in the mental process. According to the theory presented here, these three categorical distinctions in time, and the dependence of the present on the past and the future on the present, collectively represent an objective reality: the symbolically constituted, objective reality of culture and the mind. The past, present, and future are themselves derived from the experience of this objective reality even though their causally active roles with respect to one only manifest in the mind of the individual and therefore are experienced subjectively. The inescapable subjectivity of our mental processes is itself an objective fact. The lack of neurological distinction between the experiences of the past, the present, and the future reported by cognitive neuroscience does not nullify the reality of these categories in the experience (and thus their empirical existence) of each and every one of us, nor does it invalidate the invariably dependent relationships between them. Despite the lack of their perceived neurological distinction, such symbolic categories about time are essential to neuroscientific investigation because though the experience of the past, the present, or the future in the mind of an individual can only occur symbolically and subjectively, it does so according to the linear structure of change in the symbolic process. Objectively, the causal trajectory, or explanation, for any qualitative distinction in time in the mind of an individual is charted from the past to the present and
from the present to the wide expanse of possible symbolic associations of the future.

Chapter 4 of the present dissertation has already explained how this objective structure of the symbolic process allows for such explanatory analysis of the cultural reality in time. Understanding that the mental process is the process of the continuous transformation of symbolic configurations in a linear sequence where each step is dependent on the steps just before it, therefore conditioning symbolic configurations or the steps that are following, allows one to probe the causal variables that explain our subjective experience of time through its objective qualities and thereby the effects of human time on the biological organism. These effects, though supported by mechanisms of the brain, occur by virtue of the associative relationships of particular symbols.

In linguistics, for example, considerable attention has been paid to the varying temporal qualities of language. Linguist, Wolfgang Klein provides a number of examples demonstrating that concepts of time may be encoded differently within the same language and points to an even greater diversity of such representation when various languages are analyzed comparatively. Aside from the differential representation of tense, for example, Klein points to the integral role of what he calls “aktionsart”, referring to event types or states reflected in the lexical aspect of verbs themselves, in addition to temporally modifying effects of adverb indicators and clauses. Considering the potentially endless

285 Wolfgang Klein, “How Time is Encoded.” The Max Planck Institute for Psycholinguistics http://www.mpi.nl/people/klein-wolfgang/publications-old-version/fbpubs09/Klein_2009_How_time_is_encoded.pdf (accessed August 6, 2014). In fact, in reference to our particularly western view of time and its relationship to language Klein writes that “From Aristotle to present times, there is a steady stream of research on tense and on Aktionsart; in fact, the way in which we think about the expression of time is deeply shaped by what the Greek philosophers thought about it, and thus, by the structure of Greek.” And later that
combinations of expression for events or sequences in time it is possible that the
subjective experience of the temporal aspect implied in such expressions is equally as
varied making the neuroscientific search for time in the brain dependent upon an entirely
different causal structure. Reorienting our understanding of the categories of temporal
experience as symbolic categories into which particular symbols or episodes may be
placed or organized arbitrarily, albeit according to causes in the objectively linear
structure of the mental process, may allow neuroscience to discover unanticipated
patterns or processes reflecting the relative relationship that the subjective experience of
the past, present, and future have to one another in the mind of the individual. In other
words my theory shifts the attention to the symbolic quality of mental processes and
makes the distinctions between past, present and future (the distinctions that neuroscience
has been hoping to find indicated neurologically) a part of the mind’s subjective
experience rather than an element of the non-symbolic, strictly organic, processes
occurring in the brain. All the while, meaningful, symbolic, stimuli are always strung
together in an absolutely linear sequence and this sequential, symbolic, relationship
constitutes the most important analytical feature of the process for neuroscience because
these associations must be represented in correspondingly sequential neurological

our canonical idea of tense “goes back to the Greek philosophers… The word itself comes from
Latin tempus (“time”). In some languages, such as French or Italian, one and the same word is
used for time and tense, and in many other languages, the terms “past, present, future” refer
equally to the grammatical tenses and to the notions of past, present, and future. This common
origin easily invites the idea that one cannot properly express time without tense. This is, of
course, a weird idea. After all, a language which does not inflect its verbs for tense can easily add
an adverbial such as in the past, now, or in the future, let alone more differentiated
characterizations such as tomorrow, at this very moment, or in seven years from now. So, tense is
not only to be separated from time – it is not even a particularly important for the expression of
time. Many languages do not have it at all, and in those languages which do have it, it is largely
redundant.”
processes even though we at present do not know their nature. This lacuna in our current knowledge may be accounted for by the fact that we have never posed the question in this form (i.e. from the top down) before.

Let us consider the reality of the future, for instance. In the discipline as it stands, neuroscience privileges the reality of the present and the past while it is dubious of the reality of “events” which have yet to happen from an objective or external/environmental standpoint. In my account, on the mental level (and perhaps arguably in the “constructive” account that Hassabis is advancing, though in a different way) all three distinctions in time must be accorded the same real status because their experience is supported by neurological activity of the brain. The difference between the respective divisions in time that science cannot currently appreciate is that an imagined “future” is not really a future part of time; it is instead a piece of the symbolically manipulated present. Such imaginations of the future may in fact be causally active in the mental process but never in violation of the linear trajectory that runs from the past, which conditions the present, and leads to parts of time that are not yet realized. In other words, as soon as “the future” is imagined, it becomes a part of the causally active variables in symbolic conditions and causes that lie at the foundation of human thought and behavior. Despite the imagined scenario’s independence from any material feature in the external environment, it transforms the symbolic context in which “new” symbols are introduced and interpreted, not only guiding action, but also directing neural activity. Therefore, it is not the future itself that is causal, rather, it is its symbolic representation (e.g. imagination) in the present, that constitutes the significant data point for both the human
and cognitive sciences. Herein lies the importance of James’ intuitions about the symbolic representation of time—it is because time, for humans, is a real phenomenon that is constituted by symbols, the subjective experience and manipulability of which is provided for by the operations of symbolic reality and biological conditions working in tandem.

A similar argument may be made for the empirical role of the past. Tulving continually reiterates the importance of being able to mentally travel back in time as if the episodes were sitting in a metaphorical archive, unmolested by the present mental and historical processes that they have played a part in shaping. James too imagined this capacity as a reawakening of neural pathways that had been worn by the streams of experience. Contrastingly, I argue that the reactivation of episodic memory is not a reactivation of the past in the strict empirical sense. Rather, the traces of the past are invoked by present symbolic/neurological activity of which they are necessarily a conditionally active part by virtue of the associative nature of symbols and of the connective traces that such symbolic activity has left in the organism. Thus the “past”, being brought back into the present, becomes causally potent in the ongoing processes by which it is revived.286 On the neurological level this is most likely reflected by the dynamic representations of past stimuli and present neurocognitive conditions. The human mind, however, can jump freely between epochs irrespective of any constraints on “physical time” and this is only accomplished by virtue of the symbolic process’

286 For this very reason, only careful scientific analysis of the past itself (i.e. history) can prevent us from committing the anachronisms of thought and understanding to which the mental process itself makes us prone.
autonomy from material reality and organic processes. Undoubtedly, such symbolically generated neurological activity happens according to a logic that coincides with the absolutely sequential relationship between steps of the biological processes that support such neurocognitive activation. The fact that the past, when conjured up in the present, is not repeated or actually relived (i.e. it always happens within the a unique present both biologically and historically) also conforms to the objective linearity of human time. Each successive moment of it is empirically distinct on the individual, mental and biological level. The arrow of time is never bent in a loop, as Tulving suggests, but rather continues in an irreversible onward rush with the indexing capacity to bring quiescent ideas and currents back into the living, breathing déroulement of presently successive moments.

Thus, the objective features of time, the unbreakable sequential relationship between the past and the present and the conditioning though not deterministic role that this causal dynamic plays for the future in the active process, is independent from the chronological derivation—or subjective categorization—of particular symbols. On the collective level this makes the distinction between past, present and future a matter of convention; on the individual level, this makes the interactions between remembered past, the significant present and the imagined future the essence of our subjective experience of time.

**Neuropsychological Evidence in Support of Human Time**

In almost all cases, subjective experience and objective knowledge of time go hand in hand, but evidence from certain clinical case studies chronicling the pathologies
of patients with damage to their medial temporal lobe [MTL] structures (brain structures essential to the normal function of declarative memory) may indicate that the objective and subjective features of time have a more nuanced relationship. Tulving’s discussion of K.C., for example, provides some insight into the relationship between the objective structure of time and the subjective experience of it.

The knowledge of time’s units and the relationship that these units have to one another is essentially semantic—i.e. linguistic—knowledge. Tulving describes K.C.’s preservation of this semantic knowledge and points out that knowledge about time does not itself translate into autonoetic experience that would allow him to remember past episodes or imagine the future. The activation of such subjective capacities may be dependent upon the complex interaction of symbols to which distant episodes, in either the past or the future, correspond. Damage to the MTL structures that support such multi-modal associations in the cortex may occlude the full potential of complex symbolic interactions to give rise to vivid mental experience. Nevertheless, K.C. has a coherent conversational capacity and the ability to plan objectives in the very near future based on contextual knowledge and infer the conditions of a very recent past. In a review of K.C.’s case, Rosenbaum et al. point out some of K.C.’s hobbies that would seem to require a limited scope of subjective experienced time for their performance. When playing cards, for example, “He expects a new ‘trick’ after four cards are placed in the centre of the Bridge table…” And while watching TV, “…[he] anticipates Bob Barker on the ‘Price is Right’ asking contestants to ‘spin the wheel,’ though he cannot foresee

---

what he himself will do when the card game or television show is over.”\textsuperscript{288} Ostensibly, these activities constitute some subjective experience of the linear structure of time, but, the explicit content of the experience being lost as soon as his attention is turned, the breadth of K.C.’s temporal experience is greatly limited by the incapacity to associate complex sets of symbols that might correspond to the constructive process that is hypothesized in accounts of episodic experience. Though the span of the accessible time scale is limited in K.C., it is incorrect to describe his mental process as timeless or merely confined to the present. Playing cards, anticipating moments in a game, even the very act of conversing with an interlocutor requires an awareness and response to essentially temporal relationships in the past, present and future.

The paradigmatic amnesic patient H.M. has been known to engage in his own unique deduction of temporal relationships and to manipulate, to some extent, the duration of his experiences. In a study designed to assess H.M.’s perception of the passage of time, researcher Jenni Ogden informed H.M. that she was going to leave the room and, upon her return, ask him how long she had been gone. Surreptitiously noticing that the clock on the wall read 2:05 when Ogden left, H.M. repeated “2:05…2:05…2:05” to himself for the entire length of Ogden’s absence so that when asked, H.M. simply had to subtract 2:05 from 2:17 to arrive at the correct answer of 12 minutes.\textsuperscript{289} In this case the deduction of the time elapsed is easily explained by the knowledge of clock-time relationships that seem to be independent of subjectively experienced time, but the


\textsuperscript{289} Ogden’s story is chronicled by Suzanne Corkin in \textit{Permanent Present Tense} (New York: Basic Books, 2013).
preservation of the task in H.M.’s attention arguably results in a manipulation of the
duration of H.M’s particular mental experience.

Even without such intentionally persistent activity, H.M. was able to acquire
certain pieces of new, historically contingent information in ways that seem to defy
explanation in light of his pathology. Corkin describes a heart-wrenching anecdote
relative to the death of H.M.’s father in 1960, seven years following the onset of his
amnesia. For a period of about 4 years after the loss, H.M. was not able to hold this
unfortunate fact in his memory. Consequently, H.M.’s mother, his primary caregiver,
asked that the researchers not bring up his father’s death for fear that he would receive it
as news he was hearing for the very first time. “But in August 1968,” Corkin writes,
“when I was testing him, he talked about his father in the past tense…”290 It would seem
that H.M. not only eventually acquired the information of his father’s passing but also
knew that the event happened in a temporally distant past. Corkin’s hypothetical
explanation of this feat is that, “over time his brain may have absorbed the painful fact
into unconscious memory traces that stored it.” Perhaps due to the emotional content
associated with the situation or perhaps from repeated exposure to facts that implied the
event, she conjectures, H.M. was able to connect the dots. It is impossible in this case to
say for sure what caused the consolidation of this fact in H.M.’s semantic knowledge or
what “unconscious memory traces” were able to store such information. What is
particularly salient in this example, however, is his spontaneous reference to his father’s
death and representation of the fact in the past tense. Expressing his father’s death in

---

290 Ibid.,
such a manner, after years of being relatively “unaware” of the occurrence, seems to indicate that some temporal quality of the event is contained and represented not by the episode (the memory of which H.M. has no access) nor by the reality of his father’s absence from the present, but rather might be contained in the objective qualities of time with which we imbue our language.

It is possible that the dissociation between knowledge about time and our subjective experience of it can be explained by the fact that the collective representations of time, though necessarily derived from the absolute, objective features of it, are only to a small extent representative of the subjective experience of time itself. Thus, one can have knowledge of human time, and deduce logical relationships in it, the same way that one can have knowledge of Cartesian space – that is, indirectly. Because human time objectively consists of the unbreakable linear relationship between the past the present and the future—the experience of which seems to be preserved even in the cases of K.C. and H.M.—one may infer certain necessarily sequential features of complex symbolic sets without experiential “access” to specific episodes. My framework implies the possibility that this objective and universal structure of human time allows for the deduction of certain temporal relationships independently of the totality of temporal experience, thus the relative extension of temporal relationships may be severely limited in MTL patients but such patients may nevertheless retain knowledge and a limited subjective experience of time that is necessarily contained in language and thought.

A suggestive antithesis to these two examples is the abnormality of temporal experience described in cases of acute schizophrenic psychosis. A number of studies
have examined the subjective temporal deficits in patients with schizophrenia and have shown not only a distinction between the timing mechanisms of different sensory modalities between patient populations and control groups but also consistent deviation (usually in the form of overestimation) in subjective time estimation in a number of domains.\textsuperscript{291} The most salient evidence of time related pathologies observed in schizophrenia, however, comes from Greenfeld’s explanation of the clinical cases cited by Louis A. Sass in \textit{Madness and Modernism}. Relative to these detailed patient reports, Greenfeld writes,

\ldots there is one specific abnormality common to schizophrenic thinking. Their thought lacks the temporary dimension—they seem to inhabit a timeless, spatial only, world. \ldots The fact that schizophrenics lose the temporary (cultural) dimension of their experience, but retain the spatial (material) one more or less intact (they orient themselves in space quite well) points to the cultural nature of their disorder, which does not necessarily affect their (animal) brain. It is the symbolic process (the change of meanings in accordance with the changing symbolic contexts) which introduces time into our experience, necessarily making us aware of the irreversible past-present-future relationship. Conversely, it is the mind that constitutes time into the relationship of past, present, and future. The cultural process outside—history—reflects it, so one can learn this from history; still, it is the mind that discerns, supplies the organizing principle to the perceived phenomenon—therefore supplies time—not the free-ranging culture. When we lose the sense of our specific location… in the symbolic process, which is inherent in the sense of self, time disappears or completely changes its feel….

Sass stresses the disturbed sense of semiotic relationships and comments: ‘Among patients without demonstrable brain disease… it is only schizophrenics who deviate from [the normal narrative spread with a past, present, and future] in a way that indicates a profound difference in the very structure of their experience,’ \ldots\textsuperscript{292}


\textsuperscript{292} Greenfeld \textit{Mind, Modernity}, Madness quoting Sass, 155.
“Despite a hundred years’ research, the neuropathology of schizophrenia remains obscure.” writes one source from 1998. Even in the present literature, the neurological markers of the disease are still so vague that potential indicators are referred to as “neurological soft signs”, minor neurological abnormalities whose relationship to schizophrenia, depression or bi-polar disorder remains unclear, according to a June 2013 article in the journal *Progress in Neuropsychopharmacology and Biological Psychiatry*. Thus, the instance of detachment or abnormality in temporal experience in schizophrenia provides an interesting foil to the descriptions of temporal pathologies in MTL patients. For, unlike MTL patients, the brains of individuals suffering from schizophrenia do not necessarily show specific abnormalities that can be associated independently with a lack of the neurological capacity to process or encode temporal phenomena from the bottom up. Additionally, individuals carrying a diagnosis of schizophrenia have access to vivid episodic experience despite the abnormalities that they may exhibit in relationship to the objective features of human time. As Greenfeld elucidates in the case of Sass’s characterization of the semiotic discrepancies observed in schizophrenia, the meaningful relationships of the symbols themselves, being unanchored to logical structure or conventionally established objective measures, may be the cause of the deterioration of the experience of time. The deterioration or abnormal change in this mental experience would be responsible for certain pathologies on the neurological

---

294 Qing Zhao et al., “Neurological Soft Signs Discriminate Schizophrenia from Major Depression but not Bipolar Disorder.” *Progress in Neuropsychopharmacology and Biological Psychiatry* 43 (2013): 72-78.
level—*nevertheless in time*—and operate in a manner contrary to the case of traumatic brain injury (e.g. the MTL cases of K.C. and H.M.) where the limiting effects of the brain on the totality of temporal experience happens the other way around.

**Neuroscientific Evidence in Support of Human Time**

In addition to the logical coherence that my framework brings to the neuropsychological investigation of time and our experience in it, there is strong empirical support for my hypotheses about the relationship between symbolically created human mental time and the brain, although much of this evidence is quite unintentional on the part of the original research. Similar to the findings of Hassabis, Buckner and Carroll have noticed that there was significant similarity in brain areas engaged in tasks of remembering, imagining, navigating, and theory of mind. The researchers found the overlap of these disparate tasks in the common activation of Broadman’s Areas 44, 45 and 47, areas that correspond to the production of speech and the modulation of syntax in oral and signed languages. The concomitance of such functionally specific areas with active processes of memory and temporal modulation have indeed led researchers to speculate on the role of “self projection” or the necessarily constructive nature of mental processes with respect to time. My concept of human time, however, allows for a more focused interpretation incorporating the explicitly symbolic, mental role that may be played in such active processes.

---


Discussing the difference between temporal resolution and temporal order in autobiographical memory deficits of patients with damage to the medial temporal lobes, Saint Laurent, Moscovitch et al. lend support to the necessary relationship between language and the absolutely sequential nature of time. Their study showed that while the granularity of detail or resolution of an episode may be lacking, the temporal order of events is largely preserved in activities of free recall. The authors write, “… our impression is that the hippocampus is not sensitive to temporal specificity per se. Rather, we believe that our patients’ [autobiographical memory or ‘AM’] deficit is best characterized as a paucity of the kind of details most likely to contribute to the richness or vividness of AM recollection: perceptual and visuospatial details, and concrete time-specific story elements.”

Incredibly, the researchers go on to indicate that, “This finding is at odds with some of the literature reporting hippocampal involvement in memory for sequences, both in humans and in animals…. Key differences in paradigms might explain the discrepancy between our negative finding and the literature. First, most tasks assessing memory for sequences have a strong associative component due to the arbitrary nature of the association between the stimuli forming the sequence (Chiba et al, 1994, Kumaran and Maguire, 2006a,b). In contrast, the [autobiographical memories] produced by our participants were organized into narratives with a logical, causal structure, with one event leading to the next. It has been shown that a forward narration order facilitates the recall of stories and autobiographical events, suggesting that

[autobiographical memory] may naturally be structured as forward sequences (Anderson and Conway, 1993; Radvansky et al., 2005). In further alignment with my hypothesis about the role of language in the absolutely linear trajectory of time, St. Laurent and his team remark that real world semantics are remarkably resilient in MTL patients and indicate that the preservation of semantic relationships may facilitate the logical structure of events as they unfold in time.

In comparison to a similar study performed by Thaiss and Petrides, St. Laurent’s team, while showing a sequential coherence in autobiographical memory of MTL patients, did not check the veracity of the patients’ memory with the actual experience in the past. Thaiss and Petrides did, however, and they found that while MTL patients were more inaccurate than controls in their memory of the correct sequence of AM details, they nevertheless organized their response according to a coherent temporal structure (with more MTL patients scoring a 3 or a 2 than a 1, the lowest, indicating a high and somewhat high degree of temporally organized information). Indeed, this would be confounding information if time were acquired from the environment or if events had a natural sequence to them that was determined by the laws of biology or physics. Instead, this seemingly confusing data, that amnesic patients inaccurately recalled events but nevertheless organized their free recall responses according to logically coherent temporal cues may support the independent structure of human time from both the

---

298 Ibid., 418 (emphasis mine).
299 Ibid., citing Moscovitch (2005) in review
reigning physical and biological frameworks as they have been conceptualized [erroneously] by science. Drawing attention to this difference in experimental design and noting the preservation of the logical coherence of the memories in both cases serves to underline one of the most important aspects of my framework about the symbolic nature of human mental time: the real-world veracity of a memory is completely independent of both the subject’s experience of time and of time’s objective, linear structure. Not only does this make human time a phenomenon independent from declarative memory (declarative memory, on the other hand, like all mental processes, cannot happen outside of human time) but it also points to the fact that it is not our previous experience with the environment but rather our present perception of that experience that becomes the causally relevant set of variables in human thought and action.

Studies that attempt to extrapolate the qualities of the mind from the physiological characteristics of the brain are necessarily unequipped to account for the dissonance between veridical and false memories. Seeking to explain the features of episodic memory for both animals and humans from the “brain to the mind”, as her article is subtitled, Ferbinteanu writes that, “…though intuition also suggests that our memories are veridical—an accurate reproduction of past events—empirical data indicate that autobiographical memories are in fact reconstructed by active processes sensitive to systematic errors based upon inattention, suggestion, expectancy, and familiar cognitive scripts (Schacter 1999; e.g. Conway, 2001b). Even completely false memories are acquired easily (Loftus, 1997, 2004) and activate the same neural network involved in
true memories (Okado and Stark, 2005).” My theory paints the distinction between true and false memories (just as in true and false knowledge) as irrelevant for human neuroscience by recognizing simply that what happens in the mind necessarily happens in the brain and it is the corresponding activity in both that should serve as the central subject matter for the science. In other words, regardless of the veracity of the mind’s correspondence to external reality, “false” knowledge continues to play a causal role in both the mental and biological processes. Therefore the specific dynamics of the process in time are much more analytically significant than variables of the process in space. This feature of cognition may be unique to human mental (and therefore human neuropsychological) activity and perhaps this unique feature of the mind lends support to Ferbinteanu’s conjecture that “The experience of recollection could differ dramatically in people and animals even as the same fundamental psychological neural processes serve memory for past individually experienced events across species.”

My position on the fundamental difference between the experience of episodic memory and time in humans and animals centers on the necessarily spatial relationship that animal episodic memory has to material stimuli in the animal’s environment. The absence of such a spatial dependence, highlighted by the incidence of false memories in humans, may support my argument that neurological activity in the human brain is caused by stimuli of an entirely different nature. It may be objected that studies have been performed in which mice are “implanted” with false memories and thus the

---

302 Ibid., 692 (emphasis in the original).
phenomenon is not unique to the human mental process. The activation of a particular “incorrect” behavioral response in these studies, however, required a material intervention on the part of the researcher (e.g. the optogenetic manipulation that triggered a fear response in the absence of the appropriate environmental cues).303 Tonegawa, the senior researcher in both non-human false memory studies, has even intimated that, “Only humans have false memories; animals do not unless, like the mice at MIT, false memories are forced on them” .304

The distinction of true or false memories therefore, which necessarily depends on some adjudicating factor external to the individual, may not be an analytically useful distinction for human neuroscience. Instead what I propose that particular causes and effects in human cognitive neuroscience be analyzed in light of the subjective experience of time on the individual level. Such an exploration would have to recognize the autonomy of individual human times but would be able to do so on both the cultural and neurological level by understanding that the two processes happen together according to the objective, linear principles of causality that are characteristics of human time in general. Ultimately, this concept of time may be more useful from a developmental point of view than one that deals specifically with memory. For the constant interaction of the brain with the symbolic environment would result in the establishment of analytically significant conditional factors on the biological level—conditions in which new

meaningful stimuli were being introduced and reinterpreted in time. The most likely candidate responsible for this conditioning process on the developmental level is spoken language. Language, being our chief symbolic system, is perhaps the primary vehicle by which arbitrarily meaningful content, separated from the materially mediated signs of the environment, begins to enter our brains. Therefore, analyses of human mental experience happening in time must take careful account of the meaningful relationships inherent in language (necessarily corresponding to a particular culture, with its own historical trajectory, and therefore related to human time on the collective level) in order to adequately map out all of the possible causal relationships in thought.

This perhaps calls into question the longstanding position of empirical science and its view of our relationship to the external environment. If the logical structure of time is in fact an objective and universal feature of our human mental experience—in other words, the fundamental structure of our thought—and this structure operates independently from material characteristics of the environment in which it exists, then the ultimate arbiter of analytically significant variables in questions of human psychology and neuroscience (i.e. the line between subjective and objective reality) can only be found among the causal relationships of the thought process in time and their representations in neurological activity rather than in the stimuli or conditions of space. In my framework, the subjective experience of time—and therefore its corresponding representation in the individual brain—is accounted for not only by the unique combination of symbols that interact constituting any individual’s mental process but also

---

305 See Greenfeld’s discussion of language in “The Mind as an Emergent Phenomenon,” *Mind, Modernity, Madness.*
by the *independence of this process* from any material features of the environment. In other words, the subjective experience of time is accounted for by recognizing the unique causal trajectories of symbols on the individual level that constitute the multitude of human *times*. Empirically, these causal trajectories are reflected in certain individual processes of neuropsychological structure and function and it should be the fundamental question of human neuroscience to decipher the particulars of this concomitant relationship.

Logically this bipartisan relationship between the mind and the brain requires that the capacity of the organism allow for the activity of the mind; perhaps in this conditional role James’ idea of the neurologically represented specious present has more significance than previously imagined. The studies of hippocampal structure and function in the animal framework have shown the associative capacities of the brain in relation to the physical environment. This interaction takes place within time spans that can only be demonstrated empirically by the presence of neuronal activity whose character is either explained by previous interaction with the environment (i.e. in the past) or the influence that such neural activity has on the animal’s capacity to anticipate or effectuate certain behavioral responses relative to a very limited future. Since the symbolic process characteristic of the human mind must be supported by organic processes—themselves produced by evolution—it is reasonable to expect that certain organic capacities that we share with animals are co-opted by the cultural process allowing for the two to operate together. In regard to the immediate sense of the present, and the present’s constant relationship to the just-past and conditioning role for the just-future, psychological
experience *in time* probably corresponds to a certain threshold of neurological activity corresponding to mental activity which can be observed in the material processes of an extended organic present. In the case of both humans and animals, however, this organic present is never static (in both biology and culture we are always dealing with constant movement and change) and therefore the concept of time in the human case must capture not only the experience of this fluid process from the just-past into the just-future in mental reality but also must account for its reflection in the organic activity with which it corresponds. The missing link for human neuroscience has always been the explanation of how neurological activity translates into psychological experience, but perhaps this question is misplaced (and unanswerable with the tools of biological science) and we should accept instead that mental activity and brain activity happen together as psychological experience according to the operative logic of human time.

Such conjectures about the future of neuroscience undoubtedly increase the complexity of the issues that we are faced with in the human case—in fact, it adds another source of causality with which we must constantly contend in questions regarding humanity. However, I do not believe that the complexity is an insurmountable problem for the science. I have taken the first step to make way for such complex analyses by elucidating the principle to which they might all conform—the objectively linear structure between the past, the present and the future in time on both the collective and the individual psychological level in human time. I have attempted to delineate and describe the objective features of human time logically in reference to the cultural environment of symbols that create it and to justify this conceptualization empirically in
relation to the organic reality with which it interacts and has unique causal effects. Understanding that time is a symbolic phenomenon with characteristics of its own that are not derived from the physical or organic world allows science to understand the processes that happen according to it and to refine our questions about phenomena that are effected by it. Additionally, mapping the subjective features of time on the individual level in a manner that is consistent with, though not determined by, time’s objective features permits neuroscience to take empirical account of the multiplicity and autonomy of human times, a necessarily subjective feature of the mental experience heretofore inaccessible to previous conceptions of temporal phenomena. If we want to understand the unique qualities of mental experience particular to our species, then we must take account of the causal features of this time and use it to inform our investigations in a truly human neuroscience.
BIBLIOGRAPHY


Aristotle, *Organon*

Aristotle, *Physics*

Augustine of Hippo, *Confessions*


Cicero, *De Natura Deorum*


Copernicus, *De Revolutionibus Orbitorum Coelestium*


Galileo Galilei, "Letter to Madame Christina of Lorraine, Grand Duchess of Tuscany."


Hesiod, Theogeny


Kandel and Squire, see Memory: From Mind to Molecules (New York: Holt, 2003)


Klein, W. “How Time is Encoded.” The Max Planck Institute for Psycholinguistics


Koyré, A. From the Closed World to the Infinite Universe (Baltimore: Johns Hopkins Press, 1957).


Malczewski, E. “This is Social Science: a ‘Patterned Activity’ Oriented Toward Obtaining Objective Knowledge of Human Society” in *Journal of Classical Sociology*, 2013.


Plato, *Cratylus*

Plato, *Timeaus*

Plutarch, *Questiones Romanae*


CURRICULUM VITAE

EDUCATION

Boston University
University Professors Program
Ph.D. summa cum laude
Cognitive Neuroscience, History and Philosophy of Science, and Cultural Sociology.
January 2015

Boston University
Bachelor of Arts cum laude
Cognitive Science and French
May 2006

University of Paris IV: La Sorbonne
Concentration in philosophy
May 2004-2005

EXPERIENCE

Graduate Teaching Fellow
Boston University
September 2008 – January 2015

Mind, Brain and Gastronomy Series
Stir Boston
Lecturer and Research Consultant
August 2012 – December 2012

American Sociological Association
Section on Mental Health
Newsletter Editor
August 2008 – August 2012

Institute for the Advancement of the Social Sciences
Boston University
Associate Director/ Lead Researcher
January 2007 – Present

The MathWorks
Natick, MA
Usability Recruitment Program Specialist

French – English Translating
Paris, France
Freelance Translator
November 2004 – March 2005

PUBLICATIONS

2014 “Computers Vs. Humanity: Do we compete?” (with Liah Greenfeld), Ubiquity Symposium on Singularity, Association for Computing Machinery Publications; doi: 10.1145/2667647


PRESENTATIONS
AND AWARDS

Dissertation Defense
Ph.D. Candidate
“Tempora Mutantur”
University Professors Program
November 2014
Passed with high distinction

Dissertation Fellowship
Award Recipient
Gormley Family Fund
Summer 2013

Socratic Conversations
Institute for the Advancement of the Social Sciences
“Towards a Science of Human Consciousness”
July 2012

Socratic Conversations
Institute for the Advancement of the Social Science
“A Social History of Time”
March 2012

Dean’s Award
Graduate School of Arts and Sciences
Merit Award and Scholarship Recipient
2011-2014

Graduate Writing Fellowship
Boston University
Finalist
Spring 2012

Role of the University in Our Time
ETH Zürich
Panelist
July 2009

American Sociological Association
Section on Evolution and Society
“Evolutionary Theories: What is the Social in Social Neuroscience?”
August 2009

American Sociological Association
Section on Mental Health
Round Table Discussant
August 2008