HOMO DECEPTUS

HOW LANGUAGE CREATES ITS OWN REALITY

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Introduction

"Reality is merely an illusion, albeit a very persistent one." — Albert Einstein

When I started this project in 2007, I thought of it as a natural extension of the work of the Austrian philosopher Ludwig Wittgenstein. It was intended to be a comprehensive description on the nature and limits of language primarily based on Wittgenstein's ideas presented in his first book, the *Tractatus Logico-Philosophicus*.[1] A modernized and simplified version of his ideas would be presented, restructured in a manner that seemed reasonable to me if Wittgenstein had had the capacity and predilection to do so.

With the benefit of new research and the passage of time, some details of Wittgenstein's analysis dissolved into generalizations, but the core concepts remained and took on a much greater extended life, well beyond what I imagine Wittgenstein could have envisioned, although at one time he did think that he had solved all the problems of philosophy. If I had to take a single core concept from Wittgenstein which encapsulates what I have come to understand about the human condition, it is: *Language creates its own reality.* The questions which arise about this statement leave so much to be answered. Is it the case in fact that language does create its own reality, and if so, how does this happen? And what do we mean by **reality** anyway?

How can it be that we can go through life thinking we know the world when we cannot understand why we believe the things we do, or why the next person will believe something completely different given the same set of facts? How did the acquisition of language change the human mind? And how much can be said about the mind when consciousness is a near total mystery? The Australian philosopher David Chalmers gives an excellent summary of the various positions and arguments concerning consciousness in his paper *Consciousness and its Place in Nature* (Chalmers, 2003). In the end, we simply cannot reconcile the material world described by science and the phenomenon of *what it feels like* to have a conscious experience.

When I began this book I had not intended to cover the topic of consciousness, but after a period of time of putting words on pages, it seemed to flow naturally from the work on language. Once the meaning of language was clarified, it segued into some novel ideas about the phenomenological experience of consciousness. My own views on the subject are fairly close to those Chalmers classifies as *type-F monism*, or neutral monism. In this view, the phenomenological and the physical are intrinsically related. I believe the reader will find in the chapters that follow the development of a cohesive theory that reconciles the physical world with the phenomenological subjective experience.

This book touches on a broad range of contemporary issues in science and philosophy, and in this world of specialization, I would expect few readers to have a deep familiarity with all of

[1] Abbreviated as both *Tractatus* and *TLP* in this book.

them. Many topics not often discussed in the public arena, such as mathematical logic and quantum mechanics, are necessarily examined as they are germane to the central thesis. I have framed this book as a narrative in a style which is perhaps more in keeping with philosophy than science, although the boundaries are very much blurred, as most of the subject matter can be found in both disciplines.. Some of the ideas will be challenging enough without additional burdens. I have tried to be as inclusive as possible without sacrificing the essence of what the theory dictates. Many of the newer concepts presented are repeated throughout the book to afford the reader several variations on the general theme.

If I were to advise the reader by offering one helpful suggestion, it is to be open-minded about one's conception of reality. When we awake and open our eyes, it is that conscious experience that we typically label *reality*, and everything else must fall into place to account for that reality. But it is *reality* that should be the end product of our examination of the world; not something to be taken axiomatically. And when I say that *language creates its own reality,* I am putting reality in a contingent state until we examine all the elements that comprise that statement to a level of satisfaction whereby we are comfortable with our definition of reality. Therefore, the statement is both relativistic and unsettled all at once. It is best to throw away any concept of reality that might reside in one's mind and start afresh. Only at the very end of our analysis of the evidence can we perhaps say: *This is what we shall call* ***Reality***.

When philosophers speak of ontology, or theories concerning *existence*, there is some preconceived notion of what we mean by the term *existence,* in that we have some idea of what it means to exist. Generally speaking, we have never fully recovered from the Cartesian '*cogito ergo sum'* view of the world, as if thinking necessarily had something to do with existence. I would like to impress upon the reader that when we are not conscious there is nothing we can say about the existence of the world. We only surmise that it must go on without us. It is not an unreasonable assumption at all, but it leaves open the very problems that Chalmers outlines, in that this whole relationship of the physical and the phenomenological is unclear, to say the least. Furthermore, a word like *existence* represents a concept within language and is not necessarily related to anything outside of language. As will be shown, words have more to do with logic than existence. From a philosophical perspective, if we cover this ground thoroughly, the ontological should consequently emerge from this enquiry.

We begin our journey without any ontological assumptions. Descartes is for the most part left behind, except for the quite important necessity of explaining *dualism*, i.e. why it seems that the mental and the physical are separate things. We will take a look at dualism, but without doubt, Cartesian concepts must be abandoned; they only need to be accounted for. The Cartesian idea of thinking is not ontological at all, but rather epistemological. Descartes might well have agreed with this, but turned thought into a starting point for epistemic certainty, and goes on from there. If I were to devise my own *Cartesianesque* monologue, it might begin like this: *I think! Well, isn't that strange; I wonder how that came about.* Descartes however jumps to an ontological conclusion, when there remain deeper questions which are fundamentally epistemic. We should remember that Cartesian thinking originated in a pre-Darwinian world, when god was the creator of the god-like human, so it was not so fanciful to think that humans would be created so they could eventually come to know everything about the world and could entertain questions on the nature of existence, for god had taken sufficient care not to delude our thoughts.

It was not my intension to write a book about a conceptual reframing of how we view the universe, but it evolved in that direction during the course of its writing. Nevertheless, the core of the book remains about the nature and limits of language. Although some may find otherwise, I do not think the ideas about language presented here are speculative. They are more so a reformulation and expansion on Wittgenstein's ideas from the *Tractatus*, and a new conceptualization of the universe came about through the insights gained from this initial line of inquiry. As with any theory not residing in the mainstream it is to some degree speculative, but not necessarily novel. Much support can be found in the writings of some of the most respected scientists and philosophers of our era. If I have done anything in this, it is putting a new twist on things so that a different, yet unified, picture of the world emerges.

I loathe using the term *Theory of Everything*, because it has generally meant a unification of the theory of relativity and quantum mechanics, which customarily means formulating a theory of quantum gravity; and it seems a phrase that is a bit *over the top* as well. Although this book does not propose such a unification of gravity with the other forces of nature per se, it does cover a large swathe of theoretical territory regarding the workings of nature. There was a time when I would have thought it absurd to have language playing any significant role in the comprehension of the world, but now I am proposing that it is the *sine qua non* of making progress to understanding the universe from inception to the present.

Perspectives

> *"The doctrine that the world is made up of objects whose existence is independent of human consciousness turns out to be in conflict with quantum mechanics and with facts established by experiment." — Bernard d'Espagnat*

Underlying the immense complexity that we see around us may well be a rather simple world at its core; perhaps the kind of world that some physicists believe might be as simple as a formula that can fit on the back of a tee shirt. It is just difficult to see this simplicity through the miasma of language and anthropocentrism. We go about our lives giving hardly a thought to how words come into our heads and how we can make sufficient sense of it all so that we usually understand each other with relative ease. Yet we have not come to grips with the mechanism which mediates our understanding of the world, the comprehension of which is perhaps even more challenging than the comprehension of the world itself. This mechanism of how things come to be understood by humans, as beneficial as it may be, nonetheless forms a barrier to a deeper understanding of the world in all of its many manifestations.

Trying *to* make sense of the world has been the essential quest of philosophy and science through the ages. When we take stock of where we are in achieving this understanding of nature, it seems that three great perplexing questions stand out for which we have few answers. More than just questions, they represent gaps in our comprehension of what makes the universe tick.

- What is the nature of belief?
- What is consciousness?
- What is the relationship between mathematics and the physical world?

The answers to these three questions encompass the principal means by which we come to have knowledge of the world and will form the focus of this enquiry. When these questions are examined closely, we find that we actually know very little about any of them. So perhaps we should take one step back by first asking a single generic question: *How do we come to know the world?*

The first, and most common way, is through our senses. This is how humans and other living things obtain knowledge about the environment, an obligatory knowledge that permits an organism to behave in a manner *appropriate* for the occasion. Let us focus first on how human beings come to know the world, just to avoid a discussion on what other forms of life may or may not know about the world. Through the generally acknowledged five senses (although if we look at neural pathways, there are many more), we receive information from the physical world, filter it through some mechanism, and interpret that information through the sensations of vision, audition, olfaction, etc.

This leads naturally into the second feature of how we come to know the world, consciousness, which seems to form a backdrop, or stage, on which the sensations of the world play out. Cognitive scientists like to describe this as *what it is like to be something.*[2] Mental states supposedly have this phenomenological feature that differentiates them from physical states. I have classified this as a second feature of our knowledge, since we generally believe that the physical world goes on even if we are unconscious. We may be in a coma, and in due course we will die, yet we assume that the physical world will continue for others who remain conscious. At least this is the broad consensus of belief. The intriguing thing about consciousness is that this feature of nature, for which our understanding of the world totally depends, is for all intents and purposes a complete mystery. The so called *hard problem of consciousness* (perhaps best put *why does it feel this way?*) remains as far from resolution as ever. I would think that even if the most convincing arguments about consciousness were presented, and I was totally persuaded that an explanation for consciousness had been found, the question of *why does it feel this way* would remain. For the scientific community there seems little choice but to forget about this problem, brush it aside, and just move on to other things; but in a larger sense, we really cannot understand the world without making some headway in this area. The study of consciousness is not only a valid area for scientific enquiry, but perhaps the most important. The more I have thought about consciousness, the more I have come to believe that it is the lynchpin to which do much of scientific progress depends.

The third way that we come to know the world, mathematics, is made possible only because humans acquired language. The relationship between language and mathematics, or more precisely logic, for logic forms the foundation for both language and mathematics alike, was explored by the aforementioned Austrian philosopher Ludwig Wittgenstein, who will feature prominently in this discourse.

Not only do I hope to explore each of these areas separately, but also tie them together in a unified theory of nature.

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When the question arises in a public forum of why people believe the things they do, as it had in the 2006 Australian Science Festival Debate, the usual answer is: *We do not know* (RN, 2006).[3] Incredibly, even scientists argue the case supporting their point view from their own perspective on quite a superficial level, as if it should be self-evident that one's arguments should be self-evident and totally convincing. Upon reflection, one would have to wonder how we can have any confidence in our understanding of anything. If we admit that we have no idea how we come to believe something, what can we really say about anything which is not mere opinion and without foundation. Are we to think that faith alone is sufficient to make something true? This cannot be passed over lightly. It is difficult to move on to the next topic when we cannot offer any explanation for how it comes about, for example, that the words on this page

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[2] Terminology used in the philosophical debate on consciousness is discussed at length in the chapter on consciousness (page 58).

[3] For a good backgrounder on the subject of belief, see the ABC (Australia) Radio National broadcast on the subject. Much of what this book tries to resolve is discussed in this radio broadcast.

can be understood by readers, some of whom will agree with its arguments and some that will not. Furthermore, I may not be able to offer any proof or substantiation as to how, in any detail, I came upon these beliefs, nor how it will come about that the reader will interpret these ideas and to what degree it will influence the reader's belief systems in turn. And I do not mean this in a superficial sense. I am referring to the brain function which receives, processes and evaluates sensory and linguistic inputs which lead to one having particular beliefs. I am not suggesting that this explanation includes a neuron by neuron firing report, but something more at the system level. In a computer analogy, I would not be hoping to report on the activity of every logic gate on a silicon chip, but would at least wish to be able to provide a system flow diagram, with a goal of presenting the computer program that runs the analogous brain function as well.

The paucity of science community dialogue about belief is symptomatic of a taboo subject, which it effectively is, since it has been portrayed as an intrusion of science into areas traditionally covered by religion. It is a politically and socially sensitive area which most scientists tend to avoid. Only the likes of a Richard Dawkins or a Daniel Dennett, representative of the few who can rightly feel secure in their status as public intellectuals, have the confidence to make any foray into this *magisteria* (as it has been so labeled). Their approach originates from a scientific perspective which examines other perspectives from within its own, arguing the authority of one supposed truth value over another coming from a different perspective. A more dispassionate and objective style is rarely seen, but will be the approach that is taken here.

Religion tends to take center stage when addressing matters of belief, but it is by no means the only area covered by the term. Beliefs include such things as political leanings, racial perceptions, future success of a football team, and the physical appearance or intelligence of others as well as oneself. It is just the ubiquity of religion in human culture and the centrality of its role in so many lives that brings it to the forefront. The conflict between religious beliefs and scientific theory is often the focus of debate when the topic does arise, but the underlying mechanism for all types of belief is the same, only the specific neuronal details will differ. So at some physiological level the differences between beliefs should be represented by respective differences in neurological mappings, even if such mappings are beyond the realm of analysis at present. We should suppose that in the broadest interpretation of things that there is some configuration in spacetime which represents one's particular belief; otherwise we might have to deduce that it comes about by some kind of magic.

The fact that around 85% of the world's population say they have religious beliefs, and around 30% are covered by the most numerous group, Christianity, would imply on statistical grounds alone, that at least 70% of people are mistaken about the veracity of their belief system. Accordingly, we must ask how it is that so many humans could be so deceived in such an important part of their lives; many would say in the guiding force of life. I find it very odd indeed that the majority of individuals in any animal population could be so self-deceived about the context of their environment. It would not bode well for an animal to be so mistaken about its world, as if a wildebeest mistook a lion for a lamb. Self-deception seems so antithetical to the Darwinian process, in that it would seem to make the possessor of such beliefs less adaptive to its environment; one might be initially inclined to think that it must be a deleterious byproduct of natural selection. Deception of others is a common theme in the animal and plant kingdoms, but not self-deception. The fact that we do not observe other species with distorted views of

their world is suggestive that belief systems require deeper examination, and the fact that these other species do not have language and humans do is a good indication of where this is leading.

It would seem a good point to pause here and state what I mean by perspective. By the very nature of this thesis, a certain degree of formality and structure is required. The reasons for this will become clearer in due course. Every hypothesis I make will be made within a system of understanding that will have within it some assumptions that cannot be proven (or more strictly, will have undecidable propositions).[4] I hope to limit the number of these assumptions as much as possible (which is one of the points of this exercise), but it should be understood that every system of understanding or belief has some assumptions that cannot be proven. My approach to this subject about belief, and everything else in this treatise, assumes that all characteristics of living things come about via a Darwinian process. And in general, the assumptions underlying my perspective of the world will not venture too far from what would be considered mainstream science. It is the very nature of this treatise that it may challenge some interpretations of science, but the evidence based approach provided by the scientific method forms the foundation of my world view. It is quite clear that this will differ from perspectives that do not have the same assumptions, such as those of most religions. It is not my intention to condemn or deride these other perspectives, but rather to understand how they come about. I would assume that at least the 85% of the population that say they believe in god could not agree with my point of view without changing their underlying belief system, since my world view does not include deities. And it is probably far greater than that. This is of little concern, as I hope to describe a world within my belief system and say that *this is how the world works given these assumptions*, i.e., within this system. I make no judgment about other systems, except to state that they are different from mine. It is not a question of truth, but rather conformity with the system. If a fundamental Christian perspective was being advanced, and I wanted to check the standing of a proposition such as '*the world was created in six days'*, I would say that the proposition is true if I checked the Bible for conformity with that proposition, not any scientific body of evidence. It is unlikely that one would come to the same conclusion if the supporting structure for another belief system were used instead. What interests me here is not that one method of understanding the world might be right and another wrong, but rather why there are different perspectives at all, and how they come about. I hope to show that my particular perspective is in keeping with the spirit of the scientific method, in that it can only be said that a proposition generated from a system not conforming to the principles of the scientific method may not be true when viewed from within a system conforming to such principles. It is (unfortunately in some respects) necessary that such a strict interpretation need be adhered to, since things would flow so much more freely if not tied down by such formalities, but we need to be so careful about language, for it can very easily lead us off course. It should start to become evident that the workings of language and its limitations are central to one's understanding of the world and what can be known about the world. This is the first taste of the difficulties of venturing into the recursive process of using language to examine language.

Before we enter into a deeper examination of language, it is necessary to put ourselves into the most objective position possible, for the attempt of stepping out of language in order to examine it is like stepping out of one's skin. It is not going to be easy. The extent of this bewitchment that

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[4] See Glossary*: Formal Systems*.

Wittgenstein refers to cannot be underestimated. It is, in fact, the core of the problem of making sense of the world.

The task before us is to lose some of our anthropocentric disposition. But how is it possible to view the world in a non-human way while being human? And what does it mean to have a non-human perspective anyway? For one, it will require a non-linguistic view of the world, while describing that view linguistically, since that is the only mechanism for making such a description.

Another thing to keep in mind is that we tend to view the world from within our senses. For how else could it be viewed? Yet this view originates from a complex organism that has gone through 14 billion years of evolution from the event of the big bang. One should ask how the world might be viewed before there were humans, before there were animals, or even before there was life. The world was still going about its business, one would assume, without any human sensation to interpret it. Why should the world view of pre-human organisms have any less interpretive validity than the human one? How is the world to be regarded before the era of the human experience? It would seem that we need to go beyond a solely anthropocentric perspective if we are to resolve these issues.

Often associated with anthropocentrism is a *top down* approach to how the world operates. This approach states that it is us, our will, our actions that make things happen in the world, and whatever we precisely mean by '*our*', it is something that we believe is happening at a very high level; something we often call a conscious level. But then we must ask how do our conscious actions affect the molecules that supposedly bring our conscious actions into being, or the atoms within those molecules, or the protons, neutrons, quarks or whatever quantum building blocks that must change from one state to another to be in accord with our conscious actions. It is like a house deciding how the bricks are laid down to construct it. It would seem more sensible to have an approach where the bricks are building the house, rather than the other way around. The common belief of how things come about does not seem to hold up very well under just a modicum of scrutiny. This *'god makes man, and man makes the rest'* viewpoint has swept through nearly all cultures and even into the scientific community.

There are several things that support the view that the world is indeed a simple place. In the quantum mechanical depiction of the physical world, particles can seemingly be completely described at a point in time by their energy state, electric charge and spin (angular momentum). With the relatively small number of particles in the current *standard model* of particle physics (see Figure 1), this is not such a great amount of building blocks for such a large and diverse universe. Energy may take on many different forms and can be expressed in different ways, but the laws of physics state that we are dealing with a quantity which is conserved throughout time and space. That is, the amount of energy that we presently have in the universe is the same today as it was at the beginning of spacetime. Whether energy is expressed as heat or a vibrational frequency or motion or mass (rest energy) or momentum (a combination of mass and motion), whatever we started with is presumably still here today. So this thing we call energy is merely going through a transformation in time. And this transformation is said to be mediated by the four forces: Gravity, Electromagnetism, the Weak Force (radioactive decay) and the Strong Force that binds quarks in the nuclei of atoms.

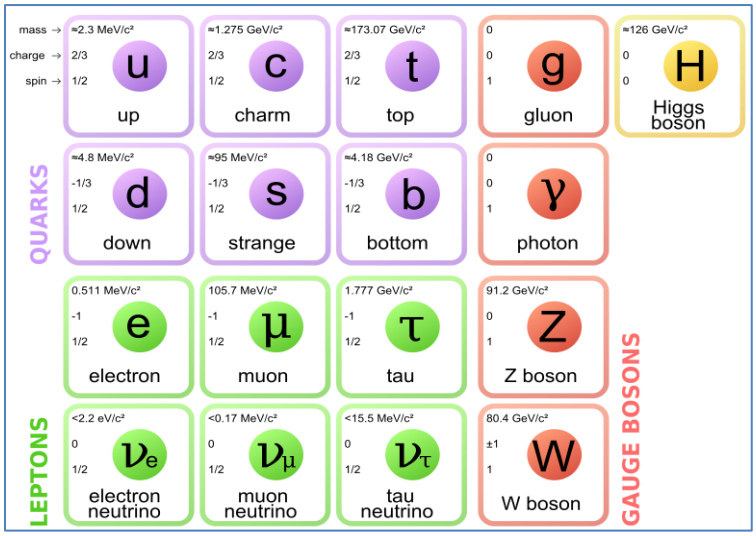

Figure 1: The Standard Model of Particle Physics

Electric charge and spin take on discrete limited quantities, which can be resolved as binary pieces of information. An electric charge is either positive or negative. Spin is either up or down, and takes on either whole or half integer values. When viewed from this perspective, there are not that many identifiers that define a particle (or should we say a point in spacetime). A description of the universe, from the quantum mechanical perspective at least, may well be presented as discrete transformations in space, in discrete units along the arrow of time.

The binary process, where something can be categorized by having either one of two possible values, but no other values, e.g. true or false, on or off, 0 or 1, seems pervasive in all descriptions of the world. It is the simplicity of the binary process which makes the world a simple place, and this is what I mean when I say the world is a simple place. I hope to show in this treatise how the binary process, and its operation as described by mathematical logic, is essential to making sense of the world.

The world can be viewed from many angles. Each perspective can tell a different story. How are we to decide which one, or combination of narratives, presents the most accurate depiction of the world? [5]

The Big Picture

My personal perspective of the world is not the common sense viewpoint that most of us share. It may have been so some years back, but I became increasingly troubled by the lack of conformity in the various perspectives offered in contemporary times. In recent years, my

[5] Many of the ideas discussed in this book are thoughtfully addressed in two papers by Dan Bruiger and present a comprehensive review of the mind-body problem and related issues (Bruiger, 2008, 2011).

picture of how the world is put together has migrated considerably from the consensus orthodoxy, so it would not be easy for the reader to delve right into the issues to be presented without offering some framework as guidance. As such, it will be helpful to most readers if I break the suspense of how this book will end, so to speak, by presenting at the outset my broad vision of how the universe works.

It may seem strange to begin this presentation with the relationship of language and logic, but I believe this will become clear in due course. For those who venture down that long tunnel that is Wittgenstein and manage to come out the other end intact, life is changed forever. There is no going back. The world is simply a different place. One sees meaning in the world as defined by language and the words *objective* and *truth* can never again sit comfortably side by side.

A belief is a set of related true propositions. It should be obvious that it is linguistic, personal and subjective. A world view is a belief system; it hardly differs from a belief except that it is likely to be an aggregation of a number of beliefs which may not be clearly related until organized into a larger coherent unit. I use the terms *organized* and *coherent* to mean in the mind of the believer, and not in any objective sense.

What can be said to be objective or subjective is an important theme in this thesis. And since this book contains words that are part of a language, hence, by my own definition it cannot be objective. Our respective individual world views are among the strongest beliefs that we have and are not readily changed. If a person is not predisposed to a world view which is similar to one's own, there is a strong likelihood that this individual will not be receptive to a conflicting world view. If this sounds a lot like the preface to the *Tractatus*, it is because I have a shared understanding with Wittgenstein about how language works and recognize that it is not the mainstream view on this subject by a long shot.

The relationship of language, our conscious experience of the world, the physical world itself and its information content, are all fundamental to the formation of a world view. However, these concepts are usually just considered part of the commonsense landscape and are seen to be just notions about how the world is, and needn't be examined in any great depth. For in fact, most of science can continue unimpeded without any consideration of such matters, usually left to philosophers to hash out.

At this point I would like to put together a few thoughts and thematic impressions which were influential in the formation of my world view. The meaning of 'theme' in this case is something that seems pervasive throughout the universe, in that it just seems to pop up wherever you look.

At the top of the list is examining the limit of what is comprehensible by a human being. There is a strong foundational belief, particularly in Western theistic tradition, that Man, as God's creation, has the capacity to completely comprehend the world, or at least come quite close; and furthermore, the world is presented to Man in a manner such that it is ostensibly and presumptively comprehensible, this being the notion that the physical world is the one and only

reality.[6] This perspective is made to the exclusion of the notion that the world may be some filtered or transformative version of a more *fundamental* form of reality, which is presented to humanity through the interpretive mechanism of the conscious experience. Without a comprehensive understanding of what consciousness is, we should not accept, *a priori*, the experience it portrays of a physical world as something fundamental or objective. So for the moment, let us hold in abeyance our thoughts on the matter until a more convincing argument can be made one way or the other.

Language is a recursive process, that is, we use words to describe other words and we use language to analyze what language is; sentences can be constructed with an unlimited number of embedded clauses in a nested series of self-reference. When we have a problem understanding something it is often because the words used in the description become spread out over an ever larger expanse of meaning, so much so that one might say that the meaning tends to become meaningless. If the definition or common usage of a term is sufficiently vague, it is hard to say what it means; the speaker, the listener, the writer and the reader all may have a different idea of the meaning to be conveyed. The word 'consciousness' is one example of this dilemma, where the term is used in common parlance, although there is barely an inkling of agreement of what it is supposed to mean. There are many points of view and positions on the matter, with not much accord to be found. I will therefore be as careful as possible when using a number of common usage terms which may have somewhat different nuances in practice.

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I came to read Jacque Monod's *Chance and Necessity* (Monod, 1971) well before I first encountered Wittgenstein. I was very much a materialist at the time and thinking a great deal about natural selection, primarily due to the book *The Selfish Gene* (Richard Dawkins, 1976), which stirred my interest in the mechanism of evolution. Over the years the title words of Monod's book have become thematic fixtures in my understanding of the universe; it just might convey more about the workings of nature than any book title I have ever come across. It is the ubiquity of the interplay of these two concepts, chance and necessity, which makes it conceptually so powerful. Although the book was ostensibly about biology, I see in the title a generalization of what is transpiring in a Darwinian process which extends beyond biology and the evolution of living things. So let's take a look at the ideas encompassing these two pervasively important words.

Necessity has a broad meaning in common parlance as well as in philosophy, particularly in reference to causality and determinism. We can think of the term to mean *how one thing leads to another in a predictable way*, in a sense that if this were not the case the world would fall apart, so to speak. For example, we expect that children will inherit some combination of genes from each of their parents and this will be portrayed in their phenotype, in accordance with the high

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[6] A spiritual reality would also be part of theistic tradition, but a spiritual perspective is not considered as a reasonable alternative here, even though it is recognized that historically mainstream perspectives with theistic origins dominate many common sense notions of *reality*. There is just no way to deal with this except from a historical perspective, lest we thrust ourselves into the commonplace *science verses religion* debate, which is something removed from this presentation.

fidelity of genetic replication. The rate of human genome mutation per nucleotide base pair per generation is estimated at around 1 in 4,000,000 (Nachman & Crowell, 2000). The large scale activities of the inanimate world also behave in calculable ways, even if our calculations must be approximations due to the complexity of interactions. The gravitational interplay amongst several celestial bodies is nearly impossible to calculate to a high degree of precision, yet is good enough to send satellites into the far reaches of space. The subatomic world also behaves in a quite predictable manner and is well defined by quantum mechanics, which also has its limits as to what can be precisely determined. Aside from these constraints, the universe is a fairly predictable place, and we can usually account for why things change over the course of time by applying some mathematical method to our observations. We may not be able to predict the weather as reliably as we would like, but we have a general idea about the contributing factors which cause it to change and evolve over time. These types of observations have led to the causal determinism which embodies the physical sciences.

Yet for all this predictability in nature, some things happen by chance alone, which itself is a necessity of nature; for without chance, the evolution of the universe would be totally deterministic from beginning to end. The deeper philosophical question is whether the randomness we observe is truly random and not some feature of determinism at a level beyond our ability to calculate. From what we are able to measure, it would seem that randomness, ranging from genetic mutation to radioactive decay is truly random, in that there is not enough information in the universe to make these events predictable.

Necessity brings stability to the world and chance makes evolution by natural selection possible. Deism, theism and atheism all leave room for this interaction of chance and necessity, despite the wide variations in these belief systems. But it should be seen that without true randomness, an omnipotent god of some sort would have to be the creator of the universe, for if nothing were left to chance, the evolution of the universe would be known at the outset or would be part of an experiment or simulation for which prior knowledge existed. We can only conjecture about this as it clearly extends beyond the limitations of our knowledge, in that it is a dialogue about something outside the time and space of our universe.

My own opinion is skewed by another theme of the universe, conservation. Given the various laws of conservation, from energy to angular momentum, it would seem to require a lot more information to create a universe which is completely deterministic than one which could evolve by some heuristic process brought about by innate randomness. It is easier to argue the case for a simpler process explainable within the universe than having to resort to extra-universal causation. Of course, those with a more religious bent would disagree with this position, but I think it is more in keeping with the principles of Ockham's razor, in that the universe can evolve a near infinite number of outcomes with roughly the same information, while a fully deterministic universe can produce just one. More on this later, but first I would like to return briefly to the discussion on causality, but taken from a somewhat different angle.

The manner in which causality fits with one's conceptualization of the world is critical to one's theoretical construction of that world. It can be said that this notion of causality is an epistemological necessity in understanding the world, for we can only make sense of the world from the passage of one state of affairs to another. And by extension, it can be said that this notion is a linguistic necessity as well, for the rules of language also, at least tacitly, assume some form of Kantian causality. Without this causal necessity the ability for linguistic

representation breaks down, for the idea of predication is meaningless if one state of affairs cannot be distinguished from another. The notion of causality wells up from the necessity of distinguishing objects in spacetime. The circularity in reasoning that arises in the discussion of causality points to the interdependence of these concepts, such that, if we refer to our understanding of the world through language, then a Kantian form of causality is taken axiomatically, including the perception of objectivity. It cannot be otherwise. If some other notion of physical relationship, such as non-local quantum causality is entertained, then that relationship cannot be rationally constructed with the tools available to the human mind. This is the reason why many concepts from quantum theory are so difficult to grasp, and why quantum entanglement causes such a conceptual problem. Anything that attempts to deconstruct the presumption of causality in our thinking is doomed to fail. In the end, causal constructions are very much subjective even though we all seem to share, more or less, the same notion of causality. Notions of causal objectivity are inferred by induction, which is fair enough, but not necessarily the case.[7] The limitations of language and rationality will have something to say about that, and we use the term *objective* at our peril.

It is nonsense to describe the world outside of these precepts. So how are we to make sense of the world? To speak of objectivity or ontology in a philosophy of the world is useless, as it falls outside the boundaries of what is possible to construct within the apparatus of our rational mind, i.e., the apparatus of language. Any rational construction of the world is thus an epistemic endeavor.

So the first notion of the world that needs to depart is that of ontic reality. It is a presupposition about the world which may be convenient, but is hardly supported by the evidence. A starting point of ontic reality is certainly not a philosophical position with any sort of neutrality, as it is supported by an unfounded *a priori* bias. Yet it is very difficult indeed to let go of both the word and notion of 'reality'. Why is this so? It's simple! We open our eyes, we see the world and there it is; so we naturally assume that must be reality. And we are led to believe that any true statement that we make about the world must conform to this notion of reality, a physical reality as revealed by our senses. To drop this notion of a fundamental physical reality would call for a total reconstruction of how the world works. And indeed this is the case.

So what is it that makes the physical world that we call reality so untenable? First there is the presupposition that our senses are fully capable of presenting the underlying reality of the world. That is, our senses give a true picture of the world as it might be understood by a hypothetical being sitting outside of the world. The arguments relating to this conception of the world are well discussed in the philosophical position called *Representationalism*, and there are many books and papers written on the subject. The general idea about Representationalism is that our mind in a conscious state produces a representation, or picture of the world, but that the world may not necessarily be that way in some more fundamental understanding of reality. Our sensory experience mediates between an objective reality and its representation in our mind. There are many variations on this theory of mind, most of which focus on notions of consciousness and the popular philosophical term of *intentionality*. Although I find myself in this broad philosophical group, I tend to differ with most of the more popular positions, particularly

[7] Induction will take the definition in logic here and not the one in mathematical proof.

those with a focus on intentionality, something I find not only unnecessary, but a hindrance to the understanding of consciousness.

If we take this one step further, it is the presupposition about the physical world which is at the heart of the problem. Under most theories of Representationalism, the physical world is still the real world; it is more a question of how this real world is represented in our minds. I would suggest that this label of *reality* that we tag onto the physical world is the part that is contentious.

If we take the representational point that what appears as our conscious experience is not actually how the physical world is, but only a mental image, then we should ask what makes up the physical world. To this we must turn to physics. Mainstream physics would propose that a *complete* description of the physical world is given by the Schrödinger wave equation. This is a quantum mechanical description of the world, where classical notions of having full knowledge of where something is and where it is heading are thrown out the window. It is a description of probabilities, not of actualities. Surely the representational view of our mental image of the world is not referring to this quantum mechanical picture but rather a more classical representation. The philosophical interpretation underpinning the quantum mechanical impression of reality has been at the center of debate since the onset of quantum theory and remains so today. In a nutshell, quantum theory defies our commonsense ideas about the physical world. Most would simply pass this off as a curiosity to be left to physicists to sort out, never to be given a further thought. However, the triumph of quantum mechanics as the most successful physical theory of all time cannot be denied, and what quantum mechanics tells us about the world cannot be ignored.

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This is the first problem underlying an ontology of the physical world is that the deep science behind explaining the characteristics of the physical world cannot tell us what it is about, except in terms of waves of probabilities, which more than hints of a problem in applying the term *reality* to the physical world. It doesn't quite sound right if you say *this is reality, but don't ask what it is, because we can't tell you*.

Having covered a bit of ground on both the mind and the physical world, we can return to the mind-body problem of relating what goes on in our minds to what goes on in the world per se. There have been many interesting terms introduced along the way which try to account for the relationship: *qualia*, *intentionality* and *representata* to name a few, let alone more common terms, such a self-awareness and self-consciousness, all of which seem to defy a tangible comprehension of what they are. There is a struggle to find the right word to describe the mental experience, because nothing quite fills the glass completely. This is where the link to the workings of language enters center stage. As a brief interlude of sorts, I would ask: Why is it that language is insufficient to describe the world?

There is much to say about what physics can and cannot tell us about the physical world. But at this point let it be said that the terms e*xistence* and *reality* should be used cautiously, as we will find that they hardly refer to anything tangible at all.

The second problem is that of consciousness itself. It would be pointless to give a definition of consciousness, because a hundred other definitions could be found that would be different. So if

we restate the problem about what we call the representational view of the *real world*, it would be the conscious representation of a quantum mechanical *reality*. So the second weakness in this quasi-orthodox notion of reality is that even at the representational level we have this term consciousness, a *thing* that remains a mystery despite the myriad theories and musings about it. We can use terms like awareness, self-awareness (or perhaps even self-self-awareness in an infinite recursive process of self-reflection), without really saying anything of what consciousness actually is. Do dogs have it? Most would say yes. How about ants? And what about plants? One's definition of consciousness seems to depend on what stage in the evolutionary process this attribute is deemed to have been acquired, although exactly what it is and how it is acquired is left a mystery.

There is much to discuss about consciousness. But at this stage I just want to say enough to show how our understanding of consciousness underpins our notion of reality, and if we delve just a little bit into this matter we actually cannot say very much at all about it. This is why I make the point that we must dispense with the ontological notion of a physical reality. It is based on a conscious mental representation of a physical world. Both sides of this relationship are for all intents and purposes unknown, or at the very least clouded in mystery. As difficult as it may be to hold in abeyance notions of an objective reality of a physical world, there really is no basis to take it as a given. To accept an objective physical reality *a priori* would first require a foundational understanding of both the world of quantum mechanics and consciousness. I would say that what we know about these two things is very meager indeed.

To this we can add the vagaries of language. We should not forget that all of this *knowledge* that we have about the world is built on the scaffolding of language, yet another thing that we tend to take for granted. We only have to look at the numerous religious belief systems to realize how deceptive the results of language-based reasoning can be. We should not forget that the worlds of science and philosophy are built on the edifice of language.

…

Most theories of reality are based on a comprehension of a combination of these three *mysteries*: the physical world, consciousness and language. We will never have an understanding of how the world works without addressing the nature of how the world that we see when we open our eyes comes about. The ingredients that make up that understanding of the world are mathematics, consciousness and language (mathematics being the language of description for the physical world). It should be more than just coincidence that both the mystery and the tools we have to solve the mystery are nearly identical.

It is not necessary to have a world of *stuff* if we have a mental representation of a world of stuff; the mental representation should suffice. A physical reality of *hard* things is quite superfluous. But we are still left with the task of explaining how that mental representation got there in the first place. The easy part is defining the problem. The solution may require a bit more imaginative alacrity.

And this brings us back to the subject matter of this treatise.

A World View

The initial point of departure on the road to my world view begins with a dismissal of all notions and preconceptions of reality. I take nothing for granted. When I open my eyes I have a conscious experience, but I can say nothing about what it is. Not the world. Not the mental experience. It is the term in language that we call *real* which must be dispensed with, as this is predicated on the several presuppositions described above, none of which am I at all comfortable in presupposing. There is nothing wrong with having ontology as a branch of philosophy so long as it is limited to categorizing speculative theories about existence. Reality is a goal, not a reality. In its common usage, reality is a tautology wrapped in a single word.

Let us begin with Wittgenstein's statement: *The limits of my language mean the limits of my world*.[8] This sets the foundation upon which my world view is assembled, which acknowledges that my knowledge of the world is limited by my senses and what I can say about the world within a linguistic framework. Without the use of language our sensory memories would fade into oblivion and we would have no way to organize them into a coherent aggregation of ideas upon which a belief system could be built. There would be no arguments, discussions, treatises, or even ideas for that matter. This is not to pass judgment on whether a world without language would be richer or poorer, better or worse, than the one we experience with language, only that it would be different. Science, philosophy and religion would simply not be possible; it is so obvious that it seems hardly worth the mention. But if science, philosophy and religion present to us certain truths about the world, and these truths are presented within a linguistic framework, we should ask how truth is extracted from language. If a certain proposition is presented as true, what does that actually mean? How did that truth value get *attached* to that proposition and what are we to make of it?

Wittgenstein would say that language gives us logical truths, to which I would agree. But he would further assert that we can check the veracity of such propositions by comparing them with facts in the physical world. To this I would differ, in that Wittgenstein accepts the objective reality of the material world, and as stated above, I do not, and certainly not *a priori*. For Wittgenstein, if a proposition in language represents a true picture (a fact) of a state of affairs in the world, (I would say a conscious sensory experience of the physical world), then that proposition is true. For the same representation, I would say that the conscious experience is an isomorphism of a proposition which is logically true.

I agree with Wittgenstein's presentation (in TLP) of language as a (formal) system of propositional logic. However, the attendant truth values (theorems of the system) should remain within their own logical space. They can say nothing about the external world. What we get from the mechanism of language presented in the must be evaluated in its own right. It should not influence what we can say about the experiential world of consciousness for which language is the tool that is used to express ideas about this world. This linkage of language and

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[8] *Tractatus Logico-Philosophicus,* 5.6.

It should be noted that it is said that Wittgenstein came to disagree with this statement later in his life. I too would not agree with this as some all-encompassing philosophical position, but rather to set the tone for how language establishes a boundary to what can be said about the world.

the conscious experience of the external world must be deconstructed, examined separately, and perhaps brought together at a later stage once we are confident that we have understood the profound implications underlying these concepts. Thus, everything that can be said about the world is accordingly stripped away. All the handles are gone. The only thing that remains is logic. And logic exists in its own space. It does not require a physical world to support it. Logic is not the world, but rather an elementary part of the world that modern human beings require to make sense of the world with their idiosyncratic biology of utilizing language as their principal tool for rational thinking.

From this new beginning a fresh pathway to comprehending the world can start without the burden of the dead-end roads where much of science and philosophy has taken us. We need to come to terms with the limits of our understanding. We are a product of Darwinian evolution with cognitive limitations; we are not the omniscient demigods that we are often portrayed to be. We experience the world in causal relationships and represent the world logically via the apparatus of language. This does not preclude the theoretical possibility of some deeper understanding of the world, only that our accessibility to that deeper understanding may be far afield in our present incarnation. It is important both to recognize and accept these limitations, and work with the tools that we have, lest we find ourselves lost on a road to nowhere.

Science is a methodology that uses language and mathematics to describe our conscious experiences, usually within the prescribed structure called the scientific method. It is at its core an experimental methodology which uses our sensory perception, and extensions thereof via the usage of clever instruments, to make generalizations about the physical world. It can tell us a great deal about the world, but must be used judiciously, recognizing our lack of understanding of the conscious experience and how it may relate to some non-subjective description of the world. As we delve into a quantum mechanical description we find clear indications of these limitations. Our senses will only take us so far, then the isomorphism of the physical world breaks down, and some other description must be found if we are to proceed; and we should not be surprised by this. Why should our senses be able to reach the limits of the universe? Quantum theory makes a great contribution to our understanding of the world, not only from what it tells us about the universe, but also from the conundrums it presents. Both should be utilized to find the best way to continue.

Once these cognitive boundary conditions are established the most reasonable way to proceed is to hold on to the things we know we can work with and try to move on from there. First we should reexamine the hierarchy of how our universe is structured. The three main variations on this theme can be found in many writings on the subject. I have taken the following three from a paper by the physicist Paul Davies that was included in a book by mathematician Gregory Chaitin (Davies, 2007):

1. Laws of physics → matter → information.
2. Laws of physics → information → matter.
3. Information → laws of physics → matter.

I would like to propose yet another way of looking at the hierarchy:

Information → Laws of nature → Consciousness

In this scenario, the universe starts out as a singularity of information all of the same type. It has been estimated by Seth Lloyd and others that the total information content of the universe is between 10^{120} and 10^{122} bits (Funkhouser, 2006). In the usual 0 and 1 notation, let's say all the bits are initially set to 1 and go through a process whereby some bits are converted to 0, so that the universe evolves into a network of 1s and 0s. Whether we call the driver of this process the laws of physics, the laws of nature, the algorithm or the computer program that runs the universe, we are saying essentially the same thing. It is perhaps preferable to call it an algorithm, as this most closely conforms to the concept of information. Planck Time (the theoretically smallest interval of measurable time) would be equivalent to the clock speed of a computer, and each instant of Planck Time would execute another iteration of the algorithm in some variation of a Hilbert Space, or perhaps best left to an even less defined *Information Space*. We should hold open the possibility of doing some type of *reverse engineering* of the physical universe from what we can discern from quantum mechanics and string theory; perhaps there are enough clues to begin deciphering the nature of this algorithm. But we are still at the early stages of this journey and for now it must suffice to simply outline the structure of a newly defined reality in the making.[9]

I would like to modify the definition of the term *'evolution'* so that it encompasses the Laws of Nature as stated above. The general use of the term has largely referred to how biology evolves, but I see biology as just a special case, involving more complex entities, of the general case of the universe as a whole. Additionally, natural selection is construed as a special-case term as applied to the evolution of biological entities, where the general case would be the evolution of the information content of the universe as dictated by the algorithm we call the Laws of Nature. But make no mistake; the laws that apply to the evolution of mammals are the same that apply to quantum mechanical objects or strings, assuming they are good representations of the subatomic world. It may not seem that apparent since the algorithm that we are looking at in biological evolution disguises the subroutines taking place at quantum scales and even Planck scales below that. When we examine the evolution of highly complex entities, such as biological entities, we are looking at the outer layers (or higher levels) of nested loops of computation, without examining the computation taking place lower down in the nested hierarchy. Upper level procedure execution cannot take place without the more fundamental procedures residing deeper in the nest. I will leave the details to a later chapter and return now to the next part of the picture.

One might wonder what happened to *matter*, and why it found itself replaced by consciousness in my hierarchal model. The reason is that they are in fact one in the same. The conscious experience of the physical world is no different than what we actually call the physical world. There is no objective physical world per se, only the experience of the physical world. There is no objective physical reality, but only a subjective experience of a physical reality. Where did all the stuff go!? Well, it was never really there in the first place. Not an illusion; just a transformation. Not Idealism, but rather elevating information and consciousness to a more prominent position in the scheme of things. When we are not conscious, whether it be in a deep

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[9] My view on the primacy of information is a variation on the general theme of what has come to be known as Digital Physics or Digital Philosophy. A paper on the field by one its leading proponents, Edward Fredkin, can be read for a more detailed background on the subject (Fredkin, 2003).

sleep, anaesthetized, or no longer amongst the living, we cannot and do not experience the physical world. We just assume that the physical world will still be *out there*, but we are not in a position to experience it. I contend that this is a misconception, mostly due to a bit of linguistic trickery and is perhaps the greatest deception that language plays on us. The reason we cannot come to terms with the nature of consciousness is because we accept the reality of the material world axiomatically. If one's description of the universe is that of an algorithm that leads to the evolution of information into aggregations of complex relationships, and consciousness is some expression of a subset of the state of affairs of the universe from the perspective of a particular entity, then everything in the universe has some form of consciousness which will vary based on the complexity and nature of the respective entity. Consciousness by its very nature is subjective. It doesn't matter if you are referring to a human being, a bat, a tree, a hydrogen atom or a cell in the liver of a chimpanzee. Each respective entity, however defined, needs to determine the state of affairs in its environment in order to *know* what to do next. That is, how the algorithm will arrange the bits of information in the universe in the next instant of Planck Time. At the level of the human organism, consciousness just happens to take the form that presents a movie type experience of tactile substances in a three dimensional space. If an oak tree had language, I am sure it would describe a completely different conscious experience. Wittgenstein might call this a different *form of life*, and perhaps expressed the same idea in his statement: *If a lion could speak, we could not understand him*.[10]

Many years had passed before Albert Einstein took the experimental evidence for the constancy of the speed of light at face value and changed the course of physics. In the same way, we should accept that where our consciousness ends, so does the physical world, just the way it seems.

…

I thought this summary would be constructive before going into the detail of how the various pieces of the puzzle fit together. It may take some convincing to let go of the physical world as an objective reality, but I hope to show how language presents a prejudicial view of the world which, when examined closely, is not justified.

There are a few anecdotal points worth noting about the philosophical position presented here:

- There is a simplicity about it that conforms quite well to Ockham's razor.
- The laws of nature are consistent at every level of size and time.
- Emergent properties can be explained by transactions at lower levels, not by the introduction of something new into the universe.
- There is a great economy of just about everything, in conformity with the conservation laws that are observed in nature.
- The world is analogous to a manufacturing process with very simple machinery. There are lots of repetitive processes. The output is something more refined than the input materials (complexity), and there are waste products at the other end of the process (entropy).

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[10] *Philosophical Investigations*, p.223

- In the spirit of Jacques Monod's *Chance and Necessity*, we find a ubiquitous fidelity of replication, spiced with the odd random occurrence, which allows the overall system (the universe) to maintain its basic structure yet evolve with the passage of time. And if time is equated to the ticking of the Planck Time clock, then there is plenty of time for randomness to do its work.
- Everything is accounted for in a single theory. If the present explanation is not totally convincing, there is at least a pathway to future progress.

Something to take out of this big picture view is that the world presented by the conscious experience is an isomorphic representation of a mathematical (or logical) construct. We needn't have language to access the representational part of this duality, which we call the physical world, but it adds to the picture. With language, we can tap into the underlying logic which creates that picture. As such, language becomes a link between the two, as it resides in both worlds: the world of logic and the world of perception. Both can be used together to construct a more meaningful picture of the world.

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The chapters that follow will present in greater detail how this picture of the world came about. It should be apparent by now that the cornerstone will be a theory of language with a foundation in the original work of Wittgenstein. It is on one hand surprising how little influence Wittgenstein has had on modern science, despite the broad recognition of his genius; yet on the other hand, an acknowledgment of how difficult it is to extract the essence of his philosophy from his writings.

Language

> *"Philosophy is a battle against the bewitchment of our intelligence by means of language."*
> *— Ludwig Wittgenstein*

A central theme of this treatise is the nature and limits of language. It is my contention that the world cannot be understood, that is, one cannot make sense of the world, without first coming to terms with how language functions. Making *sense* of something is a term in philosophy often associated with Wittgenstein, but is just another phrasing for a way of determining the meaning of something.

The basis for this contention is that the apparatus used in all rational thought, including the current argument that you are now reading, as well as every other set of arguments which purports to describe anything, is actualized within a linguistic construction. As obvious as this may be, it nonetheless needs to be emphasized that without the use of language there could be no discussion of anything at all. In respect to rational thought and communicating a sense of how the world operates, if not for language, humans would find themselves, more or less, in a position similar to that of chimpanzees. Language fosters the development of deductive reasoning, something which is seldom observed in the animal kingdom, and when it does arise, it is quite limited. I would conjecture that the pre-linguistic development of deductive reasoning as a precursor was the evolutionary driver behind the emergence of language. It is through language and the attendant deductive reasoning that humans make rational sense of the world. And further to this, the understanding of the world gained from the empiricism of science has become the orthodoxy by which knowledge is measured. All of this is due to the fact that *Homo sapiens* acquired a very handy tool for dealing with these matters; the tool which we call language.

So, how well suited is language as a mechanism for making sense of the world? Language is scrutinized herein to find the answer to this question.

Very little is known about the specifics of how humans acquired language, and perhaps for this reason it does not enter into most theories of mind to any significant degree. Although the exact details of language acquisition may not be known, there is enough evidence to piece together the evolutionary trajectory of language in order to see how it may fit into a theory about how we came to have a conscious experience largely dominated by words.

In summary, this is what can be said about the emergence of language:

Whatever language is, it certainly came about via a Darwinian process. The oldest human fossils have been dated to round 200,000 years ago, with some anthropologists estimating 250,000 years as a likely upper transition point to what can be said to be anatomically modern humans. Since speciation is not an overnight process, pinpointing an exact date is as much definitional as biological, and having to pick a number like 150,000, 200,000 or 300,000 would not change much as to how we view the nature of the human condition. Much of taxonomy, although

systematic, is about classification and subject to change, as is most of science for that matter, as when new theories cause a shift in the paradigmatic thinking of the day.

Language is believed to have arisen around 75,000 years ago, with estimates ranging up to 100,000 (Bickerton, 2007; Widgen, 2004).[11] Some anthropologists estimate that the all African human population may have been as low as 2,000 to 10,000 individuals at the time of language emergence. Around this time humans are believed to have begun their continuous colonization of the world, taking language with them as they journeyed to settle the other continents. There seems to be a growing consensus around this theory, all of which seems quite reasonable. Written language is dated to between 5,000 and 6,000 years ago, and may have arisen more than once. But most peoples had written language introduced by invaders. Many tribes still do not have a written form of language.

Some aboriginal tribes, such as the Pirahã of the Amazon rainforest, are thought to have very small languages of perhaps no more than hundreds of words (and quite likely fewer than 1000), and a distinct lack of numeracy (Everett, 2005; Nevins, Pesetsky, & Rodrigues, 2009). These tribes do not exhibit the worship of deities and have few if any stories. They would lack what more technological humans would call culture. But it would not be seriously suggested that they are not human nor do they lack the intellectual capacity of humans with larger languages.

…

Tractatus Logico-Philosophicus, an analysis of the nature of language by Ludwig Wittgenstein, was published in 1921(Wittgenstein, 1922). It was promptly recognized as a work of great importance by Bertrand Russell and other prominent philosophers and mathematicians of the time. This treatise identifies the relationship between language and logic and defines the limits of philosophy by articulating the conditions for a logically perfect language. In one of the most extraordinary and distinctive of written expositions, Wittgenstein shows how language can be understood as a formal system of propositional logic (see Glossary item). It is this great insight that sets the stage for understanding how language works in the mind.

Widely acknowledged as the 20th century's most important philosopher, Wittgenstein's life and work has been examined and debated in academic circles from the time of his early days at Cambridge University. It is not my intent to enter this debate in any significant way, but rather start with the central thesis of his work, particularly that found in the *Tractatus*, expanding upon that thesis to show how indeed natural language, and not just idealized language, is a formal system of propositional logic, and precisely what that means. To say that the *Tractatus* is a difficult work to understand, especially for those uninitiated in logic, would be an understatement. Wittgenstein makes little effort to help the reader comprehend where he is heading; many of the terms and phrases used can be interpreted in a number of ways. To have a reasonable chance of understanding the deep meaning of Wittgenstein's work, the *Tractatus* may need to be read several times. But once its meaning filters through, it can become quite poetic and almost lyrical. Whatever may be derived from the *Tractatus*, there can be little doubt that it is unique in the annals of philosophical literature.

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[11] These date ranges are very sketchy, which even the authors admit, but 50,000 to 100,000 years ago seems to fall within the general consensus.

The last 2 sections of TLP are regularly quoted and are often used to illustrate Wittgenstein's ideas and philosophical style:

> *6.54 My propositions are elucidatory in this way: he who understands me finally recognizes them as senseless, when he has climbed out through them, on them, over them. (He must so to speak throw away the ladder, after he has climbed up on it.)*
>
> *7 What we cannot speak about we must pass over in silence.*

It is interesting to note that perhaps the most critical examination of TLP comes from Wittgenstein himself, principally in his *Philosophical Investigations* (PI), first published after his death in 1953(Wittgenstein, 1958). The PI expounds upon the bare bones logic of the *Tractatus* into a more general examination of human language, and is much more approachable than the *Tractatus*. But PI has generated much debate amongst Wittgenstein scholars as well. In any case, his elusiveness has guaranteed that his writings will long remain both interesting and challenging.

Although the *Tractatus* fails to resolve all philosophical matters as Wittgenstein had initially suggested, it succeeds in expounding the fundamental relationship between language and logic. This permits us to rethink some of the assumptions that we make about the world, including those concerning causality and epistemic considerations regarding the physical world, or what most call *physical reality* or simply *reality*.

The terms *propositional logic* and *propositional calculus* are often used in the logical analysis of language; *rule-following*, a terminology sounding a bit less technical, can just as well be used in its stead. The game of chess, which will often be used metaphorically in this book, can equally be described as a rule-following system or formal system of logic; for all intents and purposes the terms can be used synonymously. What is being described is a system of a specific set of rules, that when followed, will unambiguously produce a legitimate result within that system. In the case of the game of chess, there is never a doubt as to what constitutes a legal move and what does not, as all such questions can easily be resolved by reference to the rules of the game. Nothing is left to chance.

When we explore natural language as a rule-following system, it need not be so restrictively conceived in the way it is generally applied to formal systems of number theory, as might be found in applications of mathematics or in computer programs, with a set of axioms and well defined rules for the generation of theorems. Although language is a rule-following system, these rules seem to be loosely constructed and ill-defined. This is acceptable under the circumstances; there is nothing to say that amongst the rules there will be rules that permit some fuzziness or misstatements in both their execution and interpretation. At some level the rules of binary logic will conflate with rules of fuzzy logic. It is this imprecision that defies the discovery of a definitive language algorithm. It is in our conception of what a formal language system must be that can be problematic in understanding Wittgenstein's general idea. If some form of randomness is part of the natural world, and there is every indication that it is, then we should not expect that formal systems conforming to the natural world would be strictly deterministic, in a classical sense, at every level of examination. If randomness is intrinsic to the construction of the world at a basal level, when we look at language, which operates at a very high level of complexity, the actual nature of the randomness and indeterminate complex decision-making relationships is buried so deep in the algorithmic hierarchy that it simply not

observable. As such, the connection goes undetected and without consideration by those working in the fields of linguistics and cognitive science. One cannot examine a state of affairs solely at a top-level and expect to comprehend what is going on at lower levels. An entirely new picture of this process must be constructed.

The outcomes of binary decisions at high levels of operation can be probabilistically deterministic in a manner similar to what is found in quantum mechanics, where the observed determinism is probabilistically distributed in accordance with the wave function. At the macroscopic level, we can take the example of a person coming to a fork in a road for which the person has no previous references. How does the person decide whether to go left or right? There will likely be many determining factors, including road appearance, position of the sun, general notions of the direction of the correct path, historical preferences for either left or right and similar determinants. These will go into some value weighting system. Let's say that on a scale of 0 to 100, a value of less than 50 means turn left and over 50 means turn right. A value of 50 may result in a random 'coin toss.' But a mechanism whereby calculated values between 48 and 52 result in a coin toss may be operative as well, so that close calls will be randomized as part of the rule-following system. Anecdotally, we often have this feeling of not quite knowing what to do when our internal valuation system seems finely balanced around the 50-50 mark, with each consideration and re-evaluation of the circumstances swaying the decision to one side and then the other. This is suggestive of the probabilistic determinism of the natural language decision process in action (although recognizing that there is more than just rational linguistic inputs that enter the valuation system). We cannot directly examine the quantitative value weightings of this process, but when weighing up important decisions, we may at times experience them in a mind-consuming process of long duration.

This process, as noted, is not of a purely linguistic origin. In humans there are combinations of sensory, emotional and rational (language-based) inputs. Furthermore, we may observe how a startled animal freezes when confronted with a potential danger, such as a cat spotting an unfamiliar dog or human, waiting to see how the situation evolves before making the next move. There is experimental data in controlled environments supporting this view (Montague, Hyman, & Cohen, 2004). It has been proposed that the value weighting system is moderated by neuromodulators, such as dopamine, and randomness is also integrated into the system. One should expect that decision processes which can take a range of potentialities would be normally distributed, as it would be a notable exception for nature to perform otherwise.

…

As Wittgenstein credits Gottlob Frege (1848-1925) and Bertrand Russell (1872-1970) for stimulating his ideas, I in turn credit Wittgenstein for the motivation of my own contemplations on these matters; but now must leave Wittgenstein (not completely, but to some extent) and start afresh while maintaining the kernel of Wittgenstein's conception of language and logic.[12] From here on, I will offer my own interpretation of Wittgenstein's ideas. There are many areas where I may not be in agreement with Wittgenstein's philosophy, but do not see the point of

[12] In the 1918 dated Preface to TLP, Wittgenstein writes: ….. *I am indebted to Frege's great works and of the writings of my friend Mr Bertrand Russell for much of the stimulation of my thoughts.*

examining those differences in any great depth. For example, in my own view of the world, I would not know what to make of *TLP 4.01 'A proposition is a picture of reality'*. The word *reality* is such a loaded word that I would strongly argue against its usage in such a headline statement. I understand what Wittgenstein means by the statement, but my own position has moved far enough from Wittgenstein's where I would not pursue this line of reasoning. There is no need to go further into such matters, for in the end, it is the importance of the relationship between language and logic which is the essential part, to which Wittgenstein and I are in accord.

…

There is a vital thread linking language, axiomatic systems and the perceived physical universe which unifies them together into one neat composition. We know there is something about mathematics that is at the core of what the universe is all about. The foundation of mathematics is based on the axiomatic set theory and first-order logic. An axiomatic theory stipulates within its construction its own limitations about what it can say, effectively establishing its own boundary conditions. Although the construction of a good axiomatic system may be difficult when the system being represented is complex, the structure itself is rather simple. We start by defining the symbols and grammar of the system, which is a common understanding of how the system operates, whether it be a game or a language. To this we add a set of assumptions, called axioms; these assumptions will be taken as *givens*, which generally speaking cannot or will not be proven. Further to this, we will have a set of rules that will generate true statements, or theorems within the system having aforesaid axioms, which once derived can in turn become axioms as well.

Even if one feels comfortable with mathematics, some of the concepts concerning logic and the foundation of mathematics can be daunting. It is a subject matter which rarely ventures beyond a small circle of academics, although computer scientist Douglas Hofstadter managed to reach a much wider audience with his remarkable book on *incompleteness* (discussed below) titled *Gödel, Escher, Bach: An Eternal Golden Braid* (Hofstadter, 1979). To natural language within this framework only adds to the remoteness of this topic from ordinary discourse. Except for those conversant with the subject, it is not easily seen how language would fit into a formal mathematical system. Yet, all this said, a grasp of these concepts remains critical to understanding the principal themes found in this book. I have employed the metaphoric use of games, particularly chess, to help scale this crucial barrier.

A vital addendum to formal systems are Kurt Gödel's *Incompleteness Theorems* (Gödel, 1931), which states, in part, that: *All consistent axiomatic formulations of number theory include undecidable propositions.*[13] This problem of *undecidability* has troubled mathematicians since the theorem's publication. Further to the difficulties it poses to the foundations of mathematics,

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[13] More precisely, Gödel's theorem states: *Any effectively generated theory capable of expressing elementary arithmetic cannot be both consistent and complete. In particular, for any consistent, effectively generated formal theory that proves certain basic arithmetic truths, there is an arithmetical statement that is true, but not provable in the theory*.

There has also been considerable contention as to whether Wittgenstein understood or agreed with Gödel on this matter, a debate which continues into the 21st century.

it implies that scientific theories, which are based on mathematics, cannot be proven at some scrutinized level of examination. The importance of Gödel's Theorem cannot be understated and requires an in-depth discussion in its own right, for it sets the very boundaries to knowledge and affects every aspect of investigation within the universe and how the universe itself must be viewed. And akin to the concept of *chance and necessity*, it should be regarded as a universal thematic.

The reason for this *undecidability* is recursion, or self-referencing, and the fact that formal systems are defined by their axioms, which are unproven autonomous declarations. The axioms of a formal system are said to be *recursively enumerable*, which means, by example, that a computer program can generate all the axioms of a recursively enumerable system without generating something that is not an axiom. So a formal system is a self-contained, self-defined, self-referential system. A formal system lives within its own logical space. So it should be noted that if natural language is a formal system it too would live within its own self-referential logical space.

The complications presented by Gödel's Theorem are exemplified by the following set of statements about how we come to know the world:

1. The most reliable source of knowledge about the world is obtained from science.
2. Scientific theories use mathematics as the basis for their proof and veracity.
3. Mathematics is based on logic.
4. Logic is an axiomatic formal system.
5. Gödel's Theorem states that formal systems of logic, therefore mathematics, therefore science, therefore knowledge will have statements which are deemed to be true within its own set of rules, but cannot be proven.
6. The above 5 statements are true within this recursive system, but cannot be proven since the first statement is an axiom of the system that was the trigger for producing the other statements.
7. All sets of propositions in any language will be generated within an axiomatic system and subject to the same constraints.

Since language produces the kind of knowledge that we are concerned with here, whether it be systems of scientific truths, other fact-based truths or revealed truths, its axioms must be carefully scrutinized. Furthermore, as there is a wide acceptance of belief system relativism, we have a socio-political pragmatism which allows for the flourishing of under-scrutinized truth-generating systems. Within this perspective mathematics can be viewed as a subset of language, having a more strictly defined set of rules of operation and a more rigorous scrutiny of the production of truth values. There are not any socio-political considerations to be concerned with in mathematics to muddy the waters. We would not permit an incorrect mathematical proof simply because it was deemed to be *politically correct*. It would seem that natural language is often placed outside the rigors of formalism mainly because it is just too hard to lock down all the rules and definitions necessary to deal with it effectively under such a system. But the real determining factor concerning whether natural language does or does not function as a formal system should be in its actual biological execution, regardless of its complexity.

The critical point regarding *incompleteness* as it pertains to belief systems using natural language is that perfect knowledge cannot be obtained from within a formal system, only from

outside the system (meta-system) looking back into the system under scrutiny. Since we cannot step outside our universe, or even outside our language, we have to live with this limitation. Rather than eschew these findings, they need to be embraced if we are to come to terms with how the universe operates. It is just the way things are. Language is the starting point of this re-examination of the basis of knowledge. It needs to be picked apart, warts and all, and handled with a full understanding of its limitations. So when I asked the question: *How well suited is language as a mechanism for making sense of the world?* We might reply that it has its limitations; and we will need to dig deeper to see just how far these limitations go.

Figure 2: What Can I Say About My World?

Gödel's Theorem can be put another way that might add a bit more clarity: *Anything you can draw a circle around cannot explain itself without referring to something outside the circle – something you have to assume but cannot prove.* If you have lived your whole life inside a sealed box, shut off from the outside world, you can have no knowledge of your standing in the universe. Wittgenstein states: *The sense of the world must lie outside the world. In the world everything is as it is, and everything happens as it does happen: in it no value exists— and if it did exist, it would have no value* (TLP 6.41). So if we start with an examination of language as a formal system of propositional logic, then a circle must be drawn around language and examined in self-referential terms. That is to say, that language is used to examine language.

Once we come to terms with how language functions as a formal system, we can see how it is just one idiosyncratic case representative of everything else that is going on in the universe. The same algorithm that produces language creates life in all its variations, as well as the planets, the stars, atoms and the state of consciousness that allows us to perceive the world in those terms. Language can also be seen, by dint of example, as a window to how these other things come into being. The challenge for science is to get itself in a frame of mind that allows it to find the kind of algorithm that can account for all the processes we observe in the universe and see if it can be put into a tidy package.

…

Although Wittgenstein wandered off on a somewhat different track after the *Tractatus*, it would seem to me that all that has been written in this chapter leads naturally from this work. Having contemporaries such as Kurt Gödel and Alan Turing would suggest that it would have been a good time to incorporate Wittgenstein's theory of language into the world of computing and computability. Perhaps it is because Wittgenstein went a bit off course from the central theme of the *Tractatus* that this never quite happened.

Inductive and Deductive Reasoning

Let us take a look at how an animal with true language differs from one without. Induction and deduction are the two principal classifications of how animals predict the future and decide what action to take in a given situation. I believe that the balance between these two ways of reasoning played a critical role in the development of language and will approach the subject with this in mind.

It is not by coincidence that we once again find an important duality in nature. There is an analogue here to the *chance and necessity* duality which is not immediately evident. The laws of nature are about how we go from one state of affairs to the next in respect to time. Induction corresponds to the *necessity* part of the equation; we take what was ascertained from one state of affairs and apply it to an analogous future situation, the assumption being that what has worked in the past will apply in the future. Decision making of this sort brings both stability and predictability to the world in that the past dictates the future. All animals that can learn from experience with some reasonable level of sophistication use induction as their primary driver in the decision making mechanism, with the possible exception of humans, where the balance is not so clearly resolved. Induction acts as a fine tuning mechanism for the instinctive behavior that animals are born with. Generally speaking, the more complex the animal, the more room is left for learned behavior, particularly for animals capable of adapting to diverse environmental conditions.

Deductive reasoning is another kettle of fish. With the exception of humans, it is not often observed in nature, and when it is, only to a limited degree. Some parrots and corvids have shown remarkable problem solving ability, both in the wild and under controlled conditions. Many primates along with dolphins and a number of other mammals exhibit generalized problem solving behavior that is suggestive of the process of deduction. Deductive reasoning can be viewed as bringing *chance* into decisions about how an animal might behave in a particular situation, in that, the animal must first form a hypothesis about how the world works and then test the hypothesis in a situation which seems an appropriate application of the general principle. This is what tool making is about. The relationship of the principle to the applicability is deduced, not taken from a like past experience, so there is a far greater chance of error due to misapplication of the principle.

In the context of our understanding of language development, it is important to recognize that deductive reasoning mirrors a formally logical construction. There is the formation of a set of premises about the world, and on this basis some rules will be formulated on how to proceed in the accomplishment of a task. For example, if one has used a stone to craft a piece of flint into a

sharp point, a generalization may be made about how stones can be used to shape objects. This understanding about the relationship of the use of stones in the shaping of other objects in the environment can be applied to flint in the construction of spear tips, large arrowheads and small arrowheads, arrowheads made from materials other than flint and on and on. If the premise is that *stones can be used to form arrowheads from any material*, one would eventually discover that the premise is not completely correct and would need some refinement, as when the rule is applied to things such as diamonds or butter the premise will be found out to have failed in these instances, as the relative hardness or softness of the material to be formed will play a role in the ability to complete the task. Hence, such is the case with deduction, language and other formal systems; the results are only as good as the premises. It can nonetheless be seen that once a good set of premises is established, this type of reasoning is very powerful in its potential application across a broad array of conditions.

The use of tools and the control of fire by ancestral humans are fairly well documented and were refined throughout the period of encephalization. It would seem reasonable to conclude that this is evidence of deductive reasoning due to the broad application and variations of behavior, as well as encephalization itself. If we imagine how a non-linguistic primate would construct the logic necessary for deductive reasoning, it would almost certainly be by visualization. The construction of a logical picture would require a significant amount of neuronal power, analogous to the storage of images on a computer, thus the finding of hominid encephalization corresponding with this pre-linguistic period of early technological development. This is why humans already had large brains before the acquisition of language. We needed to store all those visualizations requisite for crude deductive reasoning prior to the acquisition of the symbolic substitution for these visualizations. When I speak of symbolic substitution, I am of course referring to language. This would seem to be the evolutionary driver for language development consistent with the evidence. Symbols replace visual imagery in the deductive reasoning process. The formal system of logic is already in place and so is the computational powerhouse to deal to with it. Visual logic is replaced by propositional logic, and as they say, the rest is history.

Language as a Sense Organ

It should be clear by now that when I refer to language I attach to the definition that of a formal symbolic system. I am not referring to a variety of other aspects of human language which are shared with many other animals; these can be categorized mostly as communications represented by one-to-one relationships between the sign (usually a vocalization) and its meaning. Communication is an important aspect in the life of most animals and the word *language* is frequently used in a generic reference to this behavior. Researchers have estimated that chickens have between 20 and 30 unique vocal signs with associated meanings, including references to food, danger from above, danger from below, egg laying, brooding and imperatives (like *get away from me!*). Human language appears to be unique in its breadth of syntactic features and neural pathways. As such, it shares much with what we normally associate with traditional human senses of sight, hearing, taste, smell and touch. It is generally understood that we perceive the world through these five senses. It is not important to this discussion that the

number of senses is higher if we count neurological pathways whereby we might include pain, balance, temperature and a number of others; our common historical understanding of a sense will suffice here.

Broadly speaking, a sense organ is simply a faculty or mechanism for perceiving external stimuli. It receives input from the environment (or the world perceived to be exogenous to the mind) and processes it into something we interpret as meaningful. The eye receives electromagnetic radiation (EMR) as input, sends the signal to the brain to process into what we consciously experience as vision. The ear accepts waves of air pressure which are interpreted as sound. In effect, the input itself cannot be directly experienced; it is processed by the respective sense organ and corresponding parts of the brain. It is then stored in memory to be interpreted, directly or through recall, as a conscious experience or for subconscious processing. If one is not conscious then sound waves will not be interpreted as anything, since part of the apparatus for processing this input is not functioning, notwithstanding that there may be other neural pathways to register stimuli even if the primary organ for interpreting such stimuli is not operative (blindsight for example). Vision and hearing, as with all the senses, are something interpretive of the world external to the mind. They do not show what the outside world actually is, only an interpretation of the input. This has been previously discussed as the representational view of the world.

I would propose that the *language organ*, as ill-defined as it might be, is itself a type of sensory organ. What the sensory part of language does is receive a proposition as an input, and assigns a truth value to that proposition as its output. In this way language operates very much like any other sense organ, as it receives information from the external world and processes it into a representation in the internal world of the mind. For most people the input will be in the form of sound waves, but hand signs used mainly by the deaf work quite satisfactorily and accomplish the same task. These signals are then parsed into words and interpreted using the rule-following system of grammar to form structures such as sentences, some of which can be classified as propositions. Structures, such as imperatives, can be simple or complex constructions of one-to-one symbol-semantic relationships. But the ones we are concerned about here are the propositions, for these are the ones which allow language to grow into the combinatorial assemblies that we find in modern language. There are many neurological processes that have been skimmed over to get to the stage where we are discussing propositions. Linguistics is a broad field with numerous specializations and it is not my intent to review them in any depth, but rather jump to the part that relates to the question at hand, which is the rule-following aspect of language.

It may not be customary to include language as part of the usual panoply of senses regardless of the definition one chooses, but upon close examination, language incorporates many of the typical features of other senses. Broca's area and Wernicke's area of the brain are two regions often identified with the production of language, so a neurological basis for categorizing language as a sense is fairly well established. There is evidence that the inferior parietal lobule near Wernicke’s area may be the key region used in linguistic syntactic and numeric processing (Jackendoff, 2002).

Since language utilizes hearing as its primary input mechanism, one could say that it piggybacks on another sensory system rather than being a sensory system in its own right. But the fact that language can also piggyback on vision and touch shows that these senses are merely vehicles for

the primary pathway for linguistic inputs to get to the cellular mechanism that processes it. Although the exact mechanism of language evolution is not clear, most would agree that it evolved from a more rudimentary form of verbal communication; it should be noted that gestural origins for language have also been posited (Christiansen & Kirby, 2003; Jackendoff, 2002; Masataka, 2008). A most convincing argument for placing language among the other senses is that we don't need any other sensory vehicle to use language when thinking. We effectively talk to ourselves without vocalizing, although sounds will come into our minds if we have normal hearing function and the related visual context will take part if one is a user of a signing system such as American Sign Language. But there is nothing entering from the external world per se. All the inputs and outputs are within one's own brain. Language takes external sensory inputs, adds to this its own stored memories and creates a logic-based perception of the matter in question. Therefore, further to the usual perception that a non-linguistic animal might have, a linguistic human can have a rational take on a particular state of affairs.

Whether one feels comfortable with conjoining language with the usual senses is not all that significant, but perhaps reinforces that language is an important means for humans to make sense of the world. Language can give a blind person a very rich experience of the world despite the loss of his or her most vital traditional sense. It is this idea that I wish to impart by labeling language a sense.

What was it like before we spoke?

To gain an understanding of how language operates, it would seem helpful to cover some territory concerning its evolution. There is not much to go on in this regard, since language is not the sort of thing that leaves behind footprints; so from the period in which language was presumed to have been acquired we have to rely mostly on skeletal remains and prehistoric tools to piece together something which is not directly related to either. Some useful inferences can be made if one accepts that language is a formal system, and I will explore this path in developing my personal take on the theory of language evolution.

In the briefest of summaries, one could state that with the evolution from *Homo erectus* to *Homo sapiens* came the mastery of fire and simple tools. Perhaps this is a rather crude synopsis of one and a half million years of human history encapsulated in a single sentence, but there is not much point in dwelling on this period for which so little is known concerning language, except that it is a near certainty no animal had it. During this period the brain enlarged to modern proportions, growing by roughly 30%. What is noteworthy is that brain size increases during this epoch and it transpires before language is acquired, not after. The gross physical capacity to process linguistic information is in place first, although it is not clear that this physical capacity is actually necessary for true language production. It is however an interesting point which provides a framework for examining the development of language in the human species. The brain is a great energy-consuming organ, so it is unlikely that an animal would evolve to increase its size without having developed an important countervailing benefit. I have already offered a theory that encephalization occurred to accommodate the storage of visualizations required for deductive reasoning, and will take that as an opening point.

There are several areas of examination that can come under consideration for modeling language development in a pre-linguistic human:

- The fossil record of the period prior to human language acquisition.
- Behavior in other animals, particularly our social primate cousins.
- Non-linguistic behavior in adult humans.
- Behavior in pre-linguistic human juveniles.

We need to place ourselves into a setting a few hundred thousand years ago to imagine what might have occurred to drive one particular species to make the jump to a syntactic system of communication. It might seem to many that this is such a great leap that it takes on *leap of faith* proportions; so much so that it even led the great intellectual and father of modern linguistic theory, Noam Chomsky, to conjecture that something other than a Darwinian process may have been responsible (Chomsky, 2005, p. 104).[14] But this, of course, cannot be so. Everything evolves because of some Darwinian process; it is just that some are a bit more obscure than others. And if one does not already have a very broad view about what a Darwinian process is, this would be a good time to broaden one's view. I offer this as some inducement: If it's not evolution by natural selection, then what is it? There is nothing else science offers as an alternative, and that's because there simply is nothing else. What needs to ensue is an expansion of what comes under the ambit of *Evolution* and to appreciate how it works as a multi-level process.

It is a challenge of imagination to be taken out of our present state of being and picture ourselves back in a world before humans had language. More often than not our minds are flooded with words, at times overwhelming our consciousness to the exclusion of other sensory information. But occasionally language takes a back seat to our more primeval senses, such as when responding to a crisis situation (what we might describe as an instinctive response). Some other situations might refer to activities like surfing, walking through rainforest or observing wildlife, particularly when unaccompanied by another person to share communication. The appreciation of these situations would seemingly be reduced if language were interjected in a manner that dominates the other senses. A natural human hunter is quiet, as you might expect for any predator that uses stealth as a means of achieving a successful hunt. Native peoples often have these experiences, while those in advanced technological societies may attain this through sport and nature travel. Sexual activity is another example where language is often suppressed, ostensibly to maximize the sensory experience; listening to instrumental music is yet another. The modern world requires ever increasing processing of linguistic information, such that traditional sensory information is pushed to the background in favor of the more efficient linguistic processing. For example, it is not much help if one is trying to understand a written contract by simply staring at it without reading it. But linguistic processing is made at the expense of a dampening of our acuity in the other senses. It should start to become evident that the traditional sensory and the linguistic sensory are two semi-integrated systems, with language evolving in humans to occupy an ever greater amount of mental processes as required.

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[14] In fairness to Chomsky, he has modified his earlier views and has challenged those who have interpreted him as suggesting a non-Darwinian alternative to the evolution of language.

Momentary mental processes can manage a wide combinatorial spectrum of both traditional sensory and linguistic information.

A final example of a human lacking language is the pre-linguistic infant. Much has been written about the innate ability of humans to acquire language (Pinker, 1994). There is nothing abnormal for a human not to have language if one is young enough. Suffice to say that a baby experiences the world and absorbs more information than arguably at any other time in life, but none of it is syntactically linguistic until the programmed time for this process to kick in.

…

We will continue on this theme with a little thought experiment: Imagine a time machine is invented that will allow someone to be transported back in time. An anthropologist with access to the time machine is interested in the origins of human language, so she devises an experiment where she transports the (ubiquitous) linguist Noam Chomsky back to the year 80,000 BCE to a village in Africa where she believes that language originated. When Professor Chomsky returns to the present, the experimenter inquires: Professor Chomsky, "*do humans have language yet? And by the way, how did the people treat you?*" Professor Chomsky replies: "*No they don't have language yet, but I think we are getting close. Although they seemed surprised to see me at first, they treated me very kindly indeed; everyone smiled to show that I was a welcomed guest. One man pointed to a simple hut and made it clear to me with gestures and grunting sounds to enter the hut and sit down. Then a woman, perhaps his wife, brought me a cup of water. I pointed to myself and said 'my name is Noam Chomsky'*." So the experimenter sends the good professor back to the same village one generation later, i.e., the year 79,980 BCE, and the process is repeated. Again Prof. Chomsky returns with the same reply. This continues covering a period of many centuries, with roughly the same result. Chomsky reports that with each visitation it seems that the older people remember him, but the younger ones that were not around during his previous visit were surprised by his visitation and seemed to have no expectation that such a thing might occur. As we slowly grind our way ever closer to the present Chomsky becomes increasingly more encouraged. Finally in the year 76,540 BCE Professor Chomsky returns and says: "*Eureka! We've got language. It's pretty simple, but I definitely detected a few rules of grammar, and if I'm not mistaken, maybe even a hint of recursion. When I arrived, a smiling young man greeted me and said: 'Noam Chomsky, glick euk hok'; I wasn't sure what he meant by that, but he pointed to his hut when he made those utterances, quite like on previous occasions. And this time, even the teenagers seemed to be waiting for my arrival, as if they were expecting me*." It then comes to the mind of the experimenter to ask Professor Chomsky another question: "*By the way Professor, did you notice if the people became conscious once they learned to speak?*" And Professor Chomsky replies, "*What do you mean? Everyone seemed exactly the same in that regard. They appeared to me to be just as conscious in the year 80,000 BCE as they did on this last visit. The only difference was that before this time they could only grunt, but now they could speak*." The experimenter is overjoyed. She goes on to publish a paper where she claims that humans acquired language between the years 76,560 and 76,540 BCE.

This little parable is useful for highlighting several important points:

1. Although language certainly evolved via a Darwinian process, it is difficult to imagine a scenario that easily fits this evolution. In the parable, humans evolve from a species without language to a species with language in a single generation, yet we feel

uncomfortable about the specifics of that evolutionary process, particularly in the generational time it would take to accomplish the task. In the end, it takes an expert, Noam Chomsky in the parable, to declare what constitutes true language. Although we will never have this opportunity, if it were possible, it would probably come down to something like this; some *expert* would declare *such and such* as the moment of transition. And this of course would be disputed by other so-called experts.

2. Without language the concept of history is dramatically deflated. Language preserves events of the past and is immensely powerful in the growth of knowledge. Language permits the passage of knowledge beyond the generational experiential boundary. An individual does not have to personally experience an event to attest to its veracity. In fact, the whole concept of truth comes about in the emergence of language. In the parable, those too young to have witnessed a prior visit from Chomsky, nonetheless have a belief in his existence and likely (pseudo-messianic) return, due to the linguistic passage of knowledge to the next generation. If Chomsky never did go back in time to the year 76,540 BCE, for how many generations would the belief in the stories of the elders persist in the society? Who can say, but in modern society some seem to persist for quite a long time.
3. What was consciousness like during this transitional period of language acquisition? Would we be prepared to deny pre-linguistic *Homo sapiens* consciousness? How would we apply our concept of thoughts and thinking to these humans? Surely humans were thinking prior to language acquisition, but they had to be thinking without words and grammar. And during the transitional period from grunting to speaking there would certainly have been a transitional form of conscious experience from non-linguistic sensory to the mixed form we have today, but with a balance very much skewed toward a non-linguistic form of conscious experience. For this purpose the term *qualia* is quite useful as it can be said that the qualia of our consciousness would have changed.
4. The conscious experience of the grunting human of the year 80,000 BCE would have a lot more in common with the sensory-type consciousness of a dog or chimpanzee than that of a modern linguistic human. We need to be very cautious about where we draw the line about consciousness and recognize that the modern human conscious experience is in a long transitional period. One of the features of consciousness is that it does not lend itself to quantification; but qualitatively, it would be fair to say that language confers a far greater change in the conscious experience than does a change in speciation for late evolution mammals, to which I would include both dogs and chimpanzees. The conscious mind of a pre-linguistic hominin was probably much closer to that of a chimpanzee than to that of the modern linguistic hominin, or in the parlance of Thomas Nagel or David Chalmers, the mental experience of *what it is like to be a* pre-linguistic human is probably closer to what it is like to be a chimpanzee than what it is like to be a linguistic human. (The contributions of the philosophers of cognition Nagel and Chalmers are discussed in the chapter on consciousness).

…

I would like to bring together several pieces of mostly anecdotal evidence to suggest a theory of how language came about.

Since there is nothing in the fossil record that could indicate the transition from a non-linguistic animal to the current variety of human, we can only conjecture some reasonable accounts for

what may have transpired. The fact that all humans have some language, regardless of their technological development, is supportive of the view that an African tribe developed language around 75,000 years ago, and took this new characteristic with it as tribal members migrated far and wide. They either brought the linguistic culture with them; integrating language into the culture of tribes they mixed with, or replaced non-linguistic humans completely. If the oft used 75,000 years ago mark is assumed, then a scenario whereby a relatively small population of humans spread language to all the habitable continents within the succeeding 50,000 years, or thereabouts, seems quite likely. There is some evidence that several isolated tribes remained with small languages until encounters with more technologically advanced humans; this suggests that language, at least in some cases, remained simple prior to civilization. By simple language, I mean that language was contained to representations of everyday events and not many abstractions.

Darwin noted in his account of the *Voyage of the Beagle* the simplicity of language amongst the natives of Tierra del Fuego (Darwin, 1839). The size and complexity of Yaghan (Fuegian) language is probably much greater than Darwin had supposed. It is not at all clear what development may have occurred after the Beagle expedition, and once missionaries entered the area. Unfortunately, there are few remaining native speakers, as the Fuegian tribes are now all but extinct.

Darwin looked upon these people with considerable contempt, calling them wretched, practicing cannibalism, naked in subzero temperatures and living the most basic of subsistence lives. But he remarked that they were quick to learn foreign languages and seemed in most respects to be as intelligent as civilized people.[15] Darwin also noted their superiority of vision over that of his own countrymen.[16] Another point Darwin makes is that they did not seem to have a concept of god or spiritual matters. This is not surprising, as it takes a language of sufficient breadth to form the concepts required by religious belief systems.

In regards to linguistic characteristics, the Fuegians may be representative of how most humans were round 20,000 years ago. One may build a picture whereby in the not so distant past humans were very much like other primates, but with better communication skills and more advanced tool making ability. No small matter, but behaviorally a far cry from the modern variety of our species. One might say that an elephant is a large herbivore with an excellent memory and a marvelous prehensile snout. By making this comparison I am highlighting that humans and elephants are two animals with some very handy adaptively evolved traits. 20,000 years ago it may have been objectively difficult to say which would be more utilitarian, but as it will turn out, it is language that is indeed the extraordinary evolutionary leap forward.

In a world where there are ever decreasing numbers of speakers of aboriginal languages, it becomes difficult to imagine what conditions were like at the advent of language. Darwin's observations are useful in constructing this picture, mainly due to the fact that, notwithstanding his 19th century prejudicial views of native peoples, his observational faculty was second to none. I believe the picture that Darwin portrays of the Fuegian people is a fair representation of early linguistic humans. The main points to be taken are that early humans have a greater traditional sensory acuity and their consciousness is less skewed toward the language dominance found in modern technological humans. The balance of sensory utilization is, of course, strongly adaptive; so in a world where audiovisual acuity is most useful, one would not want to have it suppressed by the imposition of too many words clogging up one's thought processes.

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[15] Charles Darwin, *Voyage of the Beagle, Chapter X*, excerpt: *They are excellent mimics: as often as we coughed or yawned, or made any odd motion, they immediately imitated us. Some of our party began to squint and look awry; but one of the young Fuegians (whose whole face was painted black, excepting a white band across his eyes) succeeded in making far more hideous grimaces. They could repeat with perfect correctness each word in any sentence we addressed them, and they remembered such words for some time. Yet we Europeans all know how difficult it is to distinguish apart the sounds in a foreign language. Which of us, for instance, could follow an American Indian through a sentence of more than three words? All savages appear to possess, to an uncommon degree, this power of mimicry. I was told, almost in the same words, of the same ludicrous habit among the Caffres; the Australians, likewise, have long been notorious for being able to imitate and describe the gait of any man, so that he may be recognized. How can this faculty be explained? Is it a consequence of the more practised habits of perception and keener senses, common to all men in a savage state, as compared with those long civilized?*

[16] Charles Darwin, *Voyage of the Beagle, Chapter X,* excerpt: *Their sight was remarkably acute; it is well known that sailors, from long practice, can make out a distant object much better than a landsman; but both York and Jemmy were much superior to any sailor on board: several times they have declared what some distant object has been, and though doubted by everyone, they have proved right, when it has been examined through a telescope. They were quite conscious of this power; and Jemmy, when he had any little quarrel with the officer on watch, would say, "Me see ship, me no tell."*

Language must have gone through a long rough period to finally take hold when it did, but once its advantages became clear, natural selection took its course, and those humans lacking a language faculty would have been considerably disadvantaged and aptly replaced by those with the linguistic adaptation. This selection continues today as our brain must apportion ever greater capacity to language processing. Darwin's account of the Fuegians, as well as other similar accounts, is testimony that some brainpower previously allocated to other senses is being redirected to language handling.

…

I have found the experiences described by the autistic animal behaviorist Temple Grandin particularly enlightening. She has brought her manner of visual thinking into prominence, making the point that she does not convert words into visual generalizations the way that neurotypical (her term for *normal* or non-autistic) people do, but rather into specific visual representations from memorized experiences; so her memories are visual memories, not verbal. She strongly believes that many other animals are visual thinkers as well and likens her thoughts to that of animals that she has worked closely with, particularly cattle. She is arguably the world's most successful designer of cattle handling systems, applying her visual thinking abilities to the task (Grandin, 1995).

Some of Grandin's remarks pertaining to visual thinking correspond well with Charles Darwin's observations about the three Fuegians on board the Beagle. Other primates, particularly chimpanzees, due to their close genetic and behavioral relationship to humans, form good examples for what human behavior might be like without language. What happens thereafter is the interesting part of the story.

The facility which humans possessed for increasing their communication skill had exceptional selective advantages, which was evidenced by the rapid expansion of the human population in both numbers and habitats. In addition to the advantages inherent in superior communication abilities, language permits the symbolic storage of information. This method is far more economical than other representations, although ostensibly less precise. While most would agree that this change in the kind of information stored in memory represents a concomitant increase in knowledge, it may have more to do with how we define knowledge than what may be the case in fact. It would be fair to say that the kind of knowledge gained through language leads to the expansion of culture. Richard Dawkins coined the term '*meme'* to represent a unit of cultural inheritance; it is a useful term when compared to '*gene'*, since both have information at their core. One could say that culture is the phenotype of memes.

This seems a good place to break on the history of human linguistic development to discuss the linguistic conveyance of information and how that information is used by our brain. We will need to start from a rudimentary level, since much of my terminology is novel and not part of the accepted parlance of linguistics.

Words

The meaning of a word is determined by social agreement or declaration. This is my definition and the one that I use throughout this book; it is a self-referential definition made by declaration in conformity with the previous sentence. Or as Wittgenstein put it in *Philosophical Investigations* (§43): *The meaning of a word is its use in language.*

Although this may seem a rather gross oversimplification of semantics, it is often stated that there is nothing inherent in any word that need convey any particular meaning. If I am speaking English, I may use the word *house* to represent my place of abode. If I am speaking Spanish, I am likely to use the word *casa*. A word is simply a sign that represents an object or a descriptive or an action in the mind of the speaker. The generally accepted meaning applied to most words is usually not contentious, since they tend to have a commonly shared meaning by the nature of their facilitation in communication. A group speaking a common language (English in this case) will find that there is no point in debating whether a four-legged animal that barks is a dog or should be labeled with another moniker. The common definition is the essential thing, since it is a social agreement about the sign and what it represents which makes communication possible; this applies to non-syntactic communication as well, and is perhaps even more critical in one-to-one sign-semantic expressions. Agreement on the meaning of signs may not be the case for words that describe a state of affairs which is unclear in a particular social context. An example of contentious meaning might involve the use of terms like *fair* and *just* or other words related to the concept of fairness or justness. Is it a crime for a mother to steal food in order to feed her starving children if she has no other means of obtaining food? There may well be a law that clearly defines stealing as a crime that should be punished without exception. But many would argue that the act of stealing in this particular case is justified. Should the act of stealing in this case represent a punishable crime or should it not? If a poll were taken, there would surely be fair representation on both sides of the issue. Thus, the meaning of a word can be situational or contextual, or as Wittgenstein might say, can vary with its use in language.

The following will define some of the terminology used in this section. In cases where we are simply naming a definitional non-contentious sign, I will be call the word or phrase a *fact*. In a case where agreement is not that clear as to whether a word or phrase can rightfully be applied to a particular state of affairs, I will call such a case an *opinion*. An opinion can be made into a fact by declaration. I can declare that a mother who steals food in order to save her children from starvation is not committing a crime, but is acting in a fair and just manner. A fact is thus something which, in the case of a proposition, is deemed to be true because it is true in relation to a defined system of logic with a particular set of axioms. In the example above, it is the declarer who decides what system will dictate the truth or *facthood* of the proposition.

My point here is that there is nothing absolute in the nature or meaning of any word or assemblage of words. Meanings come from agreed definitions or declaratives, in essence, by social arrangement. The emperor that declares that the first-born child of every mother be sacrificed to the gods may find cause, for whatever reason, to have such declaration written into the law of the land and declared to be both proper and just, although, as one might expect, it is unlikely to be agreed to by most mothers. In the social context of the empire, such declarations are valid in determining the usage of a word in its representation of a state of affairs. That a particular definition appears in a particular dictionary next to a particular word does not make

that stated definition the meaning of that word; it is more that members of a social group have at least tacitly agreed on a particular definition, or that an authority has declared it to be the meaning. Whether something is a fact or a matter of opinion will depend on the social context. If there are ten people in a room with a four-legged animal and everyone agrees that the animal is a dog, then the animal is a dog, even if a larger group of people not in the room may say the animal is a cat. If those participating in the state of affairs are all in agreement, then it can be said to be a fact. Thus, facthood is a mental attribution, or more precisely, a linguistic attribution, rather than one determined by a state of affairs in the external world. On the other hand, returning to the room of 10 people, if 6 declare with certainty that it's a dog and 4 say it's a cat, then we would have to surmise that whether the animal is a dog or a cat is a matter of opinion. In the respective minds of 6 participants, it will be a fact that the animal is a dog, and it will be a fact that it is a cat in the respective minds of the other 4 participants.

A great deal of modern life is devoted to coming to a social agreement about the definition of words. Much of this may be fought out in courts of law or by other modes of arbitration. According to the Geneva Conventions, torture is a criminal act. Whether a specific act constitutes torture is something which is the subject of much debate. Where the word and definition fit a particular state of affairs is of great social significance, worthy of considerable time and attention. Whether the word *marriage* should have the meaning of a man and a woman joined in a civil union for the purpose of procreation and no other type of union, or be extended to include civil or religious unions of other types, is in dispute in many nations, and will almost certainly be resolved by authoritative declaration or by some method which leads to social consensus.

. . .

Language approximates states of affairs. Since the number of states of affairs is for all intents and purposes infinite, language would be useless if it were not a shorthand methodology covering groupings of similar states of affairs. We may utilize the words *human genome* to generically signify the DNA in a human being, knowing full well that no two genomes are identical, with perhaps the exception of identical twins. The words that describe an event, or a state of affairs, can never fully describe the event. If one were to look upon an expanse of beach, would there be a point in detailing the position of every grain of sand (in normal circumstances)? In that language categorizes and simplifies similar types of objects and states of affairs, some detail must necessarily be lost in the process. Language can never provide an exact description of the world. Generally speaking, our senses approximate the world with the goal that it be sufficient for survival, at least long enough to reproduce. Language is yet a further approximation of these perceptions, but comes with the added benefit of some analytic capacity.

Let us examine a few interesting words which most often express matters of opinion by the way they are used in typical circumstances. I will acknowledge beforehand that there will be some *Wittgensteinian* type problems in the very definitions that I had hoped would clarify these problems, and in the same regard I shall say they should be considered *elucidatory*. The usage of these common words as well as the underlying assumptions we make about their usage in everyday conversation should be reconsidered, for it can color the way we think about the world.

- Reality: This is the thing that we are seeking to know at the end, not the beginning or middle, of our philosophical enquiry into Nature. At some future time we might be able to make a statement about what this thing is that we call reality. Currently, it is just a word that at best can be said to be some version of *objectivity*, itself being a term that we are grappling with to define. To say something is real, as it is used in common parlance, is to say that there is certainty in our knowledge about the thing in question. It is best to leave reality as a term used to denote findings in a philosophical culmination, not a word to be posited as a resolved characteristic or property of some entity. The related word *existence* can be similarly classified. We are a long way from saying what reality is, and this will be explored in greater detail in later chapters.
- Intelligence: A word often assigned to humans when being compared to other animals, or to particular types of humans when making intra-species comparisons. I may offer 'computing power of the brain' as a definition, but I think this is rather arbitrary. It seems to be an attribution of mental power in the way that strength is an attribution of physical power. But it will always be a word with a definition in dispute, particularly as it is applied in specific cases. Since there are not many people that would separate language from the whole of mental processes, there is more than a subtle inference that intelligence refers mainly to linguistic intelligence. It is an ability to manipulate data that makes humans intelligent and the greater the ability for a human to manipulate data the more intelligent we are likely to believe a particular human is. We have gone so far as to distinguish other types of intelligence, such as emotional intelligence and common sense as being different kinds of intelligence, apart from the principal measurement of this characteristic. Another animal, a dog for instance, may be considered intelligent, but not in a way to be compared to humans, but rather to other dogs or perhaps other animals in general.
- Progress: This word seems to imply that something has improved by going from one state of affairs to another. But who is to decide? What do we mean by improve? Is the building of a dam to be considered progress if it brings electricity to millions of people that once had none, or should we consider the opinions of those people, animals and plants that have been killed or displaced because of the dam's construction?
- Better: Very much like progress. Swatting a fly may be better for the human, but worse for the fly. Much of what goes on in life is a zero sum game, substantially about energy transfers when considered at a thermodynamic level. Whether something is better or worse than before is clearly a matter of one's perspective. A gain in energy will usually be considered better than a loss of energy. The consumer is usually better off than the consumed.
- Good or evil: Again, this is an appeal to an absolute authority. How often these words are used as if they signify something that should be obvious to all. But it is usually an error on the part of the speaker concerning the authority that deems something to be good or evil that is the semantic villain. The speaker has become self-deluded into believing that there is an undisputed absolute authority, a law-giver, so to speak, that passes judgment over a range of states of affairs, labeling them accordingly on some putative scale of goodness. This is at the heart of the nature of belief.
- Morality: Utterly a matter of opinion, although rarely presented as such. It is simply a word used to signify a standard by which actions are to be judged, but the standard is completely arbitrary, although apparently not in the mind of the moralist. Ethics is a

debate about the generalities of what should be considered fair and just in a given society. Whatever the society agrees upon as moral is moral by declaration or social agreement, and thus the standard of measurement.

- Meaning: Whatever word, entity or state of affairs which is the matter at hand has meaning only relative to the subject in the relationship. Similar to the definition of a word, the meaning of anything is by dint of social agreement or declaration, even if that declaration is a self-made declaration. Meaning is both relative and internalized.
- Should: A word used to state a matter of opinion, as it is just the way the speaker advises in a particular situation.

It may seem that, at least in my opinion, just about everything is a matter of opinion. And that is in fact my opinion. The words that I have listed for clarification are but a few examples of those for which social agreement is not easily found. We can continue through a large portion of a dictionary and find many like examples, but I think the point has been made. The combination of the wide variety of social contexts and belief systems make many of the propositions of language both contentious and arbitrary. When ordinary language is understood in terms of a system of propositional logic, then this must be the case. What we call beliefs in a language system are equivalent to the axioms that form the foundation of any formal system of logic. If you change the axioms, then the theorems, or statements of truth, will change as well. So facts are obtained only when in a given social context of the respective belief systems of the participants are the same, and opinions will attain when the belief systems differ.

The relativism surrounding a wide variety of states of affairs is what we actually observe in the world. Understanding why this is the case will be shown by how language, as a formal system of logic, generates its statements of truth.

Are we alone in the universe?

I will not attempt to answer this question, or should I say, offer an opinion, but rather analyse the question itself from the perspective of the discussion on the nature of language. The question can take on several nuances, depending on how one interprets the meaning of its constituent words.

If an astronaut found something similar to an earthling spider on another planet, would this satisfy the word *we* in the question? Do we mean a creature that shares many of the animal characteristics of a human being? Or would this eight-legged creature not be close enough? Certainly finding something on another planet as remarkable as a spider would be headline news around the world, and it would likely make the SETI[17] people exuberantly confident that a more human-like *'We'* would not be far off. But these *seekers of life out there* are looking for what they call *intelligent* life, for they are hopeful of finding something that is advanced enough

[17] The *Search for Extra-Terrestrial Intelligence* is the collective name for a number of activities undertaken to search for intelligent extraterrestrial life.

to transmit radio signals. So even some creature close enough to humanity as a gibbon or a Neanderthal would not suffice for this purpose, nor would a 19th century human meet this last criterion.

In order to satisfy the term *intelligent* it would seem that we need to have something a bit more like a 21st century human. What is being sought by SETI is a creature, regardless of physical appearance, that can do science, and that means having language. So as much as might be said for the intelligence of dogs, pigs, parrots and dolphins, when we use the word 'intelligence' in this manner we usually require a modicum of linguistic ability. So I will take the liberty of rephrasing this subchapter title to read: *Are human beings the only creatures with language in the universe?* Not everyone will agree that this rephrasing is what is meant by the original, which is part of the point, in that all propositions have some degree of scope in their meaning. I have tried to be as objective as possible in attempting to find the midpoint of the normal distribution of interpretations of the question '*Are we alone in the universe?*' all the while realizing that one can never be completely objective.

This brief examination of a single interrogative sentence highlights several features of language. Foremost perhaps is to make the point yet again that language is a social activity. We regularly come across statements that are open to interpretation and usually find a way to impart the proper meaning in the context of the situation. For example, if an atheist attends a wedding in a church, she is likely to hear lots of references to god, but it is very unlikely that she will stop the ceremony to correct the minister about what she believes are the facts of the matter. We tacitly understand that others have different opinions and the expression of opinions different from one's own may not be socially acceptable in certain situations. In fact, our own opinions may be unacceptable in quite a large number of circumstances during the normal course of life. This reinforces the notion of the subjectivity of the meaning of propositions and how the system by which meaning is extracted from propositions must be examined to comprehend the nature of the process. Acknowledging that the world contains a wide range of differing opinions, it is bewildering that so little attention has been paid to how this comes about.

Another point is how we ascribe the term *intelligence* within the requisite linguistic construction, recognizing that other animals can be intelligent, but not in the same way that humans are intelligent. As previously noted, the subjectivity of language is critical when assigning definitions to words like *intelligence*, *thought* and *consciousness*; there is nothing objective about the process. Words cover a broad conceptual range, but usually we do not need to be explicit about it in the normal course of social life. Nonetheless, there are occasions when we do find it necessary to be more specific and might add an adjective, such as '*higher*', before the noun, making a distinction like '*higher intelligence*' attributable to humans and other creatures with language having the faculty to comprehend the world scientifically, wherever in the universe they might reside.

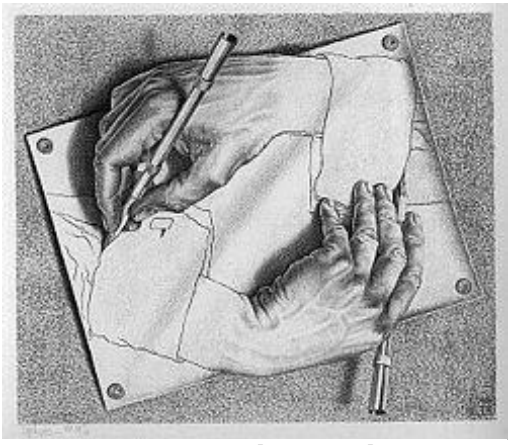

Figure 3: Drawing Hands, M C Escher, 1948

Although in the discourse of world events some debate may be focused on the meaning of words, most times we go through life without stopping for any analysis whatsoever. In the course of evolution, living things have not given much thought, linguistic or otherwise, to how they happened to have evolved a particular trait; and language, being very much a

part of the Darwinian process is no different. An examination into the workings of language, as Wittgenstein recognized, is a self-referential process, which is what makes it so difficult to do, as is depicted by the M C Escher lithograph *Drawing Hands (*Figure 3*)*. This, in part, is what Wittgenstein is saying in the last few sections of the *Tractatus*. We are trying to be as objective as possible, but cannot be completely so by the very nature of how language operates. As a formal system of propositional logic it is firmly in the grasp of *Formalism, Incompleteness* and *Undecidability*.

Truth and Logic

"Nothing is so difficult as not deceiving oneself." — Ludwig Wittgenstein

What truth is and is not in a nutshell:

- Truth is a function of language, not of the physical world.
- Truth is about logic, not semantics.
- Truth falls within the domain of logical space, not a materialistic spacetime.

This may arguably be amongst the most minimalist of all deflationary theories of truth. Truth is totally detached from the external world, which is, in this case, the world outside of language. It is not relevant that linguistic truth, more specifically that which exists in the mind of a linguistic human, agrees with some notion of reality or a particular perception of a so-called *rea*l world. The correspondence of a fact, i.e. a true proposition, with the perceived state of affairs in the physical world is a different process and a separate issue very much related to consciousness. Although this is in conflict with Alfred Tarski's conception of truth (Tarski, 1944), it is only so due to Tarski's presupposition about the reality of the physical world, which at this point in this thesis is yet to be established. For the most part I would find little difference between my conception of truth and that of Tarski, except for this notion of reality that Tarski shares with Wittgenstein and their questionable distinction between the logic governing natural and idealized languages. A perceived isomorphic relationship of a proposition to a state of affairs in the physical world is significant only in relation to a similar or dissimilar isomorphism perceived by another person, which would determine whether that person would agree or disagree with the proposition made by the first person.[18] One's own world view, or any subset of propositions relating to that world view, is rightfully open to challenge by someone with a conflicting perspective, since the only guarantee for agreement between two sets of propositions is if they are generated from a system with the same axioms; of course, this is highly unlikely in real life situations. It is this very point that explicates why people presented with the same set of facts, or information, may disagree on the truth of a particular proposition relating to those facts, and accounts for why people believe what they do, as well as why some beliefs seem so far-fetched having little correspondence with general notions of reality, or in many cases, one's personal notion of reality.

These points are meant to be both definitional and something beyond definitional. At the root of the dilemma that I find with semantic notions of truth is how natural language is viewed. There is a long history, starting with Wittgenstein himself, that there is a difference between idealized or formalized languages and natural language. I would say that natural language falls within the

[18] Under this system all truths are tautological truths, as there are no semantic considerations, only syntactic ones represented by the rules of truth generation of the system of logic applicable to the set of propositions under examination.

ambit of formalized language, but is too complex to axiomatize, so there is the predictable tendency to exclude natural language from the formal language classification. At the level which ordinary language is examined, it is impossible to access the underlying structure that leads to language output (or speech, if you like). But this belies the neuronal level of formalization which simply runs too deep to be examined. To exclude natural language from formalization is the same as for someone who does not understand the game of chess saying that chess does not have rules, simply because that person cannot figure out what the rules are. One only need examine the mechanism of cellular biology to marvel at the complexity of its operations. The intricate array of agonists and antagonists in the multitude of cellular interactions could never have been foreseen before the efforts of tens of thousands of microbiologists deciphered the wonders of the cell; and there is so much yet to be discovered. Natural language, involving cellular as well as intracellular interactions, poses the same daunting task for unraveling its intricacies as do other biological processes.

Furthermore, if the universe is to follow laws falling within the purview of information theory, natural language would be just one of the myriad processes to do so. One would need to find a compelling reason to exclude natural language from axiomatization, rather than include it within the ambit of formal systems. Theories of truth tend to put natural language to the side for fear of the challenge posed by explaining its operation via enumeration of the axioms of its formalized system It is much easier just to deal with idealized languages and wait for a solution to arise in the future, as if some novel physical law will one day be discovered governing ordinary linguistic practices.

The concept of truth presented here resolves one of the great puzzles of philosophy: *Why do people believe the things they do?* And as such, significantly bears upon how the world is to be understood. To show that truth is, in fact, only a function of language and not one of correspondence will require further elucidation as to how language works in the contemporary human mind.

Let us start with a review of the way things were for pre-linguistic humans. If we turn the clock back around 100,000 years, we find an animal with a large brain, like those of modern humans, but with vocalizations sounding roughly similar to that of chimpanzees, in that both animals would lack a grammar in their communications, but I would suspect that the vocalizations of humans would be more extensive and complex. I could also imagine that with the passage of time there being a gradual increase in ostensive, non-syntactic vocalizations. This would constitute a form of communication, but would not qualify as a true language in that there would be a lack of methodology for generating additional constructions from those already known. But at some point in time, and exactly how this happened no one is ever likely to know, language with some form of grammar took hold in humans and flourished. The details of this development can only be a matter of speculation, so it would be rather pointless to elaborate further.[19] It may be possible one day, through work in the field of genomics, to become more

[19] As a simple thought experiment, one could begin with 7 words (vocalizations or gestures in the context of the time) that one could easily imagine being part of a non-syntactic communication: *me, you, baby, dog, eat, sleep* and *kill*. It is not difficult to make a number of 2 word sentences and then a few 3 word sentences. As vocabulary increases, it may have come to the realization of some tribe that there was far more scope in communication than originally thought.

precise about this critical transition. But for the analysis herein, we must accept that the evolution from an animal without true language to an animal with true language occurred sometime around 75,000 years ago or thereabouts.

It is reasonable to assume that the first human users of true language did not go to sleep one night and awake the next morning chatting away with a full-blown grammatical language. Vocabularies must have started small and simple, grown slowly, and almost certainly lacked recursion. Nevertheless, this proto-language would have followed a system of predicate logic. At this early stage of development there would be no difference between a syntactically correct simple natural language and an idealized one. As language grows, grammatical errors creep in, precise syntactic correctness is not required for comprehension, words are dropped because they are understood without speaking them outright and a sort of fuzziness enters what was once a clean formal arrangement. But in fact, the rules are still in place; they have just become more convoluted and difficult to enumerate. At the basal level, natural language is indeed formal; but as the language matures the axioms of the system swell to an incomprehensible level.

So what was this acquisition of language about? An animal that sensed its environment in a manner similar to its close primate relatives, i.e. by way of vision, hearing, smell, etc., acquires a new sense, language. If we take vision as representative of our senses, then the function of vision is to receive electromagnetic radiation as an input and process it into a mental representation. The neuronal connections that result from this process can be interpreted as the output side of this sensory experience. If a neural network is a type of digital system (although it need not be one that functions like a digital computer), then one could say that vision digitizes the analogue electromagnetic (EM) signal so that a mental representation of the physical is made. [20] There is a close relationship between the physical and the informational in this type of input-output process. Other senses act in a similar way.

Language acquisition effectively places a kind of *computing machine* in the brain which gives it the capacity to process propositions. I will now call this *recently* acquired human sense the language module. The language module is a sensory representation of a formal system of propositional calculus and can thus be analyzed by the rules of such formal systems. This is my physiological interpretation of Wittgenstein's ideas presented in the *Tractatus*.

The language module has two key functions. First, it determines the truth value of an input proposition. Second, it stores the proposition, along with its truth value, in the memory system of the brain. It can be easily extrapolated that the language module integrates with the brain's memory system in the storage of true propositions. What is not a direct part of the module is verification with the outside world, i.e. the world as interpreted by our other senses. Simple propositions, such as '*there is a cow in the pasture*', may be easily verified visually. This creates a

[20] A neural network is a computer program for a learning system that tries to mimic a biological neural network. It would be too great a digression to get into further detail about the subject of neural networks. This topic has been explored enough, that at least to my satisfaction, there is an equivalency between the biological and the programmed neural network. It is yet one more example of the relationship between logical and physical spaces, or the informational and the physical world. This example, by the way, does not represent my position on how this function actually works, which is described in later chapters on consciousness.

correspondence between the proposition and the processed visual input which validates the truth of the proposition. The sound of the cow mooing and the smell of the cow could further validate the truth value of the proposition and reinforce one's certainty concerning its truth. In the case just mentioned, the truth of the proposition is isomorphically represented by the other processed sensory inputs. If, for example, I am in a room with a window which looks upon a familiar pasture, and there are several people in the room that have been truthful with me in the past, and they all state that '*there is a cow in the pasture'*, I would very likely interpret their statements as true even without peering out the window to verify the assertion with my own eyes. Regardless of physical world state of affairs about this particular cow I would likely store in my memory as true the proposition *'there is a cow in the pasture'*, even though in fact there may not be a cow in the pasture, thereby making the statement about this particular state of affairs false in the physical world, or its associated correspondence-theoretical formulation. Nonetheless, this does not invalidate the truth value of the proposition, as the physical-world state of affairs concerning the cow and the pasture is irrelevant to the truth value stored in the mental machinery of the person not seeing the cow, which was arrived at by believing the statements of trusted friends. One is limited to proclaiming that an isomorphism, or correspondence, between the proposition and state of affairs in the physical world would not be the case in this particular instance.

This disjunction of linguistic truths from their isomorphic representations explains why people have belief systems that do not seem to have correspondence in the physical world. When the physical world's isomorphic representations of a particular belief do not exist, then the truth value of this belief can be said to be justified by faith. So faith can be defined as a belief ensuing from theorems of a particular formal system of language when a justification from an isomorphism of those theorems in the physical world does not exist. This definition will require some revision when we examine in more detail what is meant by the '*physical world*' and '*reality*.'

So, how can it be that we have been so deceived for so long that truth had something to do with *physical reality*. There are two general misconceptions about the world which are responsible for this anomalous situation:

1. There is something called *truth* that actually has some meaning in the physical world.
2. That our conception of reality is reasonably accurate, even though there is no basis for this belief other than our conscious experiences, something of which we have little understanding (although I will offer an explanation of consciousness in a later chapter).

To show that our concept of truth does not have meaning outside of language, we should examine how the world is perceived by non-linguistic beings. For all intents and purposes, this would include all known organisms including humans that lived prior to 75,000 years ago.

Let us examine how a dog might conceive of the world. A dog does not have formal language, and operates with two-color vision and an exceptional sense of smell. When the dog perceives an odor, it categorizes and stores in memory an olfactory representation of some molecules that its nose has inhaled. There is no mechanism by which the dog's olfactory system can interrogate the particular smell as to whether it is in fact a true representation of the molecules it purports to represent, but is instead some bogus odor only disguising as the authentic set of molecules entering the olfactory system. For example, the dog would not question the veracity of its senses

if it thought it smelled a fresh sirloin steak. The dog would not query whether this was some trick and it was not in fact the smell of a sirloin steak and may in fact be the smell of a decomposing dead rat. There simply is no apparatus that the dog has to pose such a question. The odor carries its own truth value. It could never be conceived of as not being true. It could never register '*this is a bogus smell of a sirloin steak'*. It may in fact not be a sirloin steak that the dog has sniffed, but this is of no consequence, as we are not examining the functionality of the dog's olfactory system at this time. If the dog is mistaken, then it is likely to be due to a less than fully functioning olfactory system or the dog has perhaps been purposely tricked into acquiring that false belief in a manner similar to how a Venus Fly Trap plant deceives a fly. In the same way, a human can be thrown off by a mirage and be mistaken by some distorted visual input. This is just the limitation of the sensory system. No one would suggest that we should be able to see everything that exists in the physical world. Some things are too far away to be seen, some too small, others outside the range of detectible EMR wavelengths. It would be rather extravagant for natural selection to have evolved a mechanism like a non-linguistic truth checking system for sensory information, since there would be no way of attributing a proper truth value. How would one know if some visual input was or was not a mirage? There may be some question as to the certainty of the observation, but this is merely what happens when processing insufficient information to make a definitive determination. This is quite different than receiving deficient sensory information for determining if the input was what it is seemed to be or was just a hoax or a mirage. For example, if we believe that we can clearly see a cow in the pasture, but conclude, without any further input, this to be a false visual representation and the thing in the pasture is actually a horse, or perhaps a dog or maybe it's a tree. It is easy to see how ridiculous this would be, and also how excruciating it would be for an animal to go about its business if it questioned the validity of its sensory input, even if it had the capability to do so; small wonder that natural selection did not see fit to find this sort of adaptation beneficial.

At some rudimentary level, all information is ultimately binary and can be interpreted as having a truth-like value, but for living things, the matter usually at hand is one of how a particular kind of input is interpreted by a particular organism. There are countless binary triggers, such as quorum sensing in bacteria to give but one example, which are responses to environmental stimuli that have threshold triggering mechanisms (Cámara, 2006; Waters & Bassler, 2005). When sensory inputs are complex, as is the case with our own primary senses, access to binary resolution is buried deep in the underlying detail. For example, even though at some basal level vision may have binary correlates to individual photons entering the eye, our visual mechanism is built to ultimately interpret and respond at the level of the visual image, not to that of individual photons. These senses require interpretations that carry a default truth value for these types of inputs, with a course handling mechanism to deal with degrees of uncertainty due to limitations on information in both reception and interpretation. Simple organisms, as well as components of more complex organisms, such as cell membranes in mammals, have mechanisms ostensibly operating at the binary level for molecular transactions; an example being the binary *lock and key* mechanisms that are ubiquitous at the cellular level. Complex organisms have their binary decision processes executing at a subconscious level, effectively letting all the 'dirty work' take place a lower levels of resolution. This permits the organism to handle a multitude of lower level functions in the background, simplifying as such, the complex requirements of real-time high level decision processes, and is how natural selection has handled the building of organisms with trillions of cells working in coordination.

What is special about language is that it is a high level sensory apparatus that uses symbols, mainly words, for its simple structural componentry, which can produce infinite arrays of sentences. Many of these can be resolved as binary operations, which are the propositions. Other senses lack this property. Having language is like being given access to a kind of biological Turing Machine (TM) at a conscious level of experience, effectively, a theorem creating machine. This is why truth is a function of language, for it produces true statements from its axiomatic rule-following system. The capacity of an organism on our planet to resolve something consciously as either being true or false only exists by virtue of this mechanism. These truths exist in their own self-contained world, within one's own personal respective world of language. It's like being in a box with its own set of rules. What goes on outside the box is in a certain sense irrelevant to what goes on inside the box, in that truths can exist within the box regardless of evidence to the contrary outside the box. A well-functioning human being will be helped (and well-advised) by coordinating the truths of the language system with states of affairs as reported by other senses. The truths, or theorems, that are generated in the rule-following system of language are recursively defined. Whatever comes out of it is just following logic. As Wittgenstein states *(*TLP 2.012): *In logic nothing is accidental.*

A truth concept is plainly not part of the usual sensory world. Correspondence theories of truth are inconsistent with the picture presented here, in that they intend to compare an independently obtained linguistic truth value with a representation constructed by a limited system of interpretation about a physical world that is itself problematic. So, if truth is not a part of the physical world, then what is it? Truth is a condition that arises as a consequence of the binary process. The result of a binary process operation can take on one of two values. What these values are called is irrelevant. It can be *this* or *that*, but nothing else. Some of the usual *suspects* are: true and false, yes and no, 1 and 0, -1 and 0, up and down, left and right, on and off, open and closed. The physical world of our experience is not presented as a binary process. We comprehend the binary nature of physical processes due to the science that has come about from language-based knowledge. The binary process underlying the physical world exists at more fundamental levels of structure. The physical world as consciously interpreted by non-linguistic mammals is an analog world.

On the other hand, language, being a system of propositional logic, indubitably produces binary process values. Propositions take on either one of two values that we label true and false. Saying that truth can only be attributed to language (regarding the human interpretation of things) becomes self-evident when one realizes that the remainder of how we come to know the world appears analog at conscious levels. All cellular responses are ultimately binary, even if one needs to descend a level or two to reach the causative mechanism. Many are quite easy to interpret. The neuron either fires or it does not, the muscle either contracts or it does not, the protein either fits into a receptor molecule on the cell membrane or it does not. The ubiquitous lock and key configuration of cellular processes is representative of so much of biology that it is hard to find a process where an underlying binary operation is not at the root of a more complex process.

…

The truth value of a proposition or set of propositions is determined by comparing the input proposition to similar ones that exist in the memory of the person. There is no difficulty in adding a strength magnitude to the truth value of a proposition, effectively giving a proposition

any value between a generic *extremely false* to *extremely true*. Remember that we are talking about beliefs, which is something not usually enumerated, although the underlying mechanism must in fact be digitized. It is the *beauty* of the binary process that underlies logic that such complexity can grow out of such simplicity. It must be quite rare to have a belief supported by a single axiom corresponding to a single supportive enumerated memory; however that might come about biologically.

Let us see how this happens in everyday experience by examining this simple proposition: *John is an honest man.* Let us suppose that a friend has just made this statement to you. And let us further suppose that you are considering going into a business with John, so it is important to know whether John is a trustworthy person. This is analogous to a pre-linguistic human determining whether or not it is safe to walk past a pride of lions. Just like it is important for any animal to know what situations are safe and which are not, it is likewise important for modern humans to do the same, and we usually do this linguistically, although almost all of us rely on some form of intuition (or non-linguistic factors) to varying extents. Linguistically, this is done by assigning a truth value to the aforementioned proposition.

So how will your rational mind determine what truth value to assign to the proposition '*John is an honest man?*' Clearly, there will be a great number of factors which may go into this determination. If you have no knowledge of John whatsoever, you are likely to rely on the word of your friend who made the supportive statement. Alternatively, you may not necessarily consider your friend an honest person, which would be something to be taken into account. You may be a person that is generally suspicious of people that you don't know well, or to the contrary, be very trusting of others. Your mother may have said to you once: "Don't trust John, he is not an honest man." You may have suspected that John took a pen that you left on the table the last time you met. You may know that John has been convicted of robbery in the past. Or you may have heard a story how John spent two days looking for a person whose wallet he found, just so he could return it. Any number of factors may be considered in making a truth determination. Suppose there are only two pieces of information and both come from trusted sources. Your friend says that John is honest, but your mother has brought John's honesty into question. Hence, residing in your memory may well be two evenly valued truth assignments, say on some arbitrary scale, a *+5* for your friend's opinion and a *-5* for your mother's opinion; so the net value comes to zero. This is what happens in the oft experienced weighing up of a decision where pros and cons are evenly balanced. Perhaps it will be your general proclivity to be trusting, which will finally be the deciding factor, this in itself a weighing up of myriad past experiences which brought you to this particular proclivity. Exactly how the brain is wired to accomplish this task and which neurons are firing is not yet known, but I imagine one day it may well be. For our purposes here, it is not critical. It will suffice to know that there is a neurological underpinning to the process. On a systems level, the proposition to be assigned a truth value is compared to a variety of possible propositional theorems residing in memory that could influence the determination of the current input proposition and a truth value of particular strength could be assigned to the current proposition. We may characterize this process as a deliberation or a consideration of the facts.

Human beings are extremely complex creatures. We cannot begin to compute the multitude of low level binary operations that go into making us such well-functioning biological machines. But we can nonetheless surmise the methodologies that must be in place to produce that functionality. Of the myriad binary operations continually being executed at every imaginable

level, the binary truth values assigned to linguistic propositions is a very distinctive case seemingly reserved just for humans.

Comments on TLP Section 6

Section 6 of Wittgenstein's *Tractatus* is informative on a number of important matters concerning propositions and logic. As much as I would wish to refrain from direct analysis of TLP, there are several points that call for some elucidation regarding assertions made in this book which differ from the Wittgensteinian concept of truth.

To address some of the issues presented in the *Tractatus* I can supplement my definition of truth by adding the following elucidations to my earlier postulates:

- All propositions of language are propositions of logic.
- All true propositions of language are tautologies.

Let us examine the following paragraphs from TLP:

> *6.1 The propositions of logic are tautologies.*
>
> *6.11 Therefore the propositions of logic say nothing. (They are the analytic propositions.)*
>
> *6.111 All theories that make a proposition of logic appear to have content are false. One might think, for example, that the words 'true' and 'false' signified two properties among other properties, and then it would seem to be a remarkable fact that every proposition possessed one of these properties. On this theory it seems to be anything but obvious, just as, for instance, the proposition, 'All roses are either yellow or red', would not sound obvious even if it were true. Indeed, the logical proposition acquires all the characteristics of a proposition of natural science and this is the sure sign that it has been construed wrongly.*

Section 6.1 is the same as my own.

Section 6.11 is another way of stating one of my opening postulates of this chapter: *Truth is about logic, not semantics.*

Section 6.111 brings to a head the main point of contention, which is whether or not propositions of natural language are logical propositions. If they are not, then a correspondence theory of truth, like that of Tarski, would attain.

So the question may rest on how pervasive logical processes are in the world. Do they extend to natural language, as I have argued? Determining the relationship of language, truth and logic is one of the most critical tasks in philosophy; so much depends of the outcome. One can sort through Wittgenstein's own words to build a case for linking the three together, despite conclusions that one might reach from Wittgenstein's philosophy in its totality (Wittgenstein's statements, in italics, are followed by my comments):

- *The totality of true thoughts is a picture of the world* (TLP 3.01). One might ask what a false thought would be. Are the thoughts derived from language part of the picture of the world? It would seem so, for if not, what kind of thoughts are they?
- *Logical pictures can depict the world* (TLP 2.19). It would seem that Wittgenstein is referring to sensory perceptions here. Whether language belongs in this category can be argued from the point of language being a sensory perception. It would certainly be classified as such if using the *neural pathway* argument. Wittgenstein states that every picture is a logical one (TLP 2.182), so the link is being made between reality, pictures and logic.
- *The picture represents a possible state of affairs in logical space* (TLP 2.202). One could infer that propositions of language must create a pictorial representation, for if a proposition of language is true it would represent a state of affairs in logical space, and if false it would not; that is the possibility. One could surmise that pictures derived from common sensory experiences would come up against a comparison test with *physical reality* to determine the appropriate status in logical space; one could imagine that mirage-like pictures would not represent a state of affairs in logical space according to Wittgenstein.
- *If a thought were correct a priori, it would be a thought whose possibility ensured its truth* (TLP 3.04). If a thought, regardless of how it is categorized, is a theorem of the thinker's internal system of logic, and one might wonder how it could be otherwise, then its internal logical truth is assured. All thoughts as such are correct *a priori*, if they are not subjected to the test of what the inquisitor believes is the truth in an objective reality. We have seen that there can never be a consensus on objective reality if there are differences in beliefs within the population. One might defer to objective reality as scientific truth, but we know that science depicts itself as a system of contingent truth without universal consensus.
- *In mathematics everything is algorithm and nothing is meaning* (Wittgenstein, 1974, PG 468). Why would this be the case? Cannot one argue that mathematics presents a picture of reality? What are we to make of the laws of physics, which are stated as mathematical equations? Or can we simply conclude that the world itself is meaningless? But in the end I would agree with Wittgenstein here, for meaning is not the sort of word that one should apply to mathematics. So, of course Wittgenstein is correct; logic and meaning fall into different camps.

Wittgenstein continues in Section 6 of the *Tractatus* to confirm the relationships between logic and experience that have been expounded in this book. So it is only how one considers ordinary language which is in contention, at least if one is to take Wittgenstein at his word. In a sense, one has to make a determination of how the world comes about to resolve these matters. I have made the argument that natural language must fit into the domain of predicate logic along with *recognized* formal languages, as it conforms with a consistent interpretation of the world across many fields and levels of examination. One can also argue in the negative, in that, if we are to exclude natural language, then where would an explanatory theory come from? And then how are we to explain why people believe the things they do?

A Wittgensteinian State of Mind

As a way of summation of the chapters concerning language and truth, I will offer some impressions about what it is like to be in what I call a *'Wittgensteinian state of mind'*. Perhaps I have used this term for lack of a better one, even though it probably encompasses a somewhat different state of mind than Wittgenstein may have had himself, for as we are all too aware, one can never really get into the mind of another living person, let alone someone who has passed on. I am inclined to attach Wittgenstein's name to a way of looking at the world, a mindset, or perhaps the popular vernacular term *headspace* is the best one of all.

The very first line in the Preface to the *Tractatus* reads: *Perhaps this book will be understood only by someone who has himself already had the thoughts that are expressed in it, or at least similar thoughts.* Wittgenstein knows that he is in his own special headspace and others may well struggle with his *Tractatus* because they do not share that same state of mind or perspective of how things operate in the world. While my own interpretation of the physical world differs from that of Wittgenstein's, I also recognize that my views fall into a very small minority indeed, and would not expect contemporaries to share these ideas, let alone someone from Wittgenstein's era. Although I have extirpated the physical world from the process of verifying the truth value of facts, this does not lessen my own feelings about being in a Wittgensteinian headspace.[21]

What follows are the first few lines from the *Tractatus*:

> *1 The world is all that is the case.*
> *1.1 The world is the totality of facts, not of things.*
> *1.11 The world is determined by the facts, and by these being all the facts.*
> *1.12 For the totality of facts determines what is the case, and also whatever is not the case.*
> *1.13 The facts in logical space are the world.*

It is here at the outset that Wittgenstein puts logic at the heart of the world; and this is what I mean by a Wittgensteinian state of mind. The conception of our respective worlds emerges from the words that are running through our heads at this very moment and how they will be attributed meaning from what was already in our consciousness before the current stream of words took the place of the previous stream. That is a bit of a mouthful, but sums up what we might call a linguistic stream of consciousness.

Getting into a Wittgensteinian headspace is, at first, the act of becoming highly aware of what language is about, particularly the variety floating about in our own respective minds. It is not to simply take for granted that we have language and everything else that emerges from our thoughts is somehow a precise picture of an objective reality. Language is a powerful piece of software that is constantly being tuned and retuned. It has many limitations and can easily go off the rails. If we want to understand why linguistic output is the way it is, we need to go

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[21] It would be mistaken to classify my philosophy as *Idealism* due to my position regarding the physical world, since my position is not metaphysically based, nor do I approach the classical mind-body problem from the point of view of traditional Idealists.

through a process similar to that of a computer programmer when the program is not executing the way intended. For example, if we have a program that gives an answer of 5 when adding the numbers 3 and 7, we would be alerted that something is fundamentally wrong with the program and the source code will need some review and modification (debugging). Likewise, we each have our own respective linguistic source code that determines how we evaluate propositions and how these are put together to form belief systems. To understand how a propositional evaluation program is working, whether it be our own or that of someone else, we need to get into the source code, so to speak: the axioms of the language system in question.

Wittgenstein recognizes that this is not an easy task. At first inspection, there does not seem to be anything particularly mistaken about how we evaluate propositions or come to have the beliefs that we do, when taken from one's own personal perspective, of course; all of this presuming that we have given at least the slightest bit of thought that language may have some influence on why we believe the things we do. We realize that our beliefs may be different than those of others, but we trust, that if called upon, we can support why we have the one's we do, regardless that they might differ from the beliefs of others. And if we are not too dogmatic about such things, we can be comfortable with a state of affairs where we have our respective positions on matters and other people have theirs. But if Wittgenstein or I have managed to convince you that there is indeed something quite profound in the workings of language, then you might be inclined to take the next step in your contemplation of such matters.

This next step is a big one. It must first be acknowledged that we will be using the logic of language to evaluate the logic of language. So we will be working against ourselves in some sense. There is no way to step out of this subjective self-referential state; we can only swim toward the boundaries of this autonomous *language box*. A significant part of the work in Psychology and Psychiatry is aimed at getting into to the source code of our linguistic minds; and therapeutically, seeing if the code can be tweaked to improve the mental health of those being treated.

There is much fuss made about the ambiguity of meanings which arises in a wide variety of trivial situations, such as whether true statements can be made about non-existent things or fictional characters. For example, is it a true statement that *unicorns have one horn* given that unicorns are fictional entities? There is considerable philosophical debate about such encounters at the intersection of logic and reality, as it is typically defined as a fact of existence in the physical world. I find this to be a sideshow to the central issues of philosophy and more of a distraction than having anything substantive to add to the discussion. I have found Wittgenstein's use of the term '*language games'* (PI) instructive and insightful, yet at the same time, often moot. It is not for me to criticize the mental meanderings of a genius and I am rather pleased that he has covered so much ground concerning these nuances of language. In the end, a formal system of propositional logic can theoretically be constructed to account for all these nuances and trivialities, each system being slightly different in its respective construction.

…

There are several variations of the game of chess played in Southeast Asia. In Thailand the game is called Makruk, and is quite recognizable as a chess-like game, but with a number of rule changes. When I first witnessed it being played, it seemed to me that it was the regular familiar chess game, but being played by people who were not conversant with the proper rules and had

made some up. So many of the moves seemed *legal*, yet others were clearly not. Eventually I came to understand that Makruk was a variation of chess with a proper set of rules of its own that just happened to be very similar to chess. The variety of chess played in Cambodia is called Ouk-Chatrang and is virtually identical to Makruk, with only a couple of minor differences. On the king's first move, players have the option of moving the king like a knight, but only if not in check and only if no pieces have been captured. On the queen's first move, the player has the option of moving the queen two squares forward instead of just one, again only if no pieces have been captured.

Language games are a bit like Chess, Makruk and Ouk-Chatrang. There can be much discussion about the variations and merits of each game, but ultimately each game lives in its own logical space and creates its own world of truth and dare I say *reality*. Analogies can (and do) get made between games like chess and warfare or politics, as all are seen a strategic enterprises, but we would be mistaken to take these analogies too far. Usually no one dies playing chess. Each game has its own self-referential reality, and at some point it becomes rather meaningless to judge one game using the rules of a different game. It would be like a Christian saying that Hinduism was wrong because it didn't follow the doctrines of Christianity.

Language creates its own reality. And each variation, or language game, creates its own variation of that reality. This can be seen as a rewording of Wittgenstein's: *The facts in logical space are the world.*

The goal of a philosopher, I believe, is to make sense of the world. Put in another way, it is to define what reality is. In order to make any progress in this regard, one must put oneself in a Wittgensteinian headspace. The first step in that process is to recognize how everything will be framed in language, and our language must be scrutinized to an extent that we can feel reasonably assured that we are not carrying around axioms liable to lead us astray. We don't want to be playing Makruk if nature is playing Ouk-Chatrang.

We have a jigsaw puzzle before us. Let's call it *Nature*. Not all of the pieces are on the table; a few pieces seem to fit together nicely; a number of others look as if they might go together, but it is taking some forceful manipulation to get the fit just right, so maybe it really doesn't belong where we put it. We have had lots of experience in the past where pieces that seemingly fit well together were in fact not quite in the right place. So let's take out the joins that are a bit dubious and see if a different approach may hold the key to a more fitting and consistent arrangement.

What is Consciousness?

> *"Human consciousness is just about the last surviving mystery. A mystery is a phenomenon that people don't know how to think about - yet."*
>
> *— Daniel C. Dennett, Consciousness Explained*

Consciousness surely must be the most intractable of all mysteries of life and of the world. It does not readily lend itself to any avenue for comprehension. It has no edges. It has no handles. It evades definition. It avoids analysis. We want to examine it scientifically, but it refuses to submit.

Now armed with the recognition that everything we understand must be understood within the framework of language, we can attack the problem of consciousness from a new angle. There are many questions to be asked about consciousness, but the very first should be: Why is the logic of our language unable to come to terms with the subject of consciousness? It seems as though any theory of consciousness is destined to end up in the undecidable basket. So what is it about consciousness and some axioms that are common to all language systems that make consciousness so resistant to rational analysis? If we are to seriously address the many conundrums of consciousness, we first need to make the subject matter more compliant to rational thought.

Before we embark on unraveling this second of three focus points of this book, a review of how things stand would seem fitting and necessary.

Historical Context

The establishment of consciousness as one of the central issues of Western philosophy is usually attributed the methodical attention to the mind-body problem by the 17th century philosopher and polymath René Descartes (1596-1650). To concisely summarize, Descartes concluded that god had created two separate things in the world: physical things and mental things; and thus the term Cartesian dualism found its way into a central role in philosophical debate.

Despite several hundred years of mental heavy lifting, the mind-body dichotomy still remains one of the most perplexing unresolved problems in philosophy and cognitive science. No matter how many new words, definitions and philosophical positions are introduced to shed light on the matter, there seems no way to reconcile the subjective phenomenological nature of consciousness with the objective materialism that is the foundation of science. The discourse in academic circles mirrors the common sense view of the mind-body problem. Even if we can attribute our thoughts and sensations to neurological states, there still seems to be a non-physical nature to the phenomenological experience. Pre-Cartesian philosophies often identified the conscious experience with the soul or some analogous life force that transcended

the physical world; this view pertains to the present amongst the vast majority of the world's population. For a relatively small number of scholars concerned with jettisoning unwieldy dualism from philosophy, two main branches of monism have ascended: physicalism, which attempts to fit mental states into the physical world, and idealism, which states that the world is essentially a mental construction. Most of the scientific community would broadly support the former view, for denial of the material world would seem to undercut the essence of what science is about.

In 1974 Thomas Nagel published a paper titled: *What is it like to be a bat?* (Nagel, 1974).This set off both a rethinking and a reframing of questions about consciousness. Nagel states that an organism has conscious mental states "if and only if there is something that it is like to be that organism—something it is like *for* the organism." Some 20 years later Nagel's idea evolved into what was to become the common philosophical terminology: *The Hard Problem of Consciousness*, first used by David Chalmers (Chalmers, 1995), who does a superb job in succinctly formulating the central issues. I quote here two paragraphs from his paper:

> *Consciousness poses the most baffling problems in the science of the mind. There is nothing that we know more intimately than conscious experience, but there is nothing that is harder to explain. All sorts of mental phenomena have yielded to scientific investigation in recent years, but consciousness has stubbornly resisted. Many have tried to explain it, but the explanations always seem to fall short of the target. Some have been led to suppose that the problem is intractable, and that no good explanation can be given.*
>
> *The really hard problem of consciousness is the problem of experience. When we think and perceive, there is a whir of information-processing, but there is also a subjective aspect. As Nagel (1974) has put it, there is something it is like to be a conscious organism. This subjective aspect is experience. When we see, for example, we experience visual sensations: the felt quality of redness, the experience of dark and light, the quality of depth in a visual field. Other experiences go along with perception in different modalities: the sound of a clarinet, the smell of mothballs. Then there are bodily sensations, from pains to orgasms; mental images that are conjured up internally; the felt quality of emotion, and the experience of a stream of conscious thought. What unites all of these states is that there is something it is like to be in them. All of them are states of experience.*

It is this *hard problem of consciousness* that I will be addressing in what follows.

Principal Discussion Points

One of the more interesting aspects of the consciousness dialogue is just how many unresolved issues there are and how little agreement there is. There seems to be a lack of scientific focus on the matter, except that a materialist based explanation is where most want to go. Even with a sort of general agreement about the identification of the hard problem as the central issue, a definition of consciousness, what it is, who or what has it and how it came about, is anything but

settled. Perhaps there is a consensus that humans definitely have it, but beyond this point of accord there is plentiful debate, opinion and disagreement. The proliferation of terminology doesn't help either. Additional terms, definitions and categories circumvent the problem and tend to promote a discussion whereby participants talk over, under and around each other. I will try to address the main issues and be as clear as possible about my own definitions.

The first point to be addressed is by manner of elimination, that is, how consciousness does **not** come about. Any suggestion that consciousness is not a result of an evolutionary process is off the mark. What is meant by an *evolutionary process* is the conceptual extension of the Darwinian process, as it is applied to biology, to encompass all natural events so that the definition can become synonymous with the laws of nature. Natural law, whatever it may be in its detail, should apply to living organisms and inanimate objects alike. There is no indication that for the only venue for life that we know of in the universe, i.e. our planet Earth, there should be some laws of nature not available elsewhere. If the laws of nature that existed just prior to the first living substance were somehow *enhanced* to produce life at the time of this *creation*, we would have a situation suggestive of some supernatural intervention. It is far more consistent with scientific principles to think of the laws of nature having applicability to an extensive range of complexities, essentially, all things simple and complex as we find them in our universe. It is fair to ask how the same laws that apply to hydrogen also apply to viruses, fungi, clay and swans. It is a challenge for science to find a solution to explain how apparently unchanging laws of nature can account for all entities in the universe during its entire 13.8 billion year history, and for the most part science has done quite a good job. Although there are theories that hypothesize irregularities of the laws of physics in different spacetime references, current orthodox science is based on a consistent set of laws from the beginning of time, with the possible exception of the proposed inflationary period that took place in the first fraction of a second after the big bang. Whatever theory one might propose for consciousness, it should be explicable within the framework of a consistent set of natural laws.

It would be helpful if the generic use of the term *consciousness* would suffice to unambiguously describe what is meant by that term. We intuitively know what it is, and the likes of Nagel and Chalmers have nailed it down well enough where adding additional terminology is not going to enhance our understanding. I tend to use the word *awareness* as a more general non-philosophical term for perceptions derived while in a state of consciousness. But in the end, there really isn't much difference between them, and I would not say they represent two different states of affairs, nor consider it to represent something additional to consciousness, but rather a feature within its general definition. Likewise, the terms self-conscious and self-aware do not increase our understanding of the state of consciousness. Effectively, any organism that can react to its environment has some level of awareness, and if it can differentiate its own self from non-self, one can say it is self-aware as well. By this description every living thing would be aware and self-aware, conscious and self-conscious, since all organisms are behaving in response to perceptions of their environment. As Nagel points out, the respective states of experience for bats and humans are quite different. We can refer to human consciousness as being what it feels like to be a human and to bat consciousness as what it feels like to be a bat, without either having the ability to experience what it feels like to the be the other organism. We recognize that consciousness is a subjective experience that can only be known to that subject. Even within one's own species, it is somewhat different to be like another individual than to be like oneself. We reasonably surmise that one's own (human) subjective

experience is more like that of another human than it would be to be like a chimpanzee, but nonetheless, not identical.

The terms *mental states* and *physical states* are purposely being eschewed, for the whole of the dualist leitmotif forces the discussion into the same *Cartesian Theatre* that has historically restricted our thinking about the subject, often confining it to a choice between some version of idealism or physicalism. From the point of view of constructing a world that makes sense, to this point in our discussion, we have only sought to establish various manifestations of the binary process, of which language is one, and all existing within the subjective phenomenon of consciousness. There is no point in positing mental or physical states if they cannot be explained within the context of this aforementioned constrained architecture. This discourse will proceed in a different direction and not rely on many of the more popular pathways that have been taken by cognitive scientists and philosophers of mind. There will be little dialogue about the often used terms *qualia* and *intentionality* nor anything to do with a soul or *élan vital*. What is the point of introducing an entity such as *qualia* to describe what it is like to experience something, other than to lump a wide variety of these things inside a single nomenclature? I have no problem with the use of the word to categorize the various types of experiences that one has that cannot be expressed in terms of the physical world; in fact, this is exactly what qualia are. The term encapsulates the hard problem of consciousness, but to talk of qualia as a type of mental entity is just adding as bit of clutter to the room, especially since qualia as such have never been detected, nor could they be by its own definition. So it becomes just some hypothetical additive to support those building a theory of consciousness around the concept of mental states. The term *intentionality* is yet another attribution of mentality that adds nothing to our understanding of consciousness. What does it mean to say that an intrinsic part of consciousness is that it is *about* something? The starting point for intentional states is already a fully conscious human, without any discussion of what led up to the human having consciousness, or furthermore, a consciousness with intentional states. If someone makes a statement that *a human being has consciousness* and then a second statement that *a human being has consciousness with intentional states,* I find that I have no greater understanding of consciousness after the second statement than I had after the first. This is one of the generic problems of building a theory of consciousness around the characteristic of mental states. Adding terminology, attributions, properties and new entities fails to get to the core of how mental states come about without the usual allusion to some aspect of physicalism, which it had hoped to sidestep in the first place. It is dealing with a level of complexity far too elevated to develop a basal conceptual comprehension of how consciousness comes into being and what it does.

If we return to the formalist model of analysis, we see that the discussions of mentalism and physicalism both rely on too many presuppositions. We cannot examine something as crucial as consciousness without initially starting at a much more fundamental level of operation.

Physicalism: Back to Basics

It is time to let go of the physical world. It will hurt to give up the most cherished of things that science has given us. As counterintuitive as it may seem, it simply cannot be supported by the

evidence when scrutinized within a *Wittgensteinian* framework. To be clear, the physical world is not an illusion, but rather a delusion, something whose objectivity we have talked ourselves into by the logic-based nature of language. Like the moving images that appear on a television screen, the physical world cannot be denied, but is rather the result of an underlying transformative process that is hidden from discernment. It is only through the knowledge of the process, as in the case of the television images, that reveals what would otherwise be a beguiling mystery. Forsaking physicalism does not mean doing the same for physics. On the contrary, physics takes on a different and important significance. We must not look upon physics as describing a physical reality, but rather as a pathway to understanding how information and the laws describing its evolution in time, create the consciousness that animates the physical world. The findings of physics that describe the physical world are clues to how this comes about.

The discipline in science that we call physics is not physicalism; the material world along with its ontology should be seen as a language-dependent belief system. When we go from an unconscious state to a conscious state, such as when we awaken from sleep, we come to perceive the physical world. From our completely subjective viewpoint the physical world appears to come into existence. When we return to an unconscious state, the physical world disappears. Wake up again, and the world reappears. On the evidence of our conscious experience alone, the physical world is turned off and on by that phase of our state of consciousness; just like a light switch turns the state of the light bulb from on to off and back again. By all experiential accounts, it would seem that consciousness causes the physical world to come into being. When there is a 100% correlation between two events separated in time, we usually induce that there is a causative relationship between the events. Or if they are deemed to occur simultaneously, they would almost certainly be part of the same process, either in transformation or perception. And from the first person perspective, which is the only one we know, it would seem most natural to assume that our consciousness is the causative agent. So the question is: Why do most of us think otherwise? Why do we think the lights stay on after our switch is put into the off position?

To respond to this question that the physical world may become inaccessible to oneself if one becomes unconscious, however continues for those others that remain conscious, misses the point of the 100% correlation. Everyone is in the same boat and has the same personal experience regarding the physical world. What would happen if everyone simultaneously became unconscious? The world would go on, but what kind of a world would it be? What would the world *look like* in a world that only had plants as its living organisms? What could these plants *say* about the world? These are not the sort of questions that we want to have to address, as they undermine both our common sense notions of reality as well as a large body of scientific knowledge that we would prefer not to be challenged.

It is important to differentiate between what is persistent and what is transitory in this process. The physical world may come and go in respect to one's state of awareness, but the informational world continues in all respects regardless of one's subjective state. When one's lights are temporarily switched off, so to speak, the physical world may disappear, but the world is evolving in information space all the same. The laws of nature roll on irrespective of one's particular state of consciousness.

To begin our journey toward reconciling consciousness and the physical world, let's start with the assumption that *it is something to be like a dog*, and a dog has a form of doggy consciousness.

We can substitute a chimpanzee if one prefers, or any animal for that matter which we are willing to license a Nagel-type subjective experience. Let us now ask the question: How does the dog deal with the hard problem of consciousness? Is the dog troubled by the irreconcilability of its phenomenological experience of the world and the physicality of the world? Has it ever passed through the mind of a dog the wonderment about how its soul could survive its physical being? Well, there has never been an account of any dog expressing such concerns, nor any chimpanzee for that matter. Beyond the seeming absurdity of this scenario lies the key to solving the dilemma; without language, there simply is no way to pose such questions, nor to have such thoughts. The world just presents itself as it does and there is neither reason nor means to interrogate that presentation.

Language per se does not explain the nature of consciousness, but does define how consciousness came to be a problem. The hard problem of consciousness is in its rationalization, i.e. finding a solution within a logical framework. It is, in part, for this reason that science wants to force a physical solution onto the problem of consciousness, as physics shares the same logical structure as language, so they fit quite nicely together. If only consciousness could be described as physical states, then all would be fine. But so far physical explanations for consciousness have not succeeded, and never will, because it is consciousness that (to use a *Bohmian* terminology) *unfolds* the physical world.

Let us now return to the matter of how our self-deception brings us to the point where we unquestionably label the physical world as a reality to which all else must conform. If one has a language big enough to pose the question, then this rational mind may well construct such a question about how the sensory world comes about. It is difficult to say what this threshold is, as in the normal course of events in life the answer is usually imposed upon us. Most of us are either offered or dictated a creation story at a fairly early age. It will be a story that satisfies the causation requirements of our mind. In some form it will attempt to explain how we got here. There is a strong tendency to carry the substance of these early teachings with us for the rest of our lives, nevertheless recognizing that there are many exceptions to this general rule. Again, for most, this will be classified as a faith in a creator deity, carrying with it a set of stories and rituals.

The atheist-scientist, on the other hand, would think that he or she does not have a belief system as so much as a rationally objective picture of reality, and can back this up with an enormous volume of scientific data and well-constructed theories. The consensus scientific *creatio ex nihilo* story is *The Big Bang*. It has a few metaphoric holes, but it's not a bad story when compared to most others. If one has accepted scientific objectivism from an early age, this writer being a prime example, then one acquires a near unshakable belief in the rationality of science that seems in stark contrast to that of religious mythologies. But when viewed within the framework of the linguistic construct, both religious and scientific beliefs are formed by the same process. And the truths of those belief systems simply conform to the axioms of each respective linguistic mind. How close a belief system conforms to some notion of an objective reality will depend on how well the system responds to the scrutiny of its axioms. And the recursive nature of language will always leave these sorts of questions about the veracity of beliefs unresolved. If the theorem-creating rules of two respective linguistic minds are different, then their respective belief systems will be like comparing apples and oranges.

As for physicalism, regardless of how one acquires a belief system which may be termed a *world view*, whether it be scientifically or religiously based, rest assured that a presupposition about the objective reality of the physical world will be a bedrock of that belief system. Although most religious systems have spiritual components to what comprises the totality of their respective realities, including aspects of transcendence beyond the material world, few would deny the material world entirely. It is recognized however that there have been copious varieties and numerous proponents of idealism in philosophical annals. Even without exposure to any of the traditional type belief systems, one is nonetheless likely to form a belief in the reality of the physical world by dint of common sense alone, because when you open your eyes, there it is; you can see it, you can hear it, you can feel it. Furthermore, just about everyone else in the world, including those with alternative world views, is likewise accepting the reality of the physical world, so there would be no compelling reason to doubt its existence. For the vast majority, irrespective of world view, belief in the reality of the physical world is acquired early in life, reinforced continually throughout life, both linguistically and phenomenologically, and rarely challenged. This is the perfect prescription for an entrenched belief system that will be nearly impossible to unhinge.

Once again, a belief system is only as good as its axioms. We can summarily dismiss the commonsense notion of the reality of the physical world as it is wholly dependent on the yet to be understood phenomenon of consciousness. The axioms representing physicalism in such a belief system are a straightforward linguistic representation of sensory experiences, further supported by the aforementioned lack of a societal challenge to such beliefs.

Belief systems categorized as religions, as well as other spiritual systems, are mostly based on personal experience and so-called revealed truths. There is not much that can be said about this that has not already been said by Richard Dawkins in his book *The God Delusion* (2006). Religion is a good indication of our yearning for causal explanations. As incorrect as religions may be, there is no point in using science to bash it up; it is just the mind trying to find a way to reconcile the logic of its language with the phenomena of its experiences. The potency of scientifically based arguments against religion is markedly reduced by the fact that the arguments are grounded in the presupposition of the reality of a physical world. Nonetheless, the physical world does represent a correspondence with testable hypotheses within the framework of the scientific method. Whatever answers are proposed to questions pertaining to the role of consciousness and what might be deemed some ultimate reality, they will have to explain why science produces the results that it does.

It is the scientific assertion of an objectively real world which will take considerable effort in overcoming, for it is supported by a system of logic (mathematics) that beautifully describes its existence, reinforcing the belief that obtains from our sensory experiences. Everything in science holds together within its own contextual framework, whether the physical world is the definitive reality or not. It is actually quite *unempirical* to assume a physical ontology, for it closes the door to other possibilities on a basis of unproven assumptions. One cannot simply declare the physical world into existence and make it so. What is being challenged here is not physics, but rather the ontology of an incontrovertible physical reality and these two must be separated. Physicalism, as being the representative ontology of the broader scientific community, has gone unchallenged until quite recently, consigning these collective belief systems to borderline numinous speculation.

…

A more detailed discussion regarding the principal concepts germane to the physical sciences will be left for later chapters. My purpose here is first to separate concepts of the science of physics from that of physicalism and further to release consciousness from its grip. There have been numerous theories and half-measure proposals about consciousness over a period of many centuries, yet nothing to date has really come close to answering the questions posed by the *hard problem*. I would like to conclude this discussion on physicalism with a few diverse thoughts on the subject before moving on to the solution of the problem. These are meant to be more of a commentary than an argument.

- We should keep in mind the most successful physical theory in history, quantum mechanics, is a mathematical theory with a physical explanation that has eluded comprehension by its principal architects and supporters. In fact, the physical world as we understand it seems to break down to a fuzzy blur at quantum metrics. If the physical world falls away at its fundamental level of description, then what are we to make of its reality?
- In a universe that yearns for economies and efficiencies at every pass, one has to wonder why it should be composed of so much *stuff*. If one could totally represent the world with information alone, why would one go to all the trouble of actually producing *hard* matter? It would be analogous to having to choose between either playing a DVD of a movie or gathering up all the actors and actresses that were in the movie and bringing them to every set to repeatedly play out their scripts every time we wanted to view the movie. It just seems to be more functional, if one has the information to do so, to have an interpretation of that information in a constructed or evolved format, a virtual world, so to speak.
- Most of the physical stuff in the universe seems to be missing. As of this writing it is estimated that about 95% of the universe is composed of dark matter and dark energy, yet to be observed or described. These percentages are deduced by comparing the amount of matter-energy required to account for observed gravitation as well as the rate of expansion of the universe. Only 5% of the ordinary material that we are familiar with is of the kind that we find in our solar system and our bodies. I would suspect that this problem of missing material will be resolved in due course, but it does show that much ontological theory has been assumed while the full picture of the universe is still far from complete.
- The *holographic principle* finds its origins in examining the thermodynamics of black holes. It has been expanded to beyond black hole thermodynamics to state that the entropy of a volume of ordinary space (not just black holes) is proportional to its surface area, spatial volume itself is illusory and the universe is really a hologram which is isomorphic to the information *inscribed* on the surface of its boundary. Put another way, it says that all the information of a 3-dimensional volume of space can be encoded on its 2-dimensional surface. Although still a developing theory, it represents one of the more compelling arguments for linking information and physicalism, virtually equating the two, at least in a transformative way.

And here are a few interesting quotations on the subject to bring this section to a close:

- *"Everything we call real is made of things that cannot be regarded as real." — Niels Bohr*

- *"It will remain remarkable, in whatever way our future concepts may develop, that the very study of the external world led to the scientific conclusion that the content of the consciousness is the ultimate universal reality." — Eugene P. Wigner*
- *"Hence it is clear that the space of physics is not, in the last analysis, anything given in nature or independent of human thought. It is a function of our conceptual scheme [mind]. Space as conceived by Newton proved to be an illusion, although for practical purposes a very fruitful illusion." — Albert Einstein*
- *"One has to find a possibility to avoid the continuum (together with space and time) altogether. But I have not the slightest idea what kind of elementary concepts could be used in such a theory." — Letter from Albert Einstein to David Bohm, October 28, 1954*
- *"To meet the challenge before us our notions of cosmology and of the general nature of reality must have room in them to permit a consistent account of consciousness. Vice versa, our notions of consciousness must have room in them to understand what it means for its content to be reality as a whole. The two sets of notions together should then be such as to allow for an understanding as to how consciousness and reality are related." — David Bohm, from the introduction to Wholeness and the Implicate Order*
- *"We have a closed circle of consistency here: the laws of physics produce complex systems, and these complex systems lead to consciousness, which then produces mathematics, which can then encode in a succinct and inspiring way the very underlying laws of physics that gave rise to it." — Roger Penrose, from The Road to Reality: A Complete Guide to the Laws of the Universe*

The Origin of Consciousness

Having rejected both dualist and monist theories of consciousness, what is left but for something completely different? As a re-entry point we will return to the examination of animal consciousness from earlier in the chapter.

How can we tell if an animal has consciousness? To answer this question we first need to get past the language post by further elucidating upon the definition of consciousness; and for this purpose I will take Nagel's description to be the initial definition. It would be fair to say that under this definition it should not be contentious that most, if not all mammals, have their own respective form of consciousness, i.e. dogs, cats, horses, cows, rats and bats all have a first-person type of experience of the world, albeit different from ours and from each other. Once we place pre-linguistic humans into the frame, it becomes quite difficult to find criteria for when a particular species crosses from a predecessor class into a class that both I and Nagel would say is conscious. I cannot think of a single case of a mammal that goes about its business in a manner contrary to the Nagel criterion. They all seem to be aware of their world and behave in a manner consistent with their characteristics. That is to say, that I do not know of a mammal that behaves so robotically that I would doubt if it was truly having a subjective experience. Of course, it is the nature of consciousness that none of this can be proven; we can only surmise from appearances. And it would seem that resorting to solipsism is the only way out of making these sorts of judgments, whether it be for other species or other members of our own species.

We can continue back in time through the phylogenic tree as far as we like and the argument centering on the subjective experience of the organism will continue to hold. We will find that all living things have mechanisms for assessing their respective environments and methods for responding to some number of variations in conditions. Natural selection will of course dictate the robustness of these responses and breadth of environmental scope. It is rather arbitrary where the line is drawn between the haves and have-nots of consciousness. It is anthropocentrism alone and its attendant hubris that would find a line drawn too high and more specifically too far along the *Homo sapiens* branch.

I have tried to steer the definition of consciousness along a path that suits the way I would like to drive the discussion, but realize that many would not see it in the same way. It is somewhat analogous to the dilemma of Joseph K in Franz Kafka's novel *The Trial*. Everyone seems to be in agreement that the charges against Joseph K are serious and offer many avenues to resolve his case, but the charges against him are never specified by anyone. Despite not feeling that he has committed any crime, he is nonetheless forced to submit to these bizarre circumstances, for he is trapped within the system. If he steps out of the madness, he stands alone. Likewise with consciousness, nearly all the players seem to be in agreement that it is an emergent property, but cannot offer when it emerges in evolution or how it does so. It seems a bit of madness to persist along these lines, but to step out of this madness, like Joseph K, one stands alone.

…

I have stressed throughout this thesis that if we are to comprehend how the universe works it will require a specific structured approach that we are literally obliged to take if we are to use language to make our case (which of course we must). Up to this point in the discourse we have only two postulates:

1. All that we know of the world is through our conscious experience.[22]
2. Rational explanations of the world are subject to the constraints of the language in which they are expressed and the rules of its respective formal system of propositional logic.

Perhaps there should be a third postulate that states that we can assume nothing else. All of this is not much to go on, especially when we consider that consciousness itself is yet to be clarified. So the main task at this point is to elaborate on the first postulate, and we only have the second postulate to work with to accomplish that task.

Until there is a system to replace rationality there will not be another avenue to constructing a world which is both internally consistent and comprehensible. There simply is no choice but to work with whatever is permissible within language. Although the basis for this system is one of formal logic, it need not be formulated mathematically. In fact, many of the idiosyncrasies of the many varieties of logical systems only muddy the waters of an otherwise simple concept. We should not forget that we are talking about building a universe from the very modest enterprise

[22] It has been previously noted in the discussion on language that some knowledge of the world is attained through non-conscious neural pathways, but this does not change the substance of the arguments, for it would only require a more expansive definition of consciousness to incorporate these inputs.

of the binary process, or how things go from one state to the next when there is only a selection to be made from two possibilities. The 20th century struggle in the field of mathematics to find what is provable or computable helps delimit how to go about such a process. So let's begin!

Computation Meets Consciousness

What follows will be stated in the formal system of the propositional logic, i.e. the language, of the author. I recognize that I have integrated a number of beliefs into my language system, some of which I either cannot or choose not to support by evidence or argument and must be taken axiomatically. These are what I believe to be the relevant axioms of my language system:

1. The axioms of first-order logic which include formal systems of propositional logic, arithmetic and set theory.
2. Language is a formal system of propositional logic.
3. Universal Computation (of the binary process).
4. Finite Nature (i.e. the world is discrete, not continuous).

The first of these axioms is generally accepted in mathematics. The second has been argued extensively in previous chapters. The other two will be discussed in the remaining sections of this book.

…

The world is made of bits and a recursive algorithm, most likely with *attractor*-like features, which determine how the configuration of these bits transforms from one state of affairs to the next after each successive execution of the algorithm. Both the bits and the algorithm exist in logical space. There is no need to fathom how something analogous to a computer program can run without something physical like a computer to run it on. I am calling it logical space to distinguish it from a space composed of physical material. I only have logic to play with, so I cannot posit something beyond the axioms of my system. It hardly matters what I call the platform for the operation of this program of our universe, for it is a kind of space that exists beyond the boundaries of our epistemic world of normal experience. I chose the name *logical space*, as it seemed the simplest description, but it is not meant to be understood as anything other than a space in which outcomes from binary operations can evolve into different configurations.

It should be unambiguously understood that the algorithm that runs our universe effectively sits outside of the epistemic logical space of our consciousness, which should be seen as a subspace of the space created at the big bang. At these early stages in the realm of digital physics it is difficult to say how much in the greater scheme of things can be inferred about these particular laws of nature from within our subspace, but it might well be analogous to a monkey, having found the wreckage of an airplane in the jungle, managing to reverse engineer it to produce its very own flying machine. Although there are a growing number of physicists going down the pathway of a digital physics with a digital mechanics, the numbers are still rather paltry. Edward Fredkin and Stephen Wolfram are perhaps the most prominent advocates and have been prolific writers on digital physics. I have followed and agree with most of their

thinking on the subject, though we differ in a few minor respects. Suffice it to say that the only differences of substance that I seem to have with Fredkin, for instance, concern the importance of consciousness in digital physics and some details on how we get from the digital to the physical world, in effect, how they correspond. As there are not many of us in the digital philosophy parlor, there is a lot of scope for variation and gradation. At this juncture of the thesis I will limit the detail on the subject of digital physics to its applicability to consciousness and leave a more thorough discussion for a later chapter.

As we can only gain access to the physical world through consciousness, it must be established how consciousness comes about to best utilize the knowledge gained from the application of the scientific method, which is couched in *conscious* observation. This is, in part, why we are effectively forced to take a *digital philosophical* approach to resolving how the world is put together; we have a discrete system (language), but lack a methodology for going from discreteness to continuity. Furthermore, consciousness must snugly fit between the digital world and the physical world for a consistent theory to succeed. The only arrangement that can account for all of language, mathematics, consciousness and physics is the one on offer here, i.e. within my axiomatized system. In my own particular case, once it became evident that Wittgenstein's concept of language was correct, the rest, in due course, methodically fell into place. There seemed to be no alternative arrangement.

…

The essence of digital mechanics is that bits of information can programmatically build themselves into arrangements that can isomorphically be *observed* as *physical-type* structures like atoms and molecules. But it is more to the point a story about mathematics, and whether at the bottom of calculations that represent contemporary physics are discrete operations or continuous ones represented by differential calculus. So if quarks can build themselves into nucleons and we can add electrons and photons to make atoms, and aggregates of atoms can become molecules, and some complex molecules can form proteins, and so forth and so on, we can accept that the complex world that we see today came from more fundamental building blocks. This is the story of the cosmos. It is orthodox science. Complex things arose from simple things by a long and perhaps intricate process.

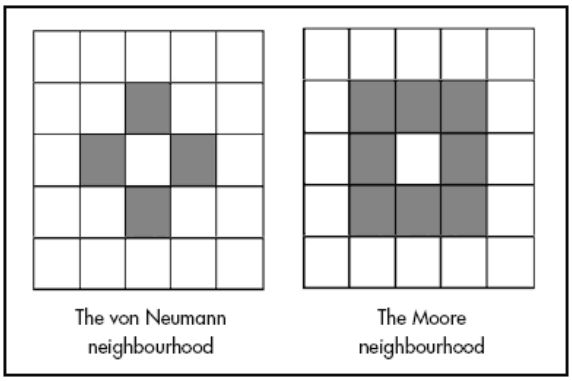

Figure 4: Cellular Automata. 2 Kinds of Neighborhoods.

There is not much argument about these generalities, but rather whether this description can be designated as a definitive physical reality or a virtual reality. Some, but not all, versions of digital physics would say that it's a virtual reality. If this evolution of increasing complexity takes place by the execution of the laws of physics, exactly what do we mean by the laws of physics? How do entities like electrons and quarks *know* what to do next? Where do they get their instructions from? It should be quite evident that the instructions are *written* in the language of mathematics; but what kind of mathematics? Let's see what happens if we go the way of a virtual reality. Remember, that everything in the world of bits can have a physical analogue, so if we are talking bits, we could just as well be talking about physical entities.

Arrangements of bits in logical space are analogous to arrangements of physical entities in spacetime. It may be easier to imagine what is happening in logical space if we assume this cosmological Universal Computation is happening on cellular automata, and for the sake of simplicity, cellular automata in a 2-dimentional lattice (see Figure 4).[23]

It might be even easier to imagine an evolution of a state of affairs by picturing a game of chess instead, as the similarities are close enough for most illustrative purposes regarding consciousness. Whether we are talking about cellular automata or a game of chess, there are two principal stages to the process. The first is the *assessment stage* and the second is the *action stage*. In a cellular automation, the cell in question evaluates the state of each cell in its neighborhood, and based on the state of affairs either changes or stays in the same state. In a 2-state system, such as a binary system of bits labeled 0 and 1, a cell starting out at 0 will either remain 0 or change to 1 as determined by a rule-following system encompassing the adjoining cells.

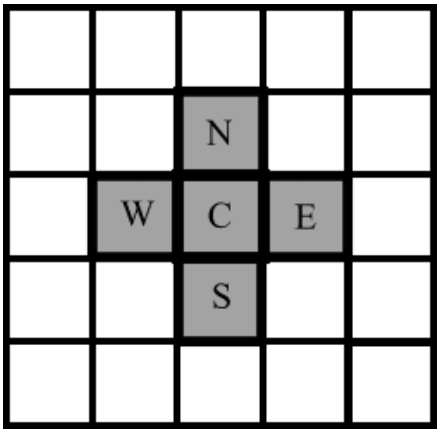

Figure 5: Cells change based on the states or adjacent cells.

For example, in what is called a cellular automation with a von Neumann neighborhood (see Figure 5), the state of cell C will evolve in a manner dependent on the respective states of cells N, E, S and W.

This evolution takes place in time, so that each execution of the rules of action will move the cell to the next state. A representative time notation *'t'* may appear like

$t_0, \ t_1, \ t_2, \ t_3, \ldots . t_n,$

reflecting the passage of time from one generation, or state of affairs, to the next. In a 2-state bitwise system the cell C may have a generational evolution like 0,0,1,0,1,1,1,0,0, . . .n; of course, depending on the values of cells N, E, S and W, which themselves may be generationally changing based on conditions in their respective neighborhoods.

A notation more suitable to these types of 2-state systems might be as follows:

- The *assessment stage* can be notated as Tc (Tc_0, Tc_1 . . . Tc_n). I will hereafter call this the ***constate*** of the system.
- The *action stage* can be notated as Ta (Ta_0, Ta_1 . . . Ta_n).

This 2 step process characterizes the *rhythm* of the universe at its most rudimentary level; it has 2 beats, one to assess the state of affairs, the other to run an algorithm to move to the next state of affairs.

I propose that the constate, or assessment stage (Tc), is what Consciousness ***is***. It is the recursive universal algorithm (UA), *reloading* itself with a new set of inputs based on the state of

[23] See (Banks, 1971) for some of the seminal work in this area.

affairs that existed after the previous execution of the UA. It is effectively how things *know* what to do next.

What things are conscious? The answer is: Everything!

In fact, it is everything at every level of complexity. Every entity which can affect the decision process of the UA is conscious. It needs to be conscious in order to know what to do next. The kind of consciousness humans have is taking place at a very high level of complexity and requires its own special explanation. But first, I would like to show how complexity and consciousness grow together. The computational aspects of cellular automation fit well with this schema, but we will leave the world of cellular automata for the moment and utilize the following game of chess as a representative metaphor.

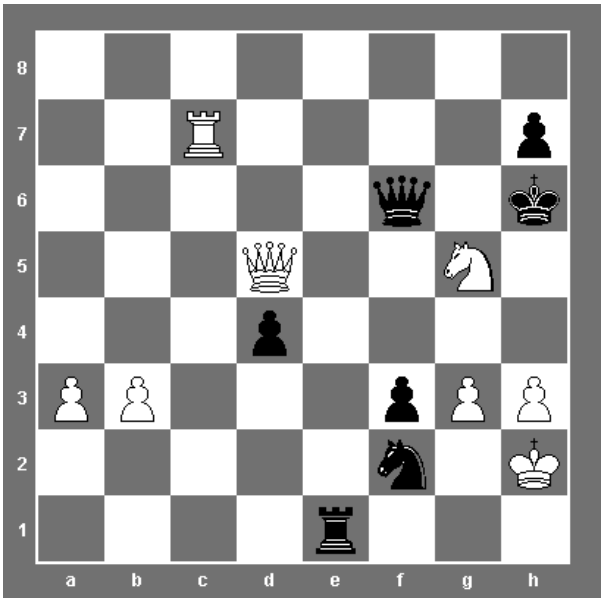

Figure 6: Deep Blue (Computer) vs. Garry Kasparov challenge (Game 1, 1996)

The position from the game between IBM's Deep Blue Computer and Garry Kasparov (Game 1, 1996) is shown in Figure 6. Deep Blue, playing White, is to move. We can see that Black can checkmate with Rook to h1. However, White wins the game with the Rook taking the Black pawn on h7 (Rxh7+). Kasparov resigned, because after Qg8+ and Nxf3, Black's position is lost.[24]

There may be some debate about what makes Kasparov tick, but we know that Deep Blue is running on a juiced-up version of a Turing machine. It only has bits to work with, yet somehow it is clever enough to beat the champ.

As previously noted, chess is a type of formal system of logic. The board, the pieces and the players are for all intents and purposes the symbols of the system. The rules about how pieces move constitutes the formal grammar of the game as well as generating theorems, or legal moves. Any legal move in a game is an axiom, e.g. *e4* is an axiom of the system on White's first move in any game of chess. We can view a game of chess as a more complex form of cellular automata. In fact, there are many aspects of a chess game that are analogous to the universe as a whole.

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[24] The game moves were as follows:

1. e4 c5 2. c3 d5 3. exd5 Qxd5 4. d4 Nf6 5. Nf3 Bg4 6. Be2 e6 7. h3 Bh5 8. O-O Nc6 9. Be3 cxd4 10. cxd4 Bb4 11. a3 Ba5 12. Nc3 Qd6 13. Nb5 Qe7 14. Ne5 Bxe2 15. Qxe2 O-O 16. Rac1 Rac8 17. Bg5 Bb6 18. Bxf6 gxf6 19. Nc4 Rfd8 20. Nxb6 axb6 21. Rfd1 f522. Qe3 Qf6 23. d5 Rxd5 24. Rxd5 exd5 25. b3 Kh8 26. Qxb6 Rg8 27. Qc5 d4 28. Nd6 f4 29. Nxb7 Ne5 30. Qd5 f3 31. g3 Nd3 32. Rc7 Re8 33. Nd6 Re1+ 34. Kh2 Nxf2 35. Nxf7+ Kg7 36. Ng5+ Kh6 37. Rxh7+

To start, we can examine the *conscious* state of the White's rook on c7. Yes, I said conscious state, because it needs to know what it can do next. This knowledge is within the system that excludes the players, so a piece cannot make an illegal move even if the player would like to do so; if it does, it wouldn't be a chess game, but some other kind of game. There are several things the rook needs to know. It first must be self-aware, that is, it must know that it is a White Rook. It must know that its position in chess-space is on square c7. It must know that the only legal moves it can make are to squares in column c and row 7. Any instruction requesting a move to any other square could not be legally made, not being a theorem of the system. Irrespective of whether this game is being played in London or Bogota, being played with wood pieces, onyx pieces or in the virtual space of the internet, being played by a man, a woman, a computer or a chimpanzee, the scope of the rook's consciousness remains the same. It is a long way down the complexity ladder from the consciousness of a human, a dog, a bat and so on, but it is functionally the same; it is an assessment of the state of affairs from the rook's perspective at time-generation $Tc_{(w37)}$ (being the state of affairs just before White's 37^{th} move). It is the subjective experience of a rook in the logical space of a particular chess game. Deep Blue instructs the rook to move to square g7. The rook checks its internal rule book, and finding that it would be a theorem, accordingly obliges. The algorithm being run on Deep Blue executes the move Rg7+ at $Ta_{(w37)}$.

Deep Blue, being a complex entity in its own right, will instruct the rook to make the move Rg7+, introduces another level of complexity to the chess game system. An entity with a complex computational mechanism is integrated with a simpler entity, the rook, to form the 2-step process at $T_{(w37)}$. Although this is just a chess game, it is very much representative of how the universe operates as a whole. It may be hard to imagine how some pre-cellular ancestor to both mammals and bacteria, perhaps something like a virus, evolved into complex organisms like ourselves with more than 10^{13} cells, but of course, we know this is the case. The enormity of the numbers and the integration of entities operating at so many levels is nearly impenetrable. For what I am proposing in the context of consciousness is that human consciousness is an evolved state of simpler forms of consciousness, like *rook-consciousness*, which is a distant cousin of virus consciousness in a way analogous to a bacterium being a distant cousin of a human being.

Assembling a universe from a computational model simplifies the architecture of complexity building for it can follow well-known concepts in computer programming, such as those of object-oriented programming (OOP). These concepts could well apply to demonstrate how the universe can build itself up from simple structures if the UA has a learning mechanism in place, such as natural selection, operational at the most fundamental levels of the world. It is both logical and intuitive to believe that if natural selection is the driving mechanism for evolution at the biological level, it should also be so at subordinate levels of complexity.

Human consciousness is a far cry from the kind of consciousness represented in this computational model, but it is important to make the point that human consciousness derives from the same process as rook-consciousness in the chess example. Like a horse and an amoeba, they are very different creatures, but have a common ancestry; there are many things that are different about them, yet there are things that they share in common. Every logical entity that evolves both recursively and algorithmically will have a constate phase separating the execution stages of the algorithm so that the system evolves as follows:

This generalization of evolution in a logical space is not very different from the kind involving the evolution of complex biology. And one should think that to be the case, for biology is a generationally advanced subset of the UA, and as such, very much a part of the universal process. The sorts of questions that arise about this kind of system often pertain to just how this mechanism works, something not easily determined due to the number of entities and interrelationships involved in the process. As it relates to a Nagelian type of consciousness, the question is how does a configuration of constates, ostensibly designed to detect the state of affairs in something analogous to a von Neumann Neighborhood, evolve into what can be called a subjective experience. And a good question it is, indeed!

Whether one favors a digital physics or a physics of a more conventional variety, we find that the universe has been evolving from simpler entities to more complex ones during the course of its history. The evidence also supports that we have the same laws of nature today that were around at the earliest moments of the universe. It would seem reasonable to assume that observables of the evolution of complex systems, such as what we witness in biology, are representative of the same laws of nature that were around when the world was a simpler place.

Definition of Consciousness

What we call consciousness is just one of the many complex arrangements generated by the algorithmic process that are the Laws of Nature, so that in any given case we get the process:

Information → Laws of nature → Consciousness + Evolution

As previously stated, serious debates on consciousness often get mired in trying to find a definition of common ground, especially if the parties have their own respective preferences on how the subject should be framed. So how would I chime in on the matter if posed the question: How would you determine if an entity has consciousness? My reply would be as follows:

If an entity, however defined, can unambiguously transition from one state of affairs to the next by following a set of rules, including choosing from a set of probabilities for transitioning, then the entity is deemed to be conscious.

…

Before returning to the subject of how consciousness creates the physical world, we will take a look at how the world, as we consciously observe it, is one that well fits into the algorithmic format described above.

Building a Universe

> *"The energy of the universe is constant. The entropy of the universe tends to a maximum."*
>
> *— Rudolph Clausius*

> *"The Fundamental Process of Physics is Computation Universal. This should be recognized as the **First Law of Physics**"! — Edward Fredkin*

If you were looking for clues on what the universe is about, the laws of thermodynamics are not a bad place to start.[25] There is near complete agreement on the scientific veracity of these laws. The first and second laws convey so much about how things evolve over time. To reprise a term used earlier in this book, it can be said that these laws are universally thematic in the sense that they are indicative of the *purpose* of the universe. Perhaps it is somewhat provocative to use a word like *purpose* in such a context. It reeks of teleology, not that this should be seen as a scientific obscenity, particularly if we set aside the anthropocentrism of theologies and the anthropic principle. From within the confinements of the box that we call our universe, nothing can be said about what lies outside the box, if anything at all. It behooves us to work with what we have inside the box and do the best we can to interpret the clues which we are given.

I have long viewed the universe as a kind of factory going through a *manufacturing* process, perhaps without either the planning or appreciation for the products which are being produced. It starts out with a fixed amount of raw material, and then goes through a series of transformations and assemblies to produce things which have a low probability configuration (high information content). This happens at the expense of a considerable amount of waste (entropy). Perhaps all of the products made in this factory have a limited lifespan and will, in

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[25] Thermodynamics is a major branch of physics covering the evolution of physical systems, such as our universe or the weather, to give but two examples. There is also a close relationship, particularly mathematically, between thermodynamics and information theory.

There are four laws of thermodynamics, the first and second being the most often cited:

- Zeroth law of thermodynamics – If two thermodynamic systems are each in thermal equilibrium with a third, then they are in thermal equilibrium with each other.
- First law of thermodynamics – Energy can neither be created nor destroyed. It can only change forms. In any process, the total energy of the universe remains the same. For a thermodynamic cycle the net heat supplied to the system equals the net work done by the system.
- Second law of thermodynamics – The entropy of an isolated system not in equilibrium will tend to increase over time, approaching a maximum value at equilibrium.
- Third law of thermodynamics – As temperature approaches absolute zero, the entropy of a system approaches a constant minimum.

turn, themselves become waste products. Is this not what energy, complexity and entropy are about? Can something be goal-oriented without necessarily being intentional? Many of the clues would say yes!

In fact, entropy, information, complexity, uncertainty, predictability, unpredictability, order and disorder, are all the same thing given particular names to suit the peculiarities of the system being examined at the time. The same mathematics applies to all. The term *information* seems the most generic and therefore the most useful in a general discussion and can stand for any of the terms above and many others as well. For example, things that seem complex in the physical world are likely to have a high information content in logical space (or information space, if one prefers), which is self-evident if the physical world is an isomorphism of an arrangement in logical space.

Let us imagine the universe as a kind of schema where the goal is to produce the most powerful computer possible within a set of constraints on both material and instruction (you may want to substitute *bits* and *algorithm* here and view it as a metaphor for an algorithmic dynamical system *attractor*). A *creator-deity* account can elucidate the kind of task that confronts such a project in that the product of the creation is so complex that it can seemingly only be accomplished by an omniscient being. But here I have imposed constraints restricting the project to produce the same results with simple and economical methodologies. I have set these impositions because it seems the best fit for the evidence of what the early universe was like and what the laws of thermodynamics inform us about the broad process of universe building. We find ourselves in a universe where the watch is more complex than the watchmaker. It is difficult to say what the schema of the universe is aiming to construct, for one cannot say how far along we are in this process. Do we have enough information at hand to tell whether the passage of some 14 billion years places us at the beginning, middle, or near the end of any such goal-oriented endeavor? With the amount of knowledge we have at present, it probably does not make much difference if we set the cosmological hypothetical to building the most powerful computer or baking the best tasting lasagna, for the process up to this point may well look the same in both cases; it may first require the production of an entity *intelligent* enough to be capable of producing either, perchance something like a human being. It is also difficult to say how applicable the concept of the anthropic principle might be, or whether the proceedings here on planet Earth are just a side show or by product of the main show that is playing out on another stage. In that complexity can take on so many forms, we need to contain our enthusiasm for a particular outcome and restrict ourselves to more generalized scenarios that might apply in a wider range of potentialities.

The similarity between the measurements of information and thermodynamic entropy links the 19th century work of Gibbs and Boltzmann with the 1948 work of Claude Shannon. Thermodynamic entropy and Shannon entropy are not necessarily equivalent as it depends on the context of the measurement. But one intuits that ultimately entropy and information stem from the same origin and only differ in the perspective of the measurement system.

In a universe that has information at its core, complexity builds through various combinations of simple logical structures; and those structures in turn assimilate into ones which are yet more elaborate. Key features of OOP can illustrate universal complexity building, as it should, since there is not much difference between them. *Objects* in OOP, which are programmatic constructs, are very much comparable to the generically labeled physical *entities* of common

parlance. Complex objects are constructed from simpler ones. A chair made from wood, nails, glue and cloth takes on a whole new purpose completely different from its components once it is assembled, and goes about its existence in a form of superstructure of its componentry; semi-autonomous, yet inextricably connected. A termite infestation of the wooden legs will take the chair down with it.

It has been hypothesized here that from a human perspective the physical world comes about through the high-level mediation of the fundamental process of consciousness. At this juncture it should suffice to show that discrete computational processes can construct complex informational entities capable of isomorphic representations in a physical spacetime mediated by consciousness. There are numerous analogues of this kind of isomorphism in our everyday world, from the digital encoding on a DVD playing a movie to the DNA of a biological organism playing the part of an operating system for replicating and running that organism. The question is whether a digital physics can produce a consciousness that in turn can generate a physical representation of itself. This thesis is not the place to review the vast body of knowledge concerning computation, algorithmic information theory or computer programming. I have selected a few of the more pertinent concepts to elucidate the ideas presented herein. This includes the notion that anything that can be produced by a particular computer can be produced by any Universal Turing Machine (UTM), which establishes a ubiquity about computation itself (Computation Universality) and should, at the very least, be seen as something fundamental to how the universe operates (Fredkin, 2003). Again, if one can be convinced that physics is Computation Universal, there only remains to show the connection between computation and its physical isomorphism. This is no small task, but it should be clear enough that general computer programming concepts are sufficient to explain an algorithmic construction of the universe. It is not necessary to derive new concepts at the theoretical level, as ordinary *physical world* computer analogies are adequate.

A search for the universal algorithm may well be a valuable exercise, but we must be realistic about the prospective achievement of such a goal. It should be understood that a computational physics can be produced by any number of diverse algorithms. There are many ways to write a program to produce a particular result, as there are many genotypes that can produce the same phenotype. It is only through the imposition of guidelines and constraints, such as certain kinds of efficiencies, that we may limit the number of possible algorithms. There are numerous algorithmic models of physical world type entities, many of which can be found in the field of cellular automation.

Notwithstanding a personal familiarity with computer programming, I cannot help but be amazed by the complexity of some of the broadly available computer programs, e.g. the big name operating systems, computer aided design (CAD) programs and virtual reality animation. Many are a result of the collaboration of thousands of contributors. It would be far too great a task for a single mind. And yet these human constructions pall against the complexity of the universe, and are clearly, in fact, a small subset of the universe. A major criticism of computational models of the universe is the impossibility of actually doing the computation. But this should not be a reason for rejection of such approaches. I have stressed in this book the importance of understanding our cognitive limitations and finding methodologies to work within those limitations.

I have shown that within an axiomatic recursive linguistic framework that any set of non-contradictory propositions can produce truth, as truth is essentially a function of logic. The success of quantum mechanics as a scientific theory should be judged within this framework, as should all theories, whether they fall under the rubric of science or some other system that professes a particular epistemology.

…

In the unfolding of the complex universe it is easy to lose sight of an underlying simplicity in light of the menagerie of particles, superposition, multiverses, strings and the like, that mainstream science offers up as reality. There are only two main processes which need concern us regarding the evolution of the universe, (with my humble apologies to the strong and weak nuclear forces which certainly play important roles in the greater scheme of things). Gravity crushes simple atoms and spews them out as more elegant ones (and makes the sun shine to boot). This crunching and spewing may happen many times over in order to produce the heavier elements, which are most likely produced in supernovae. There are 98 naturally occurring varieties emanating from this process, which can easily be found, nicely sorted, in a periodic table of elements.[26] Some of these are used to make chairs. The effect of gravity at the high densities found in stars is a brutal and crude process.

The rest, which comes under the broad heading of Chemistry, is mediated by the electron. That's it in a nutshell. Really! When it comes to chair-making, once you have your raw materials (atoms of various elements), it is thanks to the marvels of the electron to fathom together the wood, glue and carpenters to make it all happen. How did it ever become so clever?

It would seem rather pointless to have yet another detailed discussion of quantum mechanics and the standard model of particle physics filled with the usual equations. Sometimes mathematics can be a distraction from examining the broader issues. The mathematics supporting quantum mechanics self-validates the concepts within its own self-referential system, but it does little to explain what is going on. What it can do it give us clues that help us make sense of the world. What follows is a review of the main features of mainstream physics and a theory of how it can fit quite well with computational models of the world.

Quantum Weirdness

"I like to think that the moon is there even if I am not looking at it." — Albert Einstein

It is worth recalling that although quantum mechanics refers to things in the physical world, we should not submit to labeling this as *reality*. Nor are we making reference to facts, but rather observations, something that is a product of the conscious experience. We are however learning

[26] There are 118 elements listed in the periodic table including those artificially produced. There are also some opinions that as few as 90 elements occur naturally.

something about how the universe is constructed from these observations, without saying precisely what that universe *is*. If one insists on the ultimate objective reality of the physical world, then the quantum world will forever be weird. In a physical ontology, quantum physics will exhibit behaviors that are nonsensical within that ontology. This is due to inconsistencies between what the theory displays and the logic of language permits. It also fails on the essential notions of causality. It is part of normal parlance to say something is ontologically real without insisting on the requirement that it be observed. For example, if one were in New York City yesterday, but presently in London when asked the question '*does New York City exist?*', it would seem factually correct to answer '*yes*' without insisting on the requirement to revisit the city; and even if one were to hop on a plane and scoot over to New York to be certain, it would not necessarily verify with 100% certainty that it would have been true when the question was asked in London. This is yet another way of stating that our generally accepted notions of linguistic created reality do not require a personal conscious experience or observations to be a part of the picture.

A consensus of the scientific community would have consciousness as an unstated or self-evident part of the system that includes the generally accepted definition of physical reality. The presupposition of an ontic physical reality excludes any consideration of the workings of either language or consciousness; they just become part of the *a priori* construct of the physical world. So we find within orthodox science a disjunction in the three central themes put forth in this book – language, consciousness and the physical world – when referring to what is casually labeled physical reality, which, of course, includes quantum mechanical systems. Hence, this disjunction gives quantum mechanical systems the character of weirdness, since the linguistic description and the observational experience do not mesh. However, for an information based *ontology* (and I use this word reluctantly here), quantum weirdness is not weird at all.

In the quotation above, Einstein expresses the discomfort we feel about a world that comes and goes in and out of existence by the mere incidence of our observation. Yet a dog would hardly be concerned about such matters; sometimes, ignorance is bliss. Language has a knack of distorting our notions of reality. The conceptual problem with the quantum world is in the conceptualizing, in that it is taking place within language, and if the concept formed doesn't agree with observations (ostensibly what our other senses are telling us), then *weirdness* may ensue, which is another way of saying that we cannot make sense of that kind of world – the kind of world that science is telling us is reality.

If the ontological insistence of a physical reality is removed from one's set of logical-linguistic axioms, then our observations of the physical world can be taken for whatever it dishes out. We need not presuppose anything. In a world based on a digital physics unfolding in a logical space, the physical world need only comply isomorphically. The system producing that isomorphism can evolve computationally.

Fields or waves should be understood as representations of the laws of nature; and particles can be seen to embody the state of affairs at a moment in time. This conforms to the algorithmic system hypothesized earlier wherein the universe evolves in a 2-step iterative recursive process. Every cell in a hypothetical cellular lattice takes stock of its environment in the first step, and then uses that information to computationally evolve to the next state of affairs based upon the rules (algorithm or laws of nature) for moving to the subsequent state. And this process is repeated a finite, albeit a very large number of times.

Heisenberg's uncertainty principle elucidates this 2-step algorithmic process. The uncertainty is in the experimental or observational incompatibility of determining multiple states of affairs in a quantum system. The measurement of position entails the fixing of a particular state of affairs in time, while momentum (or the velocity vector) represents a computation between two position measurements. They cannot be measured in the same instant in time, because they do not occur in the same instant in time. In the (computational) time between the two measurements, the entities in question can be said to be in a superposition, effectively waiting for a measurement of the next state of affairs. This interpretation of superposition conforms to the epistemic viewpoint presented in this book, and is clearly not an ontological one. Superposition may be an ontological conundrum for quantum theoreticians, but fits quite well within an epistemic framework. We are not concerned about the objectivity of reality, but only a knowable reality. That which is unknowable is recognized as residing 'outside the box' and simply not accessible to those inside the box. We might well conjecture about what is going on outside the box, but the only certainty we can have is the certainty that any theory about such a place cannot be formally described, let alone proven.

The most precise of present day timescale measuring is in yoctoseconds (10^{-24} seconds) scale units, which is around 20 orders of magnitudes larger than the putative Planck time scale for operations in an *isomorphically-reversed* logical space. This elucidates that there is an enormous amount of potential computation executing in the space of even the most nimble of quantum measurement systems. The world is evolving between these measurements probabilistically in accordance with the wave function, which represents the algorithm for the evolution of a system in the form of partial differential equations, a necessity due to the assumption of continuity in physical systems. If there are no interactions that require a modification to the evolution of a given quantum system, i.e. an absence of particle interactions, then a measurement of the state of affairs for the given system need not take place; this being the most efficient manner to evolve the system computationally. Thus, a null encounter produces a null response. So the system can stay in superposition for as long as there is no need to change the evolution of the local neighborhood for lack of interaction between neighboring entities. Imagine a photon travelling through *empty* space; if it has no interactions, it can just continue on its merry way. If it encounters another quantum particle, such as an electron, a constate measurement occurs in logical space, followed by a new evolution in the post interaction electron-photon system. Such systems of photon absorption and emission are well studied in quantum mechanics. If measurements could in fact be made at Planck time intervals, then there would not be any superposition states, for there would be only a single computation between measured states and it would be the only computational possibility.[27] Wave functions are only relevant when computations are made at intervals greater than Planck time. In the world of human measurement there are always greater than 10^{19} unmeasured universal algorithmic computations for any given entity (the difference between Planck scale and yoctoseconds scale), so the number of superposed quantum states is so large that it can only be realistically represented by a continuous wave function.

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[27] There are other hypotheses that could account for this as well, but I believe this is the best solution. Modalities could be built into the laws of nature, such that a probabilistic evolution which takes place between computations. But it seems more consistent to have a discrete replacement for continuous functions, rather than some mix of the two.

The main point is to see the system evolving computationally independent of a purported physical system. The evolution of the system in logical space is the fundamental one and is not just a mathematical representation of a physical system evolving in spacetime. This so-called collapsing of the wave function is a logical mapping process in a computational neighborhood (constate) and the origin of consciousness. Wave function decoherence is analogous to a constate. At quantum metrics, this process turns waves into particles only to become waves again in the next instant. Except for the colossal difference in complexity, this is fundamentally equivalent to human consciousness. There is so much transpiring at the level of the human mind, it is impossible to fully describe the system using tools available within the system, that being our universe. Consciousness can further be understood as information that a computational entity has about the state of affairs in its computational domain. This will be explored further in the next chapter.

The Double-Slit Experiment Explained

The 2-slit or double-slit experiment has been rightfully called the central mystery of quantum mechanics. In 1803 Thomas Young formulated the wave theory of light as a result of wave-like interference patterns detected when a light source was projected onto a screen after having passed through 2 slits in a card. The experiment has been successfully repeated innumerable times with many variations in design.

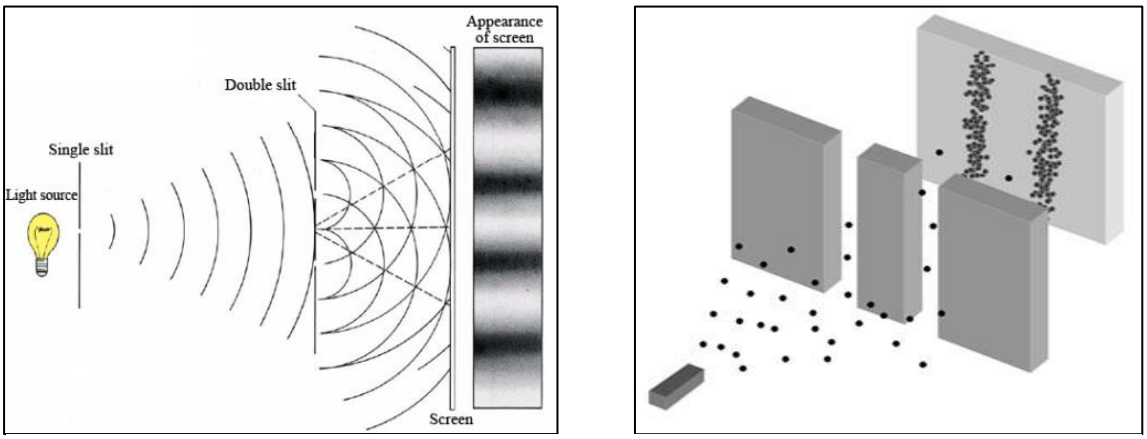

Figure 7: Light behaving like a wave (Left) and Light behaving like a particle (Right).

When a source of quantum particles, such as photons or electrons, are sent through 2 slits cut in a barrier, a wave-like interference pattern is formed on a screen beyond the barrier (see **Error! eference source not found.**, left). If a detector, or some other method of looking at what is going through the slits, is imposed on the experiment so that a measurement effectively takes place, that is, we actually detect which slit the object goes through, then a more typical particle pattern appears such as when bullets are fired through the slits (see Figure 7, right).

This experiment is the archetype illustration of the wave-particle duality of quantum mechanics. In the classical (Newtonian) physical world there are waves and there are particles; something can be either one or the other, but not both. But in the quantum world every entity has characteristics of both waves and particles. Which feature is expressed depends on how the experiment is fashioned. Physicists are, for the most part, quite accepting of this being just the

way things are, even if it does not quite sit well with our commonsense notions of how the world is supposed to work. The problem with this picture stems from the presupposition of a physical reality, so once such a reality is imposed on the situation it can only be scientifically described by the best available physical theory, which happens to be quantum mechanics. And if quantum mechanics describes a world that is somewhat puzzling, so be it; we are inculcated to accept that it is just the way *reality* is.

An epistemological perspective does not require a material based reality and accordingly has no such problems with the findings of the double-slit experiment. Observation does in fact set off the collapse of the wave function to produce an isomorphic physical representation of a logical state of affairs (constate). Observation perfectly fits the theory. There is not much difference, in principle, between wave function collapse and what ensues during a game of chess. There are myriad possibilities for an upcoming move while the player is contemplating the move, but once the move is made, the resulting board position becomes the actual fixed state of affairs in respect to that game, a constate of the game of chess system. This process repeats until the end of the game, as with photons going through slits and measurements being made until the experiment comes to an end.

…

There are numerous aspects of quantum theory, and orthodox physics in general, that form a comfortable fit with computational models of the universe. The non-commutative mathematics of quantum measurement is consistent with a 2-state binary evolution in logical space. As it is with quantum mechanical systems, the order of operations in an iterative computational process changes the final outcome as the second iteration is dependent on the state of affairs after the first iteration.

Two quantum particles can be thought of as being in an *entangled* state if they are part of the same computational neighborhood. Rules that might seem to causally apply in a 4-dimensional spacetime continuum do not necessarily apply in logical space with a representational isomorphic spacetime. Physical notions of separation and locality do not automatically hold in logical space. There is no clear and definitive solution to quantum entanglement, but it can be readily seen that paired entities created in a computational process can be so *tagged* such that they carry certain property identifiers that link their respective states regardless of their evolution in time and spatial separation in any isomorphic structure. Nevertheless, it would seem that there should be isomorphic equivalency between the speed of light in physical space and the rate of propagation of information in computational space, therefore something beyond this dynamic would seem to be in play. The usual or consensus explanation from a quantum mechanical standpoint is that 2 particles which come together or are created in such a paired state have a single composite superposition regardless of their separation in spacetime. Correspondingly, the objects of a paired entity in logical space should always remain connected even if they are propagated in opposite directions along a computational lattice at the maximum propagation rate of information.

Although the most referenced computational model in this book is that of cellular automata, which are often represented in a lattice structure with a sense of locality, it should not be construed that this particular kind of model is being imposed upon the reader as the alternative for a material world type of reality. We are just at the beginning of exploring these relationships

and cellular automation happens to be a model that is off to a good start. However, having just located the rabbit hole, we need not race down it blindly.

Logical and Physical Spaces

I would not suggest that mainstream physics should shut down in favor of the pursuit of digital physics, but rather that there should be a recognition that progress is more likely to be made by entertaining computational approaches as foundational and physical theories as isomorphic.

A fair criticism of digital physics is that it lacks scientifically testable hypotheses which can relate an algorithm to its purported physical isomorphism, or for that matter to any mainstream physical theory, although Edward Fredkin and Brian Whitworth have made a reasonable start.[28] There is a tangible contemporary pragmatism about academic physics that steers research in the direction of both fashion and funding. Even though computational science is gaining adherents, it still palls against the allure of high energy physics and M-theory. The previous chapter on consciousness listed quotations from a number of scientific luminaries supportive of computational approaches to physics, which is perhaps indicative of where the science is headed.

One advantage of a computational methodology is how easily it fits a causal construct amenable to rational thought. Although the emotional security of a material world is surrendered in favor of an algorithmic one, it is easy to comprehend the step-wise approach it engenders, since it is metaphorically like building a house with bricks, wood, nails and concrete; and there is the further familiar comparison to the execution of a computer program. The material world is in fact not really surrendered at all, but simply put into a different slot in the order of things.

This treatise has used the generalized term *logical space* germane to a non-specific computational framework, in some respects for lack of a better term. Physical theories already have related mathematical frameworks in *n*-dimensional Hilbert spaces, which themselves do not have any phenomenological reality in a physical world. Logical space can be construed as either dimensionless or multi-dimensional and conformal with nodal or lattice structures, such as cellular automation; there is no pretense that it is anything other than a mathematical construct. This is a very different starting point than one that presupposes the objectivity of the physical world.

The nascent stages in the development of digital physics are perhaps best used in forming a philosophical ground that satisfies the requirement of human comprehension as well as the rigors inherent in mathematical formalism. However, there lacks an adequate descriptive

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[28] I recommend a four part series of essays by Whitworth under the general title *The Virtual Reality Conjecture*, as we share a similar perspective on the relationship between information and the physical world. Whitworth offers a descriptive narrative with instructive metaphors which should help elucidate a subject that can be difficult to come to terms with. He also provides a level of detail that affords arguably the most complete theory of how a digital mechanics world would operate. Although there are some differences between us in the theoretical construct of the physical world, there is far more in common than not. These essays, which seem destined to be part of a forthcoming book, along with the work of Fredkin, form an important foundation to the exploration of a new kind of physics.

vocabulary complementary for this schema. Writers in the field are often compelled to contort terminology used in conventional physics to fit a digital physics model to satisfy this deficiency. If an algorithmic unfolding of the universe is to become the new underpinning of physics, it should be descriptive enough to allow the physical world described by orthodox physics to be isomorphically represented within its theoretical construction; and this construction should have some explanatory incorporation of the entropic effects of the Holographic Principle as well as the mainstream physics of quantum mechanics and relativity.

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Theories that suggest that the cosmos is a computer simulation being played out on the physical universe do not add up; there is simply too much entropy associated with changing bits in physical space. It would take 10 million photons to change a single bit. If the universe is to be computational it must either be a non-entropic or low-entropic reversible system or non-physical, and possibly both. This is a good indication that in the current cosmological playhouse the main actors of information, waves and particles are not all dancing together on the same stage. There is a different relationship playing out from the one tied to a hypothesized objective physical reality. Let's see where a system that starts with bits in logical space leads to.

Using Planck scale units and the 2-stage process introduced in the previous chapter as the starting point for measuring computational processing would imply the following minimum bit energy levels:

$$Minimum\ Energy\ of\ 1\ bit = 2\hbar \cdot\ t_p = 2\sqrt{\frac{\hbar^3\ G}{c^5}} \approx 1.14 \times 10^{-77}\ J$$

Based on a range of sources for the total energy and information content in the universe, this estimate for the energy of a bit seems much too small, as it would imply that the total information in the universe could be on the order of as much as 10^{146} bits as compared to more typical estimates of around 10^{121} bits (Funkhouser). I am not sure what to make of this discrepancy as it is quite easy to be off by very large margins when dealing with universal totals. Alternatively, the application of Planck units may not be suitable for measuring basic information content, as applying physical measurement systems to information systems is not manifest. The use of Planck time as the basic unit for a universal computational clock speed may be off by many orders of magnitude. Conformity with more generally hypothesized total information estimates would bring the single bit energy level up to around 10^{-52} J.

Photons and Electrons

Although the theoretic base computation level of a hypothesized universal algorithm is many orders of magnitude finer than the most rudimentary of quantum entities, it may be possible to map a simple computational model onto these entities, such as that of a *physical* quantum photon. The speed of light would be the one near certainty for a constant that would pertain to both logical space and physical spacetime. If there is to be an isomorphism between logical space and physical spacetime, then a computational propagation speed (how fast computations

can be made across a hypothesized lattice) would need to have an isomorphic representation equivalent to the speed of the photon, in other words, the speed of light. The photon does not have many free variables, only energy, momentum (as a vector) and angular momentum (which is conveniently quantized at $\sqrt{2}\hbar$). Since energy is conserved over time it would seem reasonable that there should be a simple formula relating bits to energy, perhaps as simple as one bit equals one unit of energy in a new basic scale, which would make energy conservation equivalent to bit conservation in computational models. In the case of photons, momentum is merely energy and an orientation vector that tells us where the photon is going in relation to the rest of the world. So a photon can be seen as the composite carrier of a variable amount of usable information from one part of information space to another part, its vibrational frequency representing the amount of available information in the energy packet. A process such as photosynthesis can be seen as the physical representation of using this informational raw material to build complexity into a system, such as a plant in this instance. Similarly, massive particles are simply carriers of more elaborate structural building blocks and instructions on how they are to be put together; it is the stuff that things like molecules are made of, consequently leading to the formation of myriad complex arrangements. We can see analogies with DNA, RNA and amino acids as corresponding building blocks with instructions at much higher levels of complexity.

Having proposed the photon as the physical representation of the fundamental carrier of information across logical space, we can now turn our attention to the electron: the particle responsible for life and just about everything that happens on planet Earth. The mass-energy of an electron is 0.511 MeV (8.2×10^{-14} J or 9.109×10^{-21} kg). The energy associated with the momentum of an electron bound in an atom is rather small by comparison and is mediated by the emission and absorption of photons. Whatever the case may be, an electron has considerable energy-information content, something around 10^{40} bits. Most of this is locked up in the electron's mass. One can pose the same questions about the information content of particles that have been asked about a particle's mass: Why do particles have the masses that they do? We have not come close to finding an answer to this and most other '*why*' questions in physics, for that matter.

Aside from the electron's *locked-up* energy there are several features that it can play with to perform its critical tasks. Most of the important work done by electrons takes place at distances of several angstroms (Loewenstein, 1999). As for the scale of things in the universe, this is at least within the scope of human comprehension, as it is roughly 50,000 times smaller than the width of a human hair and not much finer than the thickness of a cell membrane (see Figure 8).

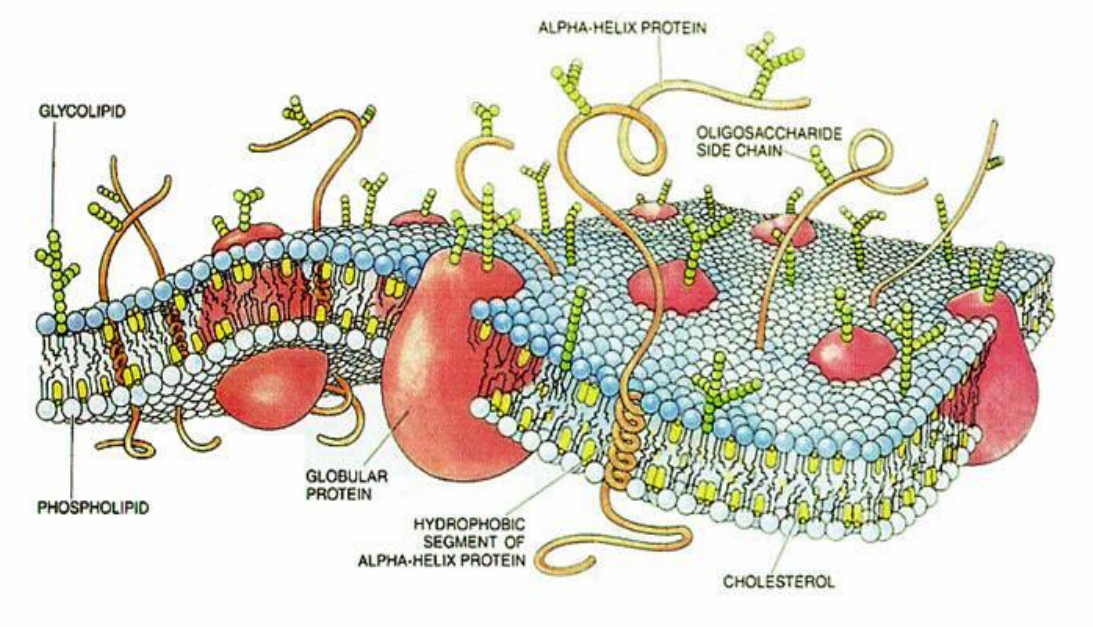

Figure 8: A cell membrane.

All up, the electron has the following key features:

1. A mass of 0.511 MeV.
2. An electric charge of -1.602×10^{-19} coulomb (shown by convention as negative).
3. An intrinsic angular momentum, or spin, of ½. Electrons are part of a class of particles called fermions which have half-integer spins.
4. An intrinsic magnetic moment along its spin axis approximately equal to 9.274×10^{-24} joules per tesla.

There are also 4 quantum integers that describe the size and shape of electron orbitals and momentum characteristics:

1. Principal quantum number associated with the primary shell or energy level.
2. Azimuthal quantum number associated with angular momentum or subshell.
3. Magnetic quantum number associated with subshell orientation.
4. Spin projection quantized as either up or down.

It is more important to take stock in the somewhat limited information content of an electron than understand the significance of these quantities and units in their own right. The fact is that the electron has eight characteristics to sort out all of its transactional behavior in the wide variety of conditions required to manage our biosphere in all its intricacies.

Most of the heavy lifting of life is wrapped up in this rather small set of characterizing numbers. Electrons bind themselves to protons to build atoms through their electric charge, form various types of chemical bonds in the assembly of molecules of enormous variety, calculate interactions based on van der Waals forces, absorb and emit photons of quantized energy levels, and form bonds with other electrons on the basis of spin orientation. Electrons are like little

Lego bricks that can bind together to form an incredible number of complex arrangements (see Figure 9).

Figure 9: Lego Man
http://www.behance.net/Gallery/Yellow/192175

The obvious question to ask is: *How does the electron know what to do under the wide variety of environmental conditions it confronts during its very long lifespan*? The equally obvious, if not unsatisfying answer is: *From the laws of nature*! But where are these laws of nature? And where does the electron go to look them up? Analogous to the manner in which a computer stores both the program and data which the program manipulates, so does the electron store its operating instructions within itself. This I would suggest is what constitutes the 0.511 MeV of locked up energy (or information) that an electron carries around wherever it goes, or at least until it gets blown away in some cataclysmic event to release this energy back into the environment in the form of photons, e.g. gamma ray creation in electron-positron annihilation (Called the Dirac process: $e^+e^- \rightarrow 2\gamma$). The Breit–Wheeler process, $2\gamma \rightarrow e^+e^-$, although conceptually simple, being the inverse process of the Dirac process, has been by far one of the most difficult to be verified experimentally (Kleinert, Ruffini, & Xue, 2008) (see Figure 10). Images produced in a bubble chamber show this process when gamma rays of sufficient energy are passed either near or are collided into an atomic nucleus. This is suggestive of the possibility that the instructions for the production of the leptons are encoded in the quarks of the nucleus, or perhaps with the electrons associated with the nucleus involved in the process.[29] When high energy gamma rays encounter nucleic matter, the electron and positron *program* instructions are copied, in a way that might be likened to mitosis, to become the newly created particles. Some of the momentum from the gamma rays is absorbed into the atomic nucleus to power this conversion process. Of course, this is quite speculative at this time, but it conforms to a computational process theory and presents some interesting analogies to known processes in computer programming, stored-program Turing machines and biological processes.

[29] Alternatively, there is the possibility that the Higgs boson could be the hypothetical carrier of such instructions in conformity with the acquisition of mass via the Higgs mechanism. There seems to be enough mass in the Higgs to carry the entire algorithm for running the universe. In fact, at an estimate of 125 GeV, the Higgs boson would have an overabundance of information even if only a small fraction of this energy were translated to the universal algorithm. Using Landauer's energy to change one bit of information gives the Higgs enough energy to manipulate around 10^{13} bits of information, which would be a rather large program by any standard.

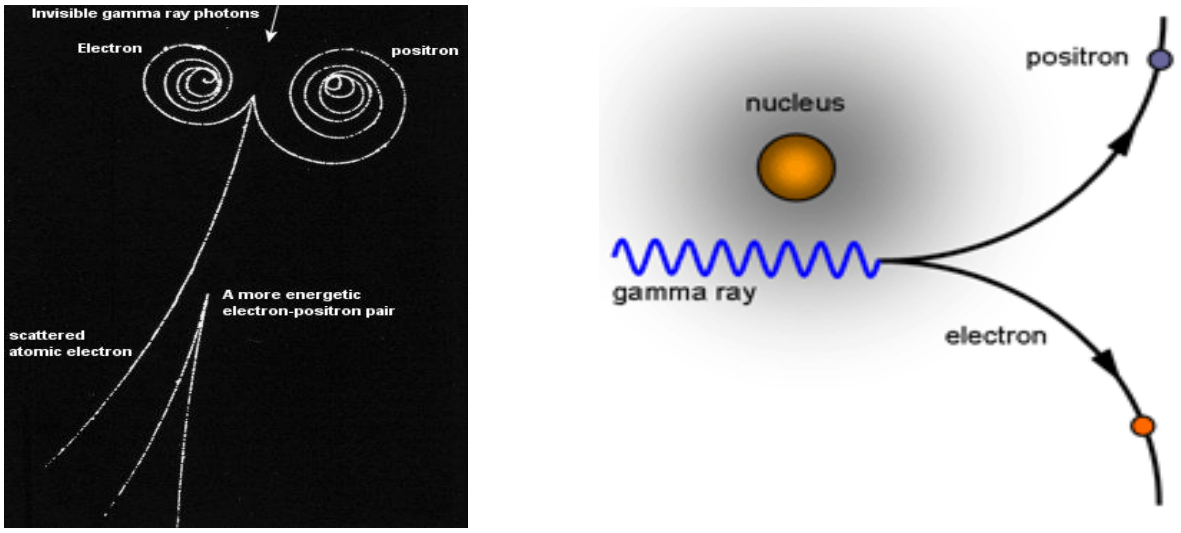

Figure 10: The Breit–Wheeler process, $2\gamma \rightarrow e^{+}e^{-}$. Bubble Chamber image and illustration.

It's a long way from photons, electrons and quarks to human beings, but if one is starting only with bits, the building process would seem to require a step-wise method along with a very large number of transactions. Key quantum determinants, such as charge and spin are already quantized in physical theory and can easily be modularized by simple bit configurations. A particle, such as an electron, can have as part of its own modular construction a sub-module component that relates to the negative electric charge as well as the necessary *n*-dimensional vector components required to give it the linear and angular momentum properties that a particular electron happens to carry. All of these properties can be seen as being the information the electron requires to *know* what to do when encountering another entity in space. Every entity in the universe, whether we perceive it in physical space or logical space, needs to know what to do next; it needs to have within its own being, its own self, the means of deciding what it will do and where it will be in the next instant of time.

Spacetime

The other major physical theory that a computational model should address is the geometry of spacetime, which includes both gravity and the relativistic effects related to inertial frames of reference. To conform to relativity theory, a constant speed of light implies that there is a related constant rate of computation in logical space; a computer analogy would equate to the clock speed of the computer's processor. And as there is a maximum to the velocity of light, there is as well a limit to the transfer rate of information across the entirety of the system. The cellular lattice structure and the idea of computational neighborhoods are helpful to imagine how these limits apply in computational terms.

How could a digital physics account for the redshift of light in respect to inertial frames of reference moving apart from each other? An observer in one of the frames would detect a slowing of the clock speed, or computation rate, in the other frame. There would also be a noted reduction of energy, represented by a frequency decrease in EMR (the redshift), as well as the amount of information communicated between the two frames. This would correspond to time-computation dilation in accordance with Einstein's theory of special relativity. In the same

way that ordinary concepts of time are used in differential calculus to compute rates of change, computational time corresponds to the rate of change for informational configurations or the rate of information flow through an information lattice or logical space.

We can further posit a computational description of relativistic time dilation in a gravitational field. A physical description would maintain that the energy density in a particular region of space would be manifested in the geometry of that space. Time dilation in a gravitational field would correspond to a computational dilation due to the information density in the related logical space. The denser the computational neighborhood, the more computations will be required, although the processor speed, or its capacity to execute the *program*, remains constant (equivalent to the speed of light constraint). To balance things out, the clock speed appears to slow down in the local region of logical space in order to accommodate the computations that are required in any given algorithmic iteration, so that all the computations that are required to be made in the algorithmic *action stage* (T_A) are in fact executed. Local computations seem to be progressing as normal when compared to similarly dense computational spaces in a given neighborhood, as would be the case in a physical general relativistic description. This computational description fits well with the idea of entropic gravity, which itself is related to information content (Verlinde, 2011). This picture brings into equivalence the mass-energy density of a 3-dimensional spatial volume, the 2-dimensional surface entropic density described by the holographic principle and the information density of logical space.[30] The importance of the holographic principle is that it brings together a wide range of concepts involving both information and physical entities. Broadly speaking, it describes how the information content of any *n*-dimensional entity is *inscribed* on its enclosing (n – 1)-dimensional surface.

The holographic principle grew from theories of black hole thermodynamics developed by physicists Jacob Bekenstein and Stephen Hawking, which has come to be known as the Bekenstein-Hawking entropy. Their work centered on what transpires when black holes grow by the accretion of material into the black hole from beyond its event horizon. The insight was that the information content of all that falls into the black hole is manifest in surface fluctuations of the event horizon. They discovered that the entropy of a black hole is proportional to the area of its event horizon, the surface from within which even light cannot escape. More precisely, a black hole with an event horizon spanning '$\boldsymbol{A}$' Planck areas has $\boldsymbol{A}/4$ units of entropy; the Planck area, approximately 10^{-66} square centimeters, is the fundamental quantum unit of area determined by the strength of gravity, the speed of light and the size of quanta. If measured as information, it is as if the entropy were written on the event horizon, with each bit (each digital 1 or 0) corresponding to four Planck areas (see Figure 11). It is worth noting the similarities to the lattice constructed from a simple 4-neighbor von Neumann neighborhood discussed earlier (see Figure 4).

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[30] The holographic principle was first proposed by Gerard 't Hooft in 1993 and has had a number of prominent contributors to its development, including Raphael Bousso and Leonard Susskind. In one of its central assertions, the holographic principle states that any 3-dimensional volume of space can be described by the information contained on the 2-dimensional surface of the volume.

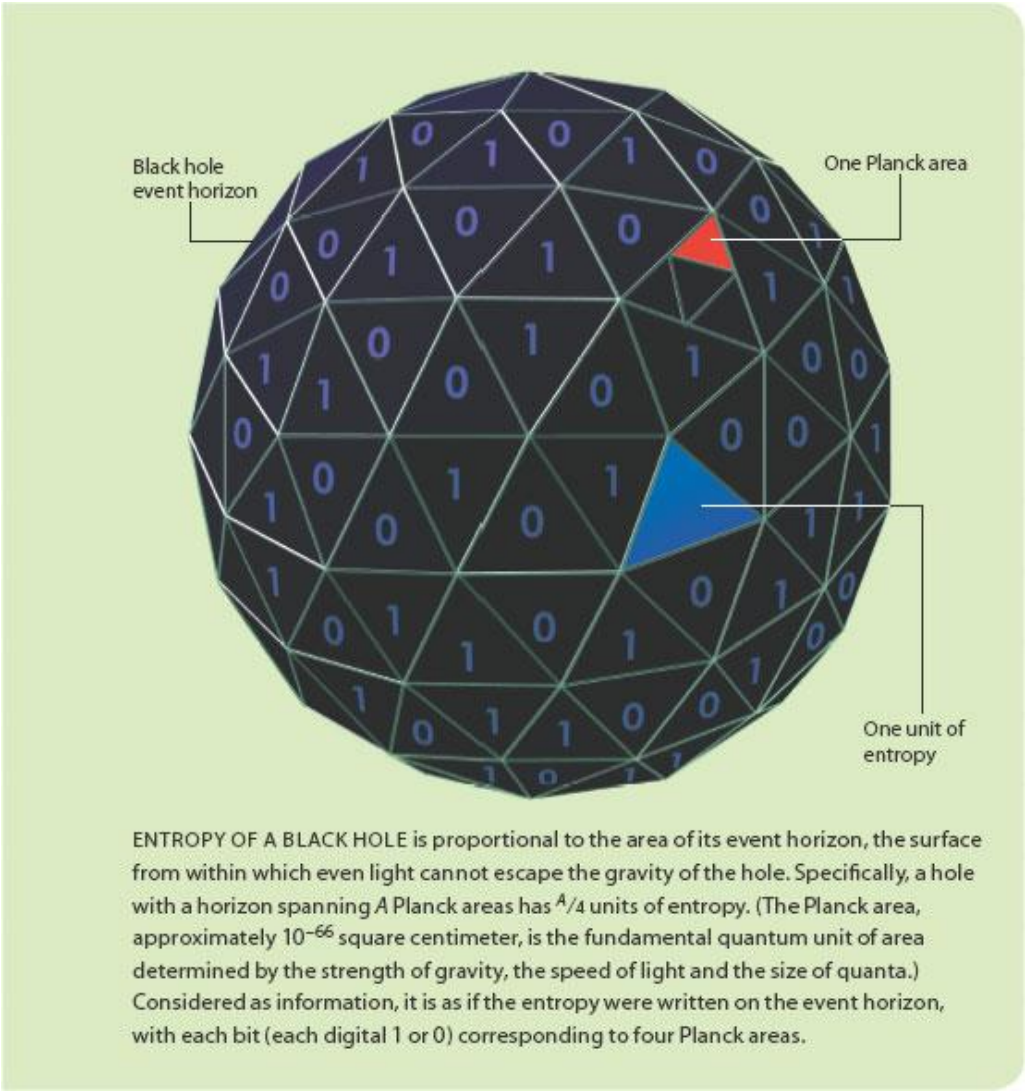

Figure 11: Black Hole Entropy (© Scientific American)

So what we find here from a historical perspective is an examination of the thermodynamics of extreme gravitational entities leading to concepts relating to the information content of matter. Furthermore, we have a physics usually described by differential calculus *morphing*, in a sense, into a Planck scale digital description. The holographic principle is yet one more piece of evidence supporting ideas relating to the melding of information and matter.

Moreover, the holographic principle resolves the black hole information paradox within the framework of string theory (and M-theory). Whether any of the various versions of string theory and its 10-dimentional framework or its 11-dimensional spacetime successor suggested by Edward Witten in 1995 dubbed M-theory, succeeds in merging gravity into a unified physical theory is yet to be seen. What is most striking about the theoretical basis of these models, along with mainstream quantum mechanics, is how the *physicality* of the world melts into a mathematical landscape to the extent that the usual notions of substance dissolve to mere metaphors for a catalogue of differential equations. In the end, these physical metaphors serve little purpose except for satisfying the limitations of human conceptualization. One might revisit earlier sections in this manuscript concerning the human necessity for making sense of the world through causal relationships.

Probabilistic Determinism and the Arrow of Time

The laws of physics are theoretically time reversible, i.e. the clock of the universe can be run equally well backward as forward. This is completely compatible with an information theoretical universe, particularly if a time-reversible logical operator is in force.[31] If we say that the mathematics of the laws of physics allow for the universe to evolve both forward and backward in time, then we are likewise saying the universe is logically reversible as well. Yet the physical experience of the universe has time exclusively *flowing* in one direction, which we happen to call forward, and as such has been labeled the *arrow of time*. A game of chess can likewise be viewed running in reverse (something easy to do on a computer by using the undo or backward keys), but only follows the rules of the game when run forward and becomes nonsensical evolving in reverse, very much the same as the universe would.

If a computational model had a random operator introduced, then time-reversibility could be preserved even in a non-deterministic universe. This might explain why the laws of quantum physics seem time reversible yet not wholly deterministic, to the extent of the predictability of the evolution of a quantum system. If continuum mathematics is used to describe the system, such as in the Wave Function, we have a predictive model which is reversible, yet not fully determinate in a classical sense. But if a discrete process is assumed, there is the possibility of evolving a non-time reversible non-deterministic system if random operators are in place. This conforms both to observations of randomness in the universe as well as the arrow of time suggested by the second law of thermodynamics. With a computational model there is no evident necessity for a *multiverse* or a *many worlds* interpretation of the universe. Although there is no exclusion for any particular number of algorithms evolving simultaneously in some sort of relationship, there does not seem to be any reason to go down this path. Wave-particle duality may pose some troubling interpretational difficulties in quantum mechanics, but not so with a computational model which integrates the role of consciousness in the process. I do not see this issue as critical, since a variety of models can fit observations and mathematics alike; the point is made merely to show the compatibility of discrete processes with a variety of interpretations of the observed universe.

The big question becomes increasingly clear with each descriptive narrative: How do all of these seemingly related phenomena fit together? We have waves, particles, strings, branes, energy, information, dimensions, time, computation, logic, mathematics, randomness, determinism, continuity, discreteness, complexity, entropy, and so on. If we just focus on gravitational systems, in the broadest of terms, we find that nature wants to draw mass-energy onto itself. The concept of entropic gravity makes sense as it conforms to the second law of

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[31] Conservative and reversible logic was developed by Edward Fredkin and Tommaso Toffoli, both of whom have invented logic gates used in computing that bear their respective names (Fredkin & Toffoli, 1982). Time reversible logic systems use a 3-bit system to preserve information flow so that it can be run in reverse without information loss. It also is quite handy as it coincides with the mathematics of both classical and quantum physics.

thermodynamics, something we loathe to ignore. It is incontrovertible that nature in its myriad forms tends to evolve to more probabilistic states of affairs. Yet this coming together of the stuff of nature, under the right conditions, leads to local complexities, i.e. states of affairs with lower probabilities, while the universe as a whole continues its inexorable path toward blandness and thermal mortality.

My emphasis on epistemology is with good cause and is particularly relevant in the philosophical conceptualizing and building of a universe that makes sense on all accounts, in that the theory holds together at all levels of examination, with an appreciation that the examination is being done by a human being with certain acknowledged attributes. It gives full recognition to the fact that biology is every bit a part of nature as quantum mechanics. There is no point in theorizing about an objective reality when it is impossible to succeed in such an endeavor. Before adopting a principle which can be accepted with certainty, we should set some benchmark whereby if the accepted principle were incorrect our entire understanding of the world would be in shambles and we would be forced to go back to basics and start afresh. For example, concepts which derive from the laws of thermodynamics fall into the category of the indispensible, for it is difficult to know how we could proceed if these laws somehow turned out not to be true after centuries of rigorous experimentation without an exception. What options would we have except to start from scratch?

One might be inclined to think that the reality of a physical universe independent of consciousness would also fall into this category. A theory of consciousness, such as the one proposed in this book, is just the sort of challenge that could undermine the entire orthodoxy of mainstream physical theories; or at the very least, we should feel compelled to rethink the meaning of physicality. Aside from the arguments presented herein, the laws of thermodynamics, and particularly the second law concerning entropy, oblige us to conceptualize the universe as a dynamic process with direction. Information theory and all of its attendant implications are central to this perspective. Whether the reference is to formal systems or entropic gravity, we are still in the same family. We are simply talking about different relations of the same generic principle. The universe is *falling*. It is falling in a sense that it is heading to a more probabilistic state of affairs, and the laws of nature are what is keeping it from going straight down in a kind of free-fall. The question is: How does it do it?

I would not go so far as to say that descriptions showing correspondence between a virtual reality of algorithmic origins and a phenomenological physical reality constitutes a scientific theory per se, mainly due to the lack of experimental evidence, but when taken along with the rest of what has been presented in this treatise, it forms a strong argument for a foundational digital physics. The concepts presented by information theory and thermodynamics should become the bedrock of the cosmogony of the future. The trickiest part of the puzzle is finding the proper place for consciousness, so we shall revisit this subject in the next chapter.

Reality

> *"Consciousness cannot be accounted for in physical terms. For consciousness is absolutely fundamental. It cannot be accounted for in terms of anything else." — Erwin Schrödinger*

Everything would be so simple if we could only open our eyes and say with certainty: "This is Reality!" And although this is seemingly the case, it is a perspective which is quite contrived and heavily skewed with historically religious and mystical predispositions. It would place man yet again at the center of the universe with some exceptional access to that which is universally and objectively true and to that which is not. The extraordinary access that humans actually do have is to that of the phenomenon of language, which in turn provides access to logical truths, and furthermore are not necessarily truths about the universe, for if they were, we might just as well learn all there is to know about the world from a game of chess.

Language is about belief, meaning and truth. It is pointless to talk about these things outside the context of language. Language is a dominant part of the human conscious experience and it happens to be the part we use to do things like analysis, science and philosophy. As such, it is used in the analysis, science and philosophy of consciousness, an ever-present recursion that always muddies the water.

We need to constantly remind ourselves that we are forever subjugated to the entrapment of language. Caution in its use is always required, for it is a tool that can be likened to a chain saw; it can be of great use, it can fell trees many times its size, but in the wrong hands can cause a great deal of damage. And I hasten to add that there have been more massacres due to language than chain saws, despite there not being any film attesting to this account (see Figure 12).

Figure 12: 1974 Film 'The Texas Chain Saw Massacre'

This note of caution is emphasized because language is a part of the conscious phenomenological experience, and we will be required to use it to explain that very phenomenological experience that is causative to its existence. There is no way out of this circularity, for we have no other tool to work with.

It is perhaps due to the historical evolution of the philosophy of language that we have seen a decline in the standing of Wittgenstein's early work on the logic of language which made Wittgenstein a central figure of the Vienna Circle.[32] Much of this is due to Wittgenstein himself, who went down the path of what became the philosophy of *Ordinary Language*. This in turn was taken up by a number of philosophers at the time, including Gilbert Ryle (1900-1976), and remained a major school of philosophy until 1970. Although an important principle in the philosophy of language, it did not seem to warrant a school of philosophy in its own right, and it was not so many years before it went into decline. Earlier in this book I summed up my account of these matters in the sentence: *The meaning of a word is determined by social agreement or declaration.* An examination of the use of language in ordinary social circumstances should make this clear. The later Wittgenstein (*PI* and *PG*) blends a convoluted introspection on the boundaries of rule-following systems, semantics and grammar that challenges one to find cohesion in the totality of his work. Nonetheless, there is much to be gleaned from both the early and later Wittgenstein.

There is a second development which contributed to the waning of the Wittgenstein of the *Tractatus* which evolved in the field of linguistics. The revolution in the field of generative grammars initiated by (Chomsky, 1957) would seem to have incorporated the formalism of Wittgenstein's early work, but for some reason Wittgenstein is cut off without a mention. In fact, Wittgenstein does not even appear in the bibliography of Chomsky's landmark paper *Syntactic Structures*. How bizarre it is that the two giants of linguistic formalism are totally disconnected. The formalist pathway is muddled by this peculiar history, which is why I have set out to synthesize the major ideas of linguistic formalism without getting too mired in the historic aspects, which is something best left to historians.

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It is critical to clearly differentiate the various challenges encompassing the subject of consciousness. There is first the problem of plainly describing what it is, for it seems to mean different things to different people. One must be clear and not get lost in the morass of definitions, nuances and interpretations. Additionally, there is the matter of distinguishing what constitute the various types of reasoning, including the kind of reasoning associated with formal systems, such as language and mathematics, as well as inductive and stochastic types of reasoning. These latter forms are syntheses of lower level binary processes that are not directly accessible to the entity involved in a decision process, that is to say that they are not accessible at the uppermost level of the decision process and are often labeled as instinctive, particularly in the case of animals. We can easily become confused because our common terminology does not clearly distinguish among these variants. For example, what do we mean by the term

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[32] The Vienna Circle was a group of scientifically trained philosophers and philosophically interested scientists who met under the nominal leadership of Moritz Schlick for often weekly discussions of problems in the philosophy of science during academic terms from 1924 to 1936. Their radically anti-metaphysical stance was supported by an empiricist criterion of meaning and a broadly logicist conception of mathematics. They denied that any principle or claim was synthetically *a priori*. Moreover, they sought to account for the presuppositions of scientific theories by regimenting such theories within a logical framework so that the important role played by conventions, either in the form of definitions or of other analytical framework principles, became evident.

thinking? As far as humans are concerned, thinking would most certainly be included as a conscious activity. Do dogs and cats think, or are they doing something else when they *decide* what to do next? And what shall we call that type of decision making? If we limit the term *thinking* to something that humans do, but other animals do not, are we limiting the term to logical forms of rational analysis and decision processes? Then what is to be said about human beings before they had true language? Are we to conclude that these humans were incapable of thought?

The previous discussion on consciousness established how the subject was to be approached. Consciousness was defined as a fundamental part of the Planck scale system-state measurement, which I termed the constate, thus taking the definition of the word *consciousness* away from that of social agreement to one defined by declaration in conformity with my own designation for the meaning of a word. Hence, we start with a definition which is at the very least rhetorically tautological and can easily be adjudged logically so as well. The case for my rationale for this belief regarding consciousness has already been argued; if one is to agree or disagree with this, either accepting or denying its truthfulness as the case may be, that choice will be made within the formalism of one's own respective system of propositional logic. If one is to contend that consciousness is something else, then they are *reading from a different hymn book* (working with a different set of axioms), and there can never be agreement about the matter. These preliminaries are necessary to avert a derailment by the mischievous proclivities of language.

This position on consciousness was developed by moving progressively backward in time from the present to more primitive and less complex states of entity decision processes in order to finally get to the bit-wise Planck scale occurrence of a constate, although I make no claim that evolution works in such a progressive and ordered manner. The entire universe is thereby conscious at every level of entity, regardless of size or complexity. It is now the task to work forward in time to build from this rudimentary state to one that can account for human language and consciousness and in turn our phenomenological experience of the physical world.

Top Down and Bottom Up

In a world which is fundamentally algorithmic and information-based, both top down and bottom up perspectives are completely valid and compatible, and furthermore, not mutually exclusive. In a computer program the stream of bits leading to the opening and closing of logic gates can be viewed as the bottom up *cause* for what appears on the computer monitor, and every one of these bits can be shown to be part of a process which is causal to something happening at a higher level, such as an image appearing on a computer monitor. Likewise, the click of a button of the computer's mouse can be seen as the top down initiation that sets off a part of the program that will cause a stream of bits to open and close logic gates that dynamically cause a change of state of the computer monitor. The human operator of the computer can be seen as making a decision based on information received from the output on the computer monitor and enacting that decision by clicking the mouse button on a particular choice displayed on the monitor, thus setting off another stream of bits that will in turn change the display output on the monitor once again, in a continuous loop of decision and process. But

then one can separately examine the portion of the process involving the human operator's decision process in its own right, momentarily exit the computer part of the loop, and enter the multi-level world of biological complexity of the human computer operator, itself involving countless decisions, before returning to the mouse click event. One can also view this from a perspective somewhere in the middle of the process, that being a *procedure call* nested within a computer program; this will yield a view of information entering (*arguments*), program execution (*processing*), and a causal output (*return value*). Processes both above and below a particular procedure are all part of the totality of the system. In a complex program, even the programmer may find it difficult to trace the entire process from top to bottom; debugging programs are usually needed to assist in this process. One should note that although the assertion is being made that consciousness is universally pervasive, it is also localized, and not to be confused with popular notions of *cosmic consciousness*. I do not believe that the arguments presented herein either add or detract from the ideas presented elsewhere about the interconnectedness of the universe as a whole.

The programmer, who can be seen as the top down cause of the program, sits outside of the program and cannot be inferred from within the program. The program and the programmer together form a causal meta-system, which itself cannot infer what may be outside of it, in a *meta-meta*-system (Hofstadter, 1979). The concept of nesting is familiar to computer programmers and involves the layering of recursively interdependent processes. But we don't have to look far to see myriad examples of nesting, looping and feedback in our everyday lives. We need only explore the complexity of our body's metabolic processes as an example (Figure 13).

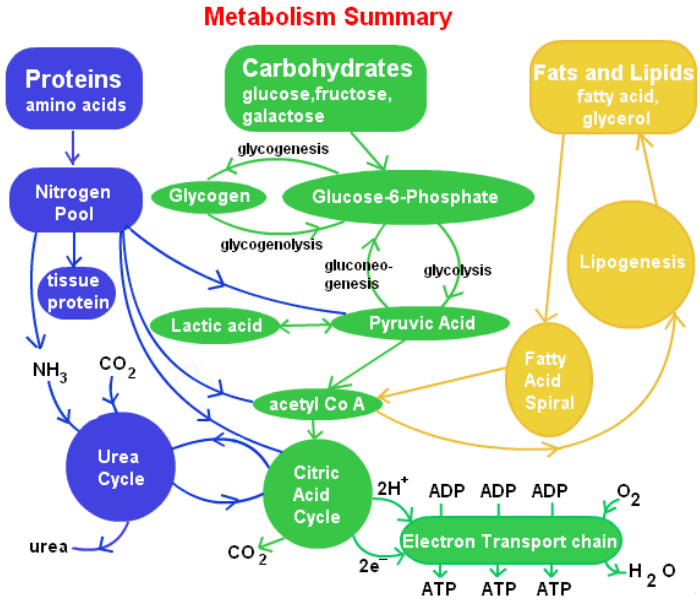

Figure 13: Metabolism overview.

The carbohydrate metabolic cycle is unconscious from the level of the organism, yet not that far down from the top level. We are in fact quite conscious of when we are in need of some carbohydrate metabolism when we have feelings of hunger or weakness, and we realize it's time to get some sugar into the machine. We can also drop down a level or two to observe some of the metabolic process from the semi-autonomous perspective of a muscle cell (see Figure 14).

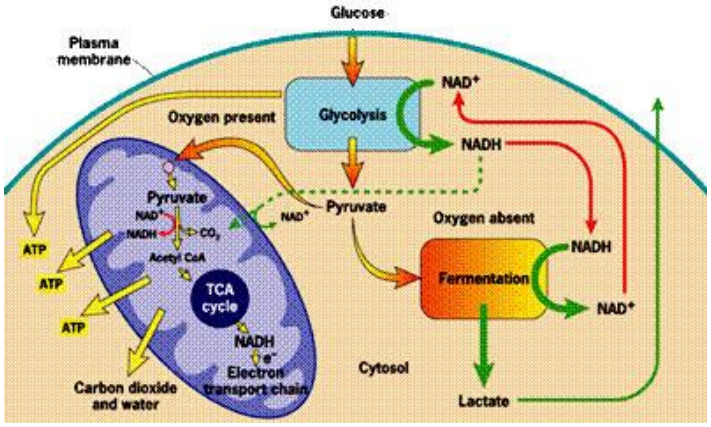

Figure 14: Metabolism of a muscle cell. (From Stephanie Seneff)

Many of the illustrations and diagrams representing biological processes resemble system flow charts often associated with information processing. Complex entities, in general, require environmental feedback and the ability to respond to 'what if' situations, whether it is how a car responds to depressing the accelerator pedal or how the body reacts if one's blood temperature registers at 40 degrees Celsius.

When it comes to the operation of complex organisms, like human beings, it is far from evident where the decisions are being made. They seem to be coming from everywhere at once with interdependencies and feedback loops not easily unraveled. Some sections of the process may become well-described, yet it is always possible to extend the scope of the process under examination so that it will encompass something that is either not well understood or reaches a level of complexity such that it overwhelms comprehension. There are simply too many *transactions* occurring all at once to properly describe the system as a whole. Whether one wishes to call them conscious or not, everywhere one looks, *decisions* are being made on the basis of *local* states of affairs, at every level, from top to bottom. In respect to living organisms, most decisions are being made below the top level of perception just to sustain the orderly functioning of the organism, with tasks such as temperature control and metabolism to give but two examples. I have chosen to call these decisions *conscious*, because they meet the criteria of assessing the relation between the entity's own state of affairs and its environment. It is irrelevant whether the *decision maker* in the process is attributed with awareness, self-awareness, intentional states or whatever; we need not get entrapped by the language. If an entity has the information or *knowledge* to make a binary decision on the basis of a rule-following system, it is for all intents and purposes conscious, regardless of the level of operation under scrutiny. There is a whole world of activity that took hundreds of millions of years to evolve that goes about its business, whether it is processing information, communicating, testing, probing, replicating, executing, which are most often filled with cybernetic loops, all taking place from the molecular level up, as well as down, falling just below the top level state of consciousness of the organism (Loewenstein, 1999). It goes on while we sleep and it goes on when awake, yet so much is unbeknownst to our conscious mind (to which I refer to as the top level of consciousness in keeping with the more common parlance). I know less about what it feels like to be a muscle cell in my own body than what if feels like to be a bat. At least the bat has a brain. But suffice to say that the muscle cell knows what it feels like to be itself in whatever way it is capable of doing so. It is not for me in my inimitable anthropocentric appraisal to pass judgment on such *feelings*.

The concept of emergence, particularly in reference to complexity, can be seen as a playing out of a rule-following system. If we use computer chess as an example, with each successive reference to the board position (state of affairs or constate), the computer plays a move that puts the state of affairs in a more complex state than that prior to the move. This can be measured as the amount of information required to evolve the system to the position in question in the particular manner that was taken to get there (being the particular moves made to arrive at that position). Although this example may meet the criteria of evolving to a less probable state of affairs, it is a far cry from the apparent improbable evolution of our universe to its current cosmological constate. So the question remains if there is sufficient evidence to support a theory that can account for human consciousness as it is generally defined (in its broadest sense). That is to say, do the definitions and mechanisms of consciousness elucidated herein fit the evidence for the observable universe?

…

There are many theories of consciousness floating about in what is a rather speculative theoretical space, all searching for the right combination of items to include and exclude from its definition and *operating manual*. It is worth taking a look at some of the current thinking on the subject. An interesting offering comes from the Noble Prize winning neuroscientist Gerald Edelman. I have chosen the work of (Edelman 2004, 2006) to use as an example due to his long and distinguished career in both physiology and neuroscience, as well as his commentary on most of the important issues on the subject.

Edelman rejects outright the analogy of the brain as a computer. His main argument is that the brain operates more like a pattern recognition machine than a logic-based Turing Machine. The central theme of his thesis is labeled *Neural Darwinism*, a value selection system that guides and reinforces neuronal pathways toward favored beneficial structures. I quite like this idea of Edelman's, as might be expected from someone strongly supporting the generic extension of Darwinian concepts, although I do not see a conflict with the computer metaphor. In fact, they should be quite compatible, as coordinated binary neuronal firings form the brain-state patterns that Edelman believes central to brain operation. But this is actually secondary to the key issue, which is that Edelman, like so many others, is focused on one layer of operation, virtually ignoring everything that leads up to the process of neuronal operations and pattern formation. An analysis at such high levels of complexity ignores that most of the computation has been packed down the chain of command. The stuff that more clearly has the appearance of operations in logical space is transpiring before a neuron ever gets to *decide* to fire or not to fire.

Edelman goes on to explain how timing mechanisms and the process of *re-entry*, a kind of feedback loop, pull everything together to give the feeling of a stream of consciousness. The theory offers quite a compelling explanation of how brain function produces the experience of phenomenological consciousness; but again, like most of those looking for the neural correlates of consciousness, he is focusing on operations near the highest levels of execution, leaving the underpinnings to the side, unquestioned and unresolved. So if we do find, with certitude, the neural correlates of consciousness, will it answer the *hard problem*? Not likely!

Then there is always the sticky issue of whom or what has consciousness. Edelman postulates that there are two levels of consciousness: *primary consciousness* is a pre-linguistic form of perceptual consciousness that we share with other mammals, in recognition that we have

substantially the same brain physiology as our phylogenetic cousins, and *higher-order consciousness*, reserved for the privileged few, one to be exact, that somehow managed the acquisition of language. This is of course true for the most part; it is just presented in a somewhat misleading way. If the only 2 mammals on the planet were bats and cats, one could say that bats had primary consciousness, but in addition to this primary consciousness, cats had a higher-order consciousness called *vision*. The *pseudo-creationist rapture* toward language is something to behold, especially amongst those self-proclaimed atheists. But this is a pitfall that one faces when taking a starting position on consciousness from the human perspective. The point has been made that language is what sets humans apart from the rest, but we need not be awestruck by the fact and walk away in utter amazement. (Griffin & Speck, 2004) are almost apologetic in their defense of attributing consciousness to animals, although their paper is ostensibly presented as strongly supporting this case. Rather than wondering if the consciousness bar is set too high or too low, the bar should simply be thrown away.

Another thing that I believe Edelman gets right is the characterization of mammalian consciousness as epiphenomenal, as he bluntly states: *Consciousness is a property of neural processes and cannot itself act causally in the world.* The approach that I have taken in this book cannot adequately determine if human consciousness is causally significant, primarily because I have defined consciousness as both fundamental and pervasive. To make such statements concerning human consciousness would require a redefining of the term *consciousness* as it has been used herein, as I have tried to be careful to differentiate between the constate of consciousness and human, animal and other varieties that fall under the ambit of the term in its general usage.

. . .

It has been repeated here often enough that we should realize that we cannot rely on our own experiential consciousness to conjure a theory of consciousness, for it failing on the grounds of being self-referential and tautological, effectively proving nothing. It is this sort of argument that has been used in support of the concept of *intentionality*. The problem with theories of consciousness that focus on attention and intentionality are that they presuppose existents more inexplicable than the ones they are claiming to resolve. In these cases the assumption is the axiomatic existence of the self and the will, such as in the phrase: *I turned my attention to the vase on the table and willed myself to pick it up*. Nor can we defer to physical theories for assistance, as these are dependent upon phenomenological consciousness for their empirical construction. In fact, by the very nature of language, there can never be a foolproof construction of a theory of consciousness. It can only be argued from within the logical construct of a formal system to make a particular case; and that case can only be judged by the weight of evidence, including its explanatory and logical consistency and completeness.

This explanation begins with the attribution of consciousness to a binary-state dynamic in a cellular or lattice structure, noting that this structure should be understood as logical rather than physical. This must be a fundamental property of the universe at every level of measurement, because every scientific measurement ever made has shown that the measured entity evolves in time from one state to another due to a causal relation between itself and its environment, notwithstanding the indeterminacies of quantum mechanics, which have already been addressed herein. There can be no argument, regardless of whatever reasoned theory is

applied, disputing that the universe is in a state of flux and its overall state is never the same from one instant to the next, however the word *instant* may be defined.

Free Will

Free will and the illusion of free will is for all intents and purposes the same thing. It is mostly about how one frames the argument. Like so many topics in philosophical debate, arguments are dismantled by means of language and a failure to deeply examine the presuppositions supporting a particular philosophical position or belief. The topic of free will seems a bit outside the scope of this book, except for its close connection with consciousness, rationality and language.

If, as is the usual case, free will is solely attributed to humans to the exclusion of other organisms, then it must be seen that it is language that bestows free will upon us. As such, it is language that must be central to any rigorous analysis of free will, and we would have to query what it is about language that conveys this ability to reign over one's decisions. The mere examination of the two words, *free* and *will*, proffers so much of the problems associated with the subject. What do we mean by *the will*? It is as if there is some entity that can be directed by the actor by the act of *willing*. Exactly what the process is and what actors must do to produce a causative effect has been a subject of much debate and clouded in confusion.

A consensus of opinion points to a definition of the *will* as being something incorporated within an agent that can direct itself in a particular causative action. I think it is safe to call this agent the self; and its agency is its intention and capacity for self-direction. When the agent is limited to humans the process is said to be mediated by rational thought, effectively language. If this rational thought process is not pre-determined, then we can say that the agency is free, in that the agent is a causative actor and thus has free will. Sometimes this is framed as having the capacity of choice, or the *ability to do otherwise*. In most cases, non-humans are not allotted this ability to do otherwise, as if they have no choice but to do exactly as they do in some predetermined way, without quite defining what agency is causative in respect to these organisms; yet humans, thanks to rationality, are said to be engendered with this ability.

The notion that the ability to do otherwise differentiates human and non-human behavior pervades both theological and secular perspectives. We tend not to blame sharks for attacking people; they are just being sharks and cannot be expected to do otherwise. Such is life in the animal kingdom. But humans can contemplate the options available and make decisions that can be judged by some standard of behavior. As has been discussed at great length, this rational process is language. It is hard to see how anything other than language being the defining factor, lest we venture into the magisteria of the theologians. Therefore, humans have a rule-following system that can churn out decisions worthy of being adjudged on some scale of normative behavior. And this is in fact what we do. So we live our lives with the presumption of free will, at least from the standpoint of responsibility, whether legal or moral.

This point deserves closer scrutiny, for it would seem by these arguments that language is the sole factor in whether the world unfolds deterministically or not. But one might ask what it is

about language that grants choices in life that is denied to all else in the universe. It is more that those supporting the case for free will have placed their focus on the apparent decision making ability of the individual without questioning or examining the processes that lead up to the behavior. It is not dissimilar to concluding that moths are spontaneously generated from old cloth. As has been discussed in an earlier chapter, a belief system, for which any position concerning free will encompasses, has no limit to the variety of its self-referential truths. The arguments supporting free will are just such a system. The framers have defined the limits of the argument to suit the conclusion. If one broadens the boundaries, we find no particular reason for surmising that humans are any more in control of their will than any other animal. The only real difference is that humans use rational thought to supplement decision making mechanism that we had prior to the acquisition of language. The will of humans can be said to be free to the extent that the determinations of their respective systems of propositional logic can be said to be free; and this would take quite an extensive examination, as the terminus of this journey would draw us back to the fundamental laws of nature.

There have been many comprehensive arguments supporting the case that free will is just an illusion. Some of these theories focus on support for an epiphenomenal consciousness (Wegner, 2002). There is also a body of experimental evidence to suggest that decisions are made unconsciously, but will set in motion actions that we feel are being made consciously (Honderich, 2005; Libet, 1999, 2003; Soon, Brass, Heinze, & Haynes, 2008). I find these arguments compelling if not totally convincing. The evidence is quite substantial that phenomenological consciousness alone is not sufficient to be a sole causative agent, as would be the case for support of free will, and it remains an open question what the function of phenomenological consciousness might be.

My own definition of the constate as a fundamental constituent of the laws of nature readily deals with the questions concerning how the world evolves in time. The matter of free will never emerges in such a theory. It is just an unnecessary play on words that may adequately describe a feeling of how things are, but not *in fact* how things are. It is for this reason that it is irrelevant whether we call free will a reality or an illusion. It is just definitional and it only matters where you look for the answers. It is also worth pointing out that the actuality of constates does not address the question of the purpose of the conscious experience. In fact, there is nothing that can adequately address such matters, for purpose must be something found outside our own particular laws of nature, i.e. external to our own reality.

The main concerns about the nature of free will revolve around issues of morality and legal responsibility, as societies need to deal with non-normative or injurious behavior. Society is concerned with retribution, punishment, reform, safety and mental competence, as well as how to deal with these matters in meeting the needs of its members and in respect to the society's power structure. There is an unfounded fear that if we deem that humans are not free agents, then they cannot be held responsible for their actions. As we would put down a rabid dog for reasons that it is a danger to our well-being, we similarly deal with deleterious human behavior. We do not blame the dog for contracting rabies and thus behaving dangerously, but nonetheless must address the matter of what is best for the society. It would be healthier for society to assume that humans do not have free will and simply deal with matters of anti-social behavior on their merits. If some anti-social behavior can be rectified by rehabilitation, then this should be the path to take; the rehabilitation process may well include some form of incarceration. Each case should be judged on its merits. Without venturing any further down this path, I make

the point that the methods utilized in addressing social needs should not be contingent upon the question of free agency. The attribution of free will and moral responsibility is a convenience for sidestepping the nature of the complex interactions in any given society. It is usually easier for a society to eliminate the problem, as if we would exterminate a rabid dog, than scrutinize the complexities that produce both acceptable and inappropriate behavior.

General Theory of Evolution

The term *evolution* has usually referred to the adaptive changes of living organisms over the course of time. But the boundary between life and non-life is not so clear. The first catalogued organisms, bacteria of various phyla, are thought to have a common ancestor, but that ancestor has yet to be discovered. Bacteria are quite complex entities in their own right, being composed of around a trillion atoms; the genome of *E. coli* (sequenced in 1997) has about 3000 genes and 4 million base pairs, although some studies show results exceeding 4000 genes (Koonin, 2000). Whatever the number, it would certainly be informative to know how those atoms ordered themselves into such complex relationships. What instructions were they following to get themselves into such an organized state?

It is perhaps due to the historical particulars regarding the emergence of the theory of evolution that it began its journey separated from the world of physics and never quite conjoined with it. Science became ever more compartmentalized, such that we presently find ourselves without a general theory of evolution. There is a troubling gap between theories concerning the evolution of the universe and those covering the evolution of living organisms, as if somehow the laws of physics gave birth to a new set of laws applicable just for living things, in a sort of *son of physics*. Not only should there not be, but there cannot be a discontinuity in the laws of nature cropping up 10 billion years after the big bang. It is fine to cultivate a deep understanding of the evolution of life in accord with Darwinian processes, but it should be understood that these processes are higher level formulations of more fundamental ones.

The application of natural selection should be broadened to encompass all natural processes in the universe, not just for living organisms. It is more a matter of which forces of nature are applicable to a particular circumstance. In the prebiotic universe the primary force *selecting* the evolutionary path for a given entity was gravity. The gravity driven star factory is well and truly running at full tilt to this very day, churning out atoms of more complex varieties than the ones that found their way into the factory. When these construction materials migrate to cooler and more amenable environments for complex entity formation, such as planet Earth, then electromagnetism can take charge in the next phase of emergence. Both organic and inorganic molecules rely on EM for their composition. Differentiations are related to the materials in use and level of complexity, not the fundamental processes involved. The fact that we cannot find agreement on how to actually define *life* reveals the arbitrariness of the term. There is tangibly nothing magical in the emergence of life, and if we were there to observe it we would probably barely notice anything special happening. It would be some innocuous chemical transition that took place which persisted over a long period of time. Not that much unlike the emergence of language, it would take a self-proclaimed expert to pass judgment on the event of life's

emergence, and other experts would disagree. In fact, it would simply come down to whose definition prevails, but the laws of physics would not be altered by the wrangle of authorities.

The prevailing scientific paradigm proclaims that the laws of nature are isotropic, continuous over time with the value of physical constants remaining unchanged and energy being conserved. There have been ongoing challenges to these beliefs, but for the most part this paradigm has held up well under scrutiny. Even if some of the factors thought to be constant over time are found to have evolved, it would seem likely that their evolution would have been prescribed by the initial laws of physics. It is hard to see a place for *outside intervention* changing the laws of nature after the earliest moments of the big bang, a time before which the physics is less understood. Yet notions of *special circumstances* of sorts seem to be acceptable when attributed to definitions of life, language and consciousness. There seems to be an allusion to outside intervention, or change of circumstances, when addressing how these things came into existence, which appears to be a divergence from generally accepted scientific principles and orthodoxy. Lee Smolin, along with other noted physicists, has argued to the contrary, although Smolin does not support magical interventions (Smolin, 2013). His argument is closer to a Darwinian form of evolution akin to the cosmological natural selection (CNS) theory.[33] CNS and the modifications over the years leading to Smolin's book is quite speculative and perhaps somewhat remote from the current cosmological orthodoxy, but is nonetheless interesting in the application of natural selection to universe building. We can add this to Edelman's neural Darwinism and see a gradual generalization of Darwinian concepts.[34] Although I find considerable disagreement with Smolin's reasoning on a number of issues, including finding that he has fallen into a few linguistic traps regarding the use of terms like *real* and *realism*, it is generally good for science to have new and controversial ideas floating around for consideration. If the entities within the universe evolve as well as the laws directing their evolution, then we are forced to reach beyond our universe for that which controls the evolution of both. It doesn't mean that such hypotheses are incorrect, but rather we would be looking at an inaccessible domain for answers to how and why things are the way they are in our own local (accessible) universe. At this point it is fitting to invoke a Smolin favorite in Leibniz's *principle of sufficient reason* and perhaps a bit of Ockham's razor as well, and stick to the more orthodox view that entities evolve in accordance with fixed universal laws, without regard to what may have transpired outside the creation of what is measureable in our own universe. This should clarify the scope of Darwinian processes that are addressed herein, as well as some of the speculations excluded.

Although my generalized model of consciousness is that it is both fundamental and intrinsic, its manifestations will vary with each respective entity in question, for everything must be conscious, since a lack of consciousness would mean that the entity would not have the information required to *know what to do next*. In this sense, consciousness evolves along with the entity, so that anything that can engage in an independent decision process is conscious and

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[33] Smolin's hypothesis of cosmological natural selection, also called the *fecund universes* theory, suggests that a process analogous to biological natural selection applies at the grandest of scales. Smolin published the idea in 1992 and summarized it in a book called *The Life of the Cosmos*.

[34] Formally called TNGS – Theory of Neuronal Group Selection (Edelman, 1993).

may well have, and in fact is almost certain to have, both subsets and supersets of conscious entities in a cascade of nested conscious entities.

…

Is This Thing Conscious?

Perhaps this question is central to settling on a veritable definition of consciousness. Can a case be made that protozoa are conscious?

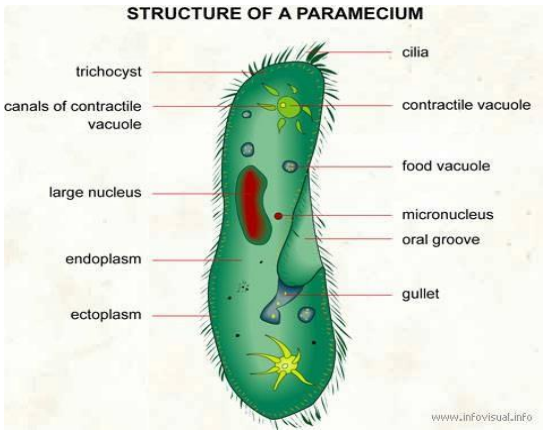

Figure 15: Paramecium

Shall we restrict the term *conscious* to only those animals with language, ostensibly humans? If one day we find clear-cut evidence that dolphins have language, then shall we add them to the consciousness club as well? And would this mean, that if dolphins had language 100,000 years ago and humans did not, that dolphins would have developed consciousness before humans?

Shall we deem that all humans, with or without language, to be conscious? So now we would have some criteria other than language to fit the classification. Would these criteria include clear evidence of self and self-awareness?

A self-awareness attribute would open the flood gates to include a menagerie of other organisms far beyond our household pets. But where would the line be drawn? Could we include small rodents, but exclude frogs? And on what basis? Both seem to be well aware of their respective environments. They search or hunt for food, they attempt to escape danger; they use vocalizations and appear that they experience pain.

Without being overtly arbitrary, it is difficult to know where to draw the line with dog, cats, mice and frogs. It would seem that any definition would necessarily be anthropocentric. Nearly every definition starts with human characteristics and lops off traits that one feels can be omitted while still retaining enough of a human-like experience to be called conscious.

Is it sufficient for consciousness to emerge if an organism has a brain? For it would be difficult to assess what criteria would be necessary to differentiate brains with and without consciousness. What could we say is the factor to divide those brained animals with consciousness from those without consciousness? Size? Number of neurons? The brain of the *C. elegans* nematode worm has just 302 neurons, but in spite of this, it is able to carry out the same requisite functions as the nervous systems of higher organisms. The nematode may be small, but seems to relate to its environment just as well as larger brained animals relate to theirs. How many neurons does it take to have a conscious experience?

The reason these questions are so difficult to answer is the same reason that the hard problem of consciousness is so difficult to answer; in fact, they are really the same question. The answer to the question can only be known by the organism having the first person experience.

So, is a paramecium conscious and what kind of consciousness would it be if it is? Well, who knows? It's a matter of definition, falling within the rubric of the language of another species — the one doing the judging. The paramecium *says* it's a *no brainer*. It's doing just fine going about its business just the way it is. How humans characterize its intellect and life experience is of no concern. It simply does what it has to do to play out the possibilities made available by its genetic program.

…

The conceptualization of both consciousness and evolution should be generalized so they form an integral and fundamental part of how the laws of nature are perceived. By limiting the scope of either, we leave ourselves with gaping holes in the explication of how things evolved from the big bang to the present. In the case of consciousness, we would not only need to explain the phenomenon of consciousness in humans, but also how it arose from non-conscious entities. Evolution is somewhat simpler. We need only to push back the clock and become more inclusive in the way we think about the laws of nature, while blotting out the entrenched demarcations separating life from non-life. Wittgenstein may have overstated his case for language being able to account for all the problems of philosophy, but he was not far off the mark. Sometimes terminology alone can cloud our viewpoint. When the laws of nature are considered from an information-centric perspective, the world unfolds from a simple inception to the one of current complexity. The pieces all fit together quite nicely, without the gaping explicatory voids we find from other theories, even if the arguments may not seem all that convincing to those with entrenched presuppositions about how the world is presumptively put together.

The laws of nature must be a rule-following system. This should be evident by the fact they are written in the language of mathematics and they are consistently predictive and postdictive. To understand the world from the context of the laws of nature, it should be obvious to turn to the fundamentals of mathematics as a foundation. Hence, the binary process and axiomatic systems are the keys. Consciousness must also fit into this schema, not the other way round. It is just one aspect of the process whereby entities *decide what to do next*, which is analogous to the playing out the laws of nature. What we typically call *perceptual consciousness* (as opposed to the more generic *constates*) may very well be epiphenomenal, and may not have any significant causal role to play in high level decision processing. The oddity of *blindsight* is one of the pointers toward such epiphenomenalism (Butler, 2003; de Gelder, 2010). In the end, consciousness becomes a term that needs revision and those in the field should find a common ground on the terminology used to cover this central theme of our perception of the world.

The lack of significant progress in formulating a theory of consciousness is due to a wide variety of factors, many of which have been discussed herein. To best sum it up, it has been putting consciousness outside of nature that has been at the heart of the problem. The term *Naturalizing Consciousness* (Edelman, 2003) can be a bit misleading due to the equating of natural with physical, to the exclusion of information-based theories, as if they were not natural. There has been too much focus on human consciousness as opposed to more generalized conceptualizations, as well as the persistent intrusion of the mind-body problem into the debate. The hard problem of consciousness and physicalism are like two trains speeding toward each other on the same track. It is truly hopeless to find a solution in this capacity; nor will the discounting of consciousness as an entity in the world make it go away. Some of the proposed solutions for human consciousness would not explain how other organisms interact with their

environments. The individual and collective decisions of termites are just as much a part of the natural world as the individual and collective decisions of humans. Whatever we are to make of the decision level processes of termites would have to likewise apply to humanity.

One can metaphorically represent the phenomenological consciousness of a person by the flow of images on a television screen. When the television is off, not powered up, not turned on, effectively not in a *conscious* state, the perception of the world is non-existent. But the world is still there to be perceived. The EMR responsible for the picture that could emerge on the screen, that is, a possibility of a state of affairs, is waiting to be expressed. When the television is switched on, the only thing that changes is that the picture on the screen goes from a potential state to a realized state. Effectively, not all that much changes. The turning on of phenomenological consciousness is like the *flick of a switch*, so to speak, that unfolds the physical isomorphism that we perceive as the experiential world, effectively bringing the world to life. Correspondingly, one can say that to flick the switch brings the television to life as well. If there so happens to be a second television in the same room, it would have no idea whether the first was on or off; television two could not say *what it was like* to be television one. It is not as if the conscious experience creates the world, but only a kind of perception of the world — a perception that we call the physical world. As such, there is not really any substantive difference between human consciousness and the physical world as it is actually experienced by humans, and clearly it is very much a subjective reality.

The solution of the hard problem of consciousness is solved by the vanishing of the problem. The hard problem is produced within a system of propositional logic which does not have within its construct any means to access the information required to produce a satisfactory answer. To the pre-linguistic human being, *Homo sapiens*, the world simply presents itself as it does and there are no baffling questions asked as to how that comes about. The linguistic *Homo deceptus*, however, does have a formal system for posing such a question. Unfortunately, we must resign ourselves to the realization that the answer resides outside this system and phenomenological aspects of consciousness cannot be resolved within the language system. The hard problem of consciousness does not really exist. It is a bit of a misnomer which should be restated as the *hard problem of language*.

Perhaps most significantly, it should be appreciated that language is as much a part of the evolutionary process as everything else. It is competing with other influences on our behavior to affect a selectively beneficial outcome for itself via its hosts. As such, language can be regarded as a kind of parasite, *infecting* its host for the benefit its own propagation. Language is a vector of delusion. In *Homo deceptus* it has managed to subsume much of the behavioral influences that have served other species well enough to survive and be our contemporaries. There is no predestination to the outcome of this ongoing process. In fact, there is every possibility that language will cause the extinction of its principal host species by dint of self-deception.

By one means or another we are probably in the final generations of our species. Language will succeed in producing one of two outcomes within the next century or so. The first is extinction by killing its host by any of the numerous means that it has furnished to humanity over the years, most likely through catastrophic war or environmental collapse. The other, which I consider more likely, is through the cooptation of natural selection itself, from a balanced process of many influences to a controlled process. *Homo deceptus* will have effectively mastered the process of evolution so that it supplants what was formerly done by a more

interdependent aggregate of natural forces. The laws of physics will remain the same, but nature will have gone through a phase change.

For all we know, something similar has already taken place somewhere else in the universe, or perhaps in a great many places. And in some future phase of evolution there will be a process of naturally selecting the fittest of formal systems of logic, in which our successor species may be a participant. There seems a certain inevitability about the emergence of language, as it is so closely tied to the very essence of the laws of nature. There is no moralizing about this. It is just whatever path the master program has within itself to unfold, something perhaps to be understood by future generations. It is what it is.

Homo Deceptus - Final Thoughts

> *"Nature is the source of all true knowledge. She has her own logic, her own laws; she has no effect without cause nor invention without necessity." — Leonardo da Vinci*

The aim of this book in the broadest sense was to rethink the relationship between logic and the physical world, or if one prefers, the relationship between mathematics and physics. This in itself is not such a novel idea. The difficult part in dealing with such weighty issues is how to construct a framework that sets out the order and boundaries in which these matters can be properly addressed, while limiting the leakage into a world of linguistic nonsense. From the human perspective, the world is not about what exists but rather about what can be said.

After such a prolonged period of success, it would be hard to argue that science is in crisis. But from deep within its bowels, all is not well, and many sense that there are troubling signs ahead. The *uncanny* relationship between mathematics and physics has been a major area of such concerns (Rosinger, 2007; Tegmark, 2008; Wigner, 1995). There is a deep philosophical question here that needs resolution if we are to attain a more foundational understanding of the universe. A resolution to the missing mass problem and quantum gravity may well be found within the current scientific paradigm, but is it likely to shed light on the more fundamental questions of *reality*? We have been in this particular paradigm for around a hundred years. It may be reaching the point of exhaustion, at least in its ability to answer the philosophical questions it has raised.

Science wants to be the most reliable system for the production of knowledge about the world. It also wants to liberally use the word *reality* to differentiate itself from other systems purporting to describe the world. Most scientists would like to use words like *truth* and *real* to distinguish the kind of knowledge they produce from that professed by religions. Is there something that science is lacking that it has failed to become the unchallenged account of how the world operates? Or is it just that science lacks the political clout to wrest control from competing philosophies. It really shouldn't matter what the majority of the world thinks; nonetheless, science would like to provide a compelling narrative that would be hard to reject. If science can convince itself it is on the right track, the rest should fall into line. But it needs to deal with some of the thornier problems that persist within its ranks.

For science to successfully move forward on these matters it is imperative to go through a rigorous redefining of what it is. At least informally, this is already happening. But the general disdain toward digital physics within scientific orthodoxy is but one example that there is still a long way to go. As reassuring as having testable hypotheses underpinning science might be, it is also limiting its reach into theoretical models which are not, at least at present, testable. It does not mean that these models are incorrect. Nor should it mean that such models cannot be substantiated through other evidence-based methodologies. The formal refining of science that I am suggesting would open science to other philosophical frameworks which meet the general principles of the scientific endeavor.

This framework for a new kind of science can be summarized as follows:

1. Science can be reformulated into an ordered structured framework which at the very least acknowledges the significance of issues that it has yet to seriously consider as part of scientific orthodoxy.
2. Science purports to assert scientific truths, but should refrain from calling these assertions *reality*.
3. Scientific truths are theorems derived from formal systems of logic falling within the scientific belief system, such being defined by its axioms. This body of knowledge is derived from language and mathematics, which should be at the top of the list of the axioms of science.
4. Science should abandon the pretense of conferring objective knowledge and replace it with a formalized axiomatic system of what it purports to be, including its boundaries and limitations.
5. As science incorporates observation and observables as a part of its system, it should categorically confront the nature of consciousness and its role in scientific observation. The plausibility of scientific truth is dependent on it, and what can be said to be scientific truth must be attenuated to the extent of any lack of incorporation of a theory of consciousness into the wider body of science.
6. The concepts of information theory, computation and digital physics should be welcomed into the main body of scientific theory.
7. The concept of evolution should be broadened so that it reaches beyond the definition of life and incorporates all that is within our universe. Evolution should be seen as a characteristic of the laws of nature.

Science has always been good at dealing with its paradigm shifts, so there should not be much fretting about why it seems to be taking so long. When you read about the history of these major transitions in thought, they appear to happen rather quickly, but when one is living through them, they seem to take forever.

Whether it is by common sense, religious belief or scientific theory, we want to understand how the past became the present and if it is possible to predict the future from what we know of both the past and the present. In this light we might say that the central issue for science is determining how things know what to do next, which in keeping with the tenor of this text can be restated: How do things *decide* what to do next? It doesn't matter what *things* we are talking about; it can be people or it can be electrons. Additionally, we not only want to understand how people decide what to do next and how electrons decide what to do next, but also how the electrons that reside in the bodies of people decide what to do next, all in sync with the higher level decisions made by the individual containing those electrons.

Complex organisms run internal programs cultivating sub-modules which enable modifications and variations to the program so that behavior is learned from environmental interactions. Learning is a high level feedback loop supported by some incalculable number of lower level nested feedback loops in a two-directional coordinated dance perhaps drilling all the way down to Planck scale dimensions.

There is a great predilection to think of ourselves as something more than just some kind of computing machine. We see a computer as a bunch of electronics in a box, and we want to be

more than that. These predispositions will either drive us toward or away from a particular theory that purports to describe the universe and our place in it. It is difficult to ask someone to be open-minded when the mind is a substantially closed system with small vents to the outside world, filtering what comes in and what goes out. It is likewise difficult to ask one to be objective when such a thing is an impossibility. Yet there is a way around these seemingly insurmountable problems. For me, it was Wittgenstein that opened the door to a pathway to thinking about the world while dealing with such perplexities.

. . .

What can we say about the world without speaking nonsense? How can we convert truth into reality without falling afoul by the very mechanisms that produce the truths that we wish to assert as reality? How much of what we think we know about the world can be incorporated into a broad and consistent theory so that there are no contradictions within such a theory?

In order to answer these questions, some of the certitude we would have liked to attribute to nature had to be abandoned. In its place boundaries were established limiting the certitude but expanding upon what can be said within that context. As with the *uncertainty principle*, the less certain we are about something the more can be said about it, and conversely, the more certain we are about something the less can be said about it. Both postures have been taken in this book at various times to suit the situation at hand. But my preference has been to aim for certitude when possible and to structure the arguments in that vein. In keeping with the spirit of Wittgenstein, we may limit what can be said about the world, but that which can be said, can be said clearly.

Glossary

Angstrom — One ten-billionth of a meter. Symbol: Å

Anthropic Principle — In astrophysics and cosmology, the anthropic principle is the philosophical consideration that observations of the physical Universe must be compatible with the conscious life that observes it.

Blindsight — Blindsight is the ability of people who are cortically blind due to lesions in their striate cortex, also known as the primary visual cortex, to respond to visual stimuli that they do not consciously see. The majority of studies on blindsight are conducted on patients who are blind on only one side of their visual field. Following the destruction of the striate cortex, patients are asked to detect, localize, and discriminate amongst visual stimuli that are presented to their blind side often in a forced-response or guessing situation, even though they cannot actually see the stimulus. Research shows a surprising amount of accuracy in the guesses of blind patients. Blindsight challenges the common belief that perceptions must enter phenomenological consciousness to affect our behavior. This phenomenon shows our behavior can be guided by sensory information of which we are consciously unaware.

Attractor — An attractor is a set towards which a variable, moving according to the dictates of a dynamical system, evolves over time. That is, points that get close enough to the attractor remain close even if slightly disturbed. In finite-dimensional systems, the evolving variable may be represented algebraically as an n-dimensional vector. The attractor is a region in n-dimensional space. In physical systems, the n dimensions may be, for example, two or three positional coordinates for each of one or more physical entities. If the evolving variable is two- or three-dimensional, the attractor of the dynamic process can be represented geometrically in two or three dimensions. An attractor can be a point, a finite set of points, a curve, a manifold, or even a complicated set with a fractal structure known as a strange attractor. If the variable is a scalar, the attractor is a subset of the real number line. Describing the attractors of chaotic dynamical systems has been one of the achievements of chaos theory. A trajectory of the dynamical system in the attractor does not have to satisfy any special constraints except for remaining on the attractor, backward and forward in time. The trajectory may be periodic or chaotic. If a set of points is periodic or chaotic, but the flow in the neighborhood is away from the set, the set is not an attractor, but instead is called a repeller (or repellor).

Cellular Automata — Cellular automata (CA) are *discrete*, *abstract computational systems* that have proved useful both as general models of complexity and as more specific representations of non-linear dynamics in a variety of scientific fields. Firstly, CA are (typically) spatially and temporally *discrete*: they are composed of a finite or denumerable set of homogeneous, simple units, atoms or cells. At each time unit, the

cells instantiate one of a finite set of states. They evolve in parallel at discrete time steps, following state update functions or dynamical transition rules: the update of a cell state obtains by taking into account the states of cells in its local neighborhood (there are, therefore, no actions at a distance). Secondly, CA are *abstract*, as they can be specified in purely mathematical terms and implemented in physical structures. Thirdly, CA are *computational* systems: they can compute functions and solve algorithmic problems. Despite functioning in a different way from traditional, Turing-machine-like devices, CA with suitable rules can emulate a universal Turing machine, and therefore compute, given Turing's Thesis, anything computable.

Computation Space See *Logical Space*

Constate System state assessment. Symbol: *Tc.* A term used in this book to represent a state in logical space associated with consciousness.

Deductive Reasoning Deductive reasoning, or *deduction*, starts with a general case and deduces specific instances. Deduction starts with an assumed hypothesis or theory. Deduction is used by scientists who take a general scientific law and apply it to a certain case, as they assume that the law is true. Deduction can also be used to test an induction by applying it elsewhere, although in this case the initial theory is assumed to be true only temporarily.
Deductive reasoning assumes that the basic law from which you are arguing is applicable in *all* cases. This can let you take a rule and apply it perhaps where it was not really meant to be applied. Scientists will prove a general law for a particular case and then do many deductive experiments to demonstrate that the law holds true in many different circumstances. In set theory, a deduction is a subset of the rule that is taken as the start point. If the rule is true and deduction is a true subset (not a conjunction) then the deduction is almost certainly true. Using deductive reasoning usually is a credible and 'safe' form of reasoning, but is based on the assumed truth of the rule or law on which it is founded. Deductive conclusions can be *valid* or *invalid*. Valid arguments obey the initial rule. For validity, the truth or falsehood of the initial rule is not considered. Thus valid conclusions need not be true, and invalid conclusions may not be false.

Formal System A formal system is broadly defined as any well-defined system of abstract thought based on the model of mathematics. Euclid's *Elements* is often held to be the first formal system. The entailment of the system by its logical foundation is what distinguishes a formal system from others which may have some basis in an abstract model.

Each formal system has a formal language, which is composed by primitive symbols. These symbols act on certain rules of formation and are developed by inference from a set of axioms. The system thus consists of any number of formulas built up through finite combinations of the primitive symbols—combinations that are formed from the axioms in accordance with the stated rules.

Formal systems in mathematics consist of the following elements:

1. A finite set of symbols (i.e. the alphabet), that can be used for constructing formulas (i.e. finite strings of symbols).
2. A grammar, which tells how well-formed formulas (abbreviated *wff*) are constructed out of the symbols in an alphabet. It is usually required that there be a decision procedure for deciding whether a formula is well formed or not.
3. A set of axioms or axiom schemata: each axiom must be a wff.
4. A set of inference rules

Fredkin Gate

The Fredkin gate (also CSWAP gate) is a computational circuit suitable for reversible computing, invented by Edward Fredkin. It is universal, which means that any logical or arithmetic operation can be constructed entirely of Fredkin gates. The Fredkin gate is a three-bit gate that swaps the last two bits if the first bit is 1.

Hilbert space

The mathematical concept of a Hilbert space, named after the German mathematician David Hilbert, generalizes the notion of Euclidean space. It extends the methods of vector algebra and calculus from the two-dimensional Euclidean plane and three-dimensional space to spaces with any finite or infinite number of dimensions. A Hilbert space is an abstract vector space possessing the structure of an inner product that allows length and angle to be measured. Furthermore, Hilbert spaces must be complete, a property that stipulates the existence of enough limits in the space to allow the techniques of calculus to be used.

Inductive Reasoning

Inductive reasoning, or induction, is reasoning from a specific case or cases and deriving a general rule. It draws inferences from observations in order to make generalizations.

Information Space

See *Logical Space*

Isomorphism

An Isomorphism is an information preserving transformation. An isomorphic relationship between two entities can be said to exist if one entity can be mapped onto the other so that for each part of the first entity there is a corresponding part in the second. If a certain dynamic in the physical world can be described by a mathematical formula then we can say, at least for this case, that an isomorphic relationship exists between that dynamical system and the formula. We can generalize this by saying that there is an isomorphic relationship between mathematics and the physical world, recognizing that both mathematics and the physical world are rather large concepts and this generalization would require a great deal of specification.

Language: A Formal Symbolic System

Language as used in this book is a formal system of signs governed by grammatical rules of combination to communicate meaning. This

definition stresses the fact that human languages can be described as closed structural systems consisting of rules that relate particular signs to particular meanings. This structuralist view of language was first introduced by Ferdinand de Saussure, and his structuralism remains foundational for most approaches to language today. Some proponents of this view of language have advocated a formal approach to studying the structures of language, privileging the formulation of underlying abstract rules that can be understood to generate observable linguistic structures. The main proponent of such a theory is Noam Chomsky, who defines language as a particular set of sentences that can be generated from a particular set of rules. This definition of language is commonly used in formal logic, and in formal theories of grammar and in applied computational linguistics. In the philosophy of language these views are associated with philosophers such as Bertrand Russell, early Wittgenstein, Alfred Tarski and Gottlob Frege.

Logical Space; Information Space; Computational Space

All three terms are used interchangeably throughout this book and are representations of abstract non-physical binary spaces. They can be considered nuances of the same concept. The preference for one term over another mostly depends on the context.

A logical space is a generalized binary process space used for symbol manipulation, and particularly the evaluations of propositions or similar logical constructs. More generally, it is the space in which objects and states of affairs exist. This is the most general kind of space there is, so everything that exists and everything that could exist exists in logical space. The term originates in Boltzmann's generalized thermodynamics, which treats the independent properties of a physical system as defining separate coordinates in a multidimensional system the points of which constitute the 'ensemble of possible states'. The *Tractatus* does not define the term 'logical space', but clearly it refers to the ensemble of logical possibilities. Logical space stands to 'reality', the existence and non-existence of states of affairs (TLP 2.05), as the potential to the actual. The term conveys the idea that logical possibilities form a 'logical scaffolding' (TLP 3.42), a systematic manifold akin to a coordinate system. The world is the 'facts in logical space' (TLP 1.13), since the contingent existence of states of affairs is embedded in an a priori order of possibilities. There are several dimensions to the analogy between space and the ensemble of logical possibilities. A 'place' in logical space is determined by a 'proposition' (TLP 3.4–3.42), which here means an elementary proposition. It is a possible state of affairs, which corresponds to the two 'truth-possibilities' of an elementary proposition – being true or being false (TLP 4.3ff.).

Information space is used primarily to indicate the storage of binary information or bits. Computational space is most often used for transformations in a binary process, such as the execution of an algorithm or computer program.

Maxwell's Demon

A hypothetical being imagined as controlling a hole in a partition dividing a gas-filled container into two parts, and allowing only fast-moving molecules to pass in one direction, and slow-moving

molecules in the other. This would result in one side of the container becoming warmer and the other colder, in violation of the second law of thermodynamics.

Planck Time

Planck time (t_p) is the time it would take a photon travelling at the speed of light to cross a distance equal to the Planck length. This is the 'quantum of time', the smallest measurement of time that has any meaning, and is equal to approximately 10^{-43} seconds.

$$t_{\mathrm{P}} \equiv \sqrt{\frac{\hbar G}{c^5}} \approx 5.39106(32) \times 10^{-44}\ \mathrm{s}$$

Predicate Logic

Sometimes called first-order logic or first-order predicate logic, it is a fundamental system of mathematical logic.

Propositional Logic

A subset of predicate logic that does not use quantified variables.

Quantum Entanglement

Quantum entanglement is a product of quantum superposition. It is a physical phenomenon that occurs when pairs of particles are generated or interact in ways such that the quantum state of each member must subsequently be described relative to the other.

Tautology

A proposition that is true regardless of what is and what is not the case. As such, tautologies lack sense (but are not nonsense) and say nothing. Wittgenstein asserts that the propositions of logic are tautologies, thus underscoring the idea that the propositions of logic cannot say anything about the world.

Turing Machine (TM)

A Turing machine is a hypothetical device that manipulates symbols on a strip of tape according to a table of rules. Despite its simplicity, a Turing machine can be adapted to simulate the logic of any computer algorithm.

Universal Turing Machine (UTM)

In computer science, a universal Turing machine is a Turing machine that can simulate an arbitrary Turing machine on arbitrary input. The universal machine essentially achieves this by reading both the description of the machine to be simulated as well as the input thereof from its own tape.

Bibliography

Banks, E. (1971). *Information processing and transmission in cellular automata*. MIT.

Bickerton, D. (2007). Language evolution: A brief guide for linguists. *Lingua*, *117*(3), 510–526. http://doi.org/10.1016/j.lingua.2005.02.006

Bruiger, D. (2008). The Rise And Fall Of Reality. http://philpapers.org/archive/BRUTRA

Bruiger, D. (2011). Is Physical Reality Reducible To Thought?

Butler, J. (2003). What Blindsight Can See.

Cámara, M. (2006). Quorum sensing: a cell-cell signalling mechanism used to coordinate behavioral changes in bacterial populations. *Membrane Computing*, (i).

Chalmers, D. J. (2003). Consciousness and its Place in Nature. *Blackwell Guide to the Philosophy of Mind*, 1–45.

Chomsky, N. (1957). *Syntactic Structures*. Berlin, Boston: De Gruyter. http://doi.org/10.1515/9783110218329

Chomsky, N. (2005). *Language and Mind* (Third Edit). Cambridge University Press.

Christiansen, M., & Kirby, S. (2003). *Language evolution*.

Darwin, C. (1839). The Voyage of the Beagle.

Davies, P. (2007). The implications of a cosmological information bound for complexity, quantum information and the nature of physical law. *Fluctuation and Noise Letters*, 1–15.

De Gelder, B. (2010). Sight in the Blind. *Scientific American*.

Edelman, G. M. (1993). Bright Air, Brilliant Fire: On the Matter Of the Mind. Basic Books.

Edelman, G. M. (2003). Naturalizing consciousness: a theoretical framework. *Proceedings of the National Academy of Sciences of the United States of America*, *100*(9), 5520–4.

Edelman, G. M. (2004). Wider than the Sky: the Phenomenal Gift of Consciousness. Yale University Press.

Edelman, G. M. (2006). Second Nature: Brain Science and Human Knowledge.

Everett, D. (2005). Cultural constraints on grammar and cognition in Pirahã. *Current Anthropology*, *46*(4), 1–69.

Fredkin, E. (2003). An introduction to digital philosophy. *International Journal of Theoretical Physics*, *42*(2), 189–247.

Fredkin, E., & Toffoli, T. (1982). Conservative logic. *International Journal of Theoretical Physics*, *21*(3-4), 219–253. http://doi.org/10.1007/BF01857727

Funkhouser, S. (2006). A New Large Number Coincidence and the Maximum Number of Bits in the Universe. The Citidel, Dept of Physics.

Godel, K. (1931). On formally undecidable propositions of principia mathematica and related systems.

Grandin, T. (1995). *Thinking in Pictures*. Doubleday.

Griffin, D. R., & Speck, G. B. (2004). New evidence of animal consciousness. *Animal Cognition*, *7*(1), 5–18.

Hofstadter, D. (1979). Gödel, Escher, Bach: an Eternal Golden Braid. New York: Random House.

Honderich, T. (2005). On Benjamin Libet: Is The Mind Ahead Of The Brain? Behind It? *Determinism and Freedom Website -- Http://www.ucl.ac.uk/~uctytho/libetnew.html*.

Jackendoff, R. (2002). Foundations of language: Brain, meaning, grammar, evolution. Oxford University Press.

Kleinert, H., Ruffini, R., & Xue, S.-S. (2008). Electron-positron pair production in space- or time-dependent electric fields. *Physical Review D*, *78*(2), 025011. http://doi.org/10.1103/PhysRevD.78.025011

Koonin, E. (2000). How Many Genes Can Make a Cell: The Minimal-Gene-Set Concept. *Annual Review of Genomics and Human Genetics*, 99–116.

Landauer, R. (1996). The physical nature of information. *Physical Letters A*, *217*(July), 188–193.

Libet, B. (1999). Benjamin Libet Do We Have Free Will? *Journal of Consciousness Studies*, *6*(8), 47–57.

Libet, B. (2003). Can conscious experience affect brain activity? *Journal of Consciousness Studies*, (12), 24–28.

Loewenstein, W. (1999). The Touchstone of Life. Oxford.

Masataka, N. (2008). The Origins of Language Unraveling Evolutionary Forces. Springer.

Monod, J. (1971). Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology. New York, NY: Alfred A. Knopf.

Montague, P. R., Hyman, S., & Cohen, J. (2004). Computational roles for dopamine in behavioural control. *Nature*, *431*(7010), 760–767.

Nachman, M. W., & Crowell, S. L. (2000). Estimate of the mutation rate per nucleotide in humans. *Genetics*, *156*(1), 297–304.

Nagel, T. (1974). What Is It Like to Be a Bat. *Philosophical Review*, *83*(4), 435–450.

Nevins, A., Pesetsky, D., & Rodrigues, C. (2009). Pirahã Exceptionality : a Reassessment. *Language*, *85*(2), 355–404.

Pinker, S. (1994). *The Language Instinct*. William Morrow and Company.

RN. (2006). ABC Radio National, All in the Mind. The Nature of Belief : Australian Science Festival Debate. 19 August 2006. http://www.abc.net.au/radionational/programs/allinthemind/the-nature-of-belief--australian-science-festival/3341660

Rosinger, E. (2007). Mathematics and "The Trouble with Physics", How Deep We Have to Go? *arXiv Preprint arXiv:0707.1163*, 1–46.

Smolin, L. (2013). *Time Reborn*. Houghton Mifflin Harcourt Publishing Company.

Soon, C. S., Brass, M., Heinze, H.-J., & Haynes, J.-D. (2008). Unconscious determinants of free decisions in the human brain. *Nature Neuroscience*, *11*(5), 543–5. http://doi.org/10.1038/nn.2112

Tarski, A. (1944). The semantic conception of truth: and the foundations of semantics. *Philosophy and Phenomenological Research*.

Tegmark, M. (2008). The Mathematical Universe. *Foundations of Physics*, *38*(2), 101–150. General Relativity and Quantum Cosmology; Astrophysics; High Energy Physics - Theory. http://doi.org/10.1007/s10701-007-9186-9

Verlinde, E. (2011). On the Origin of Gravity and the Laws of Newton. *Journal of High Energy Physics*, 1–29.

Waters, C. M., & Bassler, B. L. (2005). Quorum sensing: cell-to-cell communication in bacteria. *Annual Review of Cell and Developmental Biology*, *21*, 319–46. http://doi.org/10.1146/annurev.cellbio.21.012704.131001

Wegner, D. (2002). *The Illusion of Conscious Will*. Cambridge, MA: MIT Press.

Widgen, W. (2004). *The Evolution of Human Language*. Amsterdam/Philadelphia: John Benjamins.

Wigner, E. (1995). The unreasonable effectiveness of mathematics in the natural sciences. *Philosophical Reflections and Syntheses*, 1–9.

Wittgenstein, L. (1922). Tractatus Logico-Philosophicus (containing the original German, alongside both the Ogden/Ramsey, and Pears/McGuinness English translations). London: Paul Kegan.

Wittgenstein, L. (1958). *Philosophical investigations* (Translated). Basil Blackwell, Oxford.

Wittgenstein, L. (1974). *Philosophical Grammar*. Basil Blackwell, Oxford.

Further Reading

Appenzeller, T. (2012). Human migrations : Eastern odyssey. *Nature*, 1–7.

Bekenstein, J. (2003). Information in the holographic universe. *Scientific American*.

Bell, J. (1964). On the Einstein-Podolsky-Rosen paradox. *Physics*, *1*(3), 195–200.

Bohm, D. (1990). A new theory of the relationship of mind and matter. *Philosophical Psychology*, *3*(2-3), 271–286

Borzenko, A. (2008). Language Processing in Human Brain. *Proceedings of the First AGI Conference, 171*(February).

Briscoe, E. (2002). *Linguistic evolution through language acquisition*. Cambridge University Press.

Bulanov, S. S., Narozhny, N. B., Mur, V. D., & Popov, V. S. (2006). Electron-positron pair production by electromagnetic pulses. *Journal of Experimental and Theoretical Physics*, *102*(1), 9–23.

Carnap, R. (1956). Empiricism, Semantics, and Ontology. *Revue Internationale de Philosophie*, *4*(1950), 1–13.

Chaitin, G. (2004). Meta Math! The Quest for Omega. *arXiv:math/0404335v7*.

Chaitin, G. (2007). Algorithmic information theory: Some recollections. *arXiv Preprint math/0701164*, (January), 1–20.

Chalmers, D. J. (1995). Facing up to the problem of consciousness. *Journal of Consciousness Studies*, *2*(3), 1–27.

Chalmers, D. J. (1996). Does a rock implement every finite-state automaton? *Synthese*, *108*(3), 309–333.

Chater, N., & Christiansen, M. H. (2010). Language acquisition meets language evolution. *Cognitive Science*, *34*(7), 1131–57.

Chau, H., & Wilczek, F. (1995). Realization of the Fredkin gate using a series of one-and two-body operators, 1–7.

Chiribella, G., D'Ariano, G. M., & Perinotti, P. (2012). Quantum Theory, Namely the Pure and Reversible Theory of Information. *Entropy*, *14*(12), 1877–1893.

Dawkins, R. (1979). *The Selfish Gene*. Oxford University Press.

Dawkins, R. (1982). *The Extended Phenotype*. Oxford University Press.

Dawkins, R. (2006). *The God Delusion*. Bantam Press.

Dennett, D. (1991). *Consciousness explained*. Back Bay Books.

Deutsch, D. (1985). Quantum theory, the Church-Turing principle and the universal quantum computer. *Proceedings of the Royal Society of London*, *A*(400), 97–117.

Diggle, S. P., Gardner, A., West, S. a, & Griffin, A. S. (2007). Evolutionary theory of bacterial quorum sensing: when is a signal not a signal? *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *362*(1483), 1241–9.

Feferman, S. (2006a). The nature and significance of Gödel's incompleteness theorems. *Princeton, Institute for Advanced Study; Gödel Centenary Program*.

Feferman, S. (2006b). Turing's thesis. *Notices of the AMS*, *53*(10), 1200–1206.

Fingelkurts, A. a, & Fingelkurts, A. a. (2006). Timing in cognition and EEG brain dynamics: discreteness versus continuity. *Cognitive Processing*, *7*(3), 135–62.

Frank, M. C., Everett, D. L., Fedorenko, E., & Gibson, E. (2008). Number as a cognitive technology: evidence from Pirahã language and cognition. *Cognition*, *108*(3), 819–24.

Fredkin, E. (2004). Five big questions with pretty simple answers. *IBM Journal of Research and Development*, *48*(1), 31–45.

Goldstein, R. (2006). *Incompleteness: The proof and paradox of Kurt Gödel*. New York: W. W. Norton.

Hacker, P. M. S. (1997). *Wittgenstein on Human Nature*. Phoenix.

Hauser, M. D., Chomsky, N., & Fitch, W. T. (2002). The faculty of language: what is it, who has it, and how did it evolve? *Science (New York, N.Y.)*, *298*(5598), 1569–79.

Hestenes, D. (2008). Electron time, mass and zitter. *The Nature of Time Essay Contest*.

Heylighen, F. (1989). Causality As Distinction Conservation. a Theory of Predictability, Reversibility, and Time Order. *Cybernetics and Systems*, *20*(5), 361–384.

Heylighen, F. (1991). Cognitive Levels of Evolution: from pre-rational to meta-rational. *The Cybernetics of Complex Systems - Self-Organization, Evolution and Social Change*, 75–91.

Heylighen, F. (2010). The Self-Organization of Time and Causality: Steps Towards Understanding the Ultimate Origin. *Foundations of Science*, *15*(4), 345–356.

Heylighen, F., Cilliers, P., & Gershenson, C. (2006). Complexity and philosophy. *arXiv Preprint cs/0604072*, 1–21.

Hodges, A. (2007). Alan Turing: the logical and physical basis of computing. *British Computer Society*. University of Oxford.

Honderich, T. (2005). On Benjamin Libet: Is The Mind Ahead Of The Brain? Behind It? *Determinism and Freedom Website -- Http://www.ucl.ac.uk/~uctytho/libetnew.html*.

Huber, L., & Gajdon, G. (2006). Technical intelligence in animals: the kea model. *Animal Cognition*, *9*(4), 295–305.

Jackendoff, R. (1999). Possible stages in the evolution of the language capacity. *Trends in Cognitive Sciences*, *3*(7), 272–279.

Jackendoff, R., & Pinker, S. (2005). The nature of the language faculty and its implications for evolution of language (Reply to Fitch, Hauser, and Chomsky). *Cognition*, *97*(2), 211–225.

Jagers op Akkerhuis, G. a. J. M. (2010). Towards a Hierarchical Definition of Life, the Organism, and Death. *Foundations of Science*, *15*(3), 245–262.

Kane, G. (2005). The mysteries of mass. *Scientific American*, *293*(1), 40–6, 48.

Keeling, P. (2004). Diversity and evolutionary history of plastids and their hosts. *American Journal of Botany*, *91*(10), 1481–1493.

Knuth, K. (2010). Information physics: The new frontier. *arXiv Preprint arXiv:1009.5161*.

Kokosar, J. (2009). What is Ultimately Possible in Physics, Completeness of Quantum Mechanics, Quantum Gravity, and Consciousness. *Http://fqxi.org/data/essay-Contest-files/Kokosar_limits_and_consciou_3.pdf*.

Kouider, S. (2009). Neurobiological theories of consciousness. In *Encyclopedia of consciousness*.

Landauer, R. (1961). Irreversibility and heat generation in the computing process. *IBM Journal of Research and Development*, (July), 183–191.

Lloyd, S. (2002). Computational capacity of the universe. *Physical Review Letters*, (2), 1–17.

Maldacena, J. (2000). Black Holes, Strings and Quantum Gravity. *Princeton Centennial Lectures*, *132*.

McCabe, G. (2006). Possible physical universes. *arXiv Preprint Gr-qc/0601073*.

McGinn, M. (2006). *Elucidating the Tractatus: Wittgenstein's early philosophy of logic and language* (p. 331). Oxford University Press.

McWhinnie, J. (2011). Relativity - The Theory Of Information. *http://vixra.org/pdf/1103.0061v2.pdf*.

Miller, D. B., & Fredkin, E. (2005). Two-state, reversible, universal cellular automata in three dimensions. In *Proceedings of the 2nd conference on Computing frontiers - CF '05* (p. 45). New York, New York, USA: ACM Press.

Miller, D., & Fredkin, E. (2012). Circular Motion of Strings in Cellular Automata, and Other Surprises. *arXiv Preprint arXiv:1206.2060*, 1–14.

Montague, P. R., Hyman, S., & Cohen, J. (2004). Computational roles for dopamine in behavioural control. *Nature*, *431*(7010), 760–767.

Pantsar, M. (2009). Truth, Proof and Gödelian Arguments: A Defence of Tarskian Truth in Mathematics. *Philosophical Studies from the University of Helsinki 23*.

Parker, M. C., & Walker, S. D. (2004). Information transfer and Landauer's principle. *Optics Communications*, *229*(1-6), 23–27.

Parker, M. C., & Walker, S. D. (2010). A Dynamic Model of Information and Entropy. *Entropy*, *12*(1), 80–88.

Pederson, D. (2011). Causality and Objectivity: The Arguments in Kant's Second Analogy. *Aporia*, *21*(1).

Penrose, R. (2004). *The Road To Reality*. London: Jonathan Cape.

Perlovsky, L. I., & Ilin, R. (2010). Neurally and mathematically motivated architecture for language and thought. *The Open Neuroimaging Journal*, *4*, 70–80.

Pinker, S. (2000). Survival of the clearest. *Nature*, *404*(6777), 441–442.

Povinelli, D. (2004). Behind the ape's appearance: Escaping anthropocentrism in the study of other minds. *Daedalus*, *92*, 481–489.

Povinelli, D. J., & Vonk, J. (2003). Chimpanzee minds: suspiciously human? *Trends in Cognitive Sciences*, *7*(4), 157–160.

Psillos, S. (2000). Rudolf Carnap's "Theoretical Concepts in Science." *Stud. Hist. Phil. Sci.*, *31*(1), 151–172.

Raatikainen, P. (2008). Truth, correspondence, models, and Tarski. *Approacing Truth*.

Reid, L. (1998). Wittgenstein's Ladder: The Tractatus and Nonsense. *Philosophical Investigations*, (April).

Rhodes, R. (2001). A Cybernetic Interpretation of Quantum Mechanics. Retrieved January 07, 2014, from http://www.bottomlayer.com/bottom/argument/Argument3.PDF

Richter, D. (2004). *Wittgenstein at His Word*. Continuum.

Roederer, J. G. (2003). On the Concept of Information and Its Role in Nature. *Entropy*, *5*(1), 3–33.

Rosinger, E. (2007). Mathematics and "The Trouble with Physics", How Deep We Have to Go? *arXiv Preprint arXiv:0707.1163*, 1–46.

Scientific American. (2008). Prehistoric Migrations. *Scientific American*.

Searle, J. (2005). The phenomenological illusion.

Seth, A. (2008, June). Functions of consciousness. In *Elsevier Encyclopedia of Consciousness*.

Sher, G. (1999). What is Tarski's Theory of Truth? *Topoi*, *18*, 149–166,.

Sigmund, K., & Nowak, M. a. (1999). Evolutionary game theory. *Current Biology : CB*, *9*(14), R503–5.

Stannett, M. (2009). The computational status of physics. *Natural Computing*, *1*, 1–21.

Steinhardt, P. J. (2011). The Inflation Debate: Is the theory at the heart of modern cosmology deeply flawed? *Scientific American*, (April), 36–43.

Stix, G. (2008). Traces of a distant past. *Scientific American*, (July), 56–63.

Stokhof, M., Levy, D., & Zamuner, E. (n.d.). The Architecture of Meaning: Wittgenstein's Tractatus and formal semantics. *philpapers.org*. Retrieved from http://philpapers.org/rec/LEVTAO-5

Stoljar, D. (2001). Two conceptions of the physical. *Philosophy and Phenomenological Research*, *LXII*(2), 253– 281.

Sweller, J., & Sweller, S. (2006). Natural information processing systems. *Evolutionary Psychology*, 434–458.

Szathmáry, E. (2006). The origin of replicators and reproducers. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *361*(1474), 1761–76.

Tarski, A. (1969). Truth and Proof. *Scientific American*, (March), 63–70.

Tegmark, M. (2007). Shut up and calculate. *International Journal of Machine Consciousness*, *03*(02), 367–374

Tegmark, M. (2012). How unitary cosmology generalizes thermodynamics and solves the inflationary entropy problem. *Physical Review D*, *85*(12), 123517.

Tennant, N. (2002). Deflationism and the Gödel phenomena. *Mind*, *111*(July).

Thomas, A. (2008). Interplay of spin and orbital angular momentum in the proton. *arXiv Preprint arXiv:0803.2775*, 1–11.

Tucker, D., & Thomason, R. H. (2011). Paradoxes of Intensionality. *The Review of Symbolic Logic*, *4*(03), 394–411.

Turchin, V. F. (1993). The Cybernetic Ontology of Action. *Kybernetes*, *22*(2), 10–30.

Turing, A. (1950). Computing Machinery and Intelligence. *Mind*, *LIX*(236), 433–460.

Turing, A. (1936). On computable numbers, with an application to the Entscheidungsproblem. *Proceedings of the London Mathematical Society*.

Van Gaal, S., de Lange, F. P., & Cohen, M. X. (2012). The role of consciousness in cognitive control and decision making. *Frontiers in Human Neuroscience*, *6*(May), 121.

Vassallo, A., & Esfeld, M. (2014). A Proposal for a Bohmian Ontology of Quantum Gravity. *Foundations of Physics*, *44*(1), 1–18.

Vederal, V. (2010). *Decoding Reality*. Oxford University Press.

Velmans, M. (2009). *Understanding Consciousness* (Second Edi.). Routledge.

Vergauwen, R. (2010). Will Science and Consciousness Ever Meat? Complexity, Symmetry and Qualia. *Symmetry*, *2*(3), 1250–1269.

Vidal, C., Auffray, C., Blin, A. H., Chaline, J., Crane, L., Durt, T., van Straalen, N. M. (2009). The Evolution and Development of the Universe. *arXiv Preprint 0912.5508.*

Whitworth, B. (2008). The physical world as a virtual reality. *arXiv Preprint arXiv:0801.0337*.

Whitworth, B. (2010a). Simulating space and time. *arXiv Preprint arXiv:1011.5499*, *1*(2), 1–23.

Whitworth, B. (2010b). The emergence of the physical world from information processing. *arXiv Preprint arXiv:1011.3436*, *2*(1), 221–249.

Whitworth, B. (2011). The Virtual Reality Conjecture. *arXiv Preprint arXiv:1110.3307*, *2*(9).

Witten, E. (1998). Anti De Sitter Space And Holography. *BMC Proceedings*, *3*(Suppl 7), 253–291. High Energy Physics - Theory.

Wittgenstein, L. (1998). *The Collected Works of Ludwig Wittgenstein*. Blackwell Publishing Ltd.

Woese, C. (1987). Bacterial evolution. *Microbiological Reviews*, *51*(2), 221–271.

Yang, T., & Shadlen, M. N. (2007). Probabilistic reasoning by neurons. *Nature*, *447*(7148), 1075–80.

Zengotita, T. (1989). On Wittgenstein's Remarks on Frazer's Golden Bough. *Cultural Anthropology*.

Zenil, H., Gershenson, C., Marshall, J., & Rosenblueth, D. (2012). Life as Thermodynamic Evidence of Algorithmic Structure in Natural Environments. *Entropy*, *14*(12), 2173–2191.

Zizzi, P. (2007). Basic logic and quantum entanglement. *Journal of Physics: Conference Series*, 1–12.

Zlatev, J. (2008). The dialectics of consciousness and language. *Journal of Consciousness Studies*, (6), 5–14.