Language, Complexity, and Design

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Abstract: The phenomenon of language represents a notable counter-example to the materialist claim that there are no non-material realities. Language involves the assignment of meaning to arbitrary symbols to form a vocabulary and the application of a set of rules to join elements from the vocabulary together to generate more complex meaning structures. Although such structures are normally associated with a material medium, the meaning they convey is independent of the medium. Language is not an incidental aspect of our world. Not only is it a fundamental aspect of our conscious experience as humans and central to our social interactions with others, it also plays a significant role in the ways the material world is structured around us. Microprocessors, with language-based programming, for example, make possible increasingly complex communication, transportation, manufacturing, and commercial networks. At a much higher level of complexity, biological systems rely on language-based specification and control. As mathematical expressions are linguistic, so are the laws of chemistry and physics. This implies that the material realm itself has linguistic underpinnings. Because language is non-material and matter itself displays no apparent language generating capability, how language arises is obviously an important question. That human beings possess language capacity points to an answer.

1. Introduction

Language is such a spontaneous aspect of human experience that we rarely pause to consider its fundamental nature or how its fits with the rest of reality. In academic circles, although most might be aware that language theory is a scholarly subject treated in linguistics and philosophy departments, generally speaking, the issue of the fundamental nature of language is not a topic that garners much attention. Yet the phenomenon of language plays a profoundly important role in our world. Just what is language? Language involves the assignment of meaning to arbitrary symbols to form a vocabulary and the application of a set of rules to join elements from the vocabulary together to generate more complex meaning structures. Hence language deals with a non-material stuff called ‘meaning.’ Although language structures are normally associated with some sort of material medium, the meaning these structures convey is independent of the medium. Language thus is a non-material phenomenon and represents a notable counter-example to the materialist claim that there are no non-material realities.

Language ability is at the heart of what it means to be human. Language allows us as human beings to create incredibly complex social interrelationships. Language enables human institutions of government, industry, commerce, education, science, to name but a few. Electronic communication, including the Internet, is facilitating human linguistic interchange at astonishing new levels, transforming the manner in which we conduct our business, obtain our news, manage our finances, and add to our common understanding of our world. When we consider the number of books published each year, the number of professional journals and other periodicals produced on a regular basis, the amount of mail processed each day, not to mention all the telephone and email communication, the radio and television programming, and other types of electronic transmissions of linguistic data, it is clear that language is not an incidental aspect of our world but instead represents a prominent category of reality in which we all actively participate.

Not only are there thousands of relatively distinct natural human languages, but we have also devised languages for our machines. Computer software represents language within the scope of the definition just given, namely, the assignment of meaning to a set of arbitrary symbols to form a vocabulary and a specification of a set of rules by which elements of the vocabulary may be joined together to form more complex meaning structures. Such software enables machines to specify, monitor, and control highly complex manufacturing processes, communications networks, power grids, and transportation systems. In these applications we observe an amazing interplay between linguistic specifications and physical, material phenomena. Apart from software that microprocessors utilize to monitor and control, and in most cases, even design, humanly engineered systems of the current complexity simply are not imaginable. In the biological realm we observe a similar connection between linguistic information and the specification and control of a diverse array of processes, except the level of complexity is dramatically greater. In biological systems the structural specification is at the level of the individual atom — approaching the ultimate in nanotechnology. In both cases, we witness the intertwining of linguistic specifications and physical, material processes.

2. Language — Non-Material in Its Essence

For many people it is intuitively obvious that language, which has to do with conveyance of meaning, is ultimately a non-material phenomenon. But because of the strong influence of materialist philosophy for the past two centuries in the Western world, some today are uneasy with the notion that there might be entities which are indeed real but at the same time also non-material. Notably, Albert Einstein recognized the fundamental difference between the realm of matter and the realm of abstract entities. In this context he states, “We have the habit of combining certain concepts and conceptual relations so definitely with certain sense experiences that we do not become conscious of the gulf — logically unbridgeable — which separates the world of sensory experiences from the world of concepts and propositions” (Einstein, 1944). The world of sensory experiences to which Einstein refers is the material realm, and the world of concepts and propositions includes the realm of language. Linguists, giving due credit to Einstein for this observation, refer to the ‘logically unbridgeable’ separation of these two realms as the ‘Einstein gulf’ (Oller, 1989, Oller et al., 2006). Einstein correctly recognized that the ‘world of concepts and propositions’, which includes the laws of physics, belongs to a category of reality distinct from that of matter, despite the fact that we so commonly associate the two. Let us explore this issue a bit further.

A person who struggles with the proposition that there could be something real that is not at the same time material can correctly point out that wherever we observe an expression of language, it is associated with a material carrier. Human speech, for example, is normally generated by the human voice box as acoustic oscillations in air. If a microphone is present, the acoustic oscillations can be converted into electrical signals and relayed and/or recorded in a variety of ways, and in every case, a material medium is involved. But the crucial question here is whether or not the linguistic content of the message depends in any way on the material carrier. To be sure, the message can be degraded or even lost altogether as a result of defects and interruptions in the medium. However, to the extent that the medium is able to record/transmit the message reliably, the meaning the message conveys does not depend on the medium. If handled reliably, the message remains the same whether it is carried by acoustic waves through the air, transmitted electronically, faxed, emailed, encrypted, sent through the mail on a CD, or relayed via smoke signals. The meaning remains unaltered whether it is recorded with paper and ink, on a magnetic disk, on a plastic CD, or chiseled on a rock. The meaning remains unaltered if the message is switched from one medium to another, so long as the conversion is performed reliably. A linguistic message therefore possesses an identity and a reality that is independent of its carrier. The essence of a linguistic message is the meaning it conveys. Indeed, meaning, which encompasses the ‘world of concepts and propositions’, referred to by Einstein, is a reality distinct from matter, separated from it by a ‘logically unbridgeable’ gulf.

But just what is this stuff that language encodes which we are here calling ‘meaning’? The ancient Greeks seemed to have had a partial grasp of this issue. A notable feature of classical Greek philosophy, primarily due to Plato, was a realm of ideal entities. As to location, this realm existed outside and independent of the human mind but could be apprehended by the mind. An example of an entity from this realm of ideals is the circle. We can grasp with our minds the concept of a perfect circle. Yet even the best circle we might attempt to construct, if inspected closely enough, will be found to deviate from this ideal. Plato argued that most, if not all, features of our changing physical world have unchanging ideal counterparts in this realm of forms (Plato, 360 BC). This latter realm includes not only geometric entities such as points, lines and circles, not only concrete entities like squirrels and ships, but also more abstract entities like justice and beauty and love.

Plato’s notion of semantic abstractions, generalized to the proposition that meaning of every sort — not merely of what might be considered ideal —belongs to an extra-material realm of abstract entities is today taken very seriously among many linguists and philosophers of language (Oller et al., 2000). Advocates of ‘entity theories’ understand meanings to be individual ‘things’ or entities that are language-independent. Some understand these entities to be mental entities, which is to say that meanings of linguistic expressions are ultimately ideas in the human mind. An early advocate of this view was John Locke (Locke, 1490). Such theories of meaning are known as ideational theories. Others, however, understand meanings of linguistic expressions to correspond to abstract propositions that are not only language-independent but also have existence independent of the human mind. These theories are known as propositional theories. Bertrand Russell in 1919 argued in favor of this way of understanding (Russell, 1956). More recently, among the many philosophers who today defend this view, William Lycan, comments:

> “Like ideas, these abstract items [propositions] are “language-independent” in that they are not tied to any particular natural language. But unlike ideas, they are also people-independent. Mental entities depend upon the minds in which they inhere; a mental state has to be somebody’s mental state, a state of some particular person’s mind at a particular time. Propositions are entirely general and, if you like, eternal [by which he means, time independent]” (Lycan, 2000).

Other philosophers have sought other understandings of the ultimate nature of the content of linguistic expressions. Most restrict their scope to human language and emphasize human sociology and human psychology. One class of such theories is known as “use” theories. An example is the view set forth by Ludwig Wittgenstein who argued that words and sentences are like game tokens employed by individual human beings to make moves in the context of the rule-based society in which they find themselves (Wittgenstein, 1953). According to this theory, ‘meaning’ is not an abstract entity. Rather, meaning corresponds to the ‘use’ the expression has in a certain range of social contexts. Such theories obviously are inadequate outside the scope of natural human language, so for our purposes we mention them only in passing.

It is fitting in this context to consider computer languages that rely heavily on logical statements such as equality and inequality (i.e., greater than or less than or equal to), if-then conditions, arithmetic prescriptions, and assignment specifications. The propositional theory of meaning describes elegantly how these languages operate. The proposition of equality, for example, is precisely defined, and it retains this precise meaning as the software executes within the circuitry of the computer processor. Although logical equality as an idea is readily grasped by the human mind, it certainly appears to be a proposition that has reality and retains its force and content beyond the human mind in the inanimate world.

In concluding this section, the notion that the “world of concepts and propositions” is separate from the realm of matter, as Einstein proposed, seems to be testable and reasonably easy to establish as correct. While this “world of concepts and propositions” is distinct from that of matter, it nevertheless is capable of exerting powerful organizing influences on the material realm. This is especially evident as we consider just how it is that humans, especially in the past two centuries, have become so effective in altering their physical surroundings. Toward that end let us now consider the connection between language and complexity.

3. Language and Complexity

To most people, the meaning conveyed by the term complexity is more qualitative and relative than quantitative and absolute. One of the main reasons is that, generally speaking, complexity is difficult to quantify. Most people would readily judge a bicycle with brakes and gears and drive chain to have greater complexity than a child's tricycle. Similarly they would judge a motorcycle with an internal combustion engine and perhaps a transmission to have greater complexity than a bicycle. However, most people, including most scientists, have no criteria from which to derive quantitative values for the complexity of a physical object or system. If we seek to assess humanly engineered systems such as computers and automobiles and aircraft in regard to their complexity, we would observe that they commonly have large numbers of different components organized to perform a diversity of functions. But even if we might have available all the design drawings and other specifications for manufacturing each of the component parts and all the specifications for assembling the system, it would still be a daunting task to find a rigorous means by which to quantify the system's overall complexity.

Nevertheless, a theoretical measure of complexity does exist, a measure known as algorithmic or Kolmogorov complexity (Li and Vitanyi, 1997). In simple terms it corresponds to the minimum number of yes-no questions required to characterize a process or structure or system. Since the answer to a yes-no question can be represented by one binary bit, the Kolmogorov complexity is equal to the number of bits in the minimum length bit string needed to characterize the process or structure or system. This measure of complexity is useful, not so much in quantifying the complexities of actual systems, but rather in gaining further insight into the nature of complexity itself. It also provides a means for connecting linguistic specification with the structure of material systems, since a sequence of questions with their answers is a linguistic entity.

The interpretation of Kolmogorov complexity as the minimum number of yes-no questions needed to describe a structure highlights the fact that there is direct correspondence between structure in the material realm and language. Language, in this case as a set of yes-no questions and their answers, can fully characterize a material structure in all its complex details in a given context. Conversely, the linguistic description provides a set of specifications adequate for realizing the material structure in that same context. In other words, the features of a material structure can be translated into language and vice versa. Of course, the minimum length of the linguistic description is generally never achieved. That is not the issue here. The point is a simple, even obvious, one, namely, that language has the power to characterize structure in the material realm and, in the other direction, that linguistic expressions indeed can and do specify material structures.

As an illustration, using computer aided design (CAD) software I can design my dream house to a very high level of detail. Any additional details I can also specify linguistically. All these specifications I can record in electronic form on, say, a DVD. Potentially, after purchasing a suitable parcel of land and making appropriate financial arrangements, I could give this DVD to a contractor, leave for my five-month vacation in the Mediterranean, and return to find the house of my dreams, to an incredible degree of fidelity to what I had specified (assuming my contractor was competent and trustworthy) fully realized as part of this material world. The specifications consisted of nothing beyond marks melted into the surface of the plastic DVD encoding non-material linguistic data. But that linguistic data was adequate to specify the details of my house, including the placement of all the electrical outlets and recessed lights, the routing of all the pipes and locations of all the plumbing fixtures, choices for floor coverings and countertops, and even the wood and finish to be used for the banister on the front right staircase to the second level.

Containing the realm of ideal entities advocated by Plato, the more general realm of descriptions that language is capable of conveying is much larger and richer. In fact there appears to be no limit to the variety and complexity and detail that such linguistic descriptions can capture. Like the Greek realm of ideals, the realm of linguistic meaning is non-material, and, as argued by many contemporary philosophers, must also be independent of the human mind and independent of time. Nevertheless, it is very real and plays a central role in what it means to be a human being. It is what our thoughts are made of and is the primary medium by which we relate to others. It enables us to create complex social and economic structures, it enables us to do science and understand how the material world operates, it enables us to build machines and perform amazing feats of engineering. It enables us to articulate the issues we are probing in this very article and empowers us to explore how the realm of linguistic descriptions intersects the realm of matter.

Although we have briefly considered the *sufficiency* of language to characterize complex structures, at this point let us address the *necessity* of language for the realization of complex systems. In this regard it is useful to note that Kolmogorov complexity, measured in bits, has a close connection with Shannon self-information, also usually expressed in bits. Shannon defined the self-information I of a message m by $I(m) = -log_2 p(m)$, where $p(m)$ is the probability of message m being chosen out of all possible choices in the message space M (Shannon, 1948). This means that if the message m carries an amount of self-information I bits, then the probability of that message in its context M is 2^{-I}. There is a close connection between Shannon information and Kolmogorov complexity (Gruenwald and Vitanyi, 2004), but reviewing this connection is beyond the scope of this article. Nevertheless, both Shannon self-information and Kolmogorov complexity can be interpreted as the length of a linguistic string. Since the Kolmogorov measure represents the minimum string length, to the extent that the contexts are similar, the probability which can be associated with the linguistic description implied by the Kolmogorov measure is similar to that implied by Shannon self-information of that same linguistic message. In other words, the probability in the context of similar linguistic descriptions of the linguistic description implied by a Kolmogorov complexity K is 2^{-K}.

The simple relationship between the amount of self-information in a string of linguistic symbols and the probability of the string in its context means that messages of several hundred bits in length can specify states that random searches in the material realm could never find. The reason is simple: there are not enough 'rolls of the die' available. For example, there is an upper bound on the number of atomic collisions that could have ever occurred during cosmological history. Suppose we let an atomic interaction with some other atom count as a 'roll of the die'. Let the reciprocal of the light transit time across the diameter of a free hydrogen atom serve as the frequency that each atom reacts with a neighbor. Let every atom in the cosmos react with other atoms at this rate for a period of time equal to the estimated age of the cosmos.

An atomic diameter for hydrogen of 10^{-10} m and a light speed of 3×10^8 m/s yield a maximum frequency of 3×10^{18} reactions atom^{-1} s^{-1}. To be generous, let us round this to 10^{20} reactions atom^{-1} s^{-1}. A generous estimate for the number of atoms in the observable universe is 10^{80}. Since we do not know the actual size of the universe, let us use 10^{100} as our estimate for the number of atoms, a number 10^{20} times larger. Let us assume 15×10^9 years, or 5×10^{17} s, for cosmological age. To be generous, let us round that number to 10^{20} s. Multiplying these numbers together, we get an upper bound of 10^{140} on the number of atomic collisions that could have ever occurred in cosmological history. Surely this represents an upper bound on the number of tries in any conceivable random search process. If we limit our search process to the matter near the surface of an earth-like planet, or even a single earth-like planet, the upper bound, of course, is reduced considerably. Yet a specific message with self-information of 1000 bits has a probability of $2^{-1000} = 10^{-301}$. In a lottery, chances are essentially nil that any material random search process would ever stumble upon a winning bit sequence of this length.

This lack of enough 'rolls of the die' has noteworthy implications in regard to the sort of complexity we observe in the biological world. Proteins with genuine biological function appear to be exceedingly rare within the sequence space of similar candidates. Hubert Yockey has estimated that for a candidate protein to have any significant biological function in the context of organisms on earth, half the amino acid sites, on average, must contain the correct amino acid (Yockey, 1978, 1992). Of course, several amino acids can substitute at some of the sites and the protein will continue to display biological function. At other sites, two or three substitutions are allowed for function to occur. But in most proteins there is a so-called conserved region, in which any substitution renders the protein non-functional. Yockey's research yields the rule of thumb that, on average, half the sites must be specified exactly for a protein to have biological function, while the other sites, on average, can accommodate any amino acid. While this implies that there are gigantic numbers of possible variants which display function, it also means that the *fraction* of viable possibilities is minuscule.

To illustrate, consider a protein with 400 sites. According to this rule of thumb, 200 sites must be specified exactly, while at the other sites any amino acid will do. This implies that, while there are $20^{200} = 10^{260}$ different configurations that indeed have the set of 200 crucial sites correctly specified, there are 20^{200} *times* this number that do not. Applying any sort of random search process to find even one functional configuration when the odds are 1 in $20^{200} = 10^{260}$ is hopeless. On the other hand, a relatively modest length linguistic string can specify all 400 sites perfectly. Using the coding that occurs in biological DNA, in which three nucleotide letters from a four-letter alphabet specify an amino acid, one requires a string only 1200 letters in length to specify the precise sequence.

Certainly, in the case of the most complex systems in the cosmos of which we are aware, namely, living organisms on our planet, linguistic specification appears to be essential. Simple organisms like bacteria have on the order of 1000 proteins, and more complex ones like mammals have on the order of a hundred times more. Linguistic coding in DNA specifies not only the very special protein sequences but also how these proteins are expressed in the diversity of processes involved in the organism's development, metabolism, self-repair, and reproduction. We observe that for complex systems produced by human engineering today, essentially all rely on both internal and external linguistic specification for their realization and function. Observation therefore leads us to conclude that the link between complexity and linguistic reality is more than incidental. Indeed, it is difficult to imagine how such systems could possibly be realized apart from prior linguistic description/specification.

4. Language — From Whence Does It Come?

Language, as we have seen, involves selecting and combining elements from a non-material realm of meaning entities. This is accomplished first by assigning specific meanings to a set of arbitrary symbols to form a vocabulary. The symbols possess no intrinsic meaning in themselves. The symbols are merely bearers of meaning. In the case of spoken human language, the symbol set consists of sounds produced by the human voice. Specific meanings are assigned to specific sounds. Among English speakers, the sound 'dog' has associated with it the meaning of a distinctive type of animal. But in other languages entirely different sounds such as 'perro', 'Hund', and 'chien' carry the same meaning. The sound itself is arbitrary; it is the meaning assigned to it that gives it significance. In addition to a vocabulary, languages also have rules by which elements from the vocabulary may be joined together. These rules allow for complexity of meaning far beyond what individual vocabulary words can convey. In fact, there is no limit to the complexity of meaning that is possible. Novels may weave together a hundred thousand words of human language to develop a single integrated story that no single word could possibly express. Computer programs combine hundreds of thousands of lines of code together to represent and explore the possible modes of dynamical behavior of a wide diversity of physical systems. So a pertinent issue is how such linguistic representations originate.

Let us begin by considering the properties of matter itself. We have already noted Einstein's observation that there is a logically unbridgeable gulf between the realm of matter and the realm of propositions and concepts, that is, language and meaning. But despite the fact that matter and language appear to belong to separate categories of reality, could matter, nevertheless, somehow possess an ability to generate language? As we survey the laws of chemistry and physics, including quantum mechanics, we simply find no clue that matter has any inherent tendency or ability to assign meaning to arbitrary symbols. None. The implication is that we must take Einstein's observation seriously and look for a non-material source for language. Indeed, most people do not consider this conclusion that surprising or profound. Most people appreciate the clear distinction between the realm of meaning and the realm of matter. They are not at all surprised by the inability of matter to assign meaning to arbitrary symbols and generate coherent sequences of such meaning-bearing symbols that obey a set of grammatical rules. Most people would naturally respond that it requires an intelligent being to generate linguistic messages. In fact, we humans do it with little effort, and do so at an early age, even in the absence of a great deal of coaching or encouragement from others (Chomsky, 1972).

Therefore in addressing the question of the origin of meaning-bearing language structures, the fact that humans generate linguistic expressions so readily points to an obvious place to focus our attention. Human language ability seems to be almost synonymous with intellect or intelligence or mind, or at least a crucial component of them (Oller et al., 2006). Yet just what the human mind is and how it relates to the neural activity are issues still shrouded in deep mystery. Techniques such as functional magnetic resonance imaging (fMRI) are indeed revealing that consistent patterns of neural activity in various regions of the brain are associated with various kinds of cognitive processes (Haynes and Rees, 2005). But the proposition that mental activity correlates with physiological phenomena in the brain does not represent anything new or surprising. Moreover, the correlations discovered thus far provide no essential new understanding of the ultimate nature of human mental activity. Even the direction of causality has not as yet been established.

Some have suggested that mind and consciousness represent 'emergent behavior', that is, these phenomena 'emerge' from the connections between neurons in the human brain. Experimental evidence to date in support of this proposal is scant. Hardware and software simulations of very large neural networks have not yielded encouraging results. Most people find it difficult to imagine how a network of electrical components could ever give rise to anything akin to human consciousness and self-awareness. Especially in light of the non-material nature of language, the possibility that humans possess a distinct non-material component wherein resides language ability, intellect, and consciousness should be considered and not dismissed. Language, as we have seen, is a powerful category of reality, and it demands an adequate cause. It is not implausible for a non-material effect (in this case, language) to require a non-material cause. If we take cues from our own human perception and interpret our language ability and consciousness as manifestations of a non-material aspect of our being, then we have such a cause, at least as a working model. Which view ultimately will prove to be correct is not obvious at this point, that is, whether mind and consciousness are expressions of matter (i.e., connections of neurons in the brain) or of a real but non-material aspect of the human makeup.

The linguistic specifications that underlie all biological systems, from viruses to humans, certainly demand an adequate cause. The reality that DNA carries linguistic messages — with an alphabet, words, and grammar — represents the 'elephant in the living room' issue regarding the origin of linguistic structures. But recent investigations show the complexity of these linguistic structures to be beyond anything imagined just a few years before. In June 2007 the ENCODE (for ENCyclopedia Of DNA Elements) consortium, organized by the National Human Genome Research Institute (NHGRI) under the U. S. National Institutes of Health (NIH), reported results of its exhaustive, four-year pilot project to build a parts-list of all biologically functional elements in 1 percent of the human genome (ENCODE Project Consortium, 2007). The primary strategy for accomplishing this was to investigate the manner in which the DNA is transcribed to functional segments of RNA, similar to the copying paragraphs or articles from an encyclopedia. The results of this pilot effort are astonishing. They include the discovery that as much as 93% of *both* complementary strands of the DNA helix is transcribed into functional RNA. Moreover, many of these RNA transcripts overlap one another on a given segment of DNA. This implies, as this pilot report affirms, that in effect there is no 'junk' DNA and that the entire human genome has functionality. The fact that both DNA strands are transcribed into functional RNA messages, that a given segment of DNA can be part of multiple RNA messages, and that multiple splicings of multiple RNA messages seems to be common, means that the coding cannot be the product of random processes. This sort of multi-layered coded data compression scheme, even if the algorithms for doing it could be unraveled, would bring the world's most powerful computer to its knees to accomplish. The upshot of this work is that a much larger fraction of the genome than previously demonstrated is functional and that there appears to be a new, yet to be decoded, level of linguistic structure carried within the DNA nucleotide sequences.

Such incredible instantiations of non-material linguistic specification as we observe in the genomes of living organisms obviously demand a sufficient cause. Humans, as we have seen, display amazing linguistic facility. Not only do we have innate ability to acquire and utilize spoken language, but with some modest level of effort we can become proficient in written language. We can even develop computer languages and complex software programs to operate complex networks of machines. To account for the linguistic features of DNA, if we take our cue from our first-hand experience as human beings, it is but a small step to extrapolate from our own mental processes and facility with language to conceive of a being with similar attributes but with vastly greater intellectual capabilities. For many people this is an obvious extrapolation. Actually, there do not seem to be many alternatives.

5. Language and Design

Several have sought to find a means for identifying objects that are truly the result of what has been termed intelligent design (Dembski, 1998). In light of the foregoing discussion, it would seem that a simple and reliable indicator of intelligent design is the presence of linguistic specification associated with the object. For example, if it bears a serial number and has an instruction manual packaged with it, chances are high that the object is the result of intelligent design. If it relies on built-in coded software for its operation, it is almost certainly the product of intelligent design. Although reliable association with linguistic specification is not a necessary condition, it appears to be a sufficient one.

6. Language and Matter

What about matter itself? Does matter bear any evidence of linguistic specification? The rise of modern science is primarily a response to the discovery that the natural world behaves in ways that mathematics can successfully describe. What is today termed scientific understanding, to a large measure, corresponds to a conceptual and mathematical description of a physical process or phenomenon. These mathematical descriptions, as they are demonstrated to be reliable by repeated observation and application, become, of course, what we refer to as the laws of nature. Yet mathematical descriptions are linguistic entities. Mathematics involves the assignment of abstract meaning to an arbitrary set of symbols to form a vocabulary and the use of a set of rules to construct more complex meaning structures from the vocabulary elements. The laws of nature therefore correspond to a linguistic description of the character and behavior of the material world. This implies that matter, at a very fundamental level, has linguistic underpinnings.

7. Conclusions

Language plays a profound role in our world. It is central to our experience as humans. It enables us to create unimaginably complex machines and networks. It specifies biological systems to the level of the individual atom. Even matter itself, in the laws of chemistry and physics, appears to have linguistic underpinnings. Yet language, in that it encapsulates meaning, belongs to a realm separate from that matter and energy. Language nevertheless is real and exerts a powerful influence on the realm of material objects. The materialist axiom that matter/energy subsumes all that is real is therefore highly suspect. Almost all language that human beings normally experience is the product of the human mind. Yet whether human mental activity represents an 'emergent' property of interconnected neurons or is an expression of a non-material component of the human makeup at this point is not simple to resolve. On the other hand, language structures in complexity on a scale beyond what humans can imagine underlie biological systems. Since language facility is almost synonymous with intellect, these biological language structures imply an intellect that makes human intellect insignificant by comparison. If one is inclined to accept the biblical account of history as reliable, then the being who revealed himself to Abraham and Moses, who also, according to the account, created the cosmos, the earth, and all the living things it contains, is the logical candidate for the originator of the laws of nature as well as the biological genomes. According to the account, in making humans in his own image, he bestowed on them consciousness/mind/emotions/will, including language ability, similar in kind to his own. The observations we have considered here are in harmony with these claims.

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