Theism and the logic of evolution

Abstract

I present an evolutionary view of theism based on a relational bundle-of-interactions ontology relying on ideas drawn from existing theories of memetics and on the notion of the generalized auto-catalytic cycle. I argue that theism consists of a constellation of ideas which are adapted to well defined niches in the virtual ecosystem of human thought. Among these niches Aristotle's primum movens argument remains the most powerful. This is the consequence of the cultural and philosophical dominance enjoyed by the deductive method in the Western tradition since Euclid's Elements. I propose an alternate model of biological, cultural and scientific evolution relying on the notion of generalized auto-catalytic cycle. This approach eliminates the primum movens niche that theist memeplexes have long exploited, instead exhibiting interesting affinities to the Buddhist doctrines of inter-dependent co-origination (Pratītya-samutpāda) and emptiness (Śūnyāta).

The growing power and authority of science over the last century has made the widespread theist faiths seem intellectually outdated and obsolete. However, this is only true if one takes the view that each tradition is what the respective theologians say it is. From a more detached point of view, theism fills important niches in the virtual ecosystem of human thought. As human thought has evolved, the niches have evolved, and so theisms have evolved.

Such an objective and rational approach to understanding the role and evolution of theist beliefs has been undertaken most recently by Dennett [1]. He relies on a view of evolution, both biological and cultural, which owes much to the ideas of Dawkins [2], most notably his memetic approach to cultural evolution. In this essay I challenge some of the most basic assumptions underlying the memetic approach, in order to propose an alternate view of both biological and cultural evolution. I should stress immediately that even though this work is nominally concerned with a study of theism, the ideas presented here aim for a far broader relevance, as will become clear in the following sections. This work presents not simply an argument, but a *framework* for a new, and *truly general philosophy of evolution.*

Email address: alexcabuz@gmail.com.

My general approach is a thoroughly relational one. Though it has many features of Humean skepticism, I hope my arguments will show that it is a far more positive and constructive approach than previously thought. In the first section I lay down the main elements of the relational constructive approach I advocate. In the second section I propose a conception of memetic evolution which is in some ways radically different from existing theory [2,3]. In the third section I further develop and generalize my theory of memetic evolution by discussing the idea of internally consistent and coherent loops, or cycles, of mental and physical objects. In the fourth section I discuss the special status of science and mathematics. In the fifth and final section I discuss the impact of the above ideas with respect to theism, before concluding.

1 The bundle-of-interactions ontology

This essay takes an interaction centered view of the world. In this view, the world is not composed of objects (i.e. substance) but of interactions. All objects are nothing more than conveniently bundled collections of interactions. Substance is the macroscopic illusion created by the multitude of microscopic interactions. Suppose we have a hydrogen atom in some state (specified by the principal, orbital, magnetic and spin quantum numbers). The only way to distinguish it from other hydrogen atoms is to look at the quantum numbers, which are just ways of specifying the relationship between the proton and the electron. Since outside of these quantum numbers atoms are strictly indistinguishable (the numbers constitute a *complete* description), the identity or *state* of the atom resides in the interactions among its components. I also refer to this relational view as constructive [1] because objects are seen as constructed out of interactions, and also in order to emphasize the philosophical core of this approach: skepticism is not a negative doctrine, but on the contrary, a most constructive one, via relationalism, as illustrated below.

However, this view runs into two obvious problems. First, it seems to lead to an infinite regress, since all objects are claimed to be bundles of interaction between presumably smaller objects, and so forth, ad infinitum. Second, elementary particles such as the electron do not seem to be composed of anything, and all the evidence seems to suggest that they are truly elementary. However these problems only appear due to a lack of a relational theory of interaction in the first case and of Planck scale space-time on the other. Much ongoing effort is currently under way in the physics of information (interaction as flow of information [4,5,6]), and in the physics of space-time (quantum gravity [7,8]), which are trying to address these problems. In particular, extremely promising from the point of view of our current approach are the results of

[1] Not to be confused with *constructivist*.

R. Frieden [6] who has succeeded in reformulating a large part of the laws of physics in terms of information exchange, taking an intrinsically interaction centered approach. A relational approach to quantum gravity has also been advocated consistently by L. Smolin and coworkers [9,7]. But these are questions of science, in this case physics, and may not be settled by any amount of philosophical speculation. In this essay I attempt to provide several elements of a general philosophical framework on which a truly relational science may be constructed. The framework I propose does not aim to be scientific itself, but it might hopefully serve as a guide for the intuition of scientists .

There are two main types of bundles-of-interactions (objects): physical and mental. Examples of physical objects are hydrogen atoms or apples, while mental objects consist of neuron firing patterns in the brain corresponding to the conscious notions of hydrogen atoms or apples. The two types of objects are not different in any fundamental way, but only through the limitations encountered by us, human beings, in manipulating them. Vehiculating and controlling physical objects involves physical dexterity, while vehiculating and controlling mental objects involves mental dexterity.

The conscious effect of perceiving *objects* (rather than a confused jumble of sensory information) is obtained as a result of two different forces. First, the brain conveniently bundles together perceptions that appear in tandem, in order to save resources. Second, certain features of the world naturally lend themselves to being grouped together because they co-evolve and are therefore inter-dependent. We explain each in turn.

Convenience. The brain is an organ whose raison d'être is to enable and facilitate the survival and reproduction of its carrier, the human being. Its operation is subject to constraints and limitations, and in order to improve efficiency, the brain bundles certain impressions and sensations together in order to simplify our interaction with our environment. This is known as our tendency to label and group things in categories. For instance when we label an object as a chair, we focus on that feature of the visual perception of that object which enables us to label it as a chair (i.e. its shape), and we discard all other information coming from all the other senses. Mental objects are consequently the results of a process whereby information collected by the senses is selectively discarded. Broadly speaking this is a good survival strategy because most information is unimportant, has no impact on behavior, and would otherwise be an unnecessary burden on the processing capacity of the brain. [2]

Co-evolution. But the way the brain forms its categories is not arbitrary. There is a fundamental reason why it is useful to group together certain ob-

[2] An extensive scientific bibliography is available in Ref. [10].

jects. We do this with objects that co-evolve and are therefore inter-dependent. For instance, it is useful to group together all substances forming part of any given metabolism, for example the metabolism of a rabbit. Rabbit legs, rabbit fur, rabbit ears and rabbit teeth often go together because each of these components plays a crucial role in the propagation and reproduction of the others. Consequently it is reasonable and often the case that we place rabbit ears and legs in the same category, the rabbit category, applying the rabbit label to them. The brain has adapted to group objects that belong together due to being *inter-dependent*. In the following sections I will generally refer to such a co-evolving set of objects variously as an *autocatalytic cycle*, or in the case of mental objects as an *internally consistent cycle*. The underlying evolutionary mechanism is the same.

The detailed implementation of these ideas falls once again not within the domain of philosophy but of science, i.e. neuroscience and the cognitive psychology of categorization. Meanwhile, my main concern in this essay is with the evolution of mental objects (of which theism is an example). But before going any further, let me linger a little more on the subject of mental dexterity.

It is clear that human beings are unique in their mastery of the art of the manipulation of mental objects. They do this through two innate and complementary talents: abstraction and imagination. I explain by the straightforward analogy to physical manipulation of physical objects. The ability to make complex tools and other objects relies on two talents. That of taking things apart and that of putting things together. Take, for instance, the primitive bronze ax head. First the ore must be taken apart, to separate the copper and the tin from the dirt. Second the small pieces of copper and tin must be put together, to form the ax head alloy. To simplify even more, the two operations involved are that of separating (the dirt from the metals) and that of combining (the two metals to form the alloy).

These correspond exactly to the steps involved in the manipulation of mental objects. The raw material of mental manipulation is perception. Perception is stripped of useless details to produce primitive mental objects, for instance those corresponding to stones, trees, or other people. This can be seen as innate abstraction. Then more advanced mental objects are obtained through conscious abstraction and imagination. For instance, the abstract idea of *the color red* is obtained by considering any red object and removing (or separating) all features other than its color. Imagination involves combining existing ideas to obtain new ones, for example, the idea of *pig* and that of *wings*, to give the idea of *flying pigs*. Abstraction and imagination are the elementary skills required for the manipulation of mental objects. The close analogy between these skills and the corresponding physical skills is of course not accidental, but is an adaptation. The physical and mental abilities of separating (abstraction) and combining (imagination) have clearly evolved together.

Our discussion has overlooked an important element, up to this point: time. As time passes, both physical objects and mental objects, as well as human beings themselves and their brains, evolve. Some manage to get themselves (that is, the pattern of interactions which define their object type) re-produced, and some do not. We observe the objects that we observe (physical or mental) because they were produced in some way. I argue there is no fundamental difference between an object that reproduces "naturally" [3] or that is produced by man or by any other agent or process. We now come against a problem of terminology. The term "reproduction" has been monopolized by the life sciences and they have defined it as best suits ***their*** purposes. However, many things that re-produce in my conception, do not reproduce in the the accepted biological conception. I would therefore like to introduce a new, more general, term: *reciproduction*, that describes more accurately what I mean, and is free of the historical and scientific baggage that surrounds the word "reproduction". I illustrate with two examples.

The first example is the cycle composed of humans and their houses. A house increases the humans' chances of survival and reproduction, while the humans build houses wherever they go. Both may be said to reciproduce, because they both contribute to bringing about the conditions for their own, and each other's, production. Moreover house reciproduction exhibits heredity, mutation and adaptation to environmental constraints. The fact that humans existed prior to houses is not an argument that houses have no independent existence. Fruit trees existed prior to the monkeys which help spread their seed yet nobody denies monkeys' independent status as reproducing entities, even when *totally* dependent upon the trees.

The second example is star formation. L. Smolin [4] describes the intricate interplay of gas and dust clouds, gravity, massive stars and supernovas, and the nuclear chemistry required to generate the star's energy and enabling the return of unused matter to the surrounding gas clouds, where the cycle can start over. The account shows how all of these elements combine in such a way that each contributes to *sustaining* the others, in a symbiotic cycle. Thus stars are formed and go through their "lives" while helping bring about and maintain the factors which led to their own formation. They may be said to reciproduce. Moreover exactly the same can be said of any other of the participants in the star formation cycle (gas, dust, supernovas, etc). Stars are only special anthropocentrically.

In the following sections I pursue this general conception of reproduction, but focusing on mental objects. The connection with physical objects is discussed in Section 4.

[3] i.e. is alive

[4] An accessible account is available in Chapters 8 and 9 of Ref. [9].

2 A theory of evolution of ideas – competition

The view of mental objects as evolving, reproducing entities subject to competition is not new, it was put forward for the first time by Richard Dawkins, in Chapter 11 of his 1976 book, *The Selfish Gene* [2]. It is in the same chapter that he coins the term "meme" to describe what he considers as the unit of cultural evolution, by analogy to the gene which is, according to him, the unit of biological evolution.

The most detailed, thoughtful and coherent account of memetics in the literature is probably S. Blackmore's *The Meme Machine* [3], in which the theory of the meme is given its "best shot" according to R. Dawkins himself.

The differences between what I call a mental object and what Dawkins and Blackmore call a meme would be sufficient to warrant a different terminology, but the already widespread use and the convenience of the term "meme" compel me to retain it. I discuss the most important differences below.

According to Blackmore memes are units of cultural evolution whose essential property is the ability to replicate themselves. They are selfish replicators. What enables them to replicate is the human ability to imitate. The human imitation instinct creates an opening for an opportunistic replicator such as the meme. Thus memes are communicated from brain to brain, and they multiply. Sometimes there are errors in communication and memes thereby evolve, adapt, compete for room in the finite brain-space available, and, importantly, co-evolve with the genes that they share their hosts with. She argues that memes may even have played a role in the runaway evolution of the human brain, once the capacity to imitate crossed a certain threshold [5].

However, S. Blackmore's formulation of memetics suffers from several ambiguities and gaps which can be traced back to two of R. Dawkins' ideas about genes and memes: the emphasis on the *gene/meme* as the fundamental unit of biological/cultural evolution, and the emphasis on *imitation* as the fundamental enabler of the meme revolution. I critique each of these ideas in turn.

Following R. Dawkins, S. Blackmore as well as D. Dennett [13] see genes as special, and fundamentally different from the other chemical compounds making up the human metabolism. In a similar way, memes are seen as the units of cultural evolution, and fundamentally different from all the other artifacts which are simply carriers. However, S. Blackmore does not make clear whether a soup recipe in one's head, written on paper, and the soup itself and

[5] Runaway effects in the theory of evolution are well known and documented, starting with the groundbreaking theoretical work of R.A. Fisher in the late 1920's [11,12].

its taste and smell should all qualify as memes or not. Dennett, meanwhile, takes Dawkins' view [14] that all things outside the mind are simply carriers of memes, just as a human body is a carrier of genes.

I take the completely different view that there is nothing fundamentally different about genes, from the rest of the compounds making up the metabolism. They are different only insofar as they allow us human beings to understand the development of the organism. At best, genes may be seen as an ***information bottleneck*** in the auto-catalytic cycle which is the metabolism, making them *convenient starting points* for a scientist trying to understand the organism. But from a fundamental point of view, they are no different from any other of the thousands of organic compounds which make up the metabolism. *They all reciproduce*. Each of these compounds contribute to the survival, replication, and therefore, biological success of the rest, in the same way that rabbit ears and rabbit legs contribute to the survival, replication and biological success of each other. Saying that an organism is simply a carrier of genes is like saying a rabbit is a carrier of rabbit legs. While not false, that statement is clearly misleading. *Genes are not special*, *nor are memes*.

The second idea present in Dawkins' original proposal of memes as units of cultural evolution, is the emphasis on imitation as the main enabler. However, this leaves a gap in the argument, as it only explains the *propagation* of memes, but says nothing about their origin. Memes seem to simply pop into existence in a given mind, and then proceed to propagate and multiply through imitation. Memes are seen to evolve through blind, random mutations, due to errors in imitation, a profoundly unsatisfactory account of meme evolution if one considers that the purpose most often precedes the idea (the meme). People actively construct ideas in order to achieve specific goals. Evolution through random mutation and imitation however implies, unreasonably, that new memes just appear at random, and then find uses later. Moreover, this imitation centered view sees memes as fundamentally competitive entities, and gives no insight into memetic cooperation, for instance, in the formation of memeplexes (symbiotic groups of memes). R. Dawkins and S. Blackmore speak of memeplexes but say nothing about their origin.

These shortcomings can be addressed by adding abstraction and imagination to the mental toolset required for memetic evolution [6]. People actively come up with ideas in order to achieve their particular goals. They do this by taking apart and/or putting together old ideas, in other words, through abstraction and imagination. The construction of the primitive mental objects required to bootstrap the process is done instinctively. These primitive objects correspond to immediate physical objects and people as well as some basic sensations and emotions. In addition, by adding these two skills humans are no longer inert

[6] See Sec. 1 above.

hosts, subject to the blind forces of memetic and genetic selection. They can choose to submit to or resist memetic "infection" mainly through *faith* and *doubt* respectively [7].

Among the benefits of this refinement of memetic theory is that it opens the way to a discussion of the cooperation between mental objects leading to memeplex formation. In the next section I discuss a possible mechanism for the formation of memeplexes.

3 Auto-catalytic cycles and memetic cooperation

In the above section I used the term auto-catalytic cycle to refer to a metabolism without any explanation. In this section I would like to give a more detailed description, and in particular generalize it to apply not only to chemical interactions, but to any type of interactions at all, be they physical, mental or any combination thereof.

The importance of the auto-catalytic cycle as a model of complex evolving systems was pointed out for the first time by Stuart A. Kauffman in the 1960's [15]. [8]

The idea originated in Kauffman's attempt to construct a model of pre-biotic evolution. The main question concerns how the first cells evolved from the primitive "soup" of the primeval oceans and atmosphere. The argument starts by pointing out that the classic explanation of natural selection of random mutations cannot explain the appearance of the first cells. The simplest free-living (non-parasitic) organism known, pleuromona, has a genome of several hundred genes, and contains all the main ingredients of cellular metabolism which we see in the most modern of cells. Given that there is no simpler organism than pleuromona and that its direct assembly by random chance is practically impossible, there must be a mechanism of self-organization independent of natural selection, which must have been responsible for the appearance of the first cells. Otherwise we would expect to see a whole spectrum of increasingly simple organisms, with metabolisms down to several tens of genes, or less. Life seems to have started with a discontinuity, that is, exactly the kind of situation which natural selection, which is emphatically gradual, cannot explain.

Kauffman proposes a spontaneous non-selective mechanism through which complex organic compounds may cooperate to reproduce each other. In a

[7] See Sec. 5 for further discussion.
[8] See also Refs. [16] and [17] for recent reviews.

primeval soup containing increasingly large numbers of chemical compounds (chains of amino-acids and other organic polymers), the number of possible reactions increases combinatorially with the number of compounds. In addition, there is a non-zero probability that any of the extremely large number of possible reactions may be catalyzed by one of the existing compounds. Consequently, as the number of different molecules increases there comes a point where chains of reactions emerge in which substances react in ways that produce the catalysts needed for their own production. Such chains of reactions are known as auto-catalytic cycles. Such cycles are the ancestors of modern metabolisms.

Computer simulations [16] have confirmed that for virtual "soups" composed of polymers of fixed length, the number of available polymers increases exponentially with the length, but the number of reactions among them increases even faster. Even with very small probabilities that any given reaction may be catalyzed by any given polymer, auto-catalytic cycles emerge naturally once the length of the polymers in the simulation crosses a certain threshold. The phenomenon is an instance of what in statistical physics and complex systems research is known as a phase transition. Phase transitions are notorious for their spontaneous self-organized collective behavior. This argument sets the stage for ulterior selection and competition among auto-catalytic cycles.

The view I advocate here is that the notion of spontaneously occurring auto-catalytic cycles, that is, of groups of molecules that interact chemically in such a way as to facilitate their own production, may be generalized to understand groups of any kind of object, physical or mental, which interact in ways that lead to their own production. Memeplexes are such groups of objects.

In particular, I will argue that memes reciproduce and propagate as parts of auto-catalytic cycles containing other memes (mental objects) but also physical objects. Once again, I emphasize the view that memes are not special, they are just participants in auto-catalytic cycles leading to their own, and also other objects', reproduction. The example of the soup recipe used by Susan Blackmore now becomes easily understood. There is an autocatalytic cycle composed of a ***symbiotic series of mental and physical objects***: the name of the soup, the recipe of the soup as memorized by a given person, the sound of the words of the name and recipe of the soup in some language, the recipe as written down in some language, the soup itself, its smell and taste. The soup appears in the mind or cooking pot of some person, they experience the smell and taste, they communicate the name and recipe to their friend, either verbally, through email, or through writing, the friend listens or reads, understands the words and then they have it in their mind as well. The cycle then repeats. Soups then compete for room in minds, pots, tongues and noses, some ingredients being more or less easy to find, more or less expensive, more or less healthy in the given local climate and culinary tradition, the smell and

taste being preferred or not to other soups by different people.

The mental object of the soup recipe, the physical objects of the written recipe and the soup itself, the mental objects of the sensations of smell and taste, these are all members of an auto-catalytic cycle. Each object contributes to the reproduction of the other objects; they may be said to reciproduce.

Other, perhaps more interesting examples of memetic cooperation include the cycle composed of the sensation of hunger and thirst and the discomfort they cause, the feeling of helplessness in times of severe drought and the discomfort it causes, the ritual prayer and ritual sacrifice to the rain god, and the feeling of hope and the comforting sensation it causes. This is a cycle containing the mental object known as animist polytheism.

Another example is the one including the human partly innate partly learned expectation and association of human effort leading to order, and inaction leading to chaos. A garden untended will run down. A child uncared for will become sick and die. A field unplowed will not produce. There is a deeply ingrained expectation for the world to be hostile and non-accommodating. This instinct of intrinsic distrust for the environment that surrounds us is a useful adaptation. Whenever something good, useful or beautiful appears without human intervention we are surprised. It goes against our biological programming, so to speak. We are naturally attracted to it, fascinated by it, which is another adaptation. However, it has one unintended consequence. We have a tendency to associate useful objects or occurrences with some kind of human intervention. When hungry due to severe drought, rain makes us feel thankful. Almost instinctively we think as if someone *brought* the rain. So we almost can't help but imagine/postulate a human-like being who must have brought the rain in order to soothe our discomfort with the counter-intuitive and unreasonable notion that something good or useful can come about all by itself. We therefore see that there is a cycle composed of our instinct for distrust of the environment (innate), the association of intervention with order and of inaction with chaos (learned), the perception of many good, useful, or self-ordered things, and the existence of an ordering agent or person. This is a cycle containing the mystical pantheism espoused (among others) by scientists such as Albert Einstein [18].

The various versions of theism participate in many other cycles, of which we will see more below in Section 5. Many of the niches to which theism has adapted over time are also reviewed by Dennett in Ref. [1].

4 Science and the logic of evolution

One of the most interesting arguments of Susan Blackmore's "The Meme Machine" is what she calls meme/gene co-evolution. She argues that memes and genes are both selfish replicators, and that they interact through cooperation and competition for the finite resources of their common carrier, human beings. Consequently, there are some memes that replicate in ways that fit harmoniously with the replication of the genes, or even facilitate the replication of the genes. Examples are the memes of fire, the wheel, or basic arithmetic. But these are by no means the only memes that replicate successfully. There are also memes that spread in spite of their deleterious effect on the replication of the genes. Examples are human sacrifice or clerical celibacy in certain religious traditions, or cigarette smoking.

Blackmore's account, however, lacks any mention of reason, logic and science. Her presentation implies that memes exist in a virtual world of their own, and compete for brain space, while human genes live in the real physical world, and compete for resources. While both have their own reproductive logic, the two worlds seem to be connected through only one feedback channel: human death and suffering. In other words, if a deleterious meme spreads to the point where it starts to cause either great suffering, or it impedes the reproduction of the genes of the humans that carry it, eventually, the loss of adherents will become sufficiently large that the spread of the meme will be slowed or reversed. Marxism is an example of a meme (or memeplex) whose spread was initially successful but was eventually checked by the death and suffering it caused. Blackmore also gives numerous examples of memes that spread by exploiting some weakness or other of human nature. However, there are memes which do not fit this scheme. Examples are the Lamarckian theory of evolution, the theory that the Earth is flat, or the belief that it is possible to square the circle with a straight edge and compass. These are memes that have been eliminated in spite of having no connection with gene reproduction at all, nor were they "squeezed out" by other more competitive and successful memes. They were eliminated ***scientifically***.

There is a set of memes which have exploited the very niche offered by the fact that much of meme selection is done via human suffering and death. This group of memes can be seen as the immune system humans have evolved to defend against deleterious memes. They short-circuit the death/suffering feedback mechanism through an empirical approach, that is, they form memeplexes that straddle the two worlds, the physical and the mental. These memeplexes consist of auto-catalytic cycles that are selected on the empirical criterion that they contain both mental and physical objects, that to each physical object must correspond a mental object and that the mental construction must be consistent with the physical world. The niche occupied by this set of

memes is known as science. The points of contact between the physical and mental parts of the cycles are known as experiments since they are objects that have both physical components (the physical objects under observation) and mental components (the data). Until the advent of empirical science the only objects containing both physical and mental components were human beings themselves.

The competitive advantage of these auto-catalytic cycles therefore consists not directly of the applications and technical progress they have led to, but of their allowing humans to avoid ineffective or self-destructive techniques, practices or habits. There is still much to be done, but there are many scenarios which today are almost unthinkable. Examples are the elimination of bloodletting and alcohol "anesthesia" from medical practice, and the replacement of galley rowing by steam and internal combustion engines.

It is common today to see science as having a tree-like structure, starting with the general laws at the root, and branching off to the various special cases and applications. However, in reality, a scientific theory does not "start" with the laws because there is continuous feedback between the special cases, the experiments, and the laws. In fact much of the knowledge formalized in laws existed previously. Just like I argued above for genes and memes, the laws of science are not fundamentally different from other scientific statements, but they are simply convenient formal starting points for our theories. They contain essential information about the theory in a compact form. In this sense, and similarly to genes and memes, they may be seen as convenient information bottlenecks in the autocatalytic cycles which facilitate their (and also ***our***) propagation and reciproduction. The rules of deduction, logic and mathematics (themselves auto-catalytic cycles adapted to perform this particular task) are designed in such a way as to transmit the information in the laws with high fidelity to many other statements, of practical interest. Laws may also be modified when information from experiment becomes available, or at the very least, our perception and understanding of them may change. An experiment consistent with the law increases our confidence, or augments the domain of applicability, while an experiment inconsistent with the law decreases it, reduces its domain of applicability, or suggests ways of improving it. Scientific laws are not eternal and unmoved, but are memes which mutate, evolve, and adapt. Thus the structure of scientific theories is not tree-like. The general laws being subject to feedback from the particular instances and experiments, the structure is more akin to a cycle. *Physical laws are not special.*

Scientific memes have another property, when compared to more pedestrian memes for certain immediate physical objects, for example. Many of the mental objects involved in scientific theories are completely unable to survive on their own, and are dependent on the rest of the cycle for their existence. In this way scientific theories are similar to an ant colony, or even to a multi-cellular

organism. A single ant, or a single cell cannot survive for long without the support of the rest of the colony or the organism. Likewise, scientific memes are highly "social" mental objects. They do not appear and propagate individually but only as part of very strictly organized memeplexes.

There is one science, however, which seems to evade the empirical requirement described above. Mathematics seems to contain self-consistent cycles which do not contain any physical objects. There are no experiments in mathematics and thus there is no point of contact between the mental and physical worlds.

Mathematics seems to consist entirely of mental objects. This observation has been at the source of much baffled philosophizing, especially with respect to the deep link that seems to exist between mathematics and physics. Physics would be inconceivable without mathematics. Memes arrived at through purely mathematical thinking seem to eerily find applications in the physical theater.

However, it is my view that nothing mysterious is afoot. This can be seen if I recall, from Section 1 that two of the most distinctive and evolutionarily revolutionary features of the human species are the abilities to take things apart and to put them together. These physical skills rely crucially on their sisters, the mental skills of *abstraction* and *imagination*. Moreover, these mental skills have evolved not independently of the physical world, but, to the contrary, as adaptations to it. In other words our powers of abstraction and imagination have been designed by evolution to function in ways *exactly* analogous and parallel to the way that physical objects are taken apart and are put together. The most fundamental features of the physical world are therefore also the most fundamental features of our mental world, for our mental world was "designed" by evolution, to enhance our chances of survival in interaction with the physical world around us.

It is therefore anything but surprising that there should be deep links between empirical science and mathematics. They may even be seen as mirror images of each other. While the first is concerned primarily with taking apart physical objects, the second is concerned with taking apart mental objects. Note also that attempts to formalize mathematics begin with set theory, which is concerned with the way in which collections of elements are put together ("ensemble" = set, in French) and are *taken apart*. Thus, it is only fitting that mathematics and empirical science be seen as *abstract* mental enterprises par excellence.

The non-privileged status of the starting points is even clearer in mathematics, where it is widely known that a formal system such as Euclidean geometry can be constructed starting from many other sets of axioms than the ones most commonly used. Euclid's axioms are simply more convenient starting points, and most easily grasped by the human mind. Formal deduction has

the property that no new information is added when truth is propagated from the axioms to the theorems. Thus, the whole system may also be in principle obtained from many sets of well chosen *theorems*, if taken as starting points. Moreover, mathematicians often proceed by first investigating different sets of axioms to see how far each one can take them. Then they select the one most convenient for some particular purpose [9]. Even formal systems compete and adapt through cyclical feedback, just like any other memeplexes. *Axioms are not special* and the logic of abstract deductive science is seen to be, against all odds, ***circular***.

In the beginning of Section 1 I have claimed to take an interaction centered view of the world. It is now clear that this view departs radically from the established western philosophy of the previous 23 centuries, in that it shifts the emphasis away from Truth and toward Consistency. Truth requires a single entity, and implies a static, substance centered ontology. Consistency is a notion that necessarily connects at least two entities, and implies a relational, dynamic ontology. Western thinking may finally be liberated from one of its greatest self-imposed obstacles: the rejection of circular arguments and circular thinking. Even though western thinkers have argued circularly for thousands of years, they have done so in spite of themselves. This has led to a philosophical schizophrenia on a remarkable scale. I hope that the ideas presented here, however summarily, may constitute a step, however small, toward a cure.

5 Theism and auto-catalytic cycles

Theism is arguably the most versatile and opportunistic of known memeplexes. Throughout history it has participated in many different auto-catalytic cycles. It has mutated, adapted and exploited a wide range of niches of human nature and society, leading to unmatched longevity.

Two of these I already mentioned, containing animist polytheism and mystical pantheism. Broadly speaking these exploit, respectively, humans' fear of what is beyond their control and their instinctive assumption of a hostile, chaotic environment, leading to surprise and fascination by spontaneously organized or useful phenomena. Festering cesspools do not generally elicit the same mystical fascination of animal migrations (spontaneous *organization* on a large scale), flowers (*useful* as a future source of food), or easily defended positions such as mountaintops allowing the *useful* surveillance and control of a large territory.

More recently in human evolution, theism has also exploited human tribalism, as well as the struggle against it. The advent of the empire (Persian, Mace-

[9] See Part II of Ref. [19], particularly p. 185-242.

donian, Roman) resulted in higher stakes, and much bitter tribal warfare and struggle for domination. Since the demarcations between groups or tribes often found convenient representation in the form of tribal deities (exclusive monotheism), these consequently became one of the driving motivations for aggression and/or resistance. Inclusive monotheism (i.e. Christianity) then spread due to its universality [10], that is, its ability to damp the hostility and violence by taking away one of its main drivers: the tribal god, as the principal symbol of tribal allegiance and loyalty.

The list of niches and exploited opportunities can continue and their dazzling diversity leads inevitably to the question of what is the feature to which theism owes its unique flexibility and adaptability. I suggest that the answer can be found through an analysis of a single crucial idea which can be found in all theist auto-catalytic cycles: *faith*. Its essential feature from a memetic perspective is that it is at once a meme, and a memetic vehicle, or a meta-meme. Faith is *any* meme's best friend; it does not discriminate. In the context of meme-gene co-evolution faith is the triumph of the meme. It is also aided considerably by a human nature well disposed toward the certainty and security that faith can bring. However, its greatest strength is also its greatest weakness because it exposes its human carrier to considerable risks. In this view empirical science is simply the defense system that humans have evolved against the deleterious effects and risks to which faith exposes them [22].

Science, however, has until now been only partly successful. The deductive approach which has dominated scientific practice ever since Euclid's Elements has left a large hole in the memetic defense mechanism that science is: Aristotle's primum movens argument. The logical loose-end allowed by the common scientific practice of proceeding by first postulating principles, laws or other hypotheses [23] is almost an invitation to faith based theistic memes. The deductive approach of science has been unwittingly providing one of the strongest pillars supporting modern monotheistic theologies because deduction begs the question: "Where did the laws/axioms come from?".

The auto-catalytic cycle based relational ontology described in the preceding sections constitutes a proposal for the closing of the primum movens loophole. I believe that this may be an important step toward a science that can fulfill its mission: being an effective defense against parasitic faith based memes.

[10] See Chap. 1 of Book 2 and also p. 324 of Ref. [20] and Chap. 10 of Ref. [21].

Conclusion

In the presentation of my ideas I have borrowed from the theory of mental objects known as memetics. I advocated some new and radical views such as the importance of reciproduction over reproduction, of cycles over deduction trees, of consistency over truth, and of interaction over substance. I have tried to provide a positive and constructive formulation of relationalism. I have stressed the fact that genes, memes, physical laws and axioms are exceptional merely through their convenience and usefulness for us, human beings, and that in all other ways they are subject to the same evolutionary selection forces as any other objects, physical or mental.

Memetics is presented by Susan Blackmore [11] as an aspiring scientific enterprise. By contrast, I believe that the ideas presented here suggest that evolution theory cannot be part of science as it is practiced today, but that quite the opposite may be true: that science may some day be reformulated in the language of evolution theory. I explain this view.

Evolutionary arguments first appeared as attempts to account for certain mysterious aspects of biology and ecology. To this day it is generally thought that their validity is confined to these scientific disciplines, and that therefore, it is just one scientific theory among many. However I would like to persuade the reader that in fact evolution theory and evolutionary logic is very much broader in scope than mere bio/eco-logical applications may seem to imply. Evolution theory stands apart from the rest of scientific theories by its fundamentally different logical structure, by its singularly explicit emphasis on time, change and interaction, and by its unmatched breadth of scope. This is why I am of the view that evolution theory must be placed prior to the rest of scientific theories and laws. Unlike them, and due to its unique tautological structure, it is not subject to falsification. *At the risk of seeming reckless, I see this as a virtue.*

The ideas presented here leave many interesting open questions, which would merit further attention.

For instance it would be interesting to understand the general mechanism by which the objects participating in auto-catalytic cycles (be they molecules, memes or scientific results) evolve to assume differentiated functions. Spontaneous differentiation is a phenomenon that has been under intense scrutiny recently in complex system science [12] .

Another promising direction is the more detailed exploration of a new logic

[11] in Ref. [3]

[12] For instance node connectivity in complex networks [24,25].

of evolution, based not on the notion of bottom up truth propagation as per deduction, but on the notion of *the constructive or destructive interference of truth values propagating in networks of ideas containing loops*. The promise of this theoretical development resides in its robustness to *circular definitions* and *circular explanations*, an extremely common occurrence, as anyone can confirm who has used a dictionary or attempted to explain the axioms of Euclidean geometry to an inquisitive eighth grader (points explained as intersections of lines, and lines as connecting points [13]).

My emphasis on cyclical interactions and on consistency takes away one of the most important and lasting niches of theism in Western tradition. However, these ideas exhibit an affinity and create a new niche for a different set of memes, those associated with philosophical Buddhism [27]. In particular, Kauffman's spontaneously emerging auto-catalytic cycles [16] bear strong resemblance to the doctrines of inter-dependent co-origination and emptiness, or Pratīt̄ya-samutpāda and Śūnyāta respectively in Sanskrit. These doctrines state that no objects have independent, enduring nature, existence or origination because they are in continuous interaction with the rest of the Universe. Moreover, each object is only an illusion, an ephemeral convergence of other objects. There is no dependence, but only inter-dependence. The recursive and circular nature of the ontology is evident, as also illustrated through metaphors such as Indra's Net.

There is obviously a strong resemblance between these Eastern philosophical ideas, and the relational approach to understanding evolution presented in this essay. An interesting direction for further research would therefore be to explore the theory of evolution as a possible starting point for a long overdue synthesis of the substance centered Western tradition and process centered Eastern tradition in philosophy.

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