Special Issue

The Role of DNA in Conscious Systems

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Abstract

A unification of mind, brain, and the universe would require connecting all three somehow with interacting loops that have an influence or observable action on each other. In this work, it will be demonstrated how the DNA molecule plays a critical role in building biological systems and provides the substrate constituents that are involved in some of these action cycles - in particular the human brain. In addition, after the system is up and running, DNA continues to maintain the continuum of that conscious system. DNA is able to do this because it is in of itself, an autopoietic and conscious system, which will be established in the article. This will be verified by categorizing genes that underlay DNA autopoiesis and demonstrate how DNA consciousness can be objectified on three dynamic levels. Both of these theoretical methods lay down genetic action cycles that are proposed to be afforded by hydrogen bonds between the nucleotides and Baer's forces of consciousness Fmc and Fcm. From this point, it can be projected how the human brain and the mind are tethered to DNA consciousness by very complex neurogenetic correlates of consciousness, which allow big "I" to be big "I" and to perceive little 'i'.

Key Words: DNA autopoiesis, DNA consciousness, Cognitive Action Theory, Dynamic Levels, Genetic Action Cycles

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Introduction

The event orientated world view is a proposal that the universe is comprised of interacting action cycles. Each of these action cycles encompass their own experiences, some evolve (or de-evolve) on their own timescale, and many of these cycles interact with one another conglomerating into a vibrant unified universe. The Cognitive Action Theory (CAT)-framework combines both the classic third person objective physical models and subjective first person experience as a single whole (Baer, 2013).

This framework supports an event orientated world view as it merges the subjective and objective into a cohesive combination of both; effectively combining the two action cycles.

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In an attempt to resolve the issue of disproportionateness between the subjective and the objective, the CAT-framework identifies internal forces of material that grasps charge and mass together. These forces are charge-to-mass (Fcm) and mass-to-charge (Fmc), which are crossover forces related to the weak and strong forces in nuclear physics (Baer 2014). The manifestation of these internal forces, Fcm and Fmc, balances the external forces of gravity-inertia (Fgi) and electricity-magnetism (Fem). Hence, according to this paradigm, accommodating these outside influences by adjusting the internal structure of material can be viewed as a primitive awareness proceeding towards consciousness.

In this article, the primary focus will be on Deoxyribonucleic acid (DNA) as a conscious and autopoietic system, and the roles it maintains in larger conscious

systems, e.g., in cells and the human brain/mind.

DNA is a unique molecule that underlays the evolution of all life on planet earth. It is composed of four nucleotides: two purines (adenine and guanine) and two pyrimidines (cytosine and thymine) that are attached to a sugar-phosphate molecule. The amount of adenine always equals thymine and the amount of guanine always equals cytosine, known as Chargaff's rule. This rule transpires as adenine and thymine both have two available hydrogen bonds and guanine and cytosine both have three available hydrogen bonds, which is this is known as Watson-Crick base pairing. These bonds between the nucleotides and the stacking of the sugar-phosphate molecules forms two polynucleotide chains of genetic information; running anti-parallel, that are held together by weak thermodynamic forces (the hydrogen bonds). This ultimately forms the double-helix molecule known as DNA.

Since Francis Crick and James Watson established the structure of the DNA molecule in 1953, a great deal has been understood scientifically in regards to the behaviour of DNA. Discovering the structure of DNA has also instituted a framework of how genetic traits are inherited. However, there are still several eluding factors about the behaviour of DNA, e.g., why does DNA do what it does and what is the driving force behind its behaviour? It has been proposed in several works that the driving force is consciousness- DNA consciousness (Grandy, 2006a,b; 2011).

The human genome project was initiated in 1990 and completed in 2003. Since that time, scientists have been untangling the complexities and mysteries of the human genome. However, studying the complexities of the genome has made one thing clearly obvious, i.e., the behaviour of DNA is not a random biological system that spontaneously emerged. On the contrary, DNA demonstrates autopoiesis and a degree of consciousness. Recent work has clearly demonstrated that the complexities of DNA involve interacting action cycles or what will be called genetic action cycles in this paper. These genetic action cycles will be explained in more detail in the proceeding sections.

By attempting to understand DNA as an autopoietic and conscious system, uniquely, with its own genetic action loops, an uncharted area that was not previously recognized by the CAT-framework is revealed. From this point, it can then be appreciated how DNA has developed countless genetic action cycles; not only within the genome, but also action loops that allow human consciousness to develop by first manufacturing the components of the human brain and then second by maintaining the continuum of consciousness, commonly referred to as mind, i.e., what is being felt and experienced. Therefore, DNA makes a crucial contribution in solving the issue of unity of the mind, brain, and the world. Keep in mind that it is not being proposed that DNA is a seat of human consciousness, but rather its emergence represents a crossroad at where the microscopic degrees of conscious manifests into macroscopic degrees of consciousness in more complex systems.

1. Understanding the DNA as an Autopoietic and Conscious System

The theory of DNA consciousness has two main doctrines: 1) DNA is a degree of molecular consciousness 2) DNA possesses the ability to give rise to higher degrees of consciousness (Grandy 2006a,b). In previous works, the concept of DNA consciousness has been reified by identifying and organizing some of the genetic underpinnings of autopoiesis, which, in effect, provides a biological framework of intentionality and autonomy (Grandy, 2011; 2015a).

The theory of DNA consciousness is not intended to undermine the importance of RNA. RNA is important as it is able to transmit and store small amounts of genetic information, and it can even give rise to higher degrees of consciousness, e.g., RNA viruses. Of course, like DNA, RNA is a degree of molecular consciousness. Unlike DNA, RNA's ability

to give rise to higher degrees of consciousness, as far as we know, ends here with the manifestation of RNA virus. Ultimately, it is the emergence of the more thermodynamically stable DNA molecule, which possesses incalculable interactions that affords a profound explosion in biological complexity and subsequent emerging degrees of consciousness.

In terms of consciousness, it should be kept in mind that the phenomenon of autonomy is a consequence of an autopoietic organization. Moreover, an alternative means of expressing this notion could be that the recognition of all autopoietic systems is achieved by recognizing the intentional consequence of their operation(s). When looking at DNA, that consequence is life beginning at the level of the cell and then engaging into a trajectory of interaction-based complexity and interacting genetic action cycles, which provide the building blocks to give rise to higher degrees of consciousness in more sophisticated systems.

DNA autopoiesis was first conceptualized with a novel paradigm in 2011 in where genetic proof that the six criteria of autopoiesis were met (Grandy, 2011). This paradigm provided an initial framework that identified genetic correlates that sustain the six criteria of autopoiesis which provided a fundamental biology of autonomy. In 2015, additional genetic underpinnings were identified (Grandy, 2015a). This additional genetic and genome-based information further fortified the original proposal and furthermore provided a more robust amount of scientific evidence to support this paradigm of DNA autopoiesis. Next, the initial format and enumeration of the biochemical and genome-based proof which in effect proves that DNA meets the criteria of autopoiesis will be briefly summarizes as well as an initial attempt to devise them terms of genetic action cycles. Keep in mind, further detailed genetic and biochemical information on DNA autopoiesis and the references that support this framework can be found in the recent Grandy (2015) publication.

2. Six criteria for autopoiesis, as implemented by the DNA

The six criteria which must be fulfilled by autopoietic systems was established by Chilean biologists Humberto Maturana and Francisco Varela (1972): that system must 1) have an identifiable boundary, 2) that boundary is self -produced, 3) the components of that boundary is self-produced, 4) that system is subject to cause and effect, 5) that system possesses constituent elements/components, and 6) those constituents are self-produced.

Criteria 1-3 are met by establishing the genetic action cycles that allow DNA to maintain and regulate this border, i.e., by phospholipid synthesis and membrane biogenesis. This provides an identifiable boundary. This boundary is self-produced as are its components, i.e., the phospholipids. The pah1 gene, dgk1 gene, and reb1 gene are major contributors to this process in eukaryotic cells. These genes represent genetic action cycles operating through a tangible biochemical feedback loop which control the production of these self-produced components.

Criterion 4 was met by illustrating three lucid examples of how DNA is mechanistic and subject to cause and effect. These dynamic examples include factors controlling gene transcription (e.g., enhancers, RNA polymerase, inhibited repressors, uninhibited repressors, and RNA polymerase inhibitors), factors controlling the cell cycle (in particular the tumor suppressor gene p53), and external agents that can damage DNA in the nucleus. These three examples represent genetic action cycles that demonstrate the cause and effect of DNA mechanistically.

Criteria 5 and 6 are met by identifying genes that are responsible for producing the basic constituent elements / components of the system. As it was mentioned in the introduction, the basic constituent elements and components of the DNA molecule are the nucleotides adenine, guanine, cytosine, and thymine.

There are several genes that make a major contribution to the production of these nucleotides: TYMS gene is pivotal in the production of thymine, CTPS1/CTPS2

genes are critical in the production of cytosine, and PRPP synthetase gene is involved in the production of both adenine and guanine.

All of these genes represent genetic action loops that allow self-production of this autopoietic system.

The results tabulated in previous works have been summarized. It can be seen clearly, that there are multiple genes which serve as genetic underpinnings of DNA autopoiesis. In essence, they form genetic action loops that express a degree of consciousness in the genome of any biological system. However, this network of consciousness does not end within the confines of the genome. As it will be seen in the rest of this paper, DNA consciousness stretches across other dynamic levels, and plays a pivotal role in the consciousness of all biological systems.

3. The three dynamic levels of DNA consciousness

In Grandy (2013a), an initial framework of DNA consciousness was objectively described, resulting in three dynamic levels 1) the interactions between DNA and itself (epistasis or gene-gene interactions), 2) the interactions between DNA and other nucleic entities (RNA species, viruses, mitochondria, and other cells, and 3) the interactions between DNA and the external environment (Grandy, 2013a). These three dynamic levels of DNA consciousness will be summarized and some of the genetic action cycles will be identified- more scientific details and the references supporting these dynamic levels can be found in the Grandy 2013 publication.

In the first dynamic level of DNA consciousness there is gene-gene communication (epistasis) that influences the genome locally. Two examples that demonstrate this phenomenon are master genes that influence other genes and gene silencing directed by DNA methylation:

1) Master gene Pax3 controls the expression of some genes, e.g., TP53, Hes1, Neurog2, and Meis2. Therefore, one master gene higher up in the developmental hierarchy can influence the behaviour of many other genes, even on different chromosomes.

During development, master genes, e.g., Pax3 proceed as genetic action loops that influence the construction of a biological system. In the case of Pax3, this would be the nervous system and the brain.

2) DNA methylation is the process in where clusters of cytosine-residue cover a promoter gene on a particular gene on the DNA molecule. This in effect prevents the expression of certain genes, which effectively turns them off- known as gene silencing. The hells gene controls, to a large extent, genome-wide cytosine methylation.

Collectively, this demonstrates that another single gene that possesses a significant amount of control over the phenotypic expression of a genome and resulting body plan of a conscious biological system.

The second level of DNA consciousness consists of interactions between the genomic DNA and other nucleic-based entities, e.g., various RNA species, viruses, mitochondria, and other cells. A good example of the second dynamic level of interactions is the bigenomic relationship between nuclear DNA and the cellular organelle mitochondria.

In brief, mitochondria are cellular organelles that produce energy in eukaryotic cells. However, they were originally descendants of ancient eubacteria that somehow participated in an endosymbiotic event with ancient nucleated cells- proto-eukaryotic cells (Gray, 2001). After this event took place a strange phenomenon transpired called organelle-to-nucleus functional gene transfer. During this process of gene transfer, the majority of the genes from the ancient eubacteria were translocated into the nucleus of the host cell. Eventually, this evolved into what is seen today in modern eukaryotic cells, i.e., the presence of the organelle mitochondria (with a bare minimum subset of genes remaining) and a centralized genome in the nucleus, in where the majority of the mitochondrial genes reside.

How did this functional gene transfer take place and what type of orchestration was over seeing this process? There must have been some form of instruction for it to be successful, which I have proposed to be the intentional interactions on the second dynamic level of DNA consciousness. How do I support this proposition? Let us take a look at the modern bigenomic relationship between nuclear DNA and the mitochondria.

In modern eukaryotic cells, the expression of the mitochondrial genes in the nucleus of the cell is controlled by the nuclear genes (gene-gene interactions- the first dynamic level of DNA consciousness).

The mRNA for mitochondrial proteins are transcribed in the nucleus, exported into the cytoplasm, transcribed, and then chaperoned to the outer membrane of the mitochondria.

Therefore, the mitochondria are dependent on the nucleus for the majority of its constituent parts.

An additional example of how nuclear DNA communicates with the mitochondrial genome will be briefly discussed. DNA polymerase-gamma, which is encoded by the nuclear gene polymerase-gamma (POLG- also called pol gamma), has been demonstrated to be involved in the replication of mitochondrial DNA. Basically, the core replication apparatus consist of POLG, mitochondria DNA helicase, Twinkle, and mitochondrial single-stranded binding protein (Lee, 2009). POLG comprises a catalytic core in the replication apparatus and it has been proposed to be the lone polymerase accountable for mitochondrial DNA replication (Kaguni, 2004). Thus, a nuclear gene controls the rate at which the mitochondria replicate throughout the cell cycle by utilizing a bigenomic system of communication.

A final piece of evidence that supports the gene-gene communication system between DNA and other nucleic entities can be seen in a study involving a type of yeast, *Saccharomyces cerevisiae* nuclear loci and loci on the mitochondrial genome. In this study, an inter-organelle DNA-based communication system was identified utilizing genome conformation capture, which is a proximity-based ligation method that arrests inter- and intra- chromosomal interactions (Rodley, 2012).

In this study it was demonstrated that interactions between mitochondrial genes COX1 and Q0182, and nuclear encoded loci MSY1 and RSM7, respectively are dependent on reverse-transcriptase, which mediates these inter-organelle DNA interactions. Thus, several examples have been provided that support the second dynamic level of DNA consciousness.

The third dynamic level of DNA consciousness entails the interactions between DNA and the external environment. This is readily seen as DNA interacts with various forms of radiation, e.g., UV and gamma, which can cause mutations. Mutagens are chemical agents that interact with and produce changes in the DNA molecule. Besides radiation and mutagens, DNA can interact with other biological phenomenon, e.g., viruses. This third dynamic level of DNA consciousness is also the basis of satisfying the fourth criterion of autopoiesis mentioned earlier.

So we have observed the genetic underpinnings that provide autopoiesis and identified the three dynamic levels of DNA consciousness- all of which demonstrate unique genetic action cycles. Collectively, these phenomena justify DNA as an autopoietic degree of consciousness.

Additionally, as proposed in the introduction, there is interfacing between the nucleotides within the DNA. This interfacing takes place between the weak thermodynamic forces of the hydrogen bonds. There is also the possibility that Fmc and Fcm of these hydrogen bonds may accommodate to the external Fgi and Fem similar to the postulates of Wolfgang Baer's forces of consciousness. At this point we can no longer view DNA as an unassuming genetic storage unit, but more exactly, as a dynamic, autopoietic, and conscious system. Next we will observe the role that DNA plays in larger more complex consciousness systems and identify some of the genetic action cycles at play.

4. The Role of DNA in Human Consciousness-The Neurogenetic Correlates of Consciousness

In objectifying the role of DNA in conscious systems, it would be logical to begin at the level of the cell as this is simplest level of organized cognition arising from DNA. Of course, there is nothing simple in regards to the biochemical activity within the confines of a cell. In the cell, the RNA-DNA relationship is essential- of which the second dynamic level of DNA consciousness provides. In addition, DNA autopoiesis underlies cellular autopoiesis. DNA also allows cells to evolve into more complex cells. During the course of cellular evolution a special type of a cell emerges, the neuron.

The neuron maintains the ability to perform cell-to-cell communication. This is accomplished by synaptic connections interfacing the various groups of neurons.

Also of importance to the activity of the neurons in the action potential that is the mechanism by which the electrochemical signals are transmitted.

These signals are coordinated into brain-level functions of subjective awareness. However, it is the ion channels (which are produced by genes in the DNA) that allow the action potentials of this neuron-to-neuron cognition. There are also genes that allow a neuron to be a neuron. Here are two examples: 1) the myelin gene regulatory factor gene- the product expressed by this gene is a transcriptional regulator required for the myelination of the central nervous system (Emery, 2009) and 2) synapsins genes (I-III)- these are critical for neuron development and neuron plasticity (Fornasiero, 2010).

The definition of the neurogenetic correlates of consciousness (NgCC) is- genes or gene products (e.g., transcription factors or epigenetic factors) that have an effect on or are involved in the neurobiological process of human consciousness (Grandy, 2013b). This approach is relatively new and it has been evaluated from both a neurological and philosophical point of view.

In this model, DNA gives rise to human consciousness, provides a continuum, and at the end of the lifespan can contribute to neuron degeneration.

Consequently, there are three neurogenetic phases of human consciousness. The identification of NgCC forces consciousness researchers to look beyond (or rather beneath) the structure of the brain and the neurons. This is significant as there is a rich neurogenetic substructure that supports human consciousness. Unfortunately, this neurogenetic substructure is, for the most part, unheeded by consciousness researchers or presumed to play a role in consciousness with the absence of a working paradigm.

The neurogenetic account of human consciousness has been discussed in previous works. In addition, the neurogenetic model has attempted to remedy some of these shortcomings in the neurobiological approach in consciousness research. Here, I will briefly describe the three neurogenetic phases of human consciousness and the role DNA plays utilizing genes and gene products as genetic action cycles. Keep in mind that much more detailed descriptions that delve into more complex neurogenetic elements can be found in prior publications (Grandy 2013b,c).

The first neurogenetic phase- there is an emergence of neuron-based consciousness. This process begins at fertilization with master genes high in the developmental hierarchy that trans-activate other genes downstream. This unfolds into a very complicated genetic cascade. There are several genes that influence the construction of brain regions that will later be involved in human consciousness. Here are some examples: 1) Pax6- is a master gene for eye development and promotes the neurogenic fates of neural progenitor cells 2) Otx1- this gene influences ~80% of the size of the cerebral cortex 3) Otx2- is a gene involved in diencephalon, mesencephalon, and telencephalon development.

The second neurogenetic phase- there is a continuum of neuron-based consciousness that runs in tandem with the conscious experience. This requires the appropriate functioning of the genome.

The second neurogenetic phase can be studied objectively by observing the genetic basis of neuron plasticity and genetic abnormalities seen in certain psychiatric disorders, e.g., schizophrenia and autism.

Neuron plasticity is the ability of neurons to form new connections in response to new stimulus. This not only allows the brain to change but it is absolutely required for the continuum of human consciousness. Some the genes that are critical to neuron plasticity are- BDNF, FGF2, delta-FosB, and synapsins I-III.

In autism spectrum disorders there is a breakdown in the reciprocal interaction between the external environment and the individual's consciousness. As a result, an individual with this disorder appears more introverted. PTCHD1 locus disruptions have been associated with autism. Schizophrenia is a psychiatric disorder that has a wide variety of presentations. In some of the more severe cases the individual can be withdrawn from reality, experiencing visual and auditory hallucinations, and have delusional or paranoid thoughts representing a breakdown in the perception of reality.

The genes PDE4B and DISC1 mutations have strong correlations the schizophrenia.

In the third neurogenetic phase there is neuron degeneration and loss of brain mass which ultimately progresses into clinically observable decreases in the degree of human consciousness. The process of neurodegeneration can be a normal age-related advancement which is seen in mild cognitive impairment.

However, it can have a genetic link as seen Alzheimer disease. Some genes associated with Alzheimer disease are the APOE-ε4 gene variant, as well as, gene mutations in APP, PSEN1, and PSEN2.

Collectively, the three neurogenetic phases of human consciousness represents an extensive network of genetic action loops. It can be seen at the first neurogenetic level that genes and their gene products form genetic action loops that lay down the substrate constituents that will interact with the world. On the second neurogenetic level, the genetic action cycles established by the gene and gene products provide and maintain the continuum of human consciousness scene by scene. In a profound way, this phase tethers the brain and the mind together.

Unfortunately, towards the end of life, the system breaks down and the genes do not express as they once did. In addition, gene mutations can accelerate this process, as seen in Alzheimer's. In recent works, Alzheimer's has been used to illustrate a neurogenetic connection to the decline of human consciousness seen in this disease process (Grandy, 2015b).

5. Conclusion

The CAT-framework emphasizes that conscious awareness takes place at the intersection of the inner action loop, which is the larger self- the big "I". This is juxtaposed with the phenomena of the appearance and feelings that are included by the immediate environment and by the manifestation of the conscious system, which is referred to as little "i".

Of course this all takes place within a larger process, which is the universe or "U".

In objectifying the DNA, an intriguing possibility is opened up in the CAT-framework, in where the inner action loop I has addition inner action loops between the individual system's brain and mind, which are both tethered to the genome.

In addition, substrates called genetic action loops have been identified in this work that provide DNA autopoiesis and three dynamic levels of DNA consciousness. As demonstrated by the three neurogenetic levels of human consciousness, some of the genetic action loops, identified by the NgCC, allow I to be I, and also allow I to experience i.

Furthermore, these genetic action loops may be considered a smaller I that are within I. Perchance "ii"? In many ways this paper highlights the inner

unexplored complexities of the CAT-framework and how much more depth is required to be deciphered in order to arrive at a comprehensive embodiment of unification. The three dynamic levels of DNA consciousness and the three neurogenetic phases of human consciousness provide local activity that shoulders entanglements (grounded in genetic action loops driven by the hydrogen-bonds of the nucleotides) to coordinate between the worlds of DNA consciousness, the brain, the continuum of consciousness (or the mind), and the external environment. It is important to take into consideration that these hydrogen-bonds, interacting between the nucleotides within the DNA, may in fact perform a type of computational entanglement that may be based on Baer's internal forces of consciousness that are derived by Fmc and Fcm. This requires further investigation.

Collectively, the three dynamic levels of DNA consciousness and the three neurogenetic phases of human consciousness would engender a holistic view of human consciousness, i.e., to be viewed as a whole; including DNA, cell biology, neurophysiology, genetic action loops, and cognitive action loops in the world, rather than a sum of all the parts. This would account for what we actually feel moment to moment, i.e. our conscious experience- the continuum of human consciousness.

It has been demonstrated in this work that the role of DNA is paramount in conscious biological systems- more importantly it is tethered to the brain and mind. DNA consciousness is directly involved in the CAT-framework (which could possibly be considered ii) as it maintains vital biochemical functions intrinsic in the birth, growth, operation, decay, and death of cells- which are the building blocks of all organic macroscopic conscious systems, in so far as this planet is concerned.

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