To Know: The Intersection Between Anticipatory Action and Epigenetic Processes. God, Science and the Last Question

Elvira Nadin

Abstract Epigenetics triggers genetic processes in the living. Anticipatory processes pertain to the entirety of life. Understanding their relation is a prerequisite for approaching spiritual aspects of individual and social life. Epigenetic processes associated with non-material promoters are part of the encompassing anticipatory action through which life is preserved. Ideas can be as influential as substances (food, natural poisons, synthetic interventions such as pharmaceuticals or genetic engineering). Empirical evidence of anticipatory expression suggests that epigenetic processes are, by necessity, grounded in the anticipatory nature of life. Based on these considerations, we advance here the hypothesis that what explains the role of religion is the human drive to know.

Keywords Anticipation · Epigenetics · Genome · Religion · Spirituality

1 Preliminaries

To establish a common understanding of the concepts involved, especially when it comes to religion, is indispensable. In the spirit of C. S. Peirce's Ethics of Terminology [1], working definitions are spelled here out as a preliminary. They serve as the "common denominator" for assessing data and for the interpretation of their meaning.

Anticipation: the current state of an anticipatory system depends not only on the past state (or states), but also on possible future states. It is not prediction, forecast, expectation, guessing, conjecture.[1] It is always expressed in action [2].

[1] Nota bene: Unfortunately, dictionary definitions and those peddled on Wikipedia are frozen in a time when little was known about the role of anticipation in living processes. What was known trickled down from the less than precise formulations within psychology. Even in our days, the discourse on anticipation remains rather unfocused.

E. Nadin (✉)
antÉ—Laboratory, Institute for Research in Anticipatory Systems, University of Texas at Dallas, Richardson, TX, USA
e-mail: elvira.nadin@utdallas.edu

M. Nadin (ed.), *Epigenetics and Anticipation*, Cognitive Systems Monographs 45,
https://doi.org/10.1007/978-3-031-17678-4_7

Epigenetics: the study of changes in organisms prompted by modification of gene expression rather than alteration of the genetic code itself (Oxford Languages Dictionary).

Genetics: the scientific study of genes and heredity—of how certain qualities or traits are passed from parents to offspring as a result of changes in DNA sequence (National Institute of General Medical Sciences). This definition is questioned by scientists seeking a better understanding of reproduction in the living [3].[2]

Matter: that which occupies space and possesses rest mass, especially as distinct from energy. This is a physics informed definition. Alternative definition: substance from which everything is made, but distinct from mind and spirit.

Religion: the belief in and worship of a superhuman controlling power, especially a God or gods; a particular system of faith and worship; a pursuit or interest to which supreme importance is ascribed (Oxford Languages Dictionary).

Religiosity: the quality or state of being religious; religious feeling or devotion (Merriam Webster).

Ritual: spontaneous or staged ceremony consisting of actions performed according to a prescribed order (Oxford Lexicon).

The spiritual: relating to or affecting the human spirit or soul as opposed to material or physical things. Sometimes defined as: relating to religion or religious belief.

Spirituality: the broad concept of a belief in something beyond the self. It may involve religious traditions centering on the belief in a higher power, but it can also involve a holistic belief in an individual connection to others and to the world as a whole [40].

These definitions are not normative. They suggest a shared meaning for the purpose of speaking/thinking about the same things. Evidently, there is no consensus on definitions, as there is no consensus on the science on which they are based.

Although the role of ideas, ranging from philosophy to science, aesthetic expression, and motoric activity will be alluded to, the focus is on what is broadly defined as religion or religions (views and practices). They are neither justified nor subjected here to critical evaluation. The role they played during humankind's history changed drastically over time, often because science proposed itself as a more effective way of questioning reality, and of facilitating change. But even in our days, religion, in a variety almost impossible to account for, remains a factor impossible to ignore. Its role in community life, in politics, in promoting or justifying adversity that might lead to human suffering and death cannot be properly assessed.

[2] This definition is questioned by scientists seeking a better understanding of reproduction in the living [3].

2 Anticipation

Between prolepsis and *antecapere*, i.e., notions reflecting awareness of foresight, and the current use of the term anticipation, there is a documented history of how they were defined and how they affected human consciousness of change. The term *prolepsis*, (cf. Merriam-Webster) means "the representation or assumption of a future act or development as if presently existing or accomplished." The term is from the Greek, meaning "the process of taking in front of" or "anticipating." *Antecapere*, from the Latin suggests taking possession (not only of things) beforehand. Other notions can be added. They reflect awareness of foresight, and, more recently, focus on actions ahead of danger, and the use of "positive" cues from the environment. Empirical observations regarding how future possibilities informed actions in organisms have led to a record that suggests that reproduction, preservation of life, and adaptability imply anticipatory action. Only after progress was made in the scientific inquiry of what defines life [4] did it become possible to gain a new perspective of living processes. Once creative aspects of human activity become the subject of inquiry within physiology, cognitive and neurosciences, and of evolutionary biology, it became possible to identify the role of preparation [5] in various motoric and cerebral activity (sports, dance, playing instruments, etc.). Interdisciplinarity is not optional in studying anticipation.

With this in mind, a science of anticipatory processes has by necessity many originating authors, coming from various disciplines. These were identified [6] and further studied. In particular, the role of Soviet/Russian scientists (Bernstein, Beritashvili, Ukhtomsky, Anokhin, and Uznadze) in the 1920s to 1950s must be highlighted [7]. In his work focused on aesthetic creation, Nadin [8] suggested that creativity is by necessity the outcome of anticipation-supported expression. His book, *Mind—Anticipation and Chaos* [9], placed anticipation in the perspective of dynamic systems. Rosen [10] was the first to dedicate a whole volume to the subject.

In dialog with Rosen (aware of Nadin's book mentioned above), Nadin broadened his own inquiry, and engaged a large number of researchers in an exchange of ideas, hypotheses, and methods of inquiry. Important publications and conferences, organized by the Institute for Research in Anticipatory Systems, were dedicated to the subject: *Time and Conscious Brain*, 2011; *Anticipation—Examples of Anticipatory Expression in the Framework of Neuroscience*, 2012; *Anticipation applied to information technology, neural networks, education, politics, biological systems, engineering*, 2014; *Anticipation: The Interdisciplinary Perspective*, 2015; *Anticipation in Medicine* 2015). In 2005, Nadin conceived and built the AnticipationScope™ as an attempt to quantify aspects of anticipatory expression. The multi-year Seneludens project (https://seneludens.utdallas.edu/) addressed the challenges of aging, especially decline in anticipation, by stimulating plasticity (understood in a broad sense.) Experiments in which the AnticipationScope[3] was deployed eventually engaged 170

[3] The AnticipationScope is reminiscent of the cyclogrammerty method that N. A. Bernstein developed in 1921–1925 while working at the Central Institute for Labor. Bernstein registered movement kinematics and showed that the joints involved interacted, correcting each other.

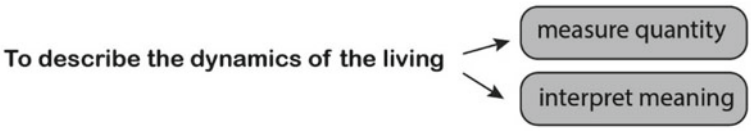

Fig. 1 Anticipation underlies change in the living. The AnticipationScope opens access to measurement data and to meaning interpretation

subjects, and representative in terms of gender, age (6–94 years), race, and cultural background. Data were accumulated in an integrated digital environment set up to capture motoric expression, as well as to document cognitive aspects involved in an *Anticipatory Profile* for each participant. As the experiments advanced, it became clear that in describing motion, the data was significant as the repository of knowledge acquisition through motoric expression, but also of intricate adaptive processes [11–13]. Most important was the realization that anticipatory action affects performance, understood in the broadest sense of the word.

Anticipatory action pre-dates physical performance (such as in sports), cognitive and aesthetic activities (playing instruments, for example), learning. In order to describe the anticipatory nature of preparing for and executing activities (running, playing the piano, golf, washing dishes, sitting on a chair, driving, etc.) a digital "film" of the activity was generated. It integrates motion capture data and sensor data pertinent to the physiology and the cognitive processes involved. While data are important and continue to be processed currently using AI-based analytic tools, the focus of the research was on meaning (Fig. 1).

The research of N. A. Bernstein (On the Construction of Movement, 1947/2020) was experimentally tested and empirically confirmed in the antÉ lab. Moreover, the investigation highlighted aspects that escaped the attempts at quantification of scientists in the last century. In this process, attention shifted from what N. A. Bernstein called dynamics, and even from the role of the central nervous system (which was his focus). The various functions of anticipatory processes in the "to know" how—knowing how to perform an action—were made explicit in particular applications. "*Anticipation and Performance, AnticipationScope and the Anticipatory Profile, with application to the game of golf*" (in collaboration with Eben Dennis, a golfing professional and instructor, 2013, Fig. 2), is a project developed by Robert W. Fuentes, assisted by several graduate and undergraduate students, developed (for the competition "Inventing the Future," 2011).

Others examined the role of movement in therapy: Amazing Grace: African dance movements for the maintenance of fitness and anticipatory functions in the aging (in the framework of the Seneludens project). Germaine Acogny, "The mother of African dance," developed an elaborate routine inspired by exercises (dance movements and singing) in a village in Senegal. Stimulating plasticity was the implicit goal. It turns out that brain plasticity and genetic plasticity are connected. Acogny's program was performed during her visit to the Institute and recorded for research purposes. It

Fig. 2 Quantifying anticipatory aspects of golf playing

forms a repository of a performance that testifies to a culture of rich traditions, in which the physical and the spiritual are intertwined.

Anticipation-driven *Adaptive Architecture Assisted Living* (under the guidance of Asma Naz, at that time a doctoral student at the University of Texas at Dallas, 2013–2018) revealed new perspectives on how behavior is an expression of knowledge, uniting past (experience), present, and the possible future [39]. Interacting with Duke University DiVE, the Institute acquired data on the effects of various parameters (e.g., color, texture, lighting, size) for a living-working space through an immersive virtual environment.

Interaction with Professor Hubert R. Dinse [14] of the University of Bochum (Neuroinformatic Institute) led us to further investigate brain processes involved in anticipatory action. In particular, plasticity—not only of the brain—became the focus. Such expressions of anticipation are necessary for survival. They can be maintained and regained even after brain performance diminishes with aging or is affected by trauma. Testing and validating the effects of interactive games for maintaining motoric and cognitive health in the aging (in cooperation with C. C. Young Community Centers, Dallas TX, and Xavix, Inc., San Diego CA/Shinsedai, Inc., Japan) afforded additional knowledge regarding the unity between the physical, the cognitive and the spiritual.

All these experiments had clearly identified targets (represented by measurable behavioral performance), but also "soft" targets. Indeed, the fully anonymized database of the persons participating in testing anticipatory performance was meant to contribute to the Anticipatory Profile of each individual. The relatively common identifiers (age, gender) were complemented by self-defined characteristics (medical history, medication record, social-economic group, sexual orientation, religion, political affiliation). The premise is straightforward: anticipation action reflects the holistic nature of living processes. They are not reducible to the organism's make-up (molecular inventory), to genetic expression, or to brain-controlled activity. The integration of background data and of interactively generated data was, and still is, an ambitious undertaking. It does not suffice to take note of the fact that reductionist-deterministic explanations are incomplete; one must try to break the limitations inherent in closed-system experiments. The ideal of producing a wearable AnticipationScope that would be like a "skin," (Fig. 3) includes research into areas of extreme anticipation expression (e.g., high-performance sports, air traffic control, military maneuvers emergency situations).

Fig. 3 The AnticipationScope in various configurations: motion capture, mobile, full body wearable

3 God is in the Question Mark

Properly deployed, the AnticipationScope could also account for the specific role of factors such as beliefs (including religion) in human performance. Just to frame the question let us consider some hypotheticals:

1. Is there any relation between human performance (no matter in which field) and beliefs? Formulated this way, this question is larger than belief in God or gods, or the role of religion in an individual's life.
2. Data (from brain activity research, as well as from genetics) concerning the role of belief (religious or otherwise) comes in different formats. Assuming that the heterogenous data can be processed in a uniform manner, can inferences be made across disciplines?

Of course, hypotheticals return at most more hypotheses, i.e., suggestions for more empirical evidence. Moreover, while a piano player or gymnast might identify with some belief (e.g., "I am a Christian" or "I am an atheist"), it would be speculative to infer from a rather undefined entity (gods, atheism, or even agnostic scientific beliefs) to the success or failure of a performance. Moreover, although Bach's music, for example, was composed for the Church, it is appreciated by believers (of various religions) as well as non-believers. Cathedrals, synagogues, mosques, monasteries, Buddhist temples, etc. are visited for their historic relevance, not necessarily for their religious messages.

Given this epistemological situation, understanding the role of knowledge in the success or failure of human activity is a path towards assessing the role of belief/beliefs. When physical evidence for an answer is nowhere to be found in nature, humans default to the supernatural. Like in life, those more powerful seem to have advantage over the others. Endowing various aspects of nature with superhuman powers and worshipping them is the extension of submission to the powerful within a community. Religion is born in the reality of human interactions. Not surprisingly many studies have concluded that religion, regardless of its origin, is so persistent that it must be a genetic trait—hence the "God-gene." Let us however focus on what explains its role:

> God was…invented to explain mystery. God is always invented to explain those things that you do not understand […] When you finally discover how something works…you don't need him anymore. [15, pp. 208–209]

Research of anticipatory actions, as a necessary ingredient of what it takes to perform certain activities, and research on brain activity and on genetic aspects of how the living knows the world, can be seen in their unity. Based on very rich data (from experiments in a variety of high-level scientific institutions presented under headings such as *The MRI of religion*, *Brain activity and art perception*, *The cognitive aspects of rituals*, it becomes possible to identify links to the genetic profile of individuals, as well as to heir Anticipatory Profile. The particular objective is to differentiate between genetic and epigenetic components in respect to religion, attributed to the so-called "God-gene" [16] is to see how, against the background of DNA, the experience of life

in facing the unknown leads to the acceptance of laws of science at the level at which God is invoked for the unexplained. Between the headlines that attracted numerous readers and the proper subject of genetic investigation, there is a huge difference.

To know is the most striking evidence for the effort of individuals to go beyond knowing who they are. This means to see, to listen, to smell, to touch, to taste—if we limit ourselves to the discrete description to the senses. Stepping out of oneself means to experience the immediate environment of existence. Reproduction preserves life, but in order for it to take place, two distinct entities need to know each other. Sexuality is the expression of this. Anticipation drives the process: there is purpose, and there are possible ways to achieve it.

Which genes, and which environmental cues are at work in the process is a matter that molecular biologists pursue. Brain research focused on what explains attraction. Empirical evidence from the study of sexuality (in its many forms) suggests that reward is part of the process. Knowing is knowing for some purpose. Anticipatory processes engage the organism's entirety. Therefore, data regarding anticipatory performance is pertinent to understanding how the organism acts as one entity. Genetics can explain aspects of the holistic perspective. The much-commented book, *The God Gene*, by the molecular biologist Dean Hamer, of the National Institutes of Health, reveals that a particular gene (SLC18A2) might explain spirituality. The inference is simple: the gene (also labeled VMAT2) partakes in the movement of monoamines. And voilà the magic: it is also involved in monoamine modulation through which psychiatric drugs might trigger all kinds of experiences. Genetics meets brain research!

Let us simplify. It is possible that plants containing such substances were discovered by some organism. It is how to know becomes reality: try, try again. That experiences similar to ingesting psilocybin might be of the same nature a ritualistic or religious events is at best conjecture. Not subject to question is the striving for, going beyond the immediate, searching. And this is anticipation at work. But what makes posing genetics-focused questions relevant is the realization that, in the end, the interplay between being and being in the world explains the necessity of the act of knowing. Therefore, not a gene, not a DNA, not a genome, and not the brain alone, but the interplay with the world explains the never-ending quest to ask more questions. Some questions are addressed to the unknown; some question the known; some establish new knowledge domains. Religion is one of them. Once upon a time, alchemy was one of them. Preformation and phlogiston theory are yet another example. Or vitalism. Transcending one's own borderline is to place oneself is the environment. Epigenetics originates from here.

Before genetic reductionism kicked in, God was "revealed": in images supposed to represent how we think. In association with measurement technology focused on neural activity, many hypotheses (including the famous brain mirrors [17]) were advanced. Religion became a matter of neurons firing on neurons aligning (from the faithful to the proselyte). Much has been written on this because fMRI devices, like sequencing devices, are an investment in search of ways to capitalize on them. Here we shall only recap the major findings, with no intention of undermining or questioning their legitimacy. May the God-Brain movement (by no means a closed

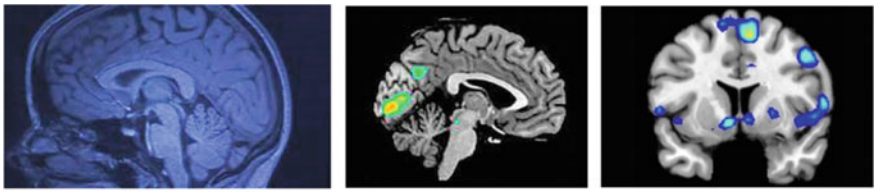

Fig. 4 How the brain registers religion. **a** Religious thought can trigger reward processes. **b** To the brain, God is just another guy (NPR). **c** This is your brain on God (Utah Health services)

chapter) serve as a warning regarding the traps of technology in search of questions (and public exposure through "hot" topics).

To start the discussion, let us consider some images.

These images are referenced to the source for a simple reason: they document various angles from which God/gods/religion became subject to fMRI representations (Fig. 4). The neuroscience of such a focus was sometimes called neuro-theology, or spiritual neuroscience. Without entering the details of the various experiments and the data generated, the following can be said:

1. The hypothalamus, amygdala, and the hippocampus were identified as the regions of the brain where divinity/religious thoughts "reside;"
2. Evidence from metabolic brain scans identified localized functional specialization of certain regions of the brain, in particular, the ventro-medial prefrontal cortex (vMPFC).
3. Once genetic focus took center stage, i.e., once a particular kind of proteins (the VMAT2) were identified, researchers of brain activity located VMAT2 proteins on synaptic vehicles. These proteins are involved in how monoamine neurotransmitters make their way to/from neurons into vesicles. This result did away with the hypothesis of a "Godspot" suggesting that multiple areas of the brain partake in the experience of religious practices.

From the perspective of the hypothesis we advanced, *the drive to know*, not a particular brain location or configuration of neurons, explains God and religion. The drive to know, connected to survival, is itself an anticipatory activity Increased awareness of the outside world and of others ("social awareness") is conducive to subduing aggression. Evidently, compassion is not an automatic outcome. It reflects the role that others play. Aggression has the opposite effect. Experience of useful (cooperative) efforts and of harmful (aggressive) interaction affect neuroplasticity. The brain learns, and in the process it changes.

The fact that religion extends from the multisensory experience of rituals explains why it remains not only a reflective practice, but also one of expression. It contains words, gestures, sound, and various images. Over time, in asking for answers from god/gods or religion, it assumes its aesthetic autonomy. It is expressed in language and in art. Prayer is a particular form of this practice of expression. Reward is part of

the larger picture, which will eventually attract the attention of those who, beyond the focus on neuroscience, got involved in the genetics and epigenetics of religion. The fact that religion, as part of the broader practice of human beings shaping their own identity, is by necessity anticipatory is the most important take-away.

4 Epigenetics

Ganesan [18], and many others trace the history and development of epigenetics back to Aristotle. In his view, Aristotle claimed that there is purpose, and thus the world seems to have a maker, which is usually the accepted view among the religious. Feynman could claim, "I told you so!" But his explanation will be overwritten as more knowledge is acquired. Although the modern science of epigenetics is relatively new [19], and still subject to questioning [20], it has attracted the attention of the scientific community. Some researchers are already looking into "reprogramming," through epigenetic changes, behaviors such as eating disorders, addiction, mental illness, memory decline, muscle biology, liver biology [21] (see also: https://ihec-epigenomes.org/). Suicide, affecting the young, as well as a great number of military service people, prompted attention because so far, the inclination to end one's life appears hidden: Is it in the genes? Others, not surprisingly, are looking at spiritual factors and their role in the life of individuals and societies. The epigenetics of solidarity—especially in extremely divisive communities, that all kinds of demographic research has tried to describe through numbers—is driven by meaning. Is it advantageous to help one another, or is it better to hate each other? The meaning of cooperation goes well beyond the numbers describing it.

On a parallel path, the role played by anticipation in surviving in various environments is the subject of in-depth research carried out by a significant number of researchers not only in the life sciences [e.g., 22–25]. Given the fact that anticipation is critical to survival, why should the question arise as to whether it is genetic or epigenetic—as long as it is a characteristic of human action? A first important distinction (along The Ethics of Terminology guiding us here): the question of whether anticipation is genetic or epigenetic [26] should not be confused with "genetic anticipation." This diagnostic refers to disorders passed on to future generations genetically (a definition is given in [27]) in sequence of shorter incidence and higher intensity. Ilkka Kronholm [28] published the findings of her investigation of this question, concluding that anticipation is epigenetic, and its functioning is dependent on environmental cues. Prior to Kronholm's report, Luo et al. [29] reported on well-being and anticipation. In short: "Anticipation for future [sic!] confers great benefits to human well-being and mental health." Their use of fMRI revealed that "… the anticipation of positive events is a key element of well-being" (p. 2), more so even than anticipation of neutral events—and even less anticipation of negative events (no matter how necessary such anticipation might be). Our lab experiments were focused on

successful performance, which is only one aspect of anticipation. Avoidance of self-harm, (i.e., no self-destructive actions) is another aspect. Neither can be traced back to genetics. Both are epigenetic in nature, i.e., triggered from outside.

Empirical evidence extending from anthropology to ethics to computer science, suggests that religiosity (God-related or any other form) affects the ways humans function in society. There is no magic formula, such as the more religious a person, the higher the performance. Although, for instance, among the religious, suicide rates are lower than that of the rest of society. The statement: "Religion A is more conducive than religion B to high performance" is rather an expression of bias. And so is "No religion at all (atheism) is more effective." After all, the history of religion itself is rather contradictory. Accomplishments connected to practicing religion (e.g., being charitable), but also to behaviors of extreme consequences (such as wars, or oppression of those not aligned with a certain religion) are well documented. In the context in which human performance, including ethical aspects, is subjected to evaluation from the perspective of the self-reproduction of life, such empirical evidence cannot be ignored. Community life, within a certain scale, was well served by "commandments" inspired by practical rules attributed to divinity. Behavioral epigenetics (where hypotheses are usually tested on surrogates, not on human beings) provides knowledge regarding factors such as taking care of offspring, respecting one's neighbors, helping the elderly, and emotional aspects of life. It is legitimate to ask to which extent genetics, as part of science, can help us explain what, at some moment in the evolution of the species, makes religion necessary or what in our times makes it more questionable. In its broad sense, spirituality affords evolutionary advantage. In our age, spirituality plays a different role that it did way back as the human condition was defined.

The pragmatics of human activity reflects the fact that "We are what we do"—which is the "school of life," i.e., the source of everything we know. Choices of means and methods corresponds to the concrete context. Anticipatory processes guide these choices: for example, "run away," "stay and fight," "help," or "hide." Genetics provided powerful tools for identifying how the change in the human being's pragmatics—from the age of foraging and hunting to what humans do now in the age of computation and synthetic biology—accrued over time in the change in genomics. Trans-generational epigenetic inheritance [30] means that environmentally, and probably socially, induced phenotypes persist over generations. Some [31] document lower baseline levels of the stress hormone cortisol in children of Holocaust survivors. Others [32] warn about overinterpretation of results. Within the controversial DNA-as-blueprint metaphor, this means that a variety of molecular processes affect gene expression and that a timeline is difficult to establish—never mind the pitfalls of surrogacy: mice and human beings. Positive and negative factors—stimulate or limit living processes. Some can lead to genetic plasticity—yet another form of adaptive behavior. Anticipation in a slowly changing environment is different in degree and in its forms of expression from that in a faster-changing context. Genetic processes can result in enhanced offspring performance (e.g., immunological defense), but also in negative influence (think about various forms of addiction).

Humankind's evolutionary path can be described in detail if the full record of anticipatory and genetic expression can be reconstructed. The focus should be on acknowledging both, and on transcending the time limits of closed-systems experiments. Once upon a time, survival took extreme forms: The ancient Greeks, for instance, abandoned the elderly no longer able to live on their own. This also reflected their views on life after death. The sense of co-dependence developed against the background of shared views or shared knowledge. Sometimes the shared knowledge is embodied in tools or in patterns of behavior. Pragmatic considerations explain the interrogations articulated over time: from perception of an enemy, of the beneficial (e.g., weather, plants, animals), or of the unknown. Neither genes nor brain configurations nor anything else subject to reductionist focus explains how sharing emerged. But through awareness of the fact that epigenetic inheritance facilitates the fitness peak of some populations [33]—expressed through successful anticipatory performance—we gain a new understanding of their condition. The evolutionary advantages of sharing over confrontation are ultimately reflected in expanding the resources available for maintaining life. Community or cohesion is not genetic, but pragmatic in nature, and as such, by necessity anticipatory. A possible future (e.g., storm, fire, drought, poisoned water) engages a community as a whole. In the process, reproduction mutates from being only the outcome of sexual drive to a process of selective attraction. Successful mating is not accidental. There is a progressive increase in what is called "intentionality." This is documented in what the history of family actually is: a record of behavioral change reflected in the genetic transcription process (with RNA involved), but not reducible to it [34]. It is in the pragmatic self-making of individuals that their encompassing profile is defined. Within this broader profile (which includes the protein profile), their genetic profile plays a particular role. The genetic clock—the record of large timescale changes in the succession of genetic bases, documents how, from reaction to interaction, the ability to question is ascertained.

5 The God of the Genome

DNA structure reflects its role in the broader dynamics of evolution. It is supposed to be chemically extremely stable, yet flexible enough to facilitate what is called gene expression. In simpler terms: there is continuity in reproduction, but also variation. From the sameness of DNA in each organism, to the uniqueness of each organism, there is a dynamic process involving al great number of parameters. Just for the sake of the argument: the situation regarding God, gods, divinity, idols, and the world in its limitless variety is similar. There are some limited ingredients (like the acids making up the DNA, each represented by a letter), and there is a generative mechanism: combine words (remember: "In the beginning was the word…." the *logos*…), combine texts, combine interpretations. A reputed scientist, Francis S. Collins—credited with discovering the genes associate with some disease, active in the Genome Project, and who worked as Director of the National Institute of

Health—ascertained: "The God of the Bible is also the God of the genome." He even asked, "…will we turn our backs on faith? […] concluding that traditional religious symbols can now be replaced by engraving the double helix on our alters?" [35]. Feynman, in describing the role of religion, explained why the more we know, the less we need God. What he did not notice was the process of turning our own constructs (in this case the DNA) into arguments in favor of religion. The theology of science–declare some entity which humans constructed to be real—leads in our days to circular thinking.

Neural correlates (e.g., [36]) of religions and spiritual experience across cultures and faith traditions and behavioral measurements document an extremely delicate process. Measuring disturbs; it also reflects, like in a mirror, those who measure and their views, no matter how much they try to remain "objective." We are exceptionally successful in measuring, but not by far as successful in transforming the data into actionable knowledge. Does gene sequencing break this vicious cycle? The organism is in a renewal dynamic with the DNA-RNA-protein one directional path postulated.

The four acids, identified through the letters G, C, A, T, (which are the initials of their names), also known as bases, are grouped in codons: groups of three. There are 64 possible ways to combine the four bases into groups of three (Fig. 5). The translation from codons to amino acids uses only 20 of them. It turns out that some genetic sequences lead to an efficient way of making proteins; others are less efficient. The environment, not the chemical make-up, explains why more protein is produced than necessary. The transfer RNA (tRNA) carries amino acids to the cell, which recognizes, in advance, i.e., in anticipation, the need to compensate for a poor environment. Anticipation is also present in avoiding the high cost (of energy and chemistry) of making proteins when not necessary.

Current sequencing means and methods embody the reactive-deterministic view inherent in the Turing machine. Therefore, the non-deterministic anticipatory component is usually omitted. Empirical evidence, i.e., documenting phenomena which take place in open systems (the living in the world), is of the nature of an open-ended record. To reduce it to genetic processes affords data describing parts of phenomena, but not their integrated nature. Let us consider, by way of an example, the energy consumed and the data collected in what can be described as adaptive performance. Indeed, in anticipation of adverse conditions, swarms of migrating birds or of fish change, respectively, flight altitude or swimming depth. Actually,

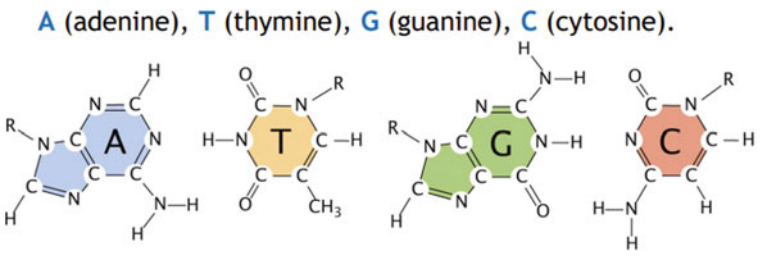

Fig. 5 From the acids of DNA to the convention of labeling them

they change the timeline (starting time)—and often the trajectory. It is quite clear that genetic processes of all kinds underlie Such adaptive behavior is related to genetic processes. Nevertheless, this behavior cannot be reduced to the genetic bases or to codons, to DNA, RNA (mRNA or tRNA), or to the process through which proteins are made in the real time of adaptive performance. There is anticipation at work informed by the integration of environmental cues of many types. Epigenetics might be the conduit assuming that it can trigger genetic processes not in reaction to stimuli but in anticipation of stimuli.

Anticipatory abilities, upon which higher performance (i.e., survival) depends, are acquired through learning. The organism is part of the world and interacts with it in terms of learning what it might mean for a particular organism or for an aggregate. The aggregate behavior (such as that of a swarm, of an ant colony, of communities, etc.) reflects the interdependence of organisms. If nothing else, the preparation for long migrations illustrates the nature of learning [37, 38]. So does the behavior of a beehive, and of those that are part of it, including its biome. And so do various forms of interaction that result in families, tribes, clans, communities, etc.

The notion of a "God gene," or of the genetics of spiritual activity is connected to human beings interacting. Francis Collins (among many reputable scientists) sees the entire universe through the "eyeglasses" of faith. Feynman, wearing the "eyeglasses" of quantum mechanics, would recognize that the complexity of life still escapes science, and thus remains a territory of explanation not aligned with scientific knowledge accumulated to date. The conclusion: We need better science. Indeed, wherever religion is invoked in matters pertaining to the dynamics of the world, the cry for a more adequate science should be heard. Religion is part of culture; as culture is changed by human activity (scientific progress included) the role of religion changes.

Within the anticipatory perspective, the spiritual—as religion or as aesthetic expression, ideas, the rich universe of feelings and emotions—is identified in acknowledging the possible future. It is against the background of culture that humans get access to understanding the very complex nature of all anticipation actions that contribute to the phenotype. If indeed the quest to know drives the human being, this awareness translates into representations that include not only atoms, electrons, chemical elements, and forces, but also meaning. Whether of religious or spiritual nature, or of other motivations (such as the competitive nature of everything that is alive), ethics—the compass of human action, in whose absence humanity dissolves—by necessity guides anticipatory actions. At the level of genetics, there is no room for it (or, as we shall see, Laplace would say: No need for this hypothesis).

6 The Last Question

It is understandable that questions pertaining to accepting or rejecting a higher authority (or a plurality of them) have been posed within a variety of scientific horizons. Laplace took note that the physics of the universe depended, in Newton's

system, on God's active role in maintaining the permanence of planetary movement. Moreover, Newton, like so many others, left the issue of the origin of the solar system open. The seductive narrative of Napoleon's asking the author of *Du Système du Monde* (The System of the World) whether it is true that God was missing in the explanation offers an indirect argument to our hypothesis. Laplace is direct: I had no need for that hypothesis. Yes, for him, everything was a nebula of extremely hot gas. This is the origin, the start. Lagrange, a no less impressive mathematician than Laplace, presumably was assuaging the emperor's worries: "Ah, it is a fine hypothesis; it explains many things." To know is by necessity to know for the future. Explaining, as Laplace did, how things work, is inconsequential. Neither the physics of Newton nor of Laplace, never mind of Einstein or of the quantum mechanics model transcend the initial question: the WHY? of the dynamics of the universe.

But there is in addition to the universe as subject of inquiry for physics and chemistry, also the universe of life—an ever-changing reality of a causality different from that of the solar system, of gravity, or of quantum phenomena. God was not a hypothesis in the ideas leading to models of organisms as machines, or as nothing other than the expression of their material composition. But unexpectedly, on examining physiology, anatomy, the brain, the chemistry of life (which is what DNA is part of), the WHY? question became a real avalanche of missing answers. Explanations are not what the divine authority is asked to provide: God, tell us why things fall down. God, tell us why people get sick. God, tell us who will become a genius or fail some exam. It is an infatuation with the future: survival, reproduction, well-being that leads to some explanations.

All activities upon which the future depends are guided by encompassing anticipatory actions. The line of argument in supporting the hypothesis articulated in this paper is straightforward: identify the variable; define the observables, present the findings (data and meaning) from descriptions of anticipatory processes; frame the God-hypothesis (or the arguments against it) in brain research and genetics. The larger questions regarding the future of religion were not part of our considerations. Only imagine, *ad absurdum*, that science (in whatever way it is understood and practiced) answered all questions pertaining to the future. It would disappear, as God and religion would. But life is an open-ended act of creations: something that never existed before continuously comes into the world, and thus change sets forth more change. As long as there is one unanswered question, God/gods/religion will stay with us humans (or whatever we might evolve into).

Acknowledgements Over many years, I've benefitted from conversations with and feedback from distinguished scholars, scientists, members of the antÉ Lab., and artists regarding religion and spirituality. Gratitude to Karoly Sohlmann, Germaine Acogny, Arthur Miller, Lotfi Zadeh, Jeffrey Nickerson, Benjamin Rubin, Paul Erdös, Solomon Marcus, Aharon Appelfeld, Esther Flath, Arthur Gelb, Leon Poliakoff, Edmund de Rothschild, Frank Gehry, Jaron Lanier, Edward Teller, Amos Oz, Arno Penzias, Jacques Derrida, Herbert A. Simon, Paul Friedman. I apologize to those who I have inadvertently not included.

Mariam Ashkaboozi provided help in illustrating some of the concepts discussed herein.

References

1. Peirce, C.S.: The ethics of terminology. In: Hartshorne, C., Weiss, P. (eds.): The Collected Papers of Charles Sanders Peirce (2.219-226). The Belknap Press of Harvard University Press, Cambridge MA (1932)
2. Nadin, M.: Anticipation—The End is Where We Start From. Lars Mueller Verlag, Basel (2003)
3. Pistori, S.: DNA Is Not a Blueprint, Scientific American (Observations/Opinions) February 6 (2020). https://blogs.scientificamerican.com/observations/dna-is-not-a-blueprint/. Retrieved June 1, 2022
4. Rosen, R.: Life Itself: A Comprehensive Inquiry Into the Nature, Origin, and Fabrication of Life. Columbia University Press, New York (1991)
5. Adam, J.J., et al.: Rapid visuomotor preparation in the human brain: a functional MRI study. Cogn. Brain Res. **16**(1), 1–10 (2003)
6. Nadin, M. (ed.): Anticipation (with annotated bibliography). Int. J. Gen. Syst. **39**(1) (2010)
7. Nadin, M. (ed.): Commitment to Knowledge. Learning from the Past. Early Soviet/Russian Contributions to a Science of Anticipation. Cognitive Science Monographs, vol. 25, pp.1–12. Springer, Cham, CH (2015)
8. Nadin, M.: To Live Art: Elements of Meta-Aesthetics (in Romanian, A Trai Arta). Eminescu, Bucharest (1972)
9. Nadin, M.: MIND-Anticipation and Chaos (Milestones in Thought and Discovery). Belser Presse, Stuttgart/Zurich (1991)
10. Rosen, R.: Anticipatory Systems: Philosophical, Mathematical and Methodological Foundations, International Series on Systems Science & Engineering, vol. 1. Pergamon Press, Oxford (1985)
11. Nadin, M.: An Integrated Mobile Wireless System for Capturing Physiological Data Streams During a Cognitive-Motor Task: Applications for Aging Motions (with Balakrishnan Prabhakaran, Gaurav Pradhan, Navzer Engineer). Proceedings of the Engineering in Medicine and Biology Workshop, 2007 IEEE Dallas, pp. 67–70. IEEE, Piscataway, November 2007
12. Nadin, M.: Integration of Motion Capture and EMG data for Classifying the Human Motions (with Prabhakaran, B., Pradhan, G., Engineer, N.) Proceedings of the IEEE 23rd International Conference on Data Engineering Workshops, Istanbul, Turkey, pp. 56–63 (April 17–20, 2007)
13. Nadin, M.: (with Prabhakaran, B., Pradhan, G., Engineer, N.) Analyzing Motoric and Physiological Data in Describing Upper Extremity Movement in the Aged in International Conference on Pervasive Technologies Related to Assistive Environments (PETRA 2008), July 16–19, 2008, Athens, Greece
14. Dinse, H.R.: Cortical reorganization in the aging brain. Prog Brain Res. **157**, 57–80 (2006). https://doi.org/10.1016/s0079-6123(06)57005-0. PMID: 17167904
15. Feynman, R.: Answering the question "why do we need god?" In: Davies, P., Julian Brown, J. (eds.) Superstrings: A Theory of Everything? Cambridge University Press, Oxford (1988)
16. Hamer, D.H.: The God Gene: How Faith is Hardwired Into our Genes. Doubleday, New York (2004)
17. Rizzolati, G., Sinigaglia, C.: The mirror mechanism: a basic principle of brain function. Nat. Rev. Neurosci. **17**, 757–765 (2016)
18. Ganesan, A.: Epigenetics: the first 25 centuries. Philos. Trans. R. Soc. B **373** (2018). https://doi.org/10.1098/rstb.2017.0067. Retrieved May 16, 2022
19. Waddington, C.H.: The Strategy of the Genes: A Discussion of Some Aspects of Theoretical Biology. Ruskin House/George Allen and Unwin Ltd., London (1957)
20. Deichmann, U.: Epigenetics: the origins and evolution of a fashionable topic. Dev. Biol. **46**(1), 249–254 (2016)
21. Kiefer, J.C.: Epigenetics in development. Dev. Dyn. **236**, 1144–1156 (2007)
22. Riegler, A: The role of anticipation in cognition. In: Dubois, D.M. (ed.) Computing Anticipatory Systems. Proceedings of the American Institute of Physics (2001). https://constructivist.info/riegler/pub/Riegler%20A.%20(2001)%20The%20role%20of%20anticipation%20in%20cognition.pdf. Retrieved 4/22/22

23. Guckelsberger, C., Polani, D.: Effects of anticipation in individually motivated behaviour on survival and control in a multi-agent scenario with resource constraints. Entropy **16**(6), 3357–3378 (2014)
24. Novoplansky, A.: Future perception in plants. In: Nadin M, (ed.) Anticipation Across Disciplines. Cognitive Systems Monographs, pp. 57–70. Springer, Cham (2016)
25. Harnett, N.G., et al.: Anticipation and the neural response to threat. In: Nadin, M. (ed.) Anticipation and Medicine, pp. 219–228. Springer, Cham (2017)
26. Petronis, A., Kenndy, J.L., Paterson, A.D.: Genetic anticipation: fact or artifact, genetics or epigenetics? Lancet Correspond. **350**, 9088, 1403–1404 (1997)
27. Gofur, N.R.P. et al.: Basic Understanding Anticipation Gene, Lead to Manifestation Oral Disease: A Review Article. Modern Approaches in Dentistry and Oral Health Care. (2021). https://lupinepublishers.com/dental-and-oral-health-journal/pdf/MADOHC.MS.ID.000193.pdf. Retrieved May 14, 2022
28. Kronholm, I.: Evolution of anticipatory effects mediated by epigenetic changes. Environ. Epigenet. **8**(1), 1–12 (2022). https://academic.oup.com/eep/article/8/1/dvac007/6550587?login=true. Retrieved May 10, 2022
29. Luo, Y. et al.: Well-being and anticipation for future positive events: evidences from an fMRI study. Front. Psychol. (2018). https://doi.org/10.3389/fpsyg.2017.02199. Retrieved May 3, 2022
30. Lind, M.I., Spagopoulou, F.: Evolutionary consequences of epigenetic inheritance. Heredity **121**(3), 205–209 (2018)
31. Yehuda, R., et al.: Cortisol levels in adult offspring of Holocaust survivors: relation to PTSD symptom severity in the parent and child. Psychoneuroendocrinology **27**(1–2), 171–180 (2002)
32. Crocker, K.: Parents' emotional trauma may change their children's biology. Studies in mice show how. Suffering triggers changes in gene expression that last for generations. (Interview with A. Curry). Science (2019). https://www.science.org/content/article/parents-emotional-trauma-may-change-their-children-s-biology-studies-mice-show-how. Retrieved June 22, 2022
33. Kronholm, I., Collins, S.: Epigenetic mutations can both help and hinder adaptive evolution. Mole. Ecol. **25**(8), 1856–1868 (2016)
34. Woolston, C.: Faking it. Nature **529**, 555–557 (2016). https://doi.org/10.1038/nj7587-555
35. Collins, F.S.: The Language of God. Free Press, New York (2006)
36. Ferguson, M.L., et al.: Reward, salience, and attentional networks are activated by religious experience in devout Mormons. Soc. Neurosci. **13**, 1 (2018)
37. Barrie, D.: Supernavigators: Exploring the Wonders of How Animals Find Their Way. The Experiment, New York (2020)
38. Gould, J.L., Grant Gould, C.: Nature's Compass: The Mystery of Animal Navigation. Princeton University Press, Princeton NJ (2012)
39. Nadin, M., Naz, A.: Architecture as service: a case for design on demand (DoD). J. Amb. Intell. Human. Comput. **10**, 4751–4769 (2019). https://doi.org/10.1007/s12652-018-1147-y
40. Scott (2020)