Neuroscience and Religion

(Second in a series of four sermons on heeding the guidance of reason and the results of science)

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Readings

Charles Darwin, as quoted in Dean Buonomano's new book "Brain Bugs", wrote, "The same high mental faculties which first led man to believe in unseen spiritual agencies, then in fetishism, polytheism, and ultimately in monotheism, would infallibly lead him, as long as his reasoning powers remained poorly developed, to various strange superstitions and customs."

Dean Buonomano himself states in the same book, "The history of science, medicine, politics, and business is littered with examples of obstinate adherence to old customs, irrational beliefs, ill-conceived policies, and appalling decisions. Similar penchants are also observable in the daily decisions of our personal and professional lives. The causes of our poor decisions are complex and multifactorial, but they are in part attributable to the fact that human cognition is plagued with blind spots, preconceived assumptions, emotional influences, and built-in biases."

These are pretty damning words. But they are also a powerful stimulus to probing <u>why</u> this indictment is so true, and this leads right into neuroscience. This morning, I'm going to share with you just a few ways in which neuroscience and religion intersect, but I'm not going to lay all these human shortcomings at the feet of religion! They belong more at the feet of evolution, which has saddled us with powerful vestiges of behaviors better suited to primeval survival than modern day adaptation.

First, let's define neuroscience.

What is Neuroscience?

Neuroscience is the study of the nervous system in any organism that has one. Key elements of a common nervous system are a brain and a network of nerves that carry signals to and from the brain. Since today we want to consider the possible connection neuroscience might have with religion, I assert that we can safely focus on the brain and set the external network of nerves aside. And since there is probably little disagreement with the idea that only humans embrace religion, we can move right to the heart of the matter: What can brain science tell us about religion and vice versa?

The Human Brain

The human brain weighs about three pounds and contains about 100 billion (10^{11}) neurons with 100 trillion (10^{14}) interconnections operating at a rate of about 100 quadrillion (10^{17}) operations per second. By comparison, today's fastest supercomputers are capable of peak operating speeds of about one one-hundredth of that, or one quadrillion (10^{15}) operations per second. The brains of larger mammals weigh more than those of humans, but the architecture of the human brain, with its many folds and fissures, renders it far more capable. Comparing the brain to a supercomputer leads immediately to the question of whether it might someday be possible to actually simulate a human brain with a computer, thus imbuing it with all the powers of its biological equivalent. Science fiction writers have had a field day with this concept, and some scientists have even gone so far as to posit the possibility that our entire universe might actually be a simulation run by a distant, extremely advanced civilization. (I'll come back to that in my next talk in early February on cosmology and religion.) Brian Greene, in his new book, The Hidden Reality, lays some groundwork for considering brains as "simulatable" by briefly describing the Blue Brain project, a joint venture between IBM and the Ecole Polytechnique Federale in Lausanne, Switzerland.

This project "is dedicated to modeling brain functions on IBM's fastest supercomputer. Blue Gene (that's Blue G-E-N-E), as the supercomputer is called, is a more powerful version of Deep Blue, the computer that triumphed in1997 over the world chess champion Garry Kasparov. Through painstaking anatomical studies of real brains, researchers are gathering ever more precise insight into the cellular, genetic, and molecular structure of neurons and their interconnections. To date, researchers have drawn on results from tens of thousands of experiments (probably "simulation runs" is a better term) focused on a pinhead-sized section of a rat brain, the neocortical column, to develop a three-dimensional computer simulation of roughly 10,000 neurons communicating through some 10 million interconnections. Comparisons between the response of a real rat's neocortical column and the computer simulation to the same stimuli show an encouraging fidelity of the synthetic model. This is far from the 100 billion neurons firing away in a typical human head, but the project's leader, the neuroscientist Henry Markram, anticipates that before 2020 the Blue Brain Project … will achieve a full simulated model of the human brain."

This is a scientist of the *functionalist* school of brain science talking here. This school holds that it doesn't matter how a network of excitable elements and synapses is physically realized, be it in living cells or silicon – if the numbers and architecture are the same, the output is the same. Other scientists, however, subscribe to *dualist* theories that maintain there is an essential nonphysical component vital to mind. To me, this is a very interesting dichotomy that can lead one to ask a number of questions that would seem logically to fall in the realm of religion and that theologians might wish to respond to.

Religion Part A and Part B

Before sharing some of these questions, however, I'd like to digress briefly and introduce my concept of Religion Part A and Religion Part B that I hope will help simplify the rest of today's talk as well as February's talk and the last one in June, tentatively titled "Faith and

Probabilities". I define Religion Part A as those religious concepts and beliefs that involve the supernatural – virgin birth, resurrection from the dead and predestination as examples. And by supernatural, I mean phenomena that have no scientific basis – they violate all known laws, they are not reproducible, and evidence of them is sketchy and questionable at best. Religion Part B essentially includes what's left, mainly the admonitions for living an upright, constructive and hopefully happy life, some of which are just as valid today as they were the millennia ago when they first evolved, while, sadly, others were either misguided to start with or have certainly become so with the passage of time, the role of women in society being a prime example. Not surprisingly, to me anyway, the most stimulating debates emanate from the intersection between brain science and Religion Part A, although there is certainly much that can be said as well about brain science and Religion Part B.

Now back to the questions…

1. Whether you are a dualist or a functionalist, what is that magic number of neurons and synapses (or circuit elements and interconnections if you're into silicon instead of cells) you believe is necessary for a brain to imbue its owner with a soul, that essence of a person thought to be above mere data processing and possessing of some form of immortality. How did you arrive at this number? If you can't conceive of a way to calculate this number, does that imply that our definition of soul may be off base?
2. Somewhat related to the first question, do animals have minds and souls? If so, which do and which don't and how did you decide? If some do, should we treat them differently from those that don't?
3. What does life after death require in terms of brainpower? Is only mankind eligible, or can some of the other mammals – dolphins, for example – qualify? Said another way, is there a doggy heaven?

You get the idea here – brain science is not leading us to a clear understanding of how some aspects of Religion Part A is manifested in our neurons and synapses, that is, how, for example, some form of immortality can be harbored there.

The God Gene

But there's more to the story of human brains and religion than you might think at this point. While brain science does not support religious supernaturalism (Part A) per se, it does reveal variations in people's predilections towards it. In 2004, Dean Hamer published a book called "The God Gene" with the subtitle, "How Faith is Hardwired into Our Genes". Let me share some of his insights with you. Notwithstanding the mechanistic characterization of the human brain above, making them all sound alike, there are clearly differences among them from one individual to the next, some quite distinct. Personality types, intelligence, talents, precociousness, psychopathy, left handedness and sexual orientation, while influenced to varying degrees by an individual's environment, all have their roots in the brain, as does spirituality, the main topic of Hamer's book.

A Few More Fundamentals of Brain Science

Before we get to Hamer's principal findings, let's go back to the 100 billion neurons that make up the human brain and talk a little about them and how they work. This is necessary in order to understand some major points about brain chemistry and in turn how genetics can play a role in differentiating one brain from another, and thus in many ways, one person from another. A neuron comprises a cell body containing a nucleus and having hairlike dendrites protruding from it plus an axon, or long, branching trunk, that can range far and wide within the brain. At the end of each branch of the axon is a small knob called a terminal button. Signals are sent from a neuron via the axon and received by the neuron via the dendrites. In each terminal button are vesicles – membrane sacks – that contain signaling molecules. One neuron signals another by releasing these signaling molecules,

which travel across a tiny gap called a synapse and attach to receptors on the dendrites of an adjacent neuron. Now what complicates matters but at the same time allows the brain to function in many different ways is that there is a variety of signaling molecules, some of which are from a class of organic chemicals called monoamines, and an even greater variety of receptors. In a sense, each signalling molecule – receptor pair and the pathways that use it make up a distinct communication network within the brain, and these networks function in their own very specific locations. Think of Verizon, T-Mobile, AT&T, Sprint and any other cell phone service providers plus a couple of landline phone companies coupled to their various service areas and you get the idea.

Two of the signaling molecules most often mentioned in brain chemistry studies are dopamine and serotonin, and it is well established that some phenomena that affect the ebb and flow of either of these two molecules manifest themselves in very noticeable ways, while other effects are more subtle. Dopamine is sometimes referred to as the “feel good” chemical or the “reward” chemical. It makes people feel good rather than just not bad, sociable rather than just not hostile. The use of cocaine, for example, releases extra amounts of dopamine. Dopamine is also the signaler involved in neurons projecting into the brain’s striatum, which is involved in motion control. When these particular neurons degenerate, an individual loses bodily motor control and experiences tremors. This is Parkinson’s disease.

Serotonin, on the other hand, might be termed the “don’t feel bad” chemical, although its massive release prompted by a dose of Ecstasy, for example, causes strong mood elevation while killing the cells that make it. This, in turn, leads to long-term depletion, which can result in severe depression, loneliness, and even suicide. Prozac, an anti-depressant, works by slowing the uptake of serotonin following its normal release, thus maintaining its activity for a longer period.

Not surprisingly, the intensity and effectiveness of these brain networks in doing various jobs in the brain depend heavily on the numbers and structures of the many proteins that allow them to function, and these, in turn, are related to the person's genome. Remember, anytime one talks about the body's proteins – enzymes, hormones, receptors, platelets, hemoglobin, and so on – one is referring indirectly to the body's DNA, which provides the instructions for making all these complex molecules. Many of the differences among humans result from the fact that about one information letter (A, C. G, or T) in 1,000, or 0.1%, is different from one individual to the next in the human genome of 35,000 or so genes.

Spirituality and the God Gene

Struck by the predilection of certain individuals toward meditation, mysticism, and other spiritual practices, Hamer decided to investigate whether there was any relation between those individuals' genomes and this predilection. He drew heavily on the work of Robert Cloninger, a psychiatrist at the Washington University Medical School in St. Louis, who had developed a method of defining and quantifying spirituality. To Cloninger, spirituality is <u>self-transcendence</u>, which he sees as a mixture of self-forgetfulness, transpersonal identification, and mysticism. It manifests an ability to get totally absorbed in a task and lose all sense of time and place, to become deeply, emotionally attached to other people, animals, trees, flowers, streams, or mountains, and to be drawn to things that can't be explained by science. A 240-question true-false psychological test known as the Temperament and Character Inventory or TCI measures self-transcendence as one of seven dimensions of personality. Hamer came across the TCI while collecting data at NIH related to the genetics of cigarette smoking, lest you think NIH is in the business of looking at health through the eyes of religion and spirituality. Yet there is a connection, which I'll

get to shortly. At the same time, it is important to note that spirituality and religion are not the same, although they are related, and I'll expand on that as well.

So, armed with a way to measure spirituality, Hamer turned to the possible correlation with genetics. The most common means for isolating the genetic contribution to a personality trait is by studying twins, especially identical twins. Even better is looking at identical twins who have been raised in separate environments. Alternatively, since identical twins raised apart are rare, it is possible to look at differences between identical and fraternal twins, each pair raised in the same environment, to calculate the heritability of a specific trait. The greater the difference between the identical and fraternal twins, the greater is the degree of heritability. Hamer took note of a famous study, the so-called "Minnesota Experiment", that examined 53 pairs of identical twins and 31 pairs of fraternal twins, all raised apart. The Minnesota researchers found that when measuring for the degree of intrinsic religiousness exhibited by the twins, the heritability of this trait came out to be 43 percent. That is to say, nearly half of the reason the twins manifested a particular degree of religiousness, that is, feeling that religion helped them, spent time privately praying, and had a sense of God's presence, was inherited.

Getting back to spirituality, in 1999, scientists Nicholas Martin, Lindon Eaves, and Katharine Kirk analyzed results from health and lifestyle questionnaire returned by over 3,000 twins from the Australian National Health and Medical Research Council Twin Registry. They found that genes were responsible for 48 percent of the variation in self-transcendence in the twins, both male and female. Using a second analysis technique, they calculated estimated heritabilities of 37 percent for men and 41 percent for women, not too different from the first analysis. Their conclusion was clear: Genes are a major factor in self-transcendence, just like with religiousness. This and other evidence compelled Hamer to dig further – could the one or more specific genes be found that differentiated a highly

spiritual person from one much less so? And, if so, could the mechanism or mechanisms by which these genes worked be elucidated? To understand this sort of work, one has to have a basic familiarity with DNA (deoxyribonucleic acid) – the famous double helix molecule – especially how it represents genetic information. It's alphabet soup, but the alphabet has only four letters – A for adenine, C for cytosine, G for guanine, and T for thymine, all from two families of organic molecules called purine and pyrimadine bases. One half of the helix contains one string of A's, C's, G's and T's, and the other a complementary string such that every A hooks up with a T and every C with a G. Thus a specific segment of DNA can be represented as a list of A's, C's, G's and T's that can occur in any order, but the actual order is very important – it spells genetic "words", unpronounce-able, of course, and some of these words, containing from 25,000 to 50,000 letters, are actual genes. What is also very important is that there can be variations in some of the letters and still have a functioning gene, giving rise to variability in the effectiveness of the gene, usually through subtle differences in the structure of the proteins it encodes. To cut to the chase, Hamer administered the TCI to 1,001 subjects and collected samples of their DNA. Clever sleuthing and first-rate laboratory techniques led to the isolation of a gene called VMAT2 located on chromosome 10 (of 23 pairs) that came in two versions, one with a "C" in a specific location and the other with an "A" there. Those individuals with a "C" in one or both of their chromosomes scored significantly higher on the self-transcendence scale than those with only "A's" in that spot on both chromosomes. To quote Hamer, "Somehow, this single-base change was affecting every facet of self-transcendence, from loving nature to loving God, from feeling at one with the universe to being willing to sacrifice for its improvement." As to how this gene works, it codes for a protein that packages all the different monoamine neurotransmitters – remember dopamine and serotonin -- into secretory vesicles for storage, thus affecting the brain's ability to employ these transmitters more collaboratively. That's it in a nutshell (or vesicle, if you will). This is not to say there

is only one gene that affects human spirituality, but that there is at least one. Now since this gene has not gone away – some but not all genes tend to do this if they don't convey some reproductive advantage – we are left with the question of whether spirituality, and religiousness for that matter, enhances human procreation and survival and, if so, how. Since I'm out of time, I will leave that question for you to ponder. And maybe I'll pick it up in my wrapup talk in early June.

Thank you.