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THE ORIGIN OF THE BRAIN AND MIND [PART I]

Brad Harrub, Ph.D. and Bert Thompson, Ph.D.

[EDITOR'S NOTE: For more than a year, Dr. Harrub and I have been working on a multi-part series of articles on the origin of the brain/mind, and the origin of consciousness—two of the three most obviously insurmountable problems in evolutionary theory (the third being the origin of gender and reproduction—a subject we examined in detail in the October and November 2002 issues of *Reason & Revelation*). The first two installments (on brain/mind matters) are planned for publication in January and February. There will be a break in March (for discussion of a Bible-related subject), and then the last two installments (on consciousness) will appear in April and May. As our regular readers are aware, we strive to produce articles in *R&R* that represent the latest, most up-to-date research, and that always are "cutting edge" in their approach. After you have read this four-part series, we believe you will conclude that, on these two critically important topics, we have done exactly that. I hope you enjoy, and profit from, the articles.]

INTRODUCTION [Brad Harrub]

On July 17, 1990, U.S. President George H.W. Bush proclaimed the years between 1990 and 2000 as the "Decade of the Brain," and declared that this proclamation was specifically intended "to enhance public awareness of the benefits to be derived from brain research" through "appropriate programs, ceremonies, and activities." Millions of grant dollars were shifted toward neurobiological studies, in order to encourage neuroscientists to try to answer some of the most basic questions in this important area.

It was during this "decade of the brain" that I found myself completing my doctorate in the neurobiology department at the University of Tennessee Medical School. Those years of in-depth study taught me a great deal about the anatomy and physiology of the brain, and about how it works within the body as a whole. But they also taught me that, as scientists, we are far from unlocking all the secrets that this incredible organ holds. In fact, scientists are not always agreed as to how (or if!) we can unlock the remaining secrets. We now possess the ability to record the activity from a single neuron located deep within the brain, but we can only speculate about the role that particular activity plays in such things as thoughts, memories, or emotions. The more we learn about this complex group of cells, the more we realize we do not know much about the "big picture."

For example, I vividly recall one occasion in a graduate class, during which my fellow students and I were asked to explain the molecular events that transpire when a neuron fires. The professor phrased the question something like this: "Suppose for a minute that you wanted to remember a phone number; what specific events would take place at the cellular level within the basal ganglia during that thought process?" After a somewhat extended discussion concerning calcium and sodium channels, a student toward the back of the class spoke up rather boldly and inquired, "Yeah, but where would that phone number be stored, and exactly how does the brain remember things?" The professor's answer was profound for its ignorance: "We don't know!"

THE "AMAZING" BRAIN

Read the following sentence: *Mom had hot apple cider ready for us on that cold snowy day.* In the few seconds required for you to complete the sentence, your brain already had carried out a vast multitude of tasks. Initially, your eyes focused on the piece of paper on which the sentence was written, and then transmitted the visual stimuli (chemically—via your optic nerve) to your brain. The brain, upon receiving that chemical signal, immediately recognized the symbols on the page as English

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letters. It then compiled those letters into a comprehensible sentence (using rules you were taught in elementary school), which it then analyzed and stored. In addition, your brain very probably painted a mental image of both the snowy day and your mother. You may even have found yourself suddenly craving a mug of steaming-hot apple cider. Also during that short span, your ears reported the sounds they were detecting, and your nose constantly was sampling the air for new odors. All the while, your brain was busily maintaining your body at homeostasis—that is, it signaled your heart to beat and your lungs to respire, it measured the hormone levels in your bloodstream (making adjustments as needed), and relayed any pain or other sensations that you might be feeling during those few short seconds. And all of this is merely the proverbial "tip of the iceberg."

The brain, and the nerves associated with it, carry out countless physiological functions, most of which we understand at only a very basic level. And therein lies the enigma surrounding the brain. How can we take three pounds of matter, and in that small space cram all of our education, memories, emotions, likes and dislikes, and communication skills—yet, all the while it is those same three pounds of matter that keep our heart beating, cause our lungs to respire, and give us a detailed internal map of the position of our arms or legs? How is it that a certain smell instantaneously can carry us back to a period in our childhood, offering us crystal-clear images of that particular time in our life? Exactly how is it that we are able to distinguish between a banana and an orange, just by using our nose? What chemical reactions convince us which fruit is the orange? **Where** is that memory stored, and how long will that particular memory **remain** stored? What part of our brain controls emotions? Where do we "put" feelings like love and hate? How is it that the mere sound of one voice can illicit calm, while the sound of another can cause our blood pressure to climb? In fact, why is it that humans love (or hate) at all?

As vexing as these questions are, they are even more troubling for those who espouse the idea that the brain is the result of evolution. They would like us to believe that the brain is nothing more than an advanced computer that receives input (via the senses). After that input snakes through neuronal circuits, output is the end result. Input equals output. Robert Ornstein and Richard Thompson commented:

> What exists as only a few extra cells in the head of the earthworm, handling information about taste and light, has evolved in us humans into the incredibly complex and sophisticated structure of the human brain.... After thousands of scientists have studied it for centuries, the only word to describe it remains **amazing** (1984, pp. 21-22, emp. in orig.).

These sentiments no doubt are shared by numerous individuals who chalk up the brain's existence to happenstance, yet who stand in utter awe of all that this "amazing" organ is able to accomplish.

Is the brain merely the product of evolution, or were humans actually created differently than animals? Truth be told, evolutionists have yet to begin to understand how this unique organ can perform so many varied functions—simultaneously and with such marvelous precision. There is one thing, however, they **do** know: **the brain did *not* have a Creator!** It simply "happened"—via organic evolution.

HISTORY OF THE BRAIN

The earliest known reference to the human brain anywhere in historical records was written on papyrus in the seventeenth century B.C. (see Breasted, 1930). According to James Breasted, the archaeologist responsible for translating and publishing the contents of that document, the word "brain" occurs only eight times in Egyptian history, six of them being on the pages of the Smith Papyrus in a description of the symptoms, diagnosis, and prognosis of two patients suffering from compound fractures of the skull.

The organ that we commonly refer to as the brain has not always held a revered status in the eyes of men. In fact, the brain was given little importance by ancient Egyptians, who believed that it cooled the body, and did little else. As these skilled preservers of the dead prepared bodies for mummification, they excised the brain through the nose with a wire loop, and then discarded it. Often, the brain simply was tossed into the sand (primary attention was given to the heart, which they considered the most important organ of the body). The classical Greeks, to whom we owe so many ideas, also were divided over whether the heart or the brain served as the seat of one's intellect. The famed Hippocratic writers rightly believed the brain to be the dominant location for things like intelligence and passion. Plato also taught that the brain was the "supreme organ" of the body, assigning to it such things as emotions, passions of the heart, and even appetites of the belly. Aristotle, a student of Plato, contended on the other hand that the heart was the center of both thought and sensation, while the brain worked as a refrigerator to cool the heart (which is ironic, now that we know the brain generates the most heat!). And so, the debate continued for centuries.

At the time the Old Testament was translated into Greek (a task that was completed during the second century B.C.), the majority of people seemed to adhere to Aristotle's viewpoint, believing that the heart

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Editor:

Bert Thompson, Ph.D.*
(*Microbiology, Texas A&M University)

Associate Editor:

Brad Harrub, Ph.D.*
(*Neurobiology, University of Tennessee)

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was the center of understanding. The Scriptures are replete with references to man's intellect and emotions as residing in "the heart"—what we now refer to as "the mind." The King James Version of the Bible lists 830 occurrences of the word heart in over 762 verses. Just a short period after Christ walked this Earth, a philosopher named Galen (A.D. 130-200) recognized Aristotle's mistake, and noted that the "power of sensations and of movement flows from the brain," and that "what is rational in the soul has its existence there" (as quoted in Fincher, 1984, p. 13). He went on to question: "Why is the brain capable of cooling the heart, and why is the heart not rather capable of heating the brain which is placed above it, since all heat tends to rise? And why does the brain send to the heart only an imperceptible nerve, while all the sensory organs draw a large part of their substance from the brain?" Unfortunately, early human anatomy was based on a combination of animal dissections and fertile imagination, which only perpetuated the confusion, allowing Shakespeare (1546-1616) to have Portia inquire: "Tell me, where is fancy bred, Or in the heart or in the head?"

Great discoveries about human physiology and the structure of the human brain were made during the Renaissance Period. Leonardo da Vinci discovered that he could pour melted wax into the ventricles (open spaces) of an ox brain, and then strip away the flesh after the wax had cooled. The wax model that resulted, represented the true shape of the cavities, which had remained clandestine within the brain for millennia. In the nineteenth century, the debate over the brain/mind erupted into a furor, led by these famous words:

"What is mind?" —"No matter."
"What is matter?" —"Never mind."

Eventually, anatomy revealed the truth, and cardiocentric believers found themselves jarred by the fact that during embryonic formation, nerves developed directly from the brain, while blood vessels developed independently from the heart. Further human dissections firmly established that the heart was more or less a pump, while the brain held all of the intricate secrets of consciousness and the senses, including emotions such as love. However, some theories die hard. For instance, we challenge you to find a Valentine's card containing a picture of a **brain** with an arrow going through it. While we know that the heart is not the center of our emotions, many people still make references such as "you always will hold a special place in my heart."

Thus, after years of deliberation and conjecture, the cerebral cortex began to be viewed as more than a mere "radiator" for the heart. Paradoxically, before men even speculated on its higher functions, part of the answer already had been deciphered. French physician and mathematician René Descartes (1596-1650) wrote: "...[I]t is to be conceived that the motor force, or the nerves themselves, take their origin from the brain, where fantasy is located" (as quoted in Fincher, p. 16). During Descartes' lifetime, a series of important biological discoveries rocked the scientific world, and stimulated Descartes to probe the brain. He was devoutly religious, and his philosophy was a bold attempt to reconcile scientific methodologies while remaining true to his faith in God. Descartes was the one who penned those famous words, "*cogito ergo sum*" ("I think, therefore I am"). Accordingly, Descartes defined thinking as the whole range of conscious mental processes—intellectual thoughts, feeling, will, and sensations. He was of the firm opinion that the mind always worked, even during periods of sleep.

The brain carries out countless physiological functions, most of which we understand at only a very basic level.

Descartes constructed a complete and total division between mind and body—one far more drastic than Plato's. Descartes' work was extremely important because it established "a modern philosophical basis for the belief that a human being lives a dual existence involving a spiritual soul and a body" (Elbert, 2000, p. 217). [NOTE: We will have much more to say about this aspect of Descartes' research in our discussion of the origin of consciousness.] However, Descartes believed that the body and soul interacted at a particular place, and he unfortunately felt obligated to try to determine that place. Due to the insufficient knowledge of his day, he concluded that the interaction took place in the pea-sized pineal gland—a structure that we now recognize as an endocrine gland that is responsible for the manufacture and secretion of melatonin, in accordance with our circadian rhythms.

THE EVOLUTION OF THE BRAIN

If you were to walk into a neuroanatomy class at a university medical school, you very likely would find fifty or more white porcelain buckets—each filled with preservative fluids, and containing a human brain that had been collected from a donor cadaver. The first thing you would notice as you examined the physical mass of the brain probably would be the various convolutions/wrinkles (known as sulci) that cover the entire surface. Had the brain not been soaking for weeks in a fixative such as formaldehyde, you would be able to see that the brain itself is extremely soft, with an almost custard-like consistency. Upon slicing the brain in half, you would be able to observe what appeared to be striations in various areas, and you would find var ious hollow ventricles that normally are bathed in cerebrospinal fluid. Hidden within this inelegant and unimpressive gray and white tissue happens to be the most intricately wired communication network in the world.

Those three pounds of "matter" consist of literally billions of interconnected nerve cells and millions of protective glial cells—which, according to evolutionists, arose from nonliving matter as a result of the effects of time, chance, and natural law. The brain has been estimated to contain 100 billion (10^{11}) neurons (Kandel, 1991, p. 18), each of which is a living unit within itself. While most neurons share similar properties, they nevertheless can be classified into "perhaps as many as 10,000 different types" (p. 18). Over 100 thousand billion electrical connections are estimated to be present throughout the human brain, which, it has been said, represent more than "all the electrical connections in all the electrical appliances in the world." In describing this incredibly awesome organ, R.L. Wysong wrote:

> The human brain weighs about three pounds, contains ten billion neurons with approximately 25,000 synapses (connections) per neuron. Each neuron is made up of 10,000,000,000 macromolecules. The human mind can store almost limitless amounts of information (a potential millions of times greater than the 10^{15} bits of information gathered in a lifetime), compare facts, weigh information against memory, judgment and conscience, and formulate a decision in a fraction of a second (1976, p. 340, parenthetical item in orig.).

The brain is arguably the most unique organ in the entire body—not merely because of its physical make-up, but because of **what it does** and **how it does it**. As evolutionist George Bartelmez put it a number of years ago: "Only a single fundamental organ has undergone great specialization in the genus *Homo*. This is the brain" (1926, p. 454). Today, from an evolutionary perspective, that assessment still is viewed as correct. As Donald Johanson and Blake Edgar observed seventy years later:

> This change in both size and shape represents one of the most remarkable morphological shifts that has been observed in the evolutionary history of any mammal, for it entailed both an enhanced cranial capacity and a radical reorganization of brain proportions (1996, p. 83).

Personally, we believe that the brain deserves a great deal more respect than evolutionists are willing to afford it. The late evolutionist Isaac Asimov characterized the human brain as "the most complex and orderly arrangement of matter in the universe" (1970, p. 10). When Paul Davies, professor of mathematics and physics at the Universe of Adelaide, referred to it as "the most developed and complex system known to science" (1992, 14[5]:4), he did not overstate the case. Sherwin Nuland, in *The Wisdom of the Body*, wrote in regard to the brain:

> Though the three pounds represent a mere 2 percent of the body weight of a 150-pound person, the quartful of brain is so metabolically active that it uses 20 percent of the oxygen we take in through our lungs. To supply this much oxygen requires a very high flow of blood. Fully 15 percent of the blood propelled into the aorta with each contraction of the left ventricle is transported directly to the brain. Not only does the brain demand a large proportion of the body's oxygen and blood, but it also begins its life requiring an equivalent share, or even more, of its genes. Of the total of about 50,000 to 100,000 genes in *Homo sapiens*, some 30,000 code for one or another aspect of the brain. Clearly, a huge amount of genetic information is required to operate the human brain.... From all of this emerges the brain's overarching responsibility—it is the chief means by which the body's activities are coordinated and governed (1997, pp. 328, 346).

James Trefil addressed the brain's complexity when he wrote:

> The brain is a physical system. **It contains about 100 billion interconnected neurons—about as many neurons as there are stars in the Milky Way galaxy**.... In the end, by mechanisms we still haven't worked out (but we will do so!), these signals are converted, by neurons in different parts of the brain, into the final signals that produce images or smells or sounds... (1996, pp. 217-218, parenthetical item in orig., emp. added).

Be sure not to miss Trefil's admission that the brain works "by mechanisms we still haven't worked out." Ian Tattersall, in his book, *Becoming Human*, wrote in a similar fashion in describing the brain's marvelous sophistication—while admitting that "there's a huge amount that we don't know."

> [T]he brain is an extremely power-hungry mechanism that, because of its size, monopolizes some 20 percent of our entire energy intake.... But the matter doesn't rest there, for sheer brain size is far from the full story. **The organization—the structure—of our brains is also unique, and it is this that appears to hold the ultimate key to our remarkable cognitive powers**. There's a huge amount, of course, that we don't know about how the brain works and especially about how a mass of chemical and electrical signals can give rise to such complex effects as cognition and consciousness (1998, pp. 69,70, emp. added).

The point in Dr. Tattersall's last sentence is well taken. There is a "**huge amount that we don't know**"—including (among other things) how "a mass of chemical and electrical signals" can give rise to such complex effects as cognition and consciousness. [Pardon us if we are more than a little skeptical of Trefil's exuberant suggestion, "but we will do so!" On this matter, we are in complete agreement with Robert Jastrow of NASA, who candidly admitted:

> Is it possible that man, with his remarkable powers of intellect and spirit, has been formed from the dust of the earth by chance alone? It is hard to accept the evolution of the human eye as a product of chance; it is even harder to accept the evolution of human intelligence as the product of random disruptions in the brain cells of our ancestors.... Among the organs of the human body, none is more difficult than the brain to explain by evolution. The powers that reside in the brain make man a different animal from all other animals (1981, pp. 98-99, 104).]

Tattersall noted: "Little as we understand the highly complex workings of our brains in producing consciousness, it is clear that there is a 'whole brain' effect in the production of our prized awareness" (2002, p. 73). Unfortunately, the "whole brain" idea does not get us very far, as Daniel Dennett admitted in *Consciousness Explained*.

> [T]he trouble with brains, it seems, is that when you look in them, you discover that **there's nobody home**. No part of the brain is the thinker that does the thinking or the feeler that does the feeling, and the whole brain appears to be no better a candidate for that very special role (1991, p. 29, emp. in orig.).

Yet in spite of the fact that when we look at the brain, "there's nobody home," and in spite of the fact that "neuroscience is said to be awash with data about what the brain does, but virtually devoid of theories about how it works" (Lewin, 1992, p. 163), there are some things we **do** know.

> The brain, although being **the most complex structure existing on Earth—and perhaps in the Universe**—is a well-defined object: it is a material entity located inside the skull, which may be visualized, touched and handled. It is composed of chemical substances, enzymes and hormones which may be measured and analyzed. Its architecture is characterized by neuronal cells, pathways and synapses. Its functioning depends on neurons, which consume oxygen, exchanging chemical substance through their membranes, and maintaining states of electrical polarization interrupted by brief periods of depolarization (Cardoso, 1997/1998, emp. in orig.).

> The brain is a helmet-shaped mass of gray and white tissue about the size of a grapefruit, one to two quarts in volume, and on average weighing three pounds (Einstein's brain, for example, was 2.75 pounds). Its surface is wrinkled like that of a cleaning sponge, and its consistency is custardlike, firm enough to keep from puddling on the floor the brain case, soft enough to be scooped out with a spoon.... **The human genome database accumulated to 1995 reveals that the brain's structure is prescribed by at least 3,195 distinctive genes, 50 percent more than for any other organ or tissue**... (Wilson, 1998, p. 97, parenthetical item in orig., emp. added).

> Some overall descriptions of the properties of the human brain are instructive. For instance, **10 billion neurons are packed into the brain, each of which, on average, has a thousand links with other neurons, resulting in more than sixty thousand miles of writing. Connectivity on that scale is beyond comprehension**, but undoubtedly it is fundamental to the brain's ability to generate cognition. Although individual events in an electronic computer happen a million times faster than in the brain, **its massive connectivity and simultaneous mode**

> **of activity allows biology to outstrip technology for speed**. For instance, the fastest computer clocks up a billion or so operations a second, which pales to insignificance beside the 100 billion operations that occur in the brain of a fly at rest.... To say that the brain is a computer is a truism, because, unquestionably, what goes on in there is computation. But so far, no man-made computer matches the human brain, either in capacity or design.... Can a computer think? And, ultimately, can a computer generate a level of consciousness... (Lewin, 1992, pp. 160,163, emp. added).
>
> The human brain's increase in neurons is due to its greater size, not to greater density, since humans have only about 1.25 as many neurons per cubic centimeter as chimpanzees do. There are approximately 146,000 neurons per square millimeter of cortical surface. The human brain has an area of about 2,200 square centimeters and about 30 billion neurons (more than assumed until quite recently). The chimpanzee and the gorilla have brains of about 500 square centimeters, and with about 6 billion neurons (Ornstein, 1991, p. 63, parenthetical item in orig.).

Can anyone—after reading descriptions (and admissions!) like these—really believe that the human brain is "only another organ" as Michael Lemonick claimed in *Time* magazine (2003, 161[3]:66)? Not without denying the obvious! In the January 16, 1997 issue of *Nature*, Sir Francis Crick's close collaborator, Christof Koch, wrote: "The latest work on information processing and storage at **the single cell (neuron) level reveals previously unimagined complexity and dynamism**" (385:207, parenthetical item in orig., emp. added). His concluding remarks were: "As always, we are left with a feeling of awe for the amazing complexity found in Nature" (385:210). "Amazing complexity" indeed! Talk about profound understatement. One would be hard pressed to top that single sentence.

And this point certainly has not been lost on evolutionists. For example, in the preface to his highly acclaimed book, *The Blind Watchmaker*, Richard Dawkins commented on the brain's incredible complexity and its "apparent design," and the serious problem posed by both for the Darwinian paradigm.

> The computer on which I am writing these words has an information storage capacity of about 64 kilobytes (one byte is used to hold each character of text). The computer was consciously designed and deliberately manufactured. The brain with which you are understanding my words is an array of some ten million kiloneurones. Many of these billions of nerve cells have each more than a thousand "electric wires" connecting them to other neurons. Moreover, at the molecular genetic level, every single one of more than a trillion cells in the body contains about a thousand times as much precisely coded digital information as my entire computer. **The complexity of living organisms is matched by the elegant efficiency of their apparent design. If anyone doesn't agree that this amount of complex design cries out for an explanation, I give up** (1986, p. ix, emp. added).

There's a huge amount we don't know about how the brain works, and especially about how chemical and electrical signals give rise to cognition and consciousness.

But, after having described the brain's immense complexity and "apparent" design, and after being just about ready to "give up," Dawkins reconsidered, and wrote:

> No, on second thought I don't give up, because one of my aims in the book is to convey something of the sheer wonder of biological complexity to those whose eyes have not been opened to it. But having built up the mystery, my other main aim is to remove it again by explaining the solution (p. ix).

He then spent the remainder of the book informing the reader (using, of all things, well-designed computer programs!) that the design in nature is merely "apparent," not "real."

NATURAL SELECTION AND THE HUMAN BRAIN

But, the question lingers: How did natural selection produce the brain? Basically, there are two views within the evolutionary camp. Some, like MIT's Steven Pinker, believe that the brain can be broken down into individual "components," each of which evolved for a specific purpose (see Morris, 2001, p. 208). To quote Pinker:

> The mind, I claim, is not a single organ but a system of organs, which we can think of as psychological faculties or mental modules.... The word "module" brings to mind detachable, snap-in components, and that is misleading. Mental modules are not likely to be visible to the naked eye as circumscribed territories on the surface of the brain, like the flank steak and the rump roast on a supermarket cow display. A mental module probably looks more like roadkill, sprawling messily over the bulges and crevasses of the brain (1997, pp. 27,30).

Others, having been heavily influenced by a theory set forth by the late paleontologist, Stephen J. Gould, and his close friend, population geneticist Richard Lewontin, take a different approach. These two Harvard professors advocated the view that the brain evolved for its own set of reasons, and that certain human traits then followed that had nothing whatsoever to do with natural selection. According to Gould:

> ...[T]he brain got big by natural selection for a small set of reasons having to do with what is good about brains on the African savannas. But by virtue of that computational power, **the brain can do thousands of things that have nothing to do with why natural selection made it big in the first place. ...Natural selection didn't build our brains to write or to read, that's for sure, because we didn't do those things for so long** (1995, emp. added).

Since written language is supposedly a relatively recent evolutionary invention, then it could not be an ability that evolved during ancestral times as hominids roamed the savannas of Africa. Gould's point, then, is that the ability to read and write must be a by-product of the way the brain itself is constructed. Indeed, says Gould, it would be easy to construct quite a large list of human intellectual abilities that could **not** have been shaped by natural selection. Such a list might include such things as the ability to learn higher mathematics, to understand complicated games like chess, to play a violin, and perhaps even to form linguistic constructions.

In addition to reading and writing, Dr. Gould cited consciousness as a "quirky accident" that was simply a fortuitous, unexpected by-product of the brain having evolved and gotten bigger. A brief history lesson is in order at this point.

In 1978, the Royal Society of London sponsored a symposium on the subject of "adaptation." Dr. Lewontin had been invited to attend, but he does not care much for airplanes. He asked his friend Dr. Gould to co-author the paper with him, and then present it at the British Symposium. The paper was titled somewhat curiously, "The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme" (see Gould and Lewontin, 1979), and became famous practically overnight. [NOTE: When Gould and Lewontin referred to the "Panglossian paradigm" in the title of their paper, they were alluding to the ideas espoused by Dr. Pangloss in Voltaire's famous novel, *Candide*. In that novel, Voltaire satirized the belief system of the eminent German philosopher Gottfried Wilhelm von Leibniz, who maintained that this was "the best of all possible worlds." According to Dr. Pangloss, in this best of all worlds, everything existed for a purpose. For example, in explaining to Candide why he had contracted syphilis, Dr. Pangloss remarked: "It is indispensable in this best of all possible worlds. For if Columbus, when visiting the West Indies, had not caught this disease, which poisons the source of generation, which frequently even hinders generation, and is clearly opposed to the great end of Nature, we should have neither chocolate nor cochineal" (see Morris, 2001, p. 85).]

The Gould/Lewontin paper (which was published a year later in 1979) began with a description of the central dome of St. Mark's Church (*San Marco* in Italian), located in Venice. The dome is supported by two distinct arches, which meet at right angles. The arches divide the dome into four tapering, triangular spaces. As Gould and Lewontin noted, these spaces are an unavoidable by-product of mounting a dome on two rounded arches; the arches could not divide the inner surface of the dome in any other way.

These spaces are known as spandrels. [The term spandrel actually was misapplied by Gould and Lewontin. As it turns out, the correct term is "pendentive," as several authors have correctly pointed out; see Houston, 1990, pp. 498-509; Dennett, 1995, pp. 271-275; Ruse, 2001b, p. 236).] In the spandrels, artisans painted mosaics of the four biblical evangelists (Matthew, Mark, Luke, and John), and mosaic images representing the Tigris, Euphrates, Nile, and Indus rivers. Gould and Lewontin called attention to the fact that the spandrels were not created by the architect for a specific purpose. On the contrary, they were "non-adaptive side effects"; that is to say, the spandrels **had** to be there. They were not created for the **purpose** of housing mosaics; they were decorated because there were **empty spaces** to be filled.

According to Gould and Lewontin, a similar phenomenon takes place during the course of evolution. Organisms, they suggested, possess numerous traits that were not molded by natural selection. Rather, the traits exist because they are by-products of something else (see Schwartz, 1999). This does not mean that these traits are not useful. Once a spandrel exists, natural selection supposedly was able to modify it in some way to make it useful, just as the architects of San Marco found that the triangular spaces (spandrels) could be used for decorative mosaics. Spandrels often turned out to be useful when adapted for some purpose, but, as Gould and Lewontin noted, the spandrels originally evolved for secondary purposes. They therefore could not be attributed directly to natural selection.

SPEAKING SCHEDULES

Dr. Bert Thompson		
January 23-25	Enterprise, AL	(334) 247-8917
January 30-February 1	Buford, GA	(770) 945-8620
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February 15-18	Mount Dora, FL	(334) 546-2565
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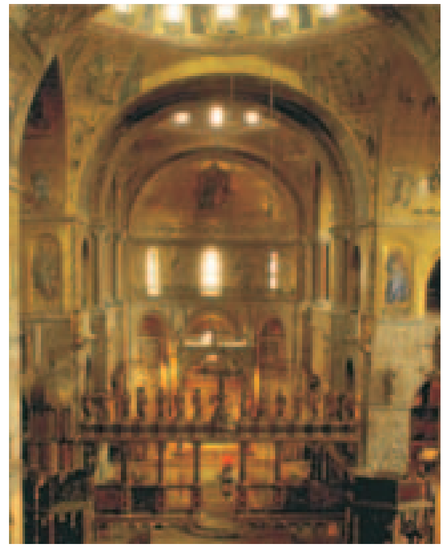

The spandrels of San Marco

Three years later, Gould and Yale University paleontologist Elisabeth Vrba invented the term "exaptation" to define and illuminate the role allegedly played by spandrels. What, exactly, is an exaptation? Gould explained: "...[W]hat shall we call structures that contribute to fitness but evolved for other reasons and were later co-opted for their current role? They have no name at present, and [Elisabeth] Vrba and I suggest that they be called 'exaptations' " (1984, p. 66; for Vrba reference, see Gould and Vrba, 1982). Thus, exaptations are spandrels that organisms have adapted for some useful purpose. In a 1997 article he authored for the *New York Review of Books* ("Evolution: The Pleasures of Pluralism"), Gould wrote: "Natural selection made the human brain big, but most of our mental properties and potentials may be spandrels—that is, nonadaptive side consequences of building a device with such structural complexity" (1997, 44[11]:52).

From an evolutionary viewpoint, the "extraordinary increase in the human brain size was **the fastest evolutionary transformation known**" (Ornstein, 1991, p. 35, emp. added). On some levels, it might make sense that the larger the brain, the more intelligent the animal. However, we now know that brain size is not responsible for the determination of intelligence. The tiny mouse lemur (*Microebus murinus*) possesses a brain that represents three percent of its overall body weight, whereas the human brain accounts for only two percent, and yet this tiny mouse cannot talk or make complex tools. Simply put, brain size does not determine intelligence. Tattersall put it this way:

> [A]s it turns out, the concept **of a gradual increase in brain size over the eons is actually rather problematic. For a start, this idea strongly implies that every ounce of extra brain matter is equivalent in intelligence production to every other brain ounce—which is clearly not the case** (2002, pp. 67-68, emp. added).

No evidence exists that demonstrates a relationship between brain size and intelligence within any given species. The human brain, for example, is known to have a range in volume from less than 1,000 cubic centimeters to more than 2,000. In fact, some of the most intelligent people in history had small brains.

Yet, evolutionists routinely classify hominid fossils largely according to brain size (see, for example, the chart in Pinker, 1997, pp. 198-199). The assumption is, of course, that the human brain started out in early primates as a relatively small, insignificant organ, and then evolved through time to the size we now see it. But **why** should this be the case? That is the very question Gould asked in the concluding chapter of his volume, *Ever Since Darwin*:

> But **why** did such a large brain evolve in a group of small, primitive, tree-dwelling mammals, more similar to rats and shrews than to mammals conventionally judged as more advanced? And with this provocative query I end, for **we simply do not know the answer to one of the most important questions we can ask** (1977, p. 191, emp. added).

Growing a bigger brain is not quite as straightforward as it might appear. It is not simply a matter of "putting on weight" like one does with his or her body. Every neuron that is "added" must be of the right kind (excitatory or inhibitory), must possess the right neurotransmitters, and must be interconnected with literally thousands of other neurons. Harvard's Ernst Mayr correctly remarked: "The unique character of our brain seems to lie in the existence of many (perhaps as many as forty) different types of neurons, some perhaps specifically human" (2001, p. 252, parenthetical item in orig.).

Also, a rich supply of oxygenated blood must be present, which would require the production of additional blood vessels to reach these new neurons. Additionally, our brains require a tremendous amount of energy. As an example, a newborn's brain consumes 60% of the energy that the baby produces (see Gibbons, 1998, 280:1345), while adults devote only 20% of their cardiac output to this organ (which accounts for only two percent of our body weight—Van De Graaf and Fox, 1989, p. 438). So the question then becomes, if humans (and their brains) evolved, why would nature "select" for a larger brain that is more energy consuming? Michael Ruse recognized the huge hurdle to be overcome in "evolving" brains: "When we developed brains, they are so expensive to produce that one needs really big ones or their benefits do not outweigh their costs" (2001a, p. 70). Furthermore, the question must be asked: Where does the energy come from in the first place? It would make sense that supporting a "bigger" brain would require higher energy consumption, yet the basal metabolic rate of a human is no higher than that of a large sheep, which has a brain one-fifth as large. As Gibbons observed: "Humans are apparently getting enough energy to feed their brains without increasing their overall energy intake, so it must be coming from some other source" (1998, 280:1345). But exactly what that "other source" is, remains to be determined.

[to be continued]

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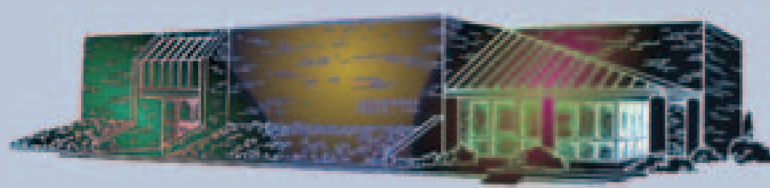

A TWENTY-FIFTH ANNIVERSARY, AND A "NEW" REASON & REVELATION!

Welcome to the "new" ***Reason & Revelation!*** Our regular readers no doubt will notice that quite a significant change has occurred in the appearance of *R&R* between the December 2003 issue and this one for January 2004. I think a word of explanation is in order.

As hard as it is for me to believe, 2004 marks the twenty-fifth anniversary of Apologetics Press. It was "way back" in 1979 when we first put pencil to paper to create the work that would become Apologetics Press. I was barely thirty years old (yes, I am aware that astute readers will be able to put their own "pencil to paper" to deduce the fact that I have now significantly passed the half-a-century-old mark—a fact that my two sons, Chad and Cody, and my staff, never let me forget). And, truthfully, if someone had asked me twenty-five years ago if I thought that A.P. would grow into the significant force that it has become today, I probably would have answered in the negative. Oh, me of little faith!

But A.P. **has** grown—**significantly and forcefully!** The Lord, Who rightly receives the credit, has blessed us richly, in more ways that I could ever successfully enumerate here. We have a lovely physical plant that has been debt free since the first day we occupied it in August of 1985. We have a small-but-faithful cadre of financial supporters who willingly (and continually!) sacrifice in order to see the work succeed (some of whom have been with us since "day one"—literally!). We have a printer who is at our beck and call day and night, and who insists that A.P. receives only the very best that his firm has to offer. We have extremely dedicated readers—adults, students, and even small children—who subscribe to our two journals (some of the college students grew up reading *Discovery*, and have since graduated to *Reason & Revelation;* some of the adults began subscribing to *R&R* with volume one, number one, and are still with us—twenty-five years later!).

And, last but not least, I work daily with some of the most dedicated people on the planet—a staff that is second to none. Four professional staff members (Kyle Butt, Brad Harrub, Eric Lyons, and Dave Miller), three secretaries (Glenda Bailey, LaRose Willis, and Pam Lowery), and three support staff personnel (Jim Estabrook, our general manager, Charles McCown, our production manager, and Thomas Tarpley, our scientific illustrator) work longer and harder than you could possibly imagine, in order to make A.P. the professional powerhouse that it has become. Each of these beloved individuals is truly "the power behind the throne." Without them, there simply would be no A.P.! [I also want to acknowledge here our incredibly talented interns—Alden Bass, Joe Deweese, Branyon May, Taylor Richardson, and Zach Smith—whose commitment to "paying their dues" is unquestioned, and who represent the future of this work when it comes time for me to "lay down the sword." With youngsters like these "in reserve," I can assure you, the future is in good hands.]

We felt that a twenty-fifth anniversary provided a good opportunity to remember, and celebrate, our blessings and successes. It also provided a good opportunity for us to "revamp" *Reason & Revelation.* We hope you like the new look. As always, we will strive to maintain balance in the articles we publish, with some dedicated to investigating scientific matters, some devoted to investigating biblical issues, and some designed to inquire about both. For the past twenty-five years, we have taken the content of each issue of *R&R* **very** seriously. You have my personal guarantee that we will take the content of every issue for the next twenty-five years just as seriously. The masthead, typestyles, and ink colors of *R&R* may change; the biblical soundness, scientific accuracy, and cutting-edge content of the articles never will. And once again, you have my word on that.

Bert Thompson