The Human Body

Intricate design that glorifies the Creator

Answers IN GENESIS®

Second Edition

Print ISBN: 978-1-9844-0915-7

ebook ISBN: 978-1-9844-1056-6

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Introduction

From the intracacies of the human brain to the precise growth of our hair follicles, the design of the human body proclaims the Creator. While atheists do their best to try to explain how our bodies evolved by random processes, their explanations fall flat when one considers the wonders of our body and how so many elements fit together "just right" to allow them to function, grow, adapt, repair themselves, and react to the environment. For example:

- Heat from our rapidly beating heart would kill us if it were not designed with a special lubricated bag that reduces friction.
- Our bones produce new bone throughout adult life, constantly changing shape to handle new stresses, such as extra weight during pregnancy.
- Unlike the wires in a hardwired computer, our brain cells are constantly making new connections and "pruning" old ones that are unused.
- Guarding our bodies is a thin layer of dead cells, arranged into precisely arranged columns that are spot-welded together.

Revel in the creativity of our Creator God as you explore his amazing design of our bodies.

NASA GRN * Apollo 13 Command Module recovery after splashdown or Odyssey On Deck

The Human Body—Wired for Extremes

by Heather Brinson Bruce

You never know what unexpected danger might put your life on the line. But God knows, and he has equipped every human with backup systems that are programmed to respond to all sorts of emergencies.

Astronauts shivering in a broken-down spacecraft far from earth. A woman falling off a cliff. A backpacker encountering a furious bear at a bend in the trail. How could these people possibly survive?

Each depended on incredible biological emergency systems to stay alive.

We live in a cursed world where dangers lurk around every corner. Recognizing the potential threats to our lives, God provided our bodies with contingency plans, ready to activate at a moment's notice. Whatever extra energy or infusion of chemicals our bodies need, whatever quick changes are required for us to make quick decisions or conserve precious resources, the brain is always ready to act.

The beauty of these emergency systems is that we don't have to learn them. Every person begins life with these abilities, which are passed down through the generations, originating in our first parents, Adam and Eve.

Researchers are learning more and more about how our brain switches operations when thrown into hazardous situations. You may never face life-threatening situations, or you may face them only once, but in any case, God has equipped you to have a better chance of surviving. Consider just three examples.

To Coldly Go

The loud bang was unexpected. At first, the other astronauts thought a crewmember was playing a practical joke. But they soon realized the situation was serious. On April 13, 1970, *Apollo 13* radioed home, "Houston, we've had a problem."

Over the next few days, NASA's Mission Control in Texas and the endangered astronauts banded together to solve nearly each problem thrown at them. They figured out how to conserve batteries and water. The NASA teams even managed to design a makeshift air scrubber to reduce the dangerous levels of carbon dioxide in the small spaceship. But one problem couldn't be solved—the lunar module *Aquarius* was getting cold, almost freezing (around 38°F [3.3°C]).

Initially, the heat given off by the computer systems helped to maintain the temperature in *Aquarius*, but later they were turned off to conserve the precious power. Three days after the explosion, the cold was nearly unbearable. The astronauts never slept. Fred Haise's feet, after getting soaked from a leaky water dispenser, were half frozen. Their food turned into blocks of ice.

Alone and exposed to near-freezing temperatures, without warm clothes or heaters, and three days away from help. Could you survive? Yes! The brain's hypothalamus (above) is ready for just such emergencies, and it made the difference in the *Apollo 13* mission.

How did they manage to survive? Their brains were ready with a contingency plan that NASA could never imagine.

One part of the brain, called the hypothalamus, regulates the body's internal temperature. When we get too hot or too cold, the hypothalamus initiates emergency systems. When the temperature plummeted to a critical low, the astronauts' hypothalamuses responded immediately.

The first defense was to generate heat. Muscles, like computers, produce heat when working. So the astronauts started shivering involuntarily.

The second defense conserved what heat their bodies still contained. As the temperature continued to drop, their brains stimulated the blood vessels just below the skin's surface to constrict, keeping the blood deeper and warmer as it circulated.

Still, it got colder, causing slowed heart rates and digestion. Their brains initiated the next step. In an effort to protect the vital organs, their brains triggered the blood to concentrate around the heart and brain, keeping those key areas warmer and vital systems functioning. Fingers, toes, and other extremities were left to the cold.

As the astronauts' bodies continued to cool, the nervous systems slowed, and clear thinking was hampered. The astronauts even struggled to understand and remember what Mission Control told them. Their brains were conserving all resources in an effort to survive, and logical thinking was unnecessary for immediate survival.

Finally, the end was in sight. After days of fighting the cold and fear, the astronauts buckled in, ready to restart the engine of the Command Module. Amidst cheers and more than a few tears, they entered earth's atmosphere. The *Apollo 13* mission is commonly known as NASA's successful failure. The astronauts made it home, thanks, in great part, to the incredible design of their bodies.

Pain, Pain Go Away

Hiking alone through the Sierra Nevada Mountains in California had always been one of Amy Racina's favorite pastimes. The beauty of the trees, the silence of the hills, and the warm August air filled Amy with peace and joy. Then the unthinkable happened.

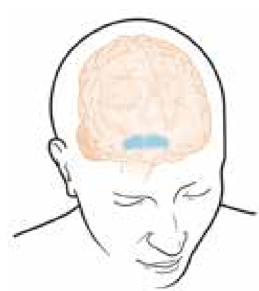
Near the edge of a cliff, the ground suddenly crumbled underneath her feet. She tumbled into space with nothing to catch her but a granite slab 60 feet (18 m) below.

When Amy woke up, she waited for pain to overwhelm her. It didn't. So she sat up and assessed her situation. Her hip was broken in two places, her right kneecap had shattered, and she noticed several other minor fractures, sprains, and dislocations.

Amy knew she was badly hurt, so why wasn't she overwhelmed with pain?

In extreme emergencies, our brain can block pain. If Amy had felt the full force of the pain from all of her injuries, she would have been unable to bind her wounds and drag herself the mile and a half to the nearest trail. The trail offered the only hope of rescue before she bled to death.

Typically, pain is a good thing. It warns us of injury or sickness. It tells us when to slow down or when we've done too much. Few things send us to the doctor faster



Isolated in remote mountains, her body broken and bleeding after a sixty-foot fall, how could Amy Racina hope to survive? Her brain's periaqueductal gray (above) went right to work, recognizing the threat and initiating an extraordinary survival strategy.

than intense pain. If we never felt pain, we would rarely notice when we hurt ourselves.

But in life-threatening situations, it's not always good to feel pain. Soldiers in the midst of battle don't always have time to treat bullet wounds. Long-term survival may demand their full attention on the enemy, so the brain can temporarily block the pain.

But how can our brains block pain? Scientists are still trying to understand the details, but the gate control theory suggests that the paths between pain-transmitting nerves can be blocked by natural painkillers.[1] Normally, nerves at the injured site send signals along a path to a projection neuron (the gate) located in the spine, which then forwards the message to the brain.

However, if the pain must be blocked, a special region in the middle of the brain, called the periaqueductal gray, closes the gate by releasing endorphins, natural painkillers more powerful than morphine. Once the danger has passed, the periaqueductal gray will remove the endorphins, allowing pain through the gate.

Once rescuers arrived to lift Amy by helicopter to a hospital, pain flooded over her. The temporary lull in pain had saved her life. Now it was time for the normal process of rest and healing to begin.

Bear in Mind

Hiking in the middle of the remote forest in the USA's Yellowstone National Park, 22-year-old Josh Beattie turned the corner and nearly stumbled over a grizzly bear cub at play, blocking his path. But mom was there, too. Suddenly, his heart raced, his breathing increased, and his muscles tensed.

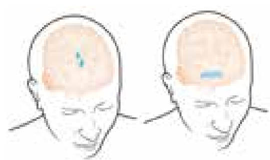
What was happening to Josh?

His brain was preparing to fight or flee. At the first sign of danger, before the problem is fully processed by the logic center, our brain already kicks into gear. In many cases, like touching a hot stove, if we waited until we consciously understood the dangers, our reaction would come too late.

So how does this fight or flight system work?

When danger nears, the hypothalamus (the same part of our brain that regulates body temperature) "flips a switch." Before we have time to think, our brain speeds ahead of us, ordering the release of appropriate chemicals. Our brain also increases blood flow to the muscles, allowing quick action. Breathing deepens to elevate oxygen intake. Heart rate and pressure increase to speed oxygen delivery. Many nonvital systems temporarily shut down. Growth, digestion, and the immune system stop functioning so that energy is not wasted on systems not required for immediate survival.

But the brain acts differently if the danger is farther away. According to one study, the distance of the threat relates to the area our brain uses to face it.[2] If the angry mother bear appears far away, the part of our brain used for strategy (called the ventromedial prefrontal cortex) activates. But as she draws closer, the focus switches to the fight or flight part of our brain, known as the periaqueductal gray (the same part that controls feeling pain). Essentially, the brain seeks to implement an escape plan before momma bear gets too close.



Far from any trail, hiker Josh Beattie stumbled on two bears, only 25 yards away. Would he survive? Before he even had time to think, his brain initiated emergency procedures. The hypothalamus (left image) ordered more blood to the muscles, increased his heart rate, and deepened breathing. Then the periaqueductal gray (right image) prepared him to make the ultimate decision: escape or fight?

Time is up. Which will you choose, fight or escape? The answer comes down to the individual. Whether we run or fight is not always clear-cut, and the decision depends on our emotions and the situation. But no matter the emergency, God designed the human brain with the specialized capabilities to help us survive, be it day-to-day hassles or perilous threats to life.

The End But Not the Limit

At the same time that mankind explores the deep mysteries of the oceans and the awesome glories of the heavens, where the Creator's genius is clearly seen, we are just as amazed by the intricacies scientists constantly discover in the human brain.

The same God who displays his power in space reminds us about his loving care in our own bodies and minds. From the very beginning, God provided for his children even before such protection was needed. Adam and Eve were well-equipped to survive in a fallen world, and so are we.

Heather Brinson Bruce earned dual degrees in English and chemistry from Clemson University. She regularly writes for *Answers* magazine.

1 R. Melzack and P. Wall, "Pain Mechanisms: A New Theory," *Science* 19 (November 1965): 971–978.

2 D. Mobbs et al., "When Fear Is Near: Threat Imminence Elicits Prefrontal-Periaqueductal Gray Shifts in Humans," *Science* 24 (August 2007): 1079–1083.

Illustration by Mads Peter Abildgaard

Is a Bigger Brain Better?

by Dr. David A. DeWitt

When it comes to intelligence, the size of your noggin isn't a factor.

If I could take out my brain and prove that mine is bigger than yours, would that mean I'm smarter than you? Hopefully, you'd say no.

Consider this. The average brain size is different between men and women (men have bigger brains). Also, the adult brain gets smaller as we age. But only an imbecile would say that men are smarter than women or that older people are less intelligent than younger people!

Yet that's just what evolutionary paleontologists have been doing since the discovery of the first "early" human fossils in the 1800s. With each new find, one of the first things scientists wanted to know was its brain size (or cranial capacity). If the skull was smaller, they assumed the brain was less evolved and less intelligent than ours.

Lately, the assumption that brain size reflects intelligence has fallen on the rocks. We now know that cranial capacity—or the volume within the skull where the brain is housed—isn't a fail-safe measure of either brain size or intelligence. Much more is involved.

Size Is Relative

While we humans pride ourselves on our intellectual capacity, several mammals have larger brains. In fact, sperm whales and elephants—even dolphins—have larger brains. So *absolute brain size* doesn't show us who is smarter.

You might assume that larger bodies need larger brains to perform more functions. To a degree, this is true, so it's important to keep in mind the relative body size.

In fact, scientists have come up with a measurement called *brain-to-body-size ratio*. The human brain is much larger compared to our body (1/40) than the brains of dolphins (1/80) or elephants (1/600). That also may help explain why men generally have bigger brains than women, by the way. (And since larger women have larger brains than smaller men, it seems to be a body size issue, not a gender issue.)

Interestingly, the tiny shrew's brain has a much larger brain ratio than any other mammal (1/10). Yet we know the shrew isn't at the head of the class. So, clearly, something more is involved in comparing intelligence. Because shrews need a minimum number of neurons to get the job done, there is a limit to how small their brain can get and still function.

What's Intelligence Anyway?

For decades, scientists have tried to determine the correlation between brain size and intelligence. Such studies have yielded mixed results, though there does appear to be a weak correlation within humans. Yet, establishing such a correlation is difficult because scientists still have not agreed on a good definition of intelligence or an absolute way to measure it.

To make things worse, scientists are not entirely sure what to measure within the brain. Even if you accept the outdated standard of cranial capacity, it can only give a maximum brain size, not the actual brain size. This is because much of the cranium's volume is a special fluid that bathes the brain, called cerebral spinal fluid.

Brain weight may seem a better indicator of intelligence. However, not all parts of the brain are equal when it comes to intelligence. Most scientists agree that the most important engine of intelligence is the brain cells called neurons, but these only appear in the portion known as gray matter. Gray matter makes up nearly 40% of our brain, while a larger portion of the brain mass is white matter, which merely forms connections between neurons. More white matter would increase brain weight but may not increase intelligence.

Brain surface area may get closer to a good measurement of intelligence. Why? Our neurons are packed into gray matter at the surface of the brain, and more surface area means more brain power. Folding up the layers of neurons increases the surface area possible within the same space. And when it comes to folded brains, humans can't be outfolded.

For example, the mouse brain is completely smooth. In contrast, the human brain appears lumpy with ridges (gyri) and grooves (sulci). This folding of the brain nearly doubles the surface area—and the number of neurons—possible within the same volume. If you unfold the human brain, the surface area ranges from 1,500 to 2,000 sq. cm. A shrew brain, in contrast, unfolds to 0.8 sq. cm.

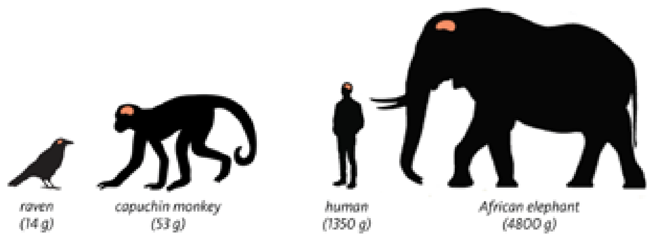
Looks Can Be Deceiving

Have you ever heard the insult "bird brain"? It turns out that this is a compliment! Birds are extremely smart. Common ravens are among the smartest of all animals—even though their brains are only the size of a walnut (14 g). In many ways they can match monkeys, whose brains are the size of a pear (53 g).

Recent studies on ravens and other animals show that brain size is not the main factor in intelligence. For instance, ravens have more densely packed neurons than monkeys. And these neurons are packed into the forebrain, where higher-order thinking occurs.

What about humans versus elephants, whose brains are almost four times bigger than ours? The number of folds in the brain allows more neuron connections, which is a better measure of intelligence. The amount of folding and the number of neuron connections in humans excels every kind of mammal, including elephants.

The bottom line? We still don't fully understand the relationship between brains and intelligence. But we know that God created many kinds of creatures with very different brain configurations to fulfill their unique purposes.



Birds vs. Primates

Ravens have an edge in some higher-thinking skills, including solving puzzles and making tools in ways monkeys can't.

Humans vs. Mammals

Humans may have smaller brains than some large mammals, but nobody doubts which is smarter.

Better to Focus on Neurons and Synapses

However, comparing gray matter doesn't tell the whole story. The brain contains several different kinds of cells, not just neurons. The neurons may be the most prominent cells (and there are an estimated 10,000 different types of neurons in the human brain). But the brain includes several types of support cells called glial cells. Microglia, for example, are tiny cells that serve an immune-like function.

One of their roles is to clear out debris in the event of a brain injury. Astrocytes are another type of support cell, which protects neurons by establishing a barrier between the neurons and blood. These cells don't seem to be tied directly to intelligence, though we can't be dogmatic.

The key is to compare the number of neurons. Only 10–50% of the cells in the human brain are neurons. The adult human brain has an estimated 100 billion neurons, beating almost every kind of animal except elephants and whales.

So we need to look at another critical factor related to intelligence: neuron density. Neurons come in a variety of sizes. Where neurons are smaller, more can be found in the same amount of space. In contrast, if neurons are larger, then fewer will be present and the neuronal density lower. Humans stand out in their neuron density, but even here we aren't the undisputed champs.

More important than the density of neurons, however, is something known as the synaptic density. Neurons make connections with other neurons called synapses. A synapsis is like a bridge over which one neuron sends a signaling neurotransmitter to another neuron. The number of synapses on a given neuron can be as high as 7,000, meaning that a neuron can provide or receive input to or from 7,000 different neurons. With 100 billion neurons, this brings the total number of synapses in the range of 100 trillion. No animal on earth comes close to this number.

Synaptic density is definitely correlated to intelligence. In fact, the loss of synaptic density is best correlated to the severity of dementia in Alzheimer's disease—better than the loss of neurons and the decrease in brain weight.

The key is not the size or weight of the brain, but how much power can be packed into a small space. Based on the Bible's teaching that we're all made in God's image and descended from Adam, we can be sure that the humans closer to Adam's time were just as intelligent as you and I are, if not more so. No matter our "cranial capacity," we can all know and honor our Creator!

One Size Doesn't Fit All

Brain volume varies widely among modern humans and differs by age and gender. One study reported that the average volume for males is 1274 cc while females average 1131 cc. However, consider how wide the range is. Males are 1053–1498 cc, and females are 975–1398 cc. This means that the normal range of a modern human brain is at least 975–1498. With such a wide range, the link between brain size and intelligence in our human ancestors loses steam.

Among the Neanderthal people, cranial capacity averaged about 1350 cc with a range of 1250–1650 cc. That's larger than ours today, but the Neanderthals had a bulge in the back, and their skull was typically long and narrow. Yet, Neanderthal brain size overlaps that of humans living today.

Humans labeled as *Homo erectus* had a range of cranial capacities of about 850–1200 cc. Fossil specimens from Africa are smaller, with an average of about 930 cc, while fossils from China have an average of 1030 cc. Yet, *Homo erectus* brain size also overlaps that of humans living today.

Interestingly, the diminutive *Homo floresiensis* (nicknamed "the Hobbit") found on an Indonesian island has a cranial capacity of just over 400 cc. Despite an exceptionally small brain size, they made stone tools and built boats. Clearly, human brains are designed to function fully, whether the brain of a giant or a little person.

Dr. David A. DeWitt received a BS in biochemistry from Michigan State University and a PhD in neuroscience from Case Western Reserve University.