Physics *All the Way Down* | BY DANIEL GIANG

Jane Seymour, the American actress who played television's *Dr. Quinn, Medicine Woman*, almost died in real life from a severe allergic reaction to penicillin. Here is how she describes the experience:

> *I literally left my body. I had this feeling that I could see myself on the bed, with people grouped around me. I remember them all trying to resuscitate me. I was above them, in the corner of the room looking down. I saw people putting needles in me, trying to hold me down, doing things. I remember my whole life flashing before my eyes, but I wasn't thinking about winning Emmys or anything like that. The only thing I cared about was that I wanted to live because I did not want anyone else looking after my children. I was floating up there thinking, "No, I don't want to die. I'm not ready to leave my kids." And that was when I said to God, "If you're there, God, if you really exist and I survive, I will never take your name in vain again."*[1]

Popular culture has come to expect such experiences with survival from cardiac arrest. Apparently, up to 5 percent of American adults say they have experienced a "near-death experience." Most Christians rejoice that such phenomena provide evidence of things hoped for in the hereafter. As often occurs, Seventh-day Adventists sulk.

Adventists espouse wholism (as opposed to dualism). Rather than seeing humans comprised of two distinct and separable components—a mortal body and an immortal soul—Adventists understand Genesis 2:7 in the more Hebraic way: that a living soul is comprised of the dust of the earth enlivened by God's breath. Thus, as media reports of near-death experiences surfaced in the late 1970s, the late Jack Provonsha, an Adventist physician and theologian at Loma Linda University, fearlessly predicted that science would eventually find neural circuits that underlie this experience in a naturalistic manner.[2]

Adventists again find themselves arguing against most conservative Christians in favor of positions taken by atheists or, at best, very liberal Christians.

Provonsha will smile one day when he reads a case recently published in the *New England Journal of Medicine* that confirms his prediction. (The fact that the prestigious journal actually published a report of a single case indicates how seriously the scientific community views near-death experiences.)

The case involves a Swiss patient who had a neural stimulator implanted in his brain as a radical treatment for tinnitus (ringing of the ears). Each time the stimulator was turned on, the patient experienced the classic near-death sensation of floating outside the body. Positron emission tomography (PET) scanning demonstrated activation of the right angular-supramarginal gyrus and superior temporal gyrus during these experiences. Rather than being evidence of the soul or the afterlife, it may turn out that the sensation of floating outside the body is all in the brain.[3]

Findings like this have spurred the development of a new discipline call *neurotheology*. Aldous Huxley coined the term in his 1962 novel, *Island*, but the field itself did not take shape until the early 1990s. As neuroscientists explored how the brain produces various types of thoughts or behaviors, they also studied religious (usually mystical) experiences. PET, single photon emission computed tomography (SPECT), and functional magnetic resonance imaging (fMRI) studies have ascertained which

Tibetan Monks of Drepung Loseling Monastery.

parts of the brain become activated during prayer or meditation, the frontal cortex being among them.

This seems to have an ecumenical quality because Franciscan nuns and Tibetan monks use the same areas. Other parts of the brain are activated when people consider moral dilemmas (mesial frontal cortex). Paul Zak, adjunct professor at Loma Linda University, has demonstrated that use of oxytocin can influence the amount of trust a subject has.[4] One could foresee an unscrupulous evangelist spraying oxytocin into the air as the organ softly plays "Just as I Am" one more time.

A naturalistic explanation for these findings might suggest that humans conceived of the supernatural from the activity of these brain centers. The putative evolutionary advantage such irrational beliefs provide for individual organisms or the species might include community bonding, bravery in the face of death, or perhaps a mechanism of ordering the observable world.

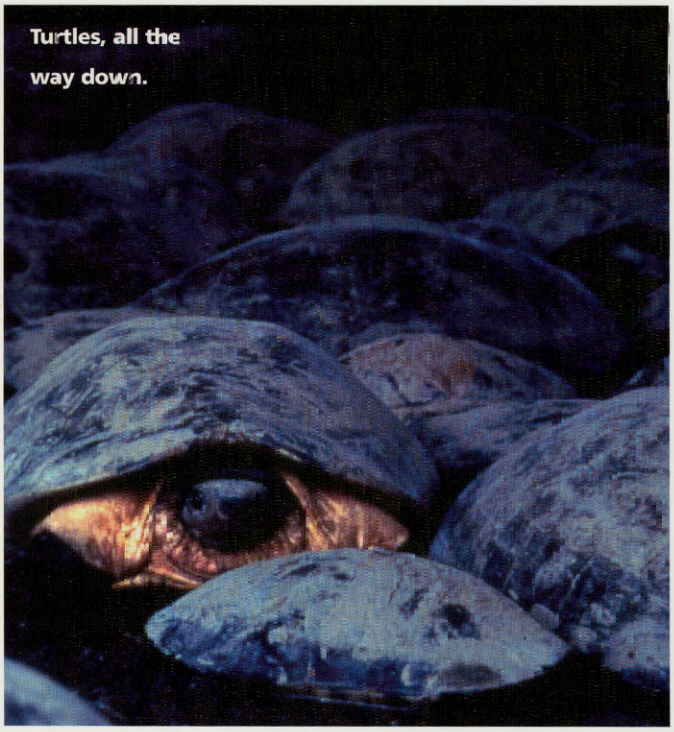
Many religious people view this entire line of inquiry as one more example of misguided "scientism," by which they mean that, although science produces wonderful antibiotics, other forms of truth have validity independent of science. Such people say, "Keep your neurosciences, just gimme that old time religion!"

That works for most Christians, but I work in the neurosciences. Thus, I find myself wondering (along with Hindus, Buddhists, and Mormons who create Web sites devoted to neurothology) what the neurosciences tell us about ourselves and God.

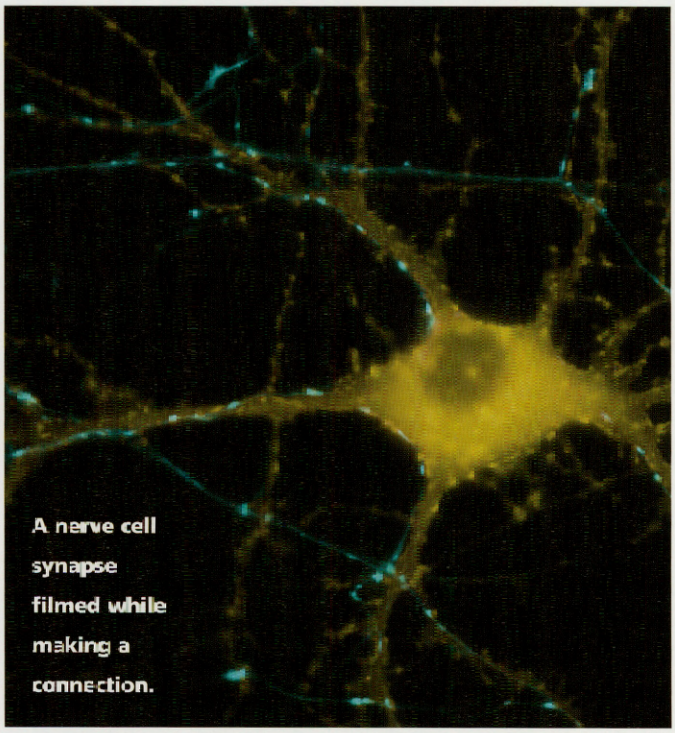
For me, neurobiology poses even more fundamental issues than the part of Jane Seymour's brain that produced the sensation of her floating above her body. I want to know what made her think of God. Did she choose to promise God she would keep the Third Commandment rather than the Second or Fourth? Did she have a choice?

I still believe that God values nothing higher than the free will of his creatures. In fact, given my upbringing in a tradition that flows from Jacob Arminius to John and Charles Wesley to Joseph Bates and James and Ellen White to Richard Rice, it is hard for me to envision how I could believe anything else.

To be precise, the free will I grew up believing was libertarian free will. I could choose between the spineless pinko George McGovern or our communist-fighting, all-American president Richard Nixon. I could choose my career: law or medicine. I could choose to be Chinese or American—at least as far as my culture went. Free choice represented such a sacred gift from God that I questioned whether physicians should



Turtles, all the way down.



A nerve cell synapse filmed while making a connection.

LEFT: CHRIS R. SHEPHERD / TRAFFIC SOUTHEAST ASIA; RIGHT: MICHAEL A. COLICOS, UCSD

tamper with it by giving medications that might alter a person's choice.

This quandary abruptly ended in August 1981 during my first clinical rotation as a junior medical student. On 2SE of the Veteran's Affairs Hospital, I met Mr. Mosley. Mosley had dementia and sat strapped into a geriatric chair all day screaming for help. Sometimes he even punched at or bit his caregivers. This went on for days until the attending physician, Don Miller, told the residents to give Mosely methylphenadate (Ritalin).

Methylphenadate is a psychostimulant that "wakes up" the brain—in particular, the frontal lobes. By the next morning, Mosley sat bright eyed in bed, smiling and pleasant. Before we rotated off service, my classmate, Lyle Helm, who was assigned to Moseley, brought his newlywed wife to the ward to meet him. "What's the secret of a long, happy marriage?" asked Lyle.

Mosley gave a mischievous grin and replied, "Love the dickens out of them!"

In addition to gaining valuable marital advice from Mosley, I acquired other insights from his case that helped me develop into a neurologist. Although medications may not actually heal the damage done by disease, they can mitigate or exacerbate behaviors. For me, Moseley's case completely removed any hesitation I had about my helping patients live better through chemistry.

One typical case occurred during my behavioral neurology fellowship. One of my multiple sclerosis patients, Brian Johnson, had a different problem. Johnson was a small-town entrepreneur with a mild case of MS. He had a monopoly on car sales in a rural county of upstate New York.

Johnson's hair-trigger temper had grown problematic. An employee would commit an error in the morning and Johnson would fly off the handle and fire him. Then, over lunch, he would realize he had just fired his best mechanic and would beg him to come back to work. Usually, the mechanic would agree to do so—for a raise. An astute businessman whose goal was to retire by the age of fifty, Johnson decided that something needed to be done immediately.

I recognized his problem as typical of a condition that many MS patients experience called emotional lability or pseudobulbar affect. It results from the emotional centers of the brain (limbic system) becoming disconnected from the judgment centers in the frontal lobes. Without any compunction, I prescribed a low dose of sertraline (Zoloft, a selective serotonin reuptake inhibitor) and asked him to return in six weeks.

"So, how is the temper problem going?" I asked him when he returned.

"It's great," Johnson replied. "I haven't fired anyone or

yelled at anyone. I haven't told the employees I am taking Zoloft. They keep asking me if I've gotten religion."

In fact, Johnson had not gotten religion. Instead of working for a lifetime to overcome his temper, as John Wesley might have advised, he had achieved the same behavioral result by taking a molecule that slows neuronal reabsorbtion of serotonin from the synapse.

The synapse is the gap between the end of one neuron and the beginning of the next. When a nerve impulse (action potential) reaches the end of one neuron, it releases packets of chemicals called neurotransmitters, such as serotonin, dopamine, or acetylcholine. These molecules diffuse across the gap of the synapse (through Brownian motion) and stimulate receptors on the next neuron's dendrite. The second neuron adds the excitatory and inhibitory influences from many neurons.

If there are not enough excitatory stimuli to reach the firing threshold, the neuron does not fire. If there are enough excitatory stimuli to trigger the neuron, it fires. Potassium rushes out of the neuron and the nerve impulse races down the nerve, past the cell body and along the axon to the next synapse. Sodium enters to equilibrate the cell's charge. Then the neuron pumps sodium out and potassium in to reset for the next possible discharge.

This sequence is illustrated by muscle stretch reflexes, such as when a physician taps a patient's knee with a reflex hammer. Muscle stretch receptors trigger a sensory neuron to discharge. This neuron synapses in the spinal cord onto a motor neuron. The second neuron travels to the quadriceps muscle in the leg and results in the knee extending briefly. This completes a simple reflex arc.

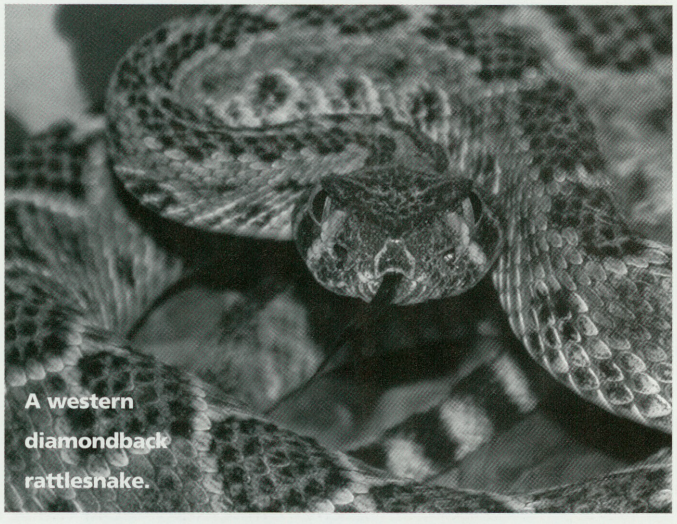
The exact same sequences occur inside the brain, albeit within a tremendously more complex wiring diagram. This results in more complex and subtle results. However, essentially the same chemical and electrical processes underlie the two-neuron reflex arc of a knee jerk reflex as every thought, movement, or subconscious motivation from our brains. Everything that we think, will, or do results from neurotransmitters that influence neurons to fire or not fire. The brain operates on the principles of chemistry and physics.

Even before we think a thought, neurons that lead to a conscious thought or decision are already firing. This fact is not entirely counterintuitive.

One Sabbath, our family was hiking in the mountains of Southern California with me in the lead. Suddenly, I found myself back about five feet from where I had been walking, my hands out like a crossing guard in front of my two sons. I did not choose this action. I certainly did not analyze the situation, thinking,

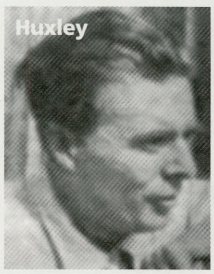
> *A snake is crossing the path directly under where I am about to put my right foot. The snake has a diamond-shaped head and is rattling its tail like a rattlesnake. Rattlesnakes are poisonous and a bite would be painful and inconvenient. Although the snake may have difficulty striking me because it is stretched out, I would be prudent not to put my right foot down on top of it. I should also take precautions to prevent my kids, who carry some of my genetic material, from putting themselves at risk.*

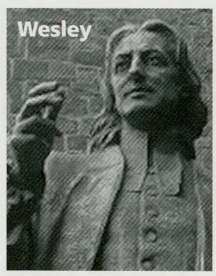
Instead, "reflexively," we say, my left leg propelled me backward. Only afterward did I reconstruct the reason I had jumped.

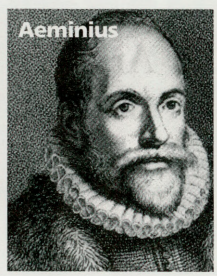


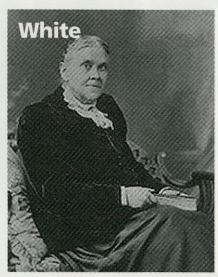
A western diamondback rattlesnake.

The scientific validation of this involves routine phenomena known to every neurologist. Before a person moves an arm, the electroencephalogram will show *mu* rhythm over the prefrontal cortex on the opposite side. When *mu* rhythm appears, an alert electroencephalogram technologist will ask the patient to move the opposite arm and the *mu* disappears. In neuropsychological experiments, *mu* rhythm is termed "Bereitschaftspotential" or "readiness potential."









In one series of experiments, scientists asked subjects to move either their left or right arms randomly while watching a clock. The subjects were instructed to recall the exact time they decided which arm to move. Scientists discovered that the *mu* activity on the opposite side of the brain appeared before the subject had "decided" which arm to move. Although the original experiments suggested that the readiness potential appeared fractions of a second prior to the "conscious" decision, more recent experiments using fMRI suggest that the brain is active seconds prior to the subject making a "conscious" decision.[5] Thus, even though the subjects "consciously" made a choice of which arm to move, the brain had already determined what that choice might be. This is not surprising if one recalls that all brain activity relies upon one neuron acting upon another.

Genetics or the environment influence complex nonconscious "decisions" commonly enough that we frequently we joke about them. We speak of "becoming" our parents. After I "chose" chemistry as my college major, I realized that I had made the same choice as my father and both of my uncles. This pattern continued when four other male cousins in a row also chose to become chemistry majors. The youngest male cousin in our generation broke this pattern when he chose computer science, but my oldest son is majoring in biochemistry.

Whether it is genetic or environmental factors that account for "the apple not falling far from the tree" is not the issue. Both are involved, but genetics may be more involved than we usually suspect. Many of my oldest son's mannerisms mimic those of my father, whom he hardly knew. Identical twins raised in different families often choose the same career, marry the same type of spouse, and demonstrate spiritual interests to the same degree.

As for environmental influences, we all know of songs getting "stuck" in our heads even when we consciously want them to stop. The entire marketing industry is based on the fact that environmental stimuli influence behavior. For example, Pepsi touts studies showing that most of us prefer the taste of Pepsi in blinded taste comparisons. However, most of us actually buy Coke when given the choice. Furthermore, studies of identical twins raised in different homes suggest that religious practices such as church attendance depend more on the environment than genetics.

In fact, one cannot pinpoint where a brain can actually make a decision. Remember, all such activity consists of one neuron firing or not firing based on the aggregation of previous neurons firing or not firing. It does not occur within the neuron, where the potential for firing or not firing is based on relative amounts of polarization or depolarization. It does not occur within the synapses, where transmission relies on the number of neurotransmitters in the synapse. Science writer Dennis Overbye describes this scenario as "physics all the way down."[6]

Overbye refers to an old joke. It seems that an astronomer goes to a remote village to describe the wonders of the solar system. A man comes up after her presentation and says, "I cannot understand this thing you call gravity. We believe the entire world exists on the back of a giant turtle. That, I can understand."

"But on what does the turtle stand?" asks the scientist.

"Upon another, even larger turtle," the man replies.

"And that turtle," persists the scientist, "upon what does it stand?"

"I see what you are getting at," the man retorts. "But, it isn't gravity. It's turtles all the way down!"

Overbye's point is that neurophysiology has been

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JOURNEYS—SOUTH OF THE RIO GRANDE

An Interview with a Chilean Artist

Editor's Note: The art of Francisco Badilla Briones first appeared on the *Spectrum* Web site in September 2008. His moving portrait of Christ's face on the Cross caught the attention of readers beyond the Café Hispano regulars.

A quick check of his Web site <www.franciscobadilla> shows the range of this talented painter. There are abstracts, murals, and several different depictions of Christ. One of the murals depicts *The Return*. Created in 2007 for the Central Hall at the Brainstorm School in Temuco, Chile, *The Return* is a reinterpretation of that classic painting by Fred Collins featured in *The Bible Story* books by Arthur Maxwell. It has shaped the imaginations of Adventists from the day it was printed in 1957.

When we decided to use Badilla's art on the cover of this issue, Ruben Sanchez, a regular contributor to Café Hispano on the *Spectrum* Web site, interviewed Badilla about some of his other paintings.

Sanchez: *What is your understanding of your picture,* Space and Time?

Briones: This work symbolizes Christ. It is a very material painting, with a lot of texture that represents Christ in his corporeal nature and his role as mediator between God and humans.

Hegel suggested that art is an intermediary between the matter and the idea; here I have tried to make a work with a lot of carnality, but make it abstract and symbolic at the same time.

Q: *How can art help us transcend our own space-time limitations and help us sense God in relation to concepts like the eternal, and his omniscience, omnipotence, and omnipresence?*

A: First, we need to take time to appreciate art, to dialogue with it. In order to do this, we need an aesthetic experience that allows us to rejoice in the Lord. Art, in its symbolic language and its polysemy, opens our perception toward a better comprehension of God.

The same should happen when we hear a piece of sacred music and enjoy the experience as something that was made for God's praise.

Q: *Why did you divide the picture into two parts?*

A: This is a diptych that represents two episodes in Christ's life, death, and resurrection. The little one on the right has colors that symbolize death with blood and carnality.

The part on the left symbolizes Jesus' resurrection, where the white space is heaven itself, which opens in order to receive its victorious king. It

also opens itself for us to reach the Father through Christ.

The use of texture reinforces the syntax for an understanding of the corporate Christ, through his material being.

Q: *What meaning do you think Jesus' crucifixion has in our postmodern society?*

A: In our society, the Crucifixion is only history, though an important historical event that launched Western Judeo-Christian thought. I think our society does not want to see Jesus crucified. Society currently senses a need for him, but in some sense, it feels uncomfortable about him.

Q: *Isn't your painting of Jesus too Catholic and Western? If so, don't these qualities come from you having studied at a Catholic university?*

A: The problem is that we don't have a Protestant Christian iconography, so to speak, or it has been decoded, so it is natural that an image of the Crucifixion refers us to Catholic paintings. I think that problems have arisen because of the distance we as Adventists have toward images in general and our Puritan heritage.

Q: *I see your Jesus, unlike many others, transmitting a lot of peace. Is it essential to feel such a peace, which only God can give, to be able to paint it?*

A: Yes. As an artist, I must be at peace, but at the same time I must feel restlessness, to be in need of God. To make a picture of Christ, I must feel the peace that allows me to make decisions in the painting, trusting that God directs my work so it may reach the heart of the people.

Q: *Where is the symbol and where the reality?*

A: Although the painting is a polyptych, its meaning is not separated; symbol and reality are intertwined, the Cross is a symbol not represented in the conventional way, but as an image of a man who carries a piece of wood. That is, the Cross is a symbol, but at the same time it is reality here and now for each one of us.

When we think of Calvary, we see our own reality. The forms on the right symbolize the Trinity: God is above, Jesus at the center, and the Holy Spirit below.

Q: *How do symbols contribute to our perception of reality?*

A: The symbol gives us identity. It takes us back to what we are and shows us that Christ died for our sins, and this should show us our own reality. We must be able to decode the symbol of the Cross every day in our life, thus widening the perception of our reality as children of God in need of him. ■