

1 Brain Birth: A Non-Immaculate Conception

"I'm coming!" my father may have cried. Continued pelvic thrusting and vigorous prostatic pumping delivered a myriad of gene-laden sperm into the welcoming warmth and wetness of my mother's vagina. He felt good. She was satisfied too, though in a less ecstatic, more enduring way. She had always wanted to be a mother, but her first pregnancy had ended sadly in a miscarriage. Although apprehensive, she had wanted to try again. Here was a chance.

And what a chance it was! Made more efficacious by the lubricity of their new environment, millions of tiny sperm cells made their way through the mouth of the uterus. Virtually weightless and invisibly small, some of the wiggly creatures entered the tube running from one of my mother's ovaries to her uterus. There one of them met its match, an egg.

My conception probably occurred in September of 1932, just before Franklin D. Roosevelt's election to his first term as president. The country was in the depths of a fearsome economic depression, and the young Hobsons were understandably apprehensive about bringing a child into such an uncertain world. But despite their misgivings, the combination of his lust and her maternal yearning set the stage for chance to play its part.

Why did one sperm cell, and only one, fertilize that particular egg? What identity did these two entirely non-conscious biological entities confer upon the future person? And how was this formidable constructive process realized? What little we know about these matters is all the more precious. The sperm and the egg that found each other in September of 1932 each contained the genetic material that would become an embryo, then a fetus, and then me. My father contributed half of the genes, my mother the other half.

In 1932 nothing was known about the molecular biology of the gene. Charles Darwin had enunciated his theory of evolution, which posited that the survival and propagation of each species was a functional adaptation

of the particular genetic foundation of that species to its environment. The first laws of heredity had been established in the late nineteenth century by the famous pea-cross experiments of Gregor Mendel.

It was not until 1953 that the molecular structure of DNA was successfully modeled by Francis Crick and James Watson. By then, the being that was conceived in 1932 had become me, and I was, biologically, 21 years old. I would come to know Francis Crick later, when we both became convinced that the brain was dynamically active in sleep and that such brain activity was functionally significant for learning.

In 1932, there was a meeting of one sperm cell and one egg. Each of these two germ cells was chock-full of DNA molecules. Those DNA molecules combined to form an entity who, with time, would become a new person. It is likely that many of the characteristics of that new person were predetermined by chance, since the genetic structure of each of the millions of sperm cells that fertilized that egg was different from all the others.

It is this rich and unpredictable molecular diversity that determines many of the traits that we later evince as persons. The conjunction of the stars at the time of my birth (or at the time of my conception) probably has little or nothing to do with my personality or my behavior. Being skeptical about such thought systems as astrology—or any other faith-based theory of genesis—may be one of the traits that I developed at any early age. I may have been born skeptical. I will certainly die that way.

Of course, astrological analyses, like other forms of psychoanalysis, can become self-fulfilling prophecies as soon as practitioners begin to use the teachings or texts of such systems as guides to life. Then circularity becomes complete, because individuals act as if the predictions were both accurate and binding. Is one any less credulous to believe in biological predestination? I think the answer to this question is Yes, because biological predestination lends itself to experimental refutation. The other belief systems cannot fulfill this criterion and are properly regarded as religions or as pseudosciences if they have any scientific pretense at all.

The man and the woman who made love in September of 1932 were both from long lines of Anglo-Saxon people. On my mother's side, which was better-researched than my father's, was Roger Williams, the rebel and reformer who founded the Providence Plantation. My familial (and presumably genetic) lines went back to the king of Scotland who was called Robert the Bruce. As myth has it, Robert the Bruce decided his battle strategy by closely observing the behavior of a spider. Was he aware that chance might have been as good a guide as a spider in making important

life decisions? Or did he believe that the spider was a messenger conveying the orders of some higher power, perhaps God or the stars? Other great kings appear in the medieval period of my family tree, as they do in the well-researched genealogy of almost any English-speaking person. That is because there are many more descendants than ancestors.

In noting the presence in my genealogy of such a historically important character as William, the Norman Conqueror of England, I do not mean to suggest that the person conceived in September of 1932 behaved as he did because he carried the genes of his forebears. It is far more likely that the superficial resemblance is either a complete coincidence or a consciously learned piece of mimicry. Rigid belief in heredity is every bit as unjustified as rigid belief in anything else.

Whatever the history of my family, and whatever the local circumstances in which my parents struggled for survival, everything I know about myself derives in some way from the biological script of that particular sperm and that particular egg. This should be emphasized because we are as tempted to attribute causes to local and proximal events (when generic and remote causes are at work) as we are to attribute aspects of our behavior to our mind (ignoring our brains and organic factors of which we are still, for the most part, in the dark). We must learn to be more cognizant and appreciative of our ignorance. This seems perverse, but saying "I don't know" leaves the door open to novel explanations. By contrast, the strong conviction that one has an explanation that is correct closes that door and decreases the probability of discovery. I am talking about the difference between faith and skepticism, and the difference between religion and science. Because that difference was not explicitly taught to me, it is possible that an innate brain function related to genetic and hereditary factors as well as to the local conditions was the proximal cause of a particular path of development. How did my brain develop?

The most rapid multiplication of brain cells took place between 8 and 15 weeks after conception. The dramatic growth of what would become a brain began around January 4, 1933. In the spring of that year, my neurons, which had begun to migrate from the center to the burgeoning surface of my brain in December, sprouted their spider-like information-collecting processes and readied my developing brain for functional activity. By March, my neuronal development was impressively advanced and capable of generating the electrical activity that activates the brain in sleep.

By the time I was (biologically) 30 weeks old, I was able periodically to activate my still-tiny brain. I did so reliably and enduringly. I was floating in the amniotic fluid of my mother's uterus, connected to her circulatory



Me and my parents (1934). I was about one year of age when these photos were taken during a family outing to Mount Greylock in western Massachusetts. In the photo at left, my mother is beaming at me and I offer my father, the photographer, a tentative smile. In the photo at right, my father is less happy, perhaps because he is about to carry me up the mountain but also because he was always less demonstrative of positive feelings. I look at my mother a bit apprehensively.

system by an umbilical stalk from which I received oxygen (enabling me to respire without breathing) and glucose (enabling me to grow without eating).

Between March and June of 1933, the weight of my little brain doubled twice. This was a much faster rate of growth than any stock market rally and one that certainly put to shame the country's slow economic recovery from the Great Depression. In the best of times, an economic recovery would take several years to match what my brain accomplished in those three months.

Thanks to work by many people who are my friends and colleagues, we now know that the primordial brain-activation state of the fetus is analogous to the REM sleep that is so prominent in the neonatal period. Together

with electrical activation of the fetal brain, writhing trunk and limb movements appear, as does deflection of the eyes. The being conceived in 1932 was very active by March of 1933, when my mother began to detect the unmistakable signs of my life. She felt good about the kicks and punches that her child-to-be unknowingly delivered to her. They were sure signs that I was alive and well inside her.

Thus, the being conceived in September of 1932 was capable of primitive behavior by March of 1933. The genetic program conferred by the sperm and the egg had constructed a body (including arms, legs, a trunk, and a head) and internal body parts (including a heart, two lungs, a digestive system, and a brain). The believer in us might say "God works in wondrous ways," explaining everything and nothing at once.

How does the fetus activate its own little brain, and to what end? Does it possess a clocklike mechanism in its tiny but already elaborate brainstem? I now think that a possible goal of prenatal brain activation is to implement a virtual-reality program that is used to guide subsequent brain development and to help meet the sensorimotor challenges of life after birth. At what point did that fetus become sentient? When did it first feel sensation, experience emotion, and attribute agency to its movements? Certainly sensation and emotional expression are present at birth. It is therefore reasonable to suppose that such primordia of consciousness are present in utero. Obviously we can't really know, because a fetus cannot speak. But because it can cry as soon as it begins to breathe, the basic brain mechanisms for emotional expression must have developed in utero, perhaps as early as 30 weeks after conception. We can make this guess with informed confidence because babies born as much as 10 weeks early (and are, biologically speaking, 30 weeks old) show definite cycles of sleep and waking and an impressive range of awake-state behaviors.

One inference is that from March to early June of 1933, between the biological ages of 30 and 40 weeks, I was not just floating in my mother's womb; I was simulating waking, and I was, in a primitive sense, also simulating dreaming. Why persist in calling this being a fetus? Why not call it a person and assume that it was conscious? This question has great relevance to scientific and philosophical models of ourselves.

To say that the fetus may experience a primary form of consciousness is to invite unwelcome debate about the intentional ending of its life. Where do we draw the line? How early does the primitive consciousness, consisting of sensation and emotion, arise? How old were this mother's two spontaneously aborted fetuses? Were they sentient? We cannot know. But we can suppose that our newborn creature, on whom his parents

conferred the nominal identity of John Allan Hobson, was not capable of the full consciousness that probably arose sometime during the first two years of postnatal life. My consciousness may be said to have begun in utero with a primitive sense of volition about the agency of my early motor behavior. It then continued to evolve until the age of 4 or 5 years, when my memories became truly autobiographical.

In other words, the creature that became me spent 5 years developing its brain to the qualitative level of adult human consciousness. And, of course, I still had a long way to go before I would write my college thesis (22 years) and my first book (53 years). I began writing this book when I was 40 years old, when I began keeping a journal, but the manuscript did not take its present form until I was 70 (and my brain was nearly 71). At this writing I am 77 and still making changes in my story. My progress, you will agree, has been very slow but also very continuous.

In the early morning hours of June 3, 1933, my mother was struggling to push me out into the world, hoping I would survive. Had I then been capable of thought, I might have wondered why my peaceful sleep was being disturbed by such violent pressure. I had been jostled before, largely by my own kicks and twists. This was quite different. I didn't initiate the pushes, and I had no idea why they came at such regular intervals. In fact, I had no idea what was going on. As far as I know now, I had no ideas whatsoever. Cognitively, I did not yet exist.

I accept the story that, on the day I was born, I was forced out of the warm bath in which for nine months I had floated, virtually weightless and not having to breathe, eat, or excrete. As I floated, did I do anything, consciously speaking? Did I dream? If I did, what was the nature of my dreams? Protoconscious dreams are hard to imagine without reference to the sort of consciousness that, once we have grown up, ensues when we wake up from sleep. By now I have developed waking consciousness and can describe the dreams I happen to remember. When I am awake I do not feel that I am dreaming, but I am now fairly sure that my dreaming brain continues to function in an important way. I have even thought that we cannot have waking consciousness without dream consciousness. This is a speculative hypothesis, but it is certainly true that we can't have either waking or dreaming consciousness without more brain development than we have when we are born.

Enter, nervously, my new concept: protoconsciousness. By 'proto' I mean both prior to and foundational of. To imagine the subjectivity of protoconsciousness is a challenging thought experiment. Let us first subtract the content of what we have good reason to believe derives from awake-state

consciousness, and see what might be left over. First and foremost is some primordial sense of self. My brain is activated, therefore I am? But is it reasonable to assume that I am only the activation state of my brain cells jabbering away to one another in the dark, afloat in my mother's belly? What does that I feel like? The mind boggles at the question.

Is there any sentience at all in utero? The query is fraught with moral weight. Since the answer is unknowable, the situation appears to be in favor of the right to life. But the likelihood of any sentience worthy of the name is so improbable as to ease the conscience of those women who decide that they do not wish to be mothers just yet.

When my brain was activated, I moved. As my mother's pregnancy entered its third trimester, I was capable of significant movement. My arms moved, and I could even suck my little thumb. My eyes moved, and sometimes their movements occurred in REM-like clusters. And my legs could kick hard enough to awaken my mother, whose own sleep was becoming more fitful as June 3, 1933 drew near. Did these movements resemble instinctively meaningful fixed action patterns, or were they simple mass reflexes? The question is moot, but an answer is now obtainable with the use of non-invasive imaging technology in humans and through direct observation of animal fetuses.

Whatever the answer about movement, we can assume it possible that I perceived myself to be the agent of the movement. Consider the twitches that often occur at the onset of sleep. I feel that I make those twitches, and I convey my sense of agency to you in giving my account. Because I often twitch violently, I may say "I must have been falling asleep." I do not say that the excitability levels of reflex circuitry in my brain were changing rapidly because I was falling asleep, although that might be a better way of putting it. The point is that as I developed I took responsibility for actions that may have been entirely reflexive. A self, an I, emerged from this process. It may at first be an illusion (and some scientists say it is always an illusion), but protoconsciousness theory insists that the sense of self as agent emerges slowly and gradually during early development.

Whenever I (or my activated brain) generated a twitch, the movement produced showers of sensory data that were incorporated into my perception of the twitch. I may have had a sense of falling (as I often do at the onset of sleep), or I may have simply jumped without really changing body position at all. And it is not uncommon for me to see something, to hear a voice, or even to perceive an external noise as a vision. I am often surprised by such experiences. Occasionally, I am fearful. Rarely, I am pleased. These emotions, seemingly consequential, are usually folded into the perceptions.

I cannot resist the temptation to back-project these phenomena onto the dark screen of pre-conscious existence. Knowing that this assumption cannot be tested directly (since protoconscious beings, such as I imagine myself to have been, cannot, by definition, give us an account of their experience), I must ask myself whether it is at all appropriate to indulge in such speculations. I answer that it is appropriate, because many implications of the theory are testable and because others are plausible.

Human development is lifelong. Its earliest stages are poorly understood because developmental neurobiology is still underdeveloped. And the science of consciousness is still in its own infancy. But the science of sleep and dreaming has now come of age, and I believe it can come to the rescue of both consciousness science and developmental neurobiology. The goal, of course, is to elaborate testable hypotheses to guide our research.

The dawn of consciousness must be gradual. By the time I was a year old, my mother was convinced that I was conscious (when awake) even if she never dreamed that I was dreaming when I was asleep. David Foulkes asserts that adult-type dreaming begins between the ages of 6 and 8 years. I think it may begin between 5 and 7, but that is still quite late. My point here is that the individual evolution of awake-state and dream consciousness is a long, gradual process that cannot be precisely demarcated. In this sense, the origin of consciousness is analogous to the origin of species, which has a long, ill-defined history.

The scientist who is interested in the development of consciousness has the great advantage that this process repeats itself over and over again before his very eyes.

But can we see into the heart of things? We must admit that we have not done a very good job. How could we do better?

A first step is to conceptualize the problem in a novel and tractable way. I will try to do this as I tell the story of my biological and psychological life. I will try to create a model with the following features: full operation of a protoconsciousness platform by the third trimester of pregnancy, damping of protoconsciousness beginning at birth, completion of the damping as the awake state increasingly takes its place and dynamic interaction between its residua (dreaming and primary consciousness) thereafter, progressive enrichment of waking (or secondary) consciousness for at least five years, a parallel development of dreaming consciousness, lifelong communication of content issues between the two states of consciousness, relatively fixed interactional dynamics between ages 15 and 60, and gradual deterioration of both systems after age 60.

At first, I thought that to tell this story it would be sufficient to write a typical autobiography. But many intelligent people persuaded me that I was not sufficiently famous to make such a book interesting to others. In response, I then thought I could spice it up by interspersing discussions of my dreams with an account of my life. Other intelligent people told me that, although the discussion of my dreams was indeed interesting enough to make a book, such a memoir would still not be up to snuff. Inspired by my recent theorizing, I attempt a neurobiology-based autobiography. In contrast with the psychobiography-based form inspired by psychoanalysis, this is a biopsychography. Think about that awkward word for a moment, then read on.