

FIRST CHAPTER**'The Ethical Brain'****By Michael S. Gazzaniga**

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Central to many of the bioethical issues of our time is the question, When should society confer moral status on an embryo? When should we call an embryo or a fetus one of us? The fertilized egg represents the starting point for the soon-to-be dividing entity that will grow into a fetus and finally into a baby. It is a given that a fertilized egg is the beginning of the life of an individual. It is also a given that it is not the beginning of *life*, since both the egg and the sperm, prior to uniting, represent life just as any living plant or creature represents life. Yet is it right to attribute the same moral status to that human embryo that one attributes to a newborn baby or, for that matter, to any living human? Bioethicists continue to wrestle with the question. The implications of determining the beginning of moral status are far-reaching, affecting abortion, in vitro fertilization, biomedical cloning, and stem cell research. The rational world is waiting for resolution of this debate.

This issue shows us how the field of neuroethics goes beyond that of classic bioethics. When ethical dilemmas involve the nervous system, either directly or indirectly, those trained in the field of neuroscience have something to say. They can peek under the lid, as it were, and help all of us to understand what the actual biological state is and is not. Is a brain present? Is it functioning in any meaningful way?

Neuroscientists study the organ that makes us uniquely human—the brain, that which enables a conscious life. They are constantly seeking knowledge about what areas of the brain sustain mental thought, parts of mental thought, or no thought. So at first glance, it might seem that neuroethicists could determine the moral status of an embryo or fetus based on the presence of the sort of biological material that can support mental life and the sort that cannot—in other words, whether the embryo has a brain that functions at a level that supports mental activity. Modern brain science is prepared to answer this question, but while the neurobiology may be clear, neuroethics runs into problems when it tries to impose rational, scientific facts on moral and ethical issues.

The Path to Conscious Life

As soon as sperm meets egg, the embryo begins its mission: divide and differentiate, divide and differentiate, divide and differentiate. The embryo starts out as the melding of these two cells and must eventually become the approximately 50 trillion cells that make up the human organism. There is no time to lose-after only a few hours, three distinct areas of the embryo are apparent. These areas become the endoderm, mesoderm, and ectoderm, the initial three layers of cells that will differentiate to become all the organs and components of the human body. The layer of the ectoderm gives rise to the nervous system.

As the embryo continues to grow in the coming weeks, the base of the portion of the embryo called the neural tube eventually gives rise to neurons and other cells of the central nervous system, while an adjacent portion of the embryo called the neural crest eventually becomes cells of the peripheral nervous system (the nerves outside the brain and spinal cord). The cavity of the neural tube gives rise to the ventricles of the brain and the central canal of the spinal cord, and in week 4 the neural tube develops three distinct bulges that correspond to the areas that will become the three major divisions of the brain: forebrain, midbrain, and hindbrain. The early signs of a brain have begun to form.

Even though the fetus is now developing areas that will become specific sections of the brain, not until the end of week 5 and into week 6 (usually around forty to forty-three days) does the first electrical brain activity begin to occur. This activity, however, is not coherent activity of the kind that underlies human consciousness, or even the coherent activity seen in a shrimp's nervous system. Just as neural activity is present in clinically brain-dead patients, early neural activity consists of unorganized neuron firing of a primitive kind. Neuronal activity by itself does not represent integrated behavior.

During weeks 8 to 10, the cerebrum begins its development in earnest. Neurons proliferate and begin their migration throughout the brain. The anterior commissure, which is the first interhemispheric connection (a small one), also develops. Reflexes appear for the first time during this period.

The frontal and temporal poles of the brain are apparent during weeks 12 to 16, and the frontal pole (which becomes the neocortex) grows disproportionately fast when compared with the rest of the cortex. The surface of the cortex appears flat through the third month, but by the end of the fourth month indentations, or sulci, appear. (These develop into the familiar folds of the cerebrum.) The different lobes of the brain also become apparent, and neurons continue to proliferate and migrate throughout the cortex. By week 13 the fetus has begun to move. Around this time the corpus callosum, the massive collection of fibers (the axons of neurons) that allow for communication between the hemispheres, begins to develop, forming the infrastructure for the major part of the cross talk between the two sides of the brain. Yet the fetus is not a sentient, self-aware organism at this point; it is more

like a sea slug, a writhing, reflex-bound hunk of sensory-motor processes that does not respond to anything in a directed, purposeful way. Laying down the infrastructure for a mature brain and possessing a mature brain are two very different states of being.

Synapses—the points where two neurons, the basic building blocks of the nervous system, come together to interact—form in large numbers during the seventeenth and following weeks, allowing for communication between individual neurons. Synaptic activity underlies all brain functions. Synaptic growth does not skyrocket until around postconception day 200 (week 28). Nonetheless, at around week 23 the fetus can survive outside the womb, with medical support; also around this time the fetus can respond to aversive stimuli. Major synaptic growth continues until the third or fourth postnatal month. Sulci continue to develop as the cortex starts folding to create a larger surface area and to accommodate the growing neurons and their supporting glial cells. During this period, neurons begin to myelinate (a process of insulation that speeds their electrical communication). By the thirty-second week, the fetal brain is in control of breathing and body temperature.

By the time a child is born, the brain largely resembles that of an adult but is far from finished with development. The cortex will continue to increase in complexity for years, and synapse formation will continue for a lifetime.

The Arguments

That is the quick and easy neurobiology of fetal brain development. The embryonic stage reveals that the fertilized egg is a clump of cells with no brain; the processes that begin to generate a nervous system do not begin until after the fourteenth day. No sustainable or complex nervous system is in place until approximately six months of gestation.

The fact that it is clear that a human brain isn't viable until week 23, and only then with the aid of modern medical support, seems to have no impact on the debate. This is where neuro "logic" loses out. Moral arguments get mixed in with biology, and the result is a stew of passions, beliefs, and stubborn, illogical opinion. Based on the specific question being asked, I myself have different answers about when moral status should be conferred on a fetus. For instance, regarding the use of embryos for biomedical research, I find the fourteen-day cutoff employed by researchers to be a completely acceptable practice. However, in judging a fetus "one of us," and granting it the moral and legal rights of a human being, I put the age much later, at twenty-three weeks, when life is sustainable and that fetus could, with a little help from a neonatal unit, survive and develop into a thinking human being with a normal brain. This is the same age at which the Supreme Court has ruled that the fetus becomes protected from abortion.

As a father, I have a perceptual reaction to the Carnegie developmental stages of a fetus: the image of Stage 23, when the fetus is approximately eight weeks old, suggests a small human being. Until that stage, it is difficult to tell the difference between a pig embryo and a human embryo. But then-bingo-up pops the beginning shape of the human head, and it looks unmistakably like one of us. Again, this is around eight weeks, more than two thirds into the first trimester. I am reacting to a sentiment that wells up in me, a perceptual moment that is stark, defining, and real. And yet, at the level of neuroscientific knowledge, it could easily be argued that my view is nonsensical. The brain at Carnegie Stage 23, which has slowly been developing from roughly the fifteenth day, is hardly a brain that could sustain any serious mental life. If a grown adult had suffered massive brain damage, reducing the brain to this level of development, the patient would be considered brain dead and a candidate for organ donation. Society has defined the point at which an inadequately functioning brain no longer deserves moral status. If we look at the requirements for brain death, and examine how they compare with the developmental sequence, we see that the brain of a third-trimester baby, or perhaps even a second-trimester baby, could be so analyzed. So why would I draw a line at Carnegie Stage 23 when the neuroscientific knowledge makes it clear that the brain at this stage is not ready for prime-time life?

I am trying to make a neuroethical argument here, and I cannot avoid a "gut reaction." Of course, it is *my* gut reaction, and others may not have it at all. In recognizing it within me, however, I am able to appreciate how difficult these decisions are for many people. Even though I can't imagine, and do not have, a gut reaction to seeing a fourteen-day-old blastocyst, an entity the size of the dot of an *i* on this page, that dot may serve as a stimulus to the belief system of those who hold that all fertilized eggs are worthy of our respect. Still, I would argue that assigning equivalent moral status to a fourteen-day-old ball of cells and to a premature baby is conceptually forced. Holding them to be the same is a sheer act of personal belief.

The Continuity and Potentiality Arguments

Obviously there is a point of view that life begins at conception. The continuity argument is that a fertilized egg will go on to become a person and therefore deserves the rights of an individual, because it is unquestionably where a particular individual's life begins. If one is not willing to parse the subsequent events of development, then this becomes one of those arguments you can't argue with. Either you believe it or you don't. While those who argue this point try to suggest that anyone who values the sanctity of human life must see things this way, the fact is that this just isn't so. This view comes, to a large extent, from the Catholic Church, the American religious right, and even many atheists and agnostics. On the other side, Jews, Muslims, Hindus, many Christians, and other atheists and agnostics do not believe it. Certain Jews and Muslims believe that the embryo deserves to be assigned the

moral status of a "human" after forty days of development. Many Catholics believe the same, and many have written to me expressing those views based on their own reading of church history.

When we examine the issue of brain death, that is when life ends, it also begins to become clear that something else is at work here: our own brain's need to form beliefs. If we examine how a common set of accepted rational, scientific facts can lead to different moral judgments, we see the need to consider what influences these varying conclusions, and we can begin to extricate certain neuroethical issues from the arbitrary contexts in which they may initially have been considered.

Different cultures view brain death differently. Brain death is declared medically when a patient is in an irreversible coma due to brain injury-from a stroke, for example-and has no brain stem response, leading to a flat EEG (that is, no sign of brain activity on an electroencephalography recording), or ability to breathe independently. A survey published in the journal *Neurology* in 2000 compared worldwide standards and regulations for declaring brain death. The concept of brain death is accepted worldwide: even in the most religious societies no one argues that human life continues to exist when the brain is irreversibly unable to function. What differs is the procedure for determining brain death. And these societal differences reveal how bioethical practices and laws can vary so wildly, for reasons that have nothing to do with science but instead are based on politics, religion, or, in most cases, the differing personal beliefs of a task force. For instance, China has no standards, while Hong Kong has well-defined criteria-left over, no doubt, from its having been under the rule of the United Kingdom. The Republic of Georgia requires that a doctor with five years of neuroscience practice determine brain death; this is not so in Russia. Iran requires the greatest number of observations-at twelve, twenty-four, and thirty-six hours-with three physicians; and in the United States, several states have adapted the Uniform Definition of Death Act, including New York and New Jersey, both of which have a religious-objections loophole.

The example of brain death illustrates how rules and regulations on bioethical issues can be formed and influenced by beliefs that have nothing to do with the accepted scientific facts. No one debates that a line has been crossed when the loss of brain function is such that life ceases. What we differ on isn't even when that line should be drawn-most countries have similar definitions of brain death. What differs is largely who makes the call and what tests are used-differences, basically, in how you know when you get there, not where "there" is.

So, too, we all seem to be in agreement that there must be a point at which moral status should be conferred on an embryo or fetus. However, we seem to have a harder time defining that point, regardless of the facts. . . .

