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Confused Meanings of Life, Genes and Parents

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Questions concerning the moral status of embryos, the validity of new technologies for human reproduction, ownership of one's own genes, gene patenting, privacy and discrimination have all been raised and debated. Although debate is healthy, it is only useful if all participants understand the fundamental biological principles underlying human life, human genes and human parenthood. Many people believe that science can play no role in determining when human life begins. I argue that this false assumption is based on a failure to separate different contradictory meanings of the term 'human life'. In actuality, science has provided great insight into when and how human life and human beings come into existence. I argue as well that, contrary to our intuitive feelings, there is no physical connection between any father and his son; shared genes represent shared information and nothing more. Nevertheless, the feeling of a physical connection between parent and child is very real and instinctive, no matter how false it may be. These new understandings have profound ramifications for the way we treat issues surrounding human reproduction, including both abortion and assisted reproductive technologies. © 2001 Published by Elsevier Science Ltd.

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1. Introduction

The essence of a human being resides not only in the life of each individual person, but also in the unique ability of human beings to beget new human beings. Although there is no simple definition of human life, most people think they can recognize human life when they see it, and most believe that the connection between parents and children is a tangible one. I will argue here that both human life and the connection between one generation and the next are not as simple as they appear to be. With new knowledge in the fields of genetics and reproductive biology, it has become clear the earliest form of human life—the preimplantation human embryo—is not distinguishable in metaphysical terms from cells washed

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off our skin in the shower, and a tangible connection between parent and child is more imagined than real.

2. What is Human Life?

When does a human being come into existence? Among all the questions asked by ethicists and theologians, this one is probably the most critical to the way in which ethical decisions are made on a daily basis. Ethical people of all religious and political persuasions agree that human beings should be treated with dignity and respect. We all agree that slavery, abuse and the murder of human beings are intolerable actions. In contrast, we must all kill other living things to sustain our lives. Thoughtful people may worry about the infliction of pain on higher animals, but if they are not vegetarian, they accept the killing of mammals for food and usually for medical research as well. And even strict vegetarians crush living cells to death as they eat their garden salads.

Many people believe that science can play no role in determining when human life begins, and that this question should be left to the realm of theology. But we now know that this assumption is false. Just as twentieth-century science has given us great insight into when and how the universe began, it has given us great insight into when and how human beings come into existence.

Before we can understand what science tells us about the beginning of human life, it is necessary to understand what we mean by the term 'human life' itself. Much confusion has been sowed by the unfortunate use of this term in two very different ways.[1] This single term is used to describe conscious individuals as well as individual human cells that scientists can grow indefinitely in the laboratory. The distinction between these two usages is best exemplified by considering what happens right after someone is shot to death with a bullet to the heart. The person is clearly dead even though more than 95% of the cells in his body are still alive. Indeed, some of the dead man's organs can continue to function if they are transplanted into the bodies of other persons!

Aristotle clearly understood the different meanings of life when he proposed the division of the soul into three components: vegetative (or nutritive), animal and human.[2] With modern science, we can interpret Aristotle's vegetative soul as being equivalent to cellular life, his animal soul as being equivalent to a functional nervous system (in any animal), and his human soul as being equivalent to human consciousness.

Every time you blow your nose, scratch your skin, or take a shower, you kill living cells, but no sane person mourns their death. Thus, it would seem that human life at the cellular level (Aristotle's vegetative soul) is simply not deserving of our

[1]For a detailed discussion of the two different scientific meanings of the term 'human life', see chapter 1 of Silver (1998).

[2]Aristotle, *On the Soul*.

respect. However, until 1997, there was near-universal belief that the one-cell human embryo was different in some fundamental way from other cells in your body because it alone had the potential to form a new human life. Based on this perceived difference, many bioethicists were willing to grant the one-cell human embryo special respect and protection from experimentation.

On February 27th of that year, Dolly, the first animal cloned from an adult cell, was announced to the world. But what was missed by many people in the media fanfare was the revolutionary implication that this one animal had for the status of human embryos. In one fell swoop, Dolly's birth shattered the illusion of a line separating human cells with the potential to form a new life from those without such potential.

What Dolly tells scientists is that there is no metaphysical difference between any living cell with a complete set of human genes. They all have the potential to become reprogrammed to start anew the development of a conscious human being. Potential is the key word here. It does not mean that we actually want to do it, it does not mean that we have the technical capability of doing it today, and it does not mean that it will ever be efficient with some cells. But it makes no sense to suggest that different degrees of potentiality (determined simply by the currently available technology) should cause us to view an embryo cell as being ethically different from a cell scratched off your skin.

It is important to understand exactly what makes an embryo cell behave differently than a skin cell. Both have the same DNA with the same genetic code. But at the outset, they have different proteins loosely attached to different regions of that DNA. The type and location of proteins on the DNA determines the portion of the genetic program that is being run which, in turn, determines the behavior and 'potential' of the cell. At the moment, with our primitive knowledge, we can only blindly re-start the genetic program of an adult cell by fusing it to an unfertilized egg. But once we understand exactly what proteins are involved, it may become possible to simply add those proteins directly to a skin cell to convert it into an embryo.

So what reasons could we have for treating a one-cell human embryo differently than a skin cell? There are only three that I can think of. The first would be in cases where the biological progenitors of a particular embryo deemed their own embryo worthy of respect. In such cases, it seems reasonable for medical personnel to abide by the wishes of the embryo progenitors if it is at all practical to do so.

A second reason could be that the mere physical positioning of protein molecules on DNA is determinative of whether a human cell is deserving of our respect. This notion is clearly absurd, but it ties into the third reason raised for granting an embryo special status—as a result of particular protein-DNA interactions, the embryo has become imbued with a special spirit or soul that does not exist in other living human cells.

There is a problem with the 'soul in a one-cell embryo' hypothesis which is best illustrated with the following thought experiment. Let us imagine that *in vitro* fertilization has been used to produce a single embryo for a couple that has been trying for a very long time to have children. The couple realizes that it might not be possible to have another embryo produced and they decide they want to turn their one embryo into two babies. To accommodate their wishes, a fertility doctor waits for the embryo to develop to the two-cell stage and then pulls the cells apart from each other so there are now two one-cell embryos with the potential to develop into identical twins. (Such a process occurs naturally in people and is easy to accomplish in the lab as well.) If you believe that every one-cell embryo is imbued with a soul, then two souls exist in these two embryos.

Quickly, however, the couple changes their mind. They decide that it's too difficult to raise two children at the same time and they really only want to have one baby. So, you take the two embryos and push them back together again to produce the single embryo that you started with, which could develop into a single normal child.

What has been lost in this process? All of the cells you started with are still alive so you haven't killed anything. Indeed there is no biological, chemical or physical difference between the sum of two embryo cells separated by a few micrometers and the single embryo that they become at the instant when their membranes touch.

The only thing that is possibly lost when the two cells touch is a human soul or spirit, but the conclusion of our thought experiment must be that this spirit can have no connection to the positions of protein on DNA, and indeed, no connection in any way to the physical world.

If the one-cell human embryo is no different metaphysically from a cell you scratch off your skin, when during embryogenesis does a significant difference arise? Unfortunately, there is no simple answer to this question. One problem is that development is slow and continuous. There are no isolated moments along the way where you can point at an embryo or fetus and say that it is substantially different from the way it was a few minutes, or even hours, earlier. Nevertheless, during the nine-month period of gestation, the embryo and fetus pass through a series of major developmental stages during which important milestones on the pathway to human life are reached. Through an appreciation of the significance of these milestones, it becomes possible for each of us individually to make an informed decision on the question of the emergence of human life.

The first important milestone occurs between 10 and 14 days after conception. At this time, the free-floating embryo latches onto the uterine wall and implants itself. The embryo begins a period of rapid growth and the individual cells in the embryo begin to distinguish themselves from each other so that twinning is no longer possible. The very first cells that will eventually develop into the spinal chord also make their appearance.

During the fourth week, one can see the beginnings of the gut, liver and heart.

At the end of the fourth week, the heart is beating and primitive blood cells are moving along embryonic veins and arteries. It is also at this stage that the very earliest development of the brain begins. Still, the embryo is less than a quarter of an inch long.

Between six and eight weeks after fertilization, the embryo turns into what appears to be a miniature human being with arms, legs, hands, feet, fingers, toes, eyes, ears and nose. It is these external human-like features that cause a shift in terminology from embryo to fetus. By 12 weeks, the inside of the fetus has also become rather human-like with the appearance of all the major organs. The first trimester of pregnancy is now completed.

Although looks alone can have a powerful effect on how we view something, it is important to understand what is, and what is not, present at this early stage of fetal development. While major organs can be recognized, they have not yet begun to function. Although the cerebral cortex—the eventual seat of human awareness and emotions—has begun to grow, the cells within it are not capable of functioning as nerve cells. They are simply precursors to nerve cells without the ability to send or receive any neurological signals. Further steps of differentiation must occur before they even look like nerves or develop the ability to make synaptic contacts with each other. And in the absence of communication among nerve cells, there cannot be any consciousness. This means that if a fetus is aborted at this stage, it cannot feel any pain.

Two independent milestones occur between the 24th and 26th weeks after conception. The first is viability. It is during this period that the fetus develops the ability to survive outside the womb. Survival becomes possible as the fetal lungs begin to function for the first time. The second critical milestone is the wiring up of the cerebral cortex, and with this functionality comes the first potential for human consciousness, which emerges slowly over the next several months.

Although it is impossible to draw a sharp line during development that separates the unconscious human entity from a conscious human being, the difference between the early embryo and a walking, talking person was absolutely clear to Aristotle, and it should be absolutely clear to every rational person alive today.

3. What are Human Genes?

Genes are everywhere these days—in newspapers, movies, casual talk among friends from every corner of society. In the fall of 1996, in the tiny village of Zonza, isolated between mountain ranges in the middle of the island of Corsica in the Mediterranean Sea, I overheard a group of friends, who support the separatists that set off nightly bombs in their quest for independence from France, sitting together eating and drinking. One man makes the others laugh with his stories and jokes, and a woman in the group wonders why he's so funny. 'C'est genetique!' is the instant response: it's genetic! The other friends at the table nod in agreement.

In their eyes, and the eyes of most people today, the gene is a powerful icon—revered to a degree much greater than it deserves to be.

It was not always this way. As recently as the year of my birth, 1952, the geneticist-authors of a popular book entitled 'Heredity, Race and Society' lamented the fact that, over half a century after it had been proven otherwise, most Americans still believed that blood was the agent of heredity.[3] Now, half a century later still, the gene icon has swept across the world of human minds. Today, it seems, all literate adults know that genes—transmitted through sperm and eggs—are the true agents of inheritance.[4]

What exactly are these genes that wield so much power in forming not just each new human being, but each new living thing on earth? What is the nature of the substance that I've received from my maternal grandmother and my other three grandparents who are no longer alive? What is it exactly that you share with your brother or sister? Most educated people in Western societies think they know the answer to this question as well. 'Genes are made of DNA', they say, 'which is the shorthand abbreviation for a type of molecule having the full name DeoxyriboNucleic Acid. And a quarter of your DNA comes from each of your grandparents. Right?'

Well, actually the answer is no, that's not right. In fact, I can state with essentially 100% confidence that none of the DNA molecules within my body came from any of my four genetic grandparents. And obviously, none of the DNA molecules in your body came from your sister, or vice versa.

What is going on here? How can I carry my grandmother's genes if I haven't received any of her DNA? If not her DNA, what did my grandmother give to me? Is it some other kind of matter?

The answer is that it's not matter at all. What I have received from my grandmother, pure and simple, is information—intangible, non-material information.

And where did the DNA molecules in my body come from? They were actually built up, piece by piece, from smaller molecules that came from the cows, chickens, fish, plants and other things that my mother ate while she was pregnant, and that I have eaten since. The old saying 'you are what you eat' is not far from the truth in purely material terms.

The best way to clear up the confusion that I have purposely created is through an analogy based on computer files. Let us say that I have written a letter on my computer at work and I save it as a file called 'letter.1' on my hard disk. Before leaving work in the early evening, I decide that I may want to modify the letter on my home computer. So I copy the file named 'letter.1' from my hard disk onto a small diskette which I eject from the computer and drop into my shirt pocket.

[3]Dunn and Dobzhansky (1952), pp. 40–1.

[4]The word 'blood' is still used in common speech to connote relationships through heredity, but it has been relegated to a figure of speech, in the same way that people still say they are 'dialing' a telephone number on a push-button phone.

After dinner, I push this diskette into my home computer and then open up the file ‘letter.1’ to read and modify what I had written earlier in the day.

What exactly is the file ‘letter.1’? Is it equivalent to a small piece of a hard disk or the diskette that I carried in my pocket? Is the file made of the magnetic material on the disk or diskette? The answer to these questions is clearly no. The file is not a material thing. If it were, it wouldn’t be eliminated by simply running a magnet over the disk, or by copying an unrelated file into the same physical place.

The file ‘letter.1’ is a packet of information that is encoded within a particular diskette by the specific alignments forced onto groups of adjacent atoms in the magnetic material. If the specific atomic alignments are changed, then the file itself is also eliminated. Magnetic alignments represent information, not matter.

In an analogous fashion, the gene is a packet of information that is encoded within the DNA molecule. And just as the magnetic surface of a disk can act as the storage medium for a computer file, the DNA molecule acts as the storage medium for a genetic file, or gene. And just as a file can be transferred from one magnetic disk to another without the actual exchange of matter, so a gene can be copied from one DNA molecule to another, even as the new DNA molecule is built up entirely from raw materials—brand new atoms ‘pulled out of the air’. The old DNA molecule—which molecular biologists refer to as the ‘template’—provides only the information upon which the new DNA molecule is structured. The information that is copied from one molecule to another—which occurs in the absence of any material exchange—makes up the gene. While most people would never confuse the messenger for the message with computer files, even many biologists do confuse the two when it comes to genes.

‘So what does a gene look like?’, you may ask. The answer is that this question makes no sense. Information may have meaning, but it doesn’t have looks. It might seem that the computer file ‘letter.1’ is encoded by a long string of zeros and ones (or magnetic ups and downs) on the surface of a disk, but this is just one arbitrary representation of the file in the binary number system used by most computers. If a hard copy of this very file is produced on paper, it will look completely different with sequential rows of 26 different alphabetic letters strung together in different combinations of different lengths separated by blank spaces and punctuation marks. Nevertheless, the information contained within this hardcopy of the file would be no different than that contained within the binary file. And its meaning would still be evoked in the form of images produced in the mind of the intended reader.

In similar fashion, it might seem that a gene looks like a sequence of hundreds or thousands of four different DNA building blocks strung together in a particular order. But the information that defines any gene can be converted into binary code and copied—by a sophisticated biotechnology machine—onto the same diskette that held the ‘file.1’ letter written to my friend. To make the circle complete, another sophisticated biotechnology machine can be used to copy the gene stored on the diskette back onto a DNA molecule.

Understanding the true nature of genes—as immaterial packets of information—has profound implications for our understanding of biological relationships among family members. Biological relationships among people—father and son, sister and brother, grandmother and grandchild—are based on entirely on shared genes. In the case of grandmother and grandchild, or father and son, the genes have been passed from one generation down to another. In the case of sister and brother, shared genes have come from a common parent or parents.

But if genes are simply packets of information, then there is no limitation on the type of media within which they can be stored. Genes stored in computer memory are no less valid than genes stored in DNA. And genes stored electronically can be moved at the speed of light from one place to another.

A simple thought experiment shows why this notion is so profound. Let us say that there is a genetic engineering company on Mars. Just like many companies can do now on earth, this company can create new DNA molecules with a DNA synthesizer. But the technology of this company is so advanced that its synthesizers can create whole human chromosomes that can be placed into human eggs (whose own DNA was previously removed), which can then be placed in the wombs of surrogate women, where they develop into babies born nine months later.

Now you and your spouse go to a company on earth which determines all the genetic information (known as the 'sequence') present in your own chromosomes. Half of your genetic information and half of your spouse's genetic information is next transmitted by radio waves to Mars, where the Martian biotech company converts it back into DNA which is used to form an embryo that develops into a baby boy. That child on Mars will be just as much your son as any son that you have on earth. There is no scientific test that could distinguish between the two as your legitimate biological sons.

The profound conclusion that we must reach is that the actual link between any father and son—and indeed between any related people—lies entirely within information. This is the only thing that gets passed down from one generation to the next.

4. What is a Parent?

4.1. The Desire to Have One's 'Own' Child

The desire to have and raise a child is such a powerful instinctive force that many people who experience it have a hard time explaining where it comes from.[5] But the source is readily apparent to those familiar with Theodisius Dobzhansky's

[5]In the essay 'Genetic Puzzles and Stork Stories: On the Meaning and Significance of Having Children', the philosopher Kenneth Alpern explores the broad range of answers given by people who are asked why they want to have children, and the so-called validity of each answer (Alpern, 1992).

famous quote, 'nothing in biology makes sense except in the light of evolution'.[6] In this light, the origin of the desire is easy to see. It emerges directly from one of the guiding principles of evolution: genes that program individuals to do a better job at reproducing themselves will be passed down with increased frequency from one generation to the next, and will eventually spread widely throughout a population.

It is easy to imagine how such a desire for one's 'own' child might have evolved in our ancestors. It probably began with the ability to generate and process abstract thoughts, and make logical connections between events that occurred far apart from each other in time and place. The fossil evidence suggests that our ancestors gained this intellectual capacity between one and three million years ago, during a period when the cerebral cortex underwent a large expansion in size.[7] And what this increased intellectual capacity provided (as a byproduct) was the ability to make connections between sex, pregnancy and babies. Once these connections were made, the stage would have been set for the evolution of the desire to have children.[8]

People whose genes programmed them with this reproductive instinct (separate from the instinct to want sexual intercourse) would be more likely to engage in activities that promoted successful pregnancy, childbirth and parenting. As a result of these activities, people with a reproductive instinct would have more children who survived to reproduce their own children relative to people without the special genes, and so on, and so on, through generation after generation. Ultimately, the emotional 'desire to have one's own children' would spread throughout the entire species.[9]

Of course, most of us know people who are childless by choice. How does biology explain this? The explanation comes from the single attribute that uniquely defines us as human beings. We alone—among all animal species—have evolved the intellectual capacity to comprehend and, at times, counteract the natural predispositions that our genes provide us with. And under certain circumstances of environment, culture or intellect, reproductive desires can be rejected in favor of other desires centered more on the self, on other human beings, or other life goals.

For the majority of adults, though, the desire to have 'one's own children' is so powerful that it outshines everything else they might possibly want to do during

[6]This aphorism is actually the title of a famous lecture given by Dobzhansky that was published in *The American Biology Teacher* (Dobzhansky, 1973). It is often quoted and used as rallying cry for the defense of teaching evolution in the public schools.

[7]Morowitz and Trefil (1992).

[8]Charles Darwin, *On The Origin of Species* (1859).

[9]There are still gene-critics in the social sciences who refuse to accept the idea that the human desire to have children is instinctual. They claim instead that 'the notion that a desire for children is natural and instinctive might also be considered a nonconscious ideology', which is based on a 'social construct' (Holmes, 1992, p. 271). In other words, the *only* reason people want to have children is because society makes them feel that way without them realizing it. This point of view—always made without any supporting evidence—can be shown to be scientifically invalid.

their lives.[10] And the inability to fulfill the desire may be accompanied by a degree of pain and grief equivalent to that felt upon the death of a loved one. Unfortunately, 9 to 15 percent of all married couples are infertile. In the United States alone, there are more than 2 million couples right now who want to conceive and are unable to do so.[11]

4.2. Whose Child is it Anyway?

From the time our ancestors first understood the connection between sex and reproduction, a mother understood her 'own' child to be the one she gave birth to, and a father's own child was the one conceived with semen that he deposited into a woman's vagina. It was on the basis of this clear distinction that the desire to have one's 'own' children became programmed into our genes—over the course of evolution—as a natural instinct.

The distinction made between one's 'own' child and 'someone else's' child throughout history was much greater than many now realize. Adoption of unrelated children was extremely rare until early in the twentieth century.[12] Children orphaned without relatives may have been cared for by foster parents in earlier times, but such parents invariably distinguished between their 'own' children and the children of others.

With the use of new reproductive technologies, the meaning of one's 'own' child becomes blurred. For IVF makes it possible for one woman to be the birth mother to a child conceived with another woman's egg. Which of these women has the right to consider the child her own?

What most educated citizens of the Western world in the late twentieth century would say is that the child 'belongs to' the woman whose egg was used in its conception. Infused, as we are, with a sophisticated understanding of biology, we know that all of the child's inherited characteristics are carried in the egg and sperm; none are contributed by the birth-mother's blood. Furthermore, we know that these characteristics are programmed by the *genes* present within the fertilized egg. We speak confidently of a genetic mother who can rightfully call a child born with her genes her 'own' child, no matter where its development took place. We place an intellectual veil over our primitive instincts in order to accept the birth of our 'own' child through the birth canal of another woman.

Is it really that straightforward, or not? The following scenarios—both fictitious and real—show that sometimes it's not.

[10]According to a 1990 Gallup poll, 84 percent of childless adults under the age of 40 would like to have children, and 60 percent of childless adults aged 40 or older wish they had children.

[11]Silver (1997).

[12]I refer here to adoption in the modern Western sense of the term. According to the *Encyclopedia Brittanica*, 'In most ancient civilizations and in certain later cultures as well, the purposes served by adoption differed substantially from those emphasized in modern times . . . The person adopted invariably was male and often adult. In addition, the welfare of the adopter in this world and the next was the primary concern; little attention was paid to the welfare of the one adopted.'

4.3. Identical Twins Confuse the Meaning of Parenthood and Childhood

Florence and Gail are identical twin sisters. Florence got married to Frank, and Gail got married to Gary. Unfortunately, before she even met Frank, Florence developed ovarian cysts which necessitated the surgical removal of both of her ovaries. Florence and Frank now want to have children but Florence is unable to produce eggs. To help her sister out, Gail agrees to donate some of her eggs to Florence. Gail's eggs are fertilized *in vitro* with Frank's sperm and introduced into Florence's uterus. Nine months later, Florence gives birth to a baby girl she names Fiora.

Who is Fiora's genetic mother? It's Gail, of course, you would say, since she contributed the egg that developed into Fiora. But, in fact, if Fiora and her birth mother Florence were subjected to DNA fingerprint testing, the results would be quite definitive—they would show, without question, that Florence herself was Fiora's gene-mom. What's going on here?

The confusion is caused by the fact that Florence and Gail are identical twins. As a consequence, they have exactly the same genes. Every egg that Gail produces carries half her genes. But any one-half portion of Gail's genes is equivalent to a one-half portion of Florence's genes. Thus, the eggs produced by Gail could all have been produced by Florence.

Another way of looking at this is from the point of view of the single fertilized egg that developed into both Gail and Florence. This single cell underwent about a hundred divisions, and then a small number of its descendant cells reduced their genetic material by half to become eggs. Some of these eggs ended up, by chance, in Gail's ovaries while others ended up, by chance, in Florence's ovaries (which were later surgically removed).

In strictly genetic terms, Gail and Florence must both be considered Fiora's genetic mother. But this conclusion is rather unsettling, because it means that by DNA fingerprint analysis, the children of *all* identical twins will be found to have two genetic mothers or two genetic fathers—their social parent and their aunt or uncle. It also means that all first cousins related through identical twin parents are actually half-brothers or half-sisters.

The children of an identical twin mother don't normally think in this way for a very simple reason. Their social mother is also their birth-mom as well as their gene-mom, while their aunt is connected only by genes. But what about Florence and Fiora? Florence is a gene mom, she is the birth-mom, and she intends to be the social mom of Fiora. Does this combination trump Gail's contribution of an egg that Florence could have produced herself if she had ovaries? The only unique contribution made by Gail is that of storing the egg for some 25 years before graciously handing it over for use by her sister.

Let's consider another scenario that is similar but goes beyond semantics to a question of medical approach. This time the identical twin sisters are Amy and Jane. Amy is married to Andrew and Jane is married to Jay. Amy has a uterine infection that forces her to have a hysterectomy, but her ovaries remain intact and functional. Amy and Andrew want to have their 'own' children, and Jane has agreed to act as a gestational surrogate mother. Amy plans to have her eggs recovered for fertilization *in vitro* with her husband Andrew's sperm. The fertilized eggs will then be introduced into Jane's uterus for implantation. Jane will carry the fetus to term and then give the baby over to Amy and Andrew so that they can raise their 'own child'.

What we learned from the previous scenario of Florence and Gail is that identical twin sisters can both be considered genetic mothers of any child conceived from eggs produced by either woman. This means that a child conceived by *in vitro* fertilization with Amy's egg and Andrew's sperm would have the same genetic heritage as one conceived through the fertilization of Jane's egg by Andrew's sperm, which could be accomplished by artificial insemination.

What does Amy do? Artificial insemination is cheaper and much less intrusive than IVF for both women. The child born in either case will have the same birth mom and the same pair of gene-moms. So what difference does it make?

Amy may try to argue that although she and her sister share the same genes, she wants to use her egg so that her child receives the particular DNA molecules that she produced in her own body. Surprisingly to Amy, this argument doesn't work because, for the most part, the particular DNA molecules present in a human egg don't actually end up in the body that it develops into. Even with this knowledge, Amy may still want to contribute her *own* egg to this collaborative reproduction arrangement. Though a child conceived from Amy's egg will be indistinguishable by any imaginable test from a child conceived from her sister's egg, Amy may feel that she needs to make some *physical contribution* to her child, however ephemeral that contribution might be, and however irrational her feelings might seem to us.

In fact, rationality has nothing to do with it. It's all based on the primeval instinct programmed into Amy's genes that makes her want to have her 'own' child. This instinct evolved when the distinction between 'one's own child' and 'someone else's child' was crystal clear. And while the evolutionary purpose served by this instinct is the increased transmission of our genes to offspring, the instinct itself operates on the *physical connection between mother and child*. This is why Amy may want that physical connection instinctually even though it makes no difference to the transmission of her genes.

4.4. Twin Brothers, Shared Testicles and an Unusual Cure for Sterility

Let's consider one final 'twins scenario', this one actually true. The story began in 1947 on the day that Mrs. Twomey gave birth to her identical twin sons Tim and Terry. Like all pairs of identical twins, Tim and Terry looked pretty much alike and it was hard to tell them apart from each other. But Tim and Terry were critically different in a way that was hidden from the world—Tim was born without testicles as a result of a rare developmental abnormality that had occurred while he was still within his mother's womb.

With the help of modern medicine, Tim was able to lead an outwardly normal life. At the age of 18, he began to receive weekly injections of the hormone testosterone, which allowed him to go through puberty (at a late age). And as he grew older, continued injections of the hormone provided him with the ability to engage in a normal sex life. At the age of 29, Tim married Jannie. In the meantime, Tim's brother Terry had married and become the father of three children.

At the time of their marriage, Jannie and Tim were convinced that they would never have children 'of their own'. For five years, Tim had been searching without success for a medical authority who could treat his fertility problem. And then shortly after his marriage, he found Dr. Sherman Silber at the St. Luke's Hospital in St. Louis, Missouri. Dr. Silber was a urologist and skilled microsurgeon who was noted for his ability to reverse vasectomies by delicately re-connecting the severed tubes. Dr. Silber said that he might be able to cure Tim's sterility by transplanting one of Terry's testicles into Tim's scrotum. No one before had ever performed such an operation, and the obstacles to connecting both sperm and blood vessels were enormous, but Dr. Silber was convinced that he had the skills to do it successfully.

Terry and Tim both agreed to undergo the procedure, and on May 17, 1977, Dr. Silber performed the transplantation.[13] It was a success. Within a few months, Tim achieved a normal sperm count in his ejaculate, and he no longer needed hormonal injections to maintain his secondary sexual characteristics. On March 25, 1980, Tim and his wife Jannie—both Sacramento police officers—had a 6-pound, 14-ounce baby boy named Christopher Gene (no joke, this is really his middle name!).[14] If genetic tests were ever performed, they would show, without a doubt, that Christopher Gene was indeed Tim's son.

How should Tim feel about this child? Should he consider Christopher 'his own' son or his brother's? Would he have felt the same way if the testicular transplantation had not been possible and his child was born after his wife was artificially inseminated with his brother's sperm? Or was the production of sperm within his own scrotum necessary to set up the physical connection that allowed him to consider the child 'his own'?

The facts certainly suggest that Tim would have viewed a child born by artificial insemination of his wife with Terry's sperm *differently* from the child that he gave life to himself. But why should he feel this way when 'his sperm' actually came from Terry's testicle?

[13]Silber (1978).

[14]An interesting side note is that even after Tim's sterility problem was cured, the Twomeys were still unable to achieve pregnancy because of a subsequently discovered problem with Jannie's menstrual cycle. This problem was eliminated with appropriate medical treatment, and the Twomeys achieved pregnancy a few months later (Silber and Rodriguez-Rigau, 1980).

Again, how we think a person *should* feel rationally need not bear any resemblance to how a person *does* feel when primeval instincts prevail. But many people in society today confuse the driving force of the reproductive instinct with the nature of the instinct itself. Although genes drove early members of our species to desire children of their own, the kinship between parent and child was defined instinctually through the physical connections imparted by semen, gestation and birth. Only today can we think abstractly about the genes that sit at the root of inheritance. Only today can we understand that the physical connection between father and son is an illusion. But when intellectualization conflicts with the primeval instinct for a physical connection to one's child, we are apt to become utterly confused.[15] There is nothing profound about this confusion. It is simply one more way in which the modern world fails to play by the rules under which we evolved.

5. The Ethical Conduct of Bioethicists

With ever greater frequency, bioethicists have been called upon to provide ethical solutions to conflicts that arise in the areas of human reproduction and human genetics. Questions concerning the moral status of embryonic stem cells, the validity of new technologies for human reproduction, ownership of one's own genes, gene patenting, privacy and discrimination have all been raised and debated. Debate on all these issues is healthy, but is only useful if all participants in the debate understand the fundamental biological principles underlying human life, human genes and human parenthood.

6. Conclusion

In this paper, I have used modern understanding in the fields of developmental biology, cell biology and genetics to argue that the term 'human life', has multiple independent meanings which are often confounded. I argue as well that, contrary to our intuitive feelings, there is no physical connection between any father and his son; shared genes represent shared information and nothing more. Nevertheless, the feeling of a physical connection between parent and child is very real and instinctive, no matter how false it may be. These new understandings have profound

[15]The philosopher Kenneth Alpern has described other interesting 'genetic puzzles' which also confuse the meaning of 'one's own child' (Alpern, 1992). The most thought-provoking of these is one in which a woman walking down the street happens to discover a baby in a stroller with a genetic makeup that is identical to her own, just by chance. In a variation of this scenario, one can imagine that the baby actually shares only half of its genetic material with the woman walking down the street, so that it would appear—by all imaginable tests—to be that woman's child. Alpern asks whether the woman should view this child as 'her own', even if she has no reproductive link to it. He concludes that 'The science of genetics certainly does not provide full answers to the questions that we have been asking . . .'. In fact, Alpern is wrong in his conclusion because of a failure to appreciate the distinction between the *ends* (increased transmission of genes) and *means* (the instinctive desire to have children that are physically connected) that operated during the process of evolution.

ramifications for the way we treat issues surrounding human reproduction, including both abortion and assisted reproductive technologies.

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