Human Embryos, Development of Human Specific Behavior, and Personhood: A Biologist's View

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The 21st century biotechnologies of human embryonic stem cell (hESC) use, therapeutic cloning (TC), and preimplantation biopsy (PB), give fresh urgency to defining personhood. Is it morally acceptable to destroy 5-day-old human blastocysts to cure disease, repair injured tissue, or prevent birth defects? In his 1486 essay "On the Dignity of Man," Pico della Mirandola expressed a view of human nature that can help us in our deliberations about personhood. Pico maintained that the capacity for moral choice-making is what distinguishes humans from other creatures. This view suggests that our use of biotechnology ought to respect and protect humankind's choice-making capacity. Examination of a set of attributes necessary for choice-making shows that it emerges gradually between 5 weeks after fertilization and 10 years after birth. By this analysis, blastocysts cannot be persons, and hESC use, TC, and PB do not violate personhood. Possible criticisms of this analysis are acknowledged.

A diversity of ethical problems is raised by 21st century biotechnologies like cloning, embryonic stem cell use, genetic engineering, extending human life spans, and neuropharmacology. Satisfying solutions to some of the problems will require a consensus on questions about the nature of humanity and the condition of personhood. With a few exceptions, biologists I know do not normally contemplate these issues during a normal day in the laboratory or university classroom. Maybe this is because solutions to such nonfigurative questions are not viewed to be answerable by science. In the United States it may also be due in part to an educational system that does little to encourage cross disciplinary thinking. Whatever the reasons for the compartmentalized thinking in many disciplines, the time has come to apply interdisciplinary approaches to the problems of human nature and personhood which for centuries have been treated primarily as the property of philosophy, art, and theology. Certainly, these ways of knowing are essential for a holistic understanding of our species. But the evolutionary origin of our species demands that generative thinking about human nature and personhood also incorporate information from the sciences including the multitudinous subdisciplines within biology, psychology and anthropology. After all, *Homo sapiens* and its 6-7 million year old bipedal primate cousins share an ancestry with thousands of other extant and extinct mammals whose bloodlines are linked to the therapsids, mammalian-like reptiles that lived 220 million years ago. Unfortunately, our thoroughly animal lineage has frequently been underappreciated or straight-out denied by clergy, legislators, and others whose ideas and work are influential in defining for us who we are. Now that 21st century biotechnologies endow us with an unprecedented capacity for self-sculpting, the need is urgent to develop balanced, realistic, and practical approaches to discovering who we are and what we wish to become. My aim in this essay is to apply an interdisciplinary approach to answering a well-defined question about the moral status of early human embryos. The question is whether 5-day-old and earlier stage human embryos ought to be dignified with the status of "personhood."

I begin with a presumption about the concepts of personhood, dignity and moral worth. My presumption is that these qualities are conferred upon human beings by other human beings. I do not deny that a supernatural Creator may also do this, but I do not assume it. My intent in defining personhood as a state or trait conferred upon us by ourselves is to avoid the pitfall of presuming to know which Creator is preeminent in the realm of personhood and what She/He/It had in mind when assigning it.

I consider the ideas presented here to be works in progress. They are not exhaustively described or argued to tight completion. My hope is that they will convince readers of the value of interdisciplinary approaches to difficult theoretical problems in need of solutions with real life applications. I like to think that my approach to and conclusions about personhood differ from those of most theologians in that they are undogmatic and open to criticism and correction. Similarly, I like to believe that they differ from those of most philosophers by being comprehensible to non-philosophers. Finally, I maintain that my approach to the personhood question promotes respect for the diversity of views that exist on this subject.

What I wish to say comes in six parts:
1) definitions of some key terms,
2) descriptions of three specific biotechnologies and how they raise the issue of personhood,
3) an overview of varying criteria that have been used for identifying *Homo sapiens'* uniqueness among other creatures and/or personhood for certain of its members,
4) some information on a young philosopher of the Italian Renaissance, Pico della Mirandola, his view on human nature, and how this might inform 21st century views on personhood,
5) application of Pico's view on human nature to the personhood problem raised by the above three biotechnologies, and
6) acknowledgment of some problems and unfinished business for this analysis.

Definitions

Definitions are important. In the majority of articles and books I have read about personhood, terms like embryo, human life, human being, and person are either undefined, used differently by different authors, or even used differently within the same work by the same author. Also, incorrect use of the term fetus by some writers has encouraged some to mistakenly believe that embryonic stem cells are derived from tissue of aborted fetuses. Confusion can be avoided by beginning with clear definitions of these terms.

Human life refers to any cell or group of cells that is alive and possesses a functioning human genome. By this definition, human cells of any type growing in a culture dish constitute human life, as would an egg, a sperm, a fertilized egg, and cells, tissues, organs, and individuals from any later stages of development. Human cells to which one or a few genes from a different species have been added and functionally integrated into the intact human genome would also constitute human life. What proportion of an engineered genome must be human in order for the cell to qualify as human life is an interesting question but not germane to this discussion.

Human being designates an organism that belongs to the species *Homo sapiens*. By "organism" I mean a cell or group of cells with interdependent parts that can exist autonomously in its environment. This definition includes individuals we may call persons, but it may not be limited to persons. The fertilized ovum is a human being by this definition, and so too are entities at all stages of prenatal development, whether inside the womb or in a glass culture dish. All living postnatal *Homo sapiens* are human beings including those who are asleep, otherwise unconscious, comatose (with or without life support apparatus), or without memory. By contrast, a severed toe is not a human being, but the entity that loses an appendage remains a human being since it constitutes an autonomous composition of interdependent parts.

Human embryo and ***fetus*** both refer to prenatal human beings. *Embryos* exist at stages of development from fertilization through the end of organ formation which is at about 8 weeks. Thereafter until birth the entity is called a *fetus*, a term that also implies that the being is beginning to look like the adult form of its type.

Person I reserve for human beings upon which dignity has been conferred. One property of dignity is the right to continued existence. It is a bit embarrassing as a biologist who recognizes the continuity between all living things and the dynamic nature of species to be restricting personhood to *Homo sapiens*, and the problems with doing so have been clearly described (Kushe and Singer, 1986; Tooley, 1998). My defense is to say that I do not feel like a "speciesist" on the personhood issue and that it is primarily for expediency in discussing the moral status of human embryos that I have made persons a subset of human beings here.

Three Specific Biotechnologies

Recent advances in cell biology and human reproductive biology raise the questions of what criteria are to be used for conferring personhood and when human beings first meet these criteria. Although not a new problem, it now needs discussion and a practical resolution with an urgency that matches the rate of biotechnological advances in these disciplines. This essay addresses three specific biotechnologies that make personhood an urgent issue for very early human embryos: 1) the derivation of human embryonic stem cells from 5-day old embryos, 2) therapeutic cloning, and 3) pre-implantation embryo biopsy. How does each of these technologies bear upon the human embryo and for what purpose?

Human Embryonic Stem Cells. In November, 1998, James Thomson and his co-workers at the University of Wisconsin reported having used cells from 5-day old human embryos to establish human embryonic stem cell lines that retained the ability to differentiate into several types of adult cells and tissues. The therapeutic potential of human embryonic stem cells for treatment of diseases like Type I diabetes, Parkinson's, Alzheimer's, and congestive heart failure and to repair tissue damaged by stroke, heart attack, or spinal cord injury was immediately recognized. Before such therapies can be performed though, much research is needed to discover how to induce human embryonic stem cells to develop along specific pathways of differentiation to give rise to specialized cells like neurons, cardiac muscle cells, and insulin-producing pancreatic cells. Prior to 1998 most Americans had never heard of embryonic stem cells or cell lines. Now six years later the terms are much more familiar, but my experience is that there is widespread confusion about their meanings. Since an understanding of the origin and basic nature is of human embryonic stem cell lines is crucial for evaluating the argument I will present here, let us now consider properties of 5-day-old human embryos and how Thomson and others have created embryonic stem cell lines from them.

By 5 days after fertilization, the human embryo is at a stage of development called the *blastocyst*, a group of about 150 cells a bit smaller than the head of a pin. The blastocyst is a miniature, hollow ball of cells containing a small mass of nondescript cells, the *inner cell mass*, growing against the inside wall of its hollow interior. Implantation during a normal pregnancy results in the blastocyst becoming attached to the inner wall of the uterus. Ultimately, cells of the single-cell layer thick wall of the blastocyst give rise to the fetal component of the placenta, and the *inner cell mass* grows into the fetus. To obtain human embryonic stem cells, the inner cell mass is removed from the blastocyst, placed in a glass or plastic culture dish, and its cells disaggregated and grown in a nutrient-rich culture medium. Cultured in the laboratory like this, the cells appear to be able to proliferate indefinitely producing more and more cells like themselves. The cells are then referred to as an embryonic stem cell line, all of them being derived from a single blastocyst. Presently about 20 lines of human embryonic stem cells are available in the United States for federally funded research. A presidential decree in 2001 banned production of any additional human embryonic stem cell lines. The reasons cited were that 1) using blastocysts in this way shows or encourages disrespect for human life, and 2) enough stem cell lines were already available for research. Research funded by the private sector was not affected by this ban. Consider now how human blastocysts come to be available for human embryonic stem cell research.

At in vitro fertilization (IVF) clinics, eggs are fertilized in glass test tubes. The resulting embryos are grown to the blastocyst stage outside the womb in preparation for their introduction into a hopeful mother's uterus for implantation. For each attempt

at assisted reproduction by IVF, several more embryos than needed for one implantation procedure are produced. This is to help insure that at least 3-5 healthy appearing blastocysts are available for implantation (all normally do not successfully implant), and also to have available additional embryos should the first implantation attempt not result in a pregnancy. Surplus blastocysts are put into suspended animation by freezing them in liquid nitrogen. They can then be retrieved and reanimated from their frozen state if they are needed for additional attempts at implantation. Tens of thousands of unused, surplus embryos are presently in frozen storage at IVF clinics in the United States and around the world. After a period agreed upon by the clinic and its clients, surplus embryos are removed from storage and discarded. The 2001 ban on producing new human embryonic stem cell lines did not address the eventual fate of surplus blastocysts stored at IVF clinics.

Therapeutic cloning. In February, 2004, South Korean researchers reported the successful cloning of a human being to the blastocyst stage and from it the derivation of a line of hESCs. The motivation for this successful experiment was to aid in development of a procedure called therapeutic cloning. The experiment involved replacing the chromosome-containing nucleus of a woman's egg cell with the chromosome-containing nucleus from a somatic (body) cell form another individual, activating the egg cell to begin undergoing DNA replication and cell division, allowing the embryo to develop to the blastocyst stage, and then using the blastocyst to derive a line of human embryonic stem cells as described above. The clinical value of this procedure is that the resulting embryonic stem cells and any cells derived from them are perfectly immunologically compatible with the individual from which the somatic cell nucleus was taken. Introduction of such cells into that individual for the treatment of disease or injury would not elicit a rejection response, so there would be no need to chemically suppress the immune system as part of the treatment. As for normal human embryonic stem cell research, therapeutic cloning requires the destruction of a human blastocyst to obtain an inner cell mass for the production of embryonic stem cells.

Pre-implantation biopsy. It is now possible to quickly test for the presence of certain disease-causing genes by biopsy of an early human embryo created *in vitro*. A single cell can be removed from a pre-implantation stage embryo for genetic testing without disrupting the future development of the embryo because of the great developmental plasticity of the cells during the early stages of embryogenesis. This procedure is called pre-implantation biopsy and is now used primarily by couples in need of assisted reproduction by IVF. This could change though if the expense of IVF were lowered so that it becomes a feasible option for couples simply wishing to exert some control over the genotype of the embryo that becomes implanted. Recently it was reported that fetal biopsy can now detect several hundred genetic diseases and other conditions that some may consider to be handicapping, like deafness and dwarfism (Harmon, 2004). Pre-implantation biopsy makes possible a future, widespread selection and discarding of blastocysts based on genotype, a "pre-implantation eugenics." Such a practice would of course be accompanied by its own ethical issues that are not subjects of the present discussion.

Relevant to us here is the fact that all three of these biotechnologies - human embryonic stem cell production, therapeutic cloning, and pre-implantation biopsy - bring up the question, "Is the blastocyst a person?" Therefore, let us consider next what characters might warrant the conferring of personhood status upon certain human beings.

Criteria for Human Uniqueness and Personhood

Since "person" has been defined here as a subset of *Homo sapiens*, surveying approaches and criteria that have been used to identify what makes us different from other animals, perhaps deserving of some special dignity, is of value in the attempt to discern when a human being meets the criteria for personhood. Finding more than 30 criteria for human uniqueness mentioned by authors from diverse disciplines, I examined the list to see if it might be systematized in some way. I found that each of the putatively human-specific traits could be classified under one of three approaches primarily used to identify it: evolutionary, comparative, or pre-suppositional.

The ***evolutionary approach*** considers biological/anatomical (material) and/or behavioral (activity) traits that appear to distinguish human ancestors in the hominid line from non-hominid primates. Among the biological/anatomical traits identified by this approach are bipedalism, cranial capacity, dentition, an opposable thumb, a lowered larynx, a developed Broca's area of the brain, the presence of a frameshift mutation in the MYH 16 (myosin heavy chain type 16) gene, and the structure of the ASPM (abnormal spindle-like microcephaly) associated gene. The last two of these are especially interesting applications of molecular/cellular biological studies to problems in human evolution and offer possible explanations for *Homo sapiens'* large and complex cerebral cortex.

Hansell Stedman and his coworkers at the University of Pennsylvania have reported evidence that a muscle protein localized exclusively to the jaw muscle of primates was inactivated by a mutation occurring in the hominid line about 2.4 million years ago, just shortly before a dramatic increase in the cranial capacity of *Homo erectus* that occurred about 2 million years ago. Stedman hypothesizes that inactivation of this gene resulted in a sudden and dramatic decrease in jaw muscle mass, relieving powerful forces that had been exerted on the brain case at the muscle insertion points. With less force on the brain case, the way may have been opened for the evolution of a larger, more gracile cranium whose increased volume became filled by cerebral cortex material. This finding is of special interest since a consensus has developed that certain behavioral traits associated with humanness have as their basis a species-specific development and functioning of the cerebral cortex.

Bruce Lahn and his colleagues at the University of Chicago have reported what one journalist has proclaimed as "the gene that made us human" (Evans et al., 2003; Zorich, 2004). The ASPM (abnormal spindle-like microcephaly associated) gene, when mutated in humans, results in microcephaly, a condition characterized by an abnormally small cerebral cortex (Bond et al., 2002; 2003). The gene is also present in other primates and non-primate mammals, but in humans the specific structure of the gene seems to have been under selective pressure to produce a protein whose function results in a human sized cerebral cortex (Evans, et al., 2003). Although the specific action of the protein product of the human ASPM gene is not fully understood, the

function and locality of expression of homologous genes in developing Drosophila and mice has led to the suggestion that is may be involved in regulating prenatal cell division in the developing cerebral cortex (Evans et al., 2003).

Among the behavioral traits that an evolutionary approach has identified for humanness are tool use/making, fire use/building, foresight, speech, language, culture, a "killer" instinct, cooperation within social groups, religion, art, and altruism. Whether each of these is a uniquely human trait is controversial, but a discussion of those arguments is not necessary unless one of the ambiguous criteria like tool use or language is selected as a definitive marker for personhood. Since I do not do that, we can move on to the other two approaches.

The ***comparative approach*** focuses on differences between modern humans and other contemporary species. Within this approach I categorize traits as being either biological, behavioral, or metaphysical in nature.

Modern cell biology has also made a contribution here. That the cellular basis for humanity's uniqueness may have been found is implied by the title of a lead article appearing in the New York Times' *Science Times*, "Humanity? Maybe It's in the Wiring" (Blakeslee, 2003). The article reports the finding by John Allman and his colleagues at the California Institute of Technology that giant, cigar-shaped neurons called spindle cells occurring primarily in the right frontoinsular cortex may be responsible for processing information used to respond to complex, socially emotional situations associated with feelings like romance, deception, and embarrassment. Humans have 5-40 times as many of these cells than do the living great apes, the the only other species known to possess spindle cells (Allman, et al., 2003).

Behavioral based traits considered by some to place us apart from other contemporary animals include the ability to empathize or "othermindedness," our possession of non-momentary interests, emotion, art, a capacity for beliefs or propositional attitudes, intentionality, an awareness that we are subjects of mental states, problem-solving ability, or a moral sense (Doran, 1989).

Due to their abstruseness, I have placed two human distinguishing traits in the metaphysical category. The first of these is ensoulment in the sense as first proposed by Aristotle. Although one now rarely sees Aristotle cited in the context of human soul acquisition, I mention his ideas here because of the great influence they had on later Christian thinking. Aristotle proposed that during early development, humans sequentially acquire three types of souls, a vegetative soul which makes us alive, a sensitive soul which allows for animal-like sentience, and a rational soul which makes us human. Aristotle believed that the rational soul appeared in the fetus at about 40 days after conception. For Aristotle, who of course did not know about eggs and sperm, conception was the time at which the semen encounters menstrual blood, thereby imparting life to it. As it turns out, were this event actually to occur, its timing would not be far off from the moment of coalescence of the genomes of male and female gametes into one zygote nucleus, the marker now used by biologists for "fertilization." The second abstruse, human-defining trait is consciousness. It is difficult to find clear and concise definitions of what is meant by human consciousness as distinct from animal consciousness, but it is sometimes described as having a sense of self with an existence moving through time and an interest in the continuation of that existence (Kuhse and Singer, 1986; Tooley, 1983).

With the ***presuppositional approach*** it is presumed at the start that humans are deserving of dignity and that this assumption requires no justification. The questions then become, "When during development does this dignity kick in, and once conferred, can it be lost?" Criteria for dignified humanness that I view as presuppositional include theologically based ensoulment, individuation, the onset of electroencephalogram (EEG) detected brain waves, viability, and birth.

Regarding ensoulment, it is interesting to note that in the 13th century, St. Thomas Aquinas concurred with Aristotle that ensoulment occurred at 40 days of development, but only for male fetuses. Strangely, Aquinas believed ensoulment of females was delayed until 90 days after conception. Presently, the official Vatican position is that all human embryos from conception onward ought to be treated as though they have been ensouled by God and possess full moral status.

Individuation is a developmental event marking the point beyond which one and only one individual can result from subsequent embryogenesis and fetal development. This event occurs at the so-called primitive streak stage of development about 14 days after fertilization, the point beyond which the embryo can no longer spontaneously split to form identical twins. Salesian priest, theologian, and philosopher, Norman M. Ford, has suggested that the embryo be given full moral status at the primitive streak stage because of the phenomenon of individuation (Ford, 1988).

Viability is the criterion for personhood cited in the 1973 U.S. Supreme Court decision in the Roe vs. Wade case and is set at the end of the second trimester of pregnancy. Coincidently, this is also a time marked by adult-like patterns of EEG activity (Morowitz and Trefil, 1992) and a dramatic increase in the rate of synapse formation between neurons of the cerebral cortex (Purpura, 1975; Rakic et al., 1986).

The above listing contains only some of the bewildering array of criteria that have been suggested for marks of human uniqueness or claiming special moral status for human beings among other living creatures. Examining this list with the issue of personhood raised by modern biotechnologies in mind, I found it difficult to commit to any one or even a cluster of the criteria as a satisfying marker for personhood. Many are no longer considered human-specific, and others have become so controversial as to preclude reasonable hope for their consensual international acceptance. It was then that I thought of an essay that my colleagues and I have assigned for many years to our students in an interdisciplinary history course. The essay is titled *Oration on the Dignity of Man.* It was written by a 23-year-old philosopher of the Italian Renaissance named Giovanni Pico. He is better known as Pico della Mirandola because of his northern Italian village of origin, Mirandola.

Pico della Mirandola (1463-1494)

Pico's view of human nature can be very useful to us today as we move into the uncertain ethical world of 21st century biotechnology. In fact, it is the essence of human nature that Pico describes in his *Oration*, *our capacity for choice-making*, that I propose using as a basis for personhood when faced with certain dilemmas about the ethical use of modern biotechnologies.

It is legitimate to ask why I chose Pico as an authority on human nature rather than one of a score of other philosophers who have written since Pico on the question of human nature and personhood. Primarily, I chose Pico because his view emerges from a diligent and respectful study of virtually all of the philosophical, theological, literary, and mystical traditions of humankind knowable to him. It is inclusive thinking like this that is needed if we are to reach a consensus about how to behave in today's biotechnological world.

How Pico came to write his famous essay is an interesting story. He was obsessed with understanding the diverse paths humankind has taken toward wisdom and self-understanding. As a teenager, he began arming himself with the tools needed to gain such understanding. These included a reading knowledge of Greek, Latin, Hebrew, Arabic, and Aramaic, and facility with canon law. He used these tools to teach himself about the pagan philosophies of ancient Greece and Rome, Neoplatonism, the writings of the Greek and Latin Church fathers, 13th and 14th century scholasticism, Averroism, the Hermetic and Orphic texts, and Jewish philosophy, theology, science, and mysticism.

His lifelong project was to identify the threads of truth coursing through each of the world's diverse traditions and to weave these into a unified synthesis of human insight and wisdom spanning two millennia and representing all of the religious and philosophical thought known to the West. His ultimate objective was to foster peace between the world's traditions by reconciling their insights, one with another.

The major outcome of these studies was the formulation of 900 theses (Farmer, 2003) which Pico proposed to defend in Rome during the winter of 1486-1487 against any and all philosophers, theologians, or other scholars willing to debate them. Leaving few scholarly disciplines untouched, the subjects represented by the propositions included metaphysics, moral philosophy, astrology, physics, numerology, theology, magic, epistemology, physiology, and several others. This extraordinary debate was to be held before the college of cardinals with Pope Innocent VIII presiding as judge. Although the debate never took place, the reason being another story in itself, Pico did prepare a speech to open the debate. It is that speech that we now know as the essay, *Oration on the Dignity of Man* (Pico, 1486). In Pico's *Oration* is this famous paragraph that states his view on human nature. In it God is speaking to Adam in the Garden of Eden, explaining to him how he differs from all other creatures.

We have given to thee, Adam, no fixed seat, no form of thy own, no gift peculiarly thine, that thou mayest feel as thine own, have as thine own, possess as thine own the seat, the form, the gifts which thou thyself shall desire. A limited **nature** *in other creatures is confined within the laws written down by Us. In conformity with thy free judgment, in whose hands I have placed thee, thou art confined by no bounds; and thou wilt fix limits of nature for thyself...Neither heavenly nor earthly, neither mortal nor immortal have We made thee. Thou, like a judge appointed for being honorable, art the molder and maker of thyself; thou mayest sculpt thyself into whatever shape thou dost prefer. Thou canst grow downward into the lower natures which are brutes. Thou canst again grow upward from thy soul's reason into the higher natures which are divine. (Translation by Charles Glenn Wallis)*

Here we have a Renaissance humanist and world philosopher promoting the notion that humans are co-creators of themselves. There is little doubt that Pico had the Christian God in mind as the other artisan in co-creation. But, in my view, whether God or natural selection is placed as the co-creator opposite humankind in its own creation is not what is important in Pico's thought. What is important is that we recognize ourselves as equal, if not major, partners in co-creation. Both the species and each individual have been endowed with a capacity for choice-making-the former some 100,000 years ago, and the later fairly early in life. How we use that capacity to sculpt ourselves as a species and as individuals is up to us. That is what Pico is telling us. And just what kind of choices does Pico have in mind when proposing that *choice-making* distinguishes us from all other creatures? I feel confident that it is not the kind of choice a humming bird makes when it visits red flowers and not white flowers, or the "decision" of a Baltimore oriole to nest in the high branches of an oak rather than on the ground. Those are instinctual acts, "confined within the laws written down by Us," and not really choices at all. The human-specific choices attributed to Adam by Pico are moral choices derived from "thy soul's reason." These are behavioral choices we make that effect, among other things, our own and others' quality of life and the stability and beauty of the planet itself.

From Pico's view that a capacity for choice-making is at the core of human nature, I derive the following principle: *Our use of biotechnology ought to respect and protect the choice-making capacity of human beings and of humankind.* How can this principle be applied to the issue of the moral status of the human blastocyst, the problem at hand for each of the three biotechnologies described at the beginning of this essay?

Applying the Pico Principle to 21st Century Biotechnologies

Acceptance of the capacity for choice-making as a useful criterion for personhood requires asking what attributes a human being must acquire in order to possess a choice-making capacity. To answer that question, I suggest the following abilities as necessary components of a moral choice-making capacity: 1) gathering sensory data, 2) storing those data, 3) selectively retrieving data, 4) analyzing data to imagine outcomes for various paths of action, and 5) applying reason, emotion, and empathy to choose the desired outcome.

When does this constellation of capacities develop? One thing that can be said with certainty is that all of these abilities do not develop at once. In fact, based on current information from the disciplines of human developmental biology and psychology, it appears that the biological hardware necessary for having at least a capacity to exercise these five abilities at some point in time is assembled during a period beginning at about 5 weeks after conception and extending for about 10 years into postnatal development. For example, sensory neurons from the olfactory apparatus first establish synapses in the developing brain at 5 weeks into prenatal development (Larsen, 2001), marking the first establishment of the hardware required for gathering some sensory data. Spindle cells of the prefrontal cortex implicated in data storage and retrieval begin appearing at about 4 months into development, and the proliferation of cells that form the cerebral cortex also begins at about this time, pre-

sumably under the control of ASPM gene activity. Data analysis requires communication between neurons in the cerebral cortex, and the intra-cortical synapses needed to mediate this are forming at an exponential rate between weeks 25 and 32 of prenatal development (Morowitz & Trefil, 1992). A fully functional brain requires that its nerve axons be myelinated. Myelination begins during the second trimester of prenatal development, occurs at its most rapid rate after birth, and is not completed until the child is about 10 years old (Morowitz & Trefil, 1992). Awareness that one has a future is needed in order to apply foresight to the decision-making process, and that awareness is thought not to begin until about two years after birth. "Other-mindedness," or the capacity for empathy occurs even later during the 3rd of 4th year of postnatal life.

So, if a capacity for choice-making is taken as a useful criterion for personhood, and if that capacity emerges gradually between 5 weeks of prenatal development and 10 years of postnatal life, what can be concluded about personhood and the moral status of the human embryo? I offer the following: 1) at the least, a nascent choice-making capacity is required for conferring personhood on a human being, and 2) prior to 5 weeks of development, the embryo cannot qualify for personhood.

These conclusions may appear very minimal and of questionable value since they do not specify a beginning point for personhood; however, in the context of the three biotechnologies described earlier, they are very useful. They allow a decision to be made about the moral status of the human blastocyst and therefore about the ethical status of stem cell research, therapeutic cloning, and pre-implantation biopsy. Since not even a nascent choice-making capacity is present prior to 5 weeks of prenatal life, the use of the 5-day old blastocyst in these technologies does not violate the dignity of personhood.

This is not to say that other ethical issues are unimportant. Indeed, many other ethical issues associated with these biotechnologies would remain to be resolved even if a consensus could be reached on the personhood issue. What should be the source of blastocysts for research? Of eggs for therapeutic cloning? Who shall benefit the most from the development of these technologies into actual clinical procedures? What will be the cost for bringing the technologies into the clinic? Can the cost be justified when millions of persons worldwide experience malnourishment and starvation and when three children die each minute from malaria, all under circumstances that could benefit from monies applied to research and other activities aimed at improving the human condition? Still, if the present analysis helps to resolve the personhood problem for early embryos, emotional and intellectual energies may be freed to devote to addressing these additional issues. Finally, although my analysis of personhood and the moral status of the human embryo are vulnerable to criticisms which space prevents me from addressing here, I must nevertheless acknowledge their existence.

Problems Remaining to be Addressed

Three problems that need addressing in order to undergird the value of this analysis of personhood for human embryos are 1) the so-called "is-ought" dichotomy and the associated "naturalistic fallacy," 2) the question of free will for human activity, and 3) the pitfalls of arguing for personhood on the basis of potentiality.

The *"is-ought" dichotomy*, the formulation of which is usually credited to David Hume, asserts that it is not possible to logically derive a statement of moral obligation from an empirical observation about nature. Those who claim otherwise are often accused of a failure of logic called the *naturalistic fallacy*. The "is" of this dichotomy for the present analysis is that choice-making is identified as a species-specific marker for human nature. The "ought" is the claim that the choice-making trait should be protected, honored, and preserved. In other words, just because humans are moral choice-makers, why does it follow that this is a trait to be preserved and that beings possessing it deserve the dignity of personhood and continued existence? This question needs answering.

Obviously, placing high value on human choice-making capacity presumes the existence of *free will* for the ultimate expression of that capacity. Therefore, arguments for a strongly deterministic universe and genetic determinism must be addressed for "choice-making" to be taken seriously as a human trait that ought to be protected and preserved.

Finally, by identifying the acquisition of moral "choice-making capacity" as a developmental process occurring over more than 10 years, I leave myself open to the criticism that an argument for conferring personhood on human beings younger than 10 years old must be an *argument from potential*. The pitfalls of an argument based on potentiality have been described by English bioethicist, John Harris (1998), who points out the absurdities to which this argument leads. Thus, not only would the single-celled conceptus be a person, but so too the unfertilized egg which may be stimulated to develop parthenogenetically, and also virtually any one of our body cells in the hands of an adept cloning biotechnician. Although I have not concluded when personhood ought to be conferred, only when it is not present, I admit to an unwillingness to say that a 9-year-old child (or even a newly born infant) is not a person. This may mean that one or more incipient levels of personhood and their moral status may need to be defined for human beings within the 10-plus year long period of development for choice-making capacity. The same applies to the end period of life when choice-making components may be *lost* gradually over an extended period of time.

To conclude, I turn to another familiar figure of the Italian Renaissance, Michelangelo Buonarroti (1475-1564), and his masterpiece *The David* now standing in the Academy in Florence, Italy. In a PBS film on Florence and the Renaissance, Bill Moyers had this to say about *The David* and the legacy of 15th century humankind's decision to grasp control of its own fate:

> *The heroic ideal of David was the ultimate expression of Florentine optimism - their belief in the divinity of the human being. Created in the image of God, now Man was creating images of himself. Contained in the marble was the mirror of the soul. We needed only to free it as Michelangelo had liberated David from the block. But what does it bring, this gift of freedom? Certainly the ability to dream and the power to achieve. But perhaps, as Michelangelo had seen, it also leaves us standing alone - to make and face our fate.*

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