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Article

Personhood status of the human zygote, embryo, fetus

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The fields of biology, medicine, and embryology have described the developmental milestones of humans throughout gestation in great detail. It is less clear as to when humans are recognized as people, persons, or beings with rights that are protected by legislation. The practice of law is irrevocably intertwined with that of ethical conduct; and the time at which a human life is considered a person has implications that extend to health care, legislation on abortion, and autonomy of individuals. This article reviews the economical position that fertilization is the moment that personhood of the conceptus begins. Alternate positions proposing that personhood begins at other possible times after fertilization are presented and contrasted to the economical hypothesis.

Summary: This article is an original work critically analyzing the various arguments for human personhood at fertilization and thereafter. The various positions on human personhood are compared and contrasted herein. The time of the human lifespan at which personhood is conferred has important implications for health care, legislation, and personal autonomy.

Keywords: Personhood, Zygote, Embryo, Fetus, Fertilization, Capacity

INTRODUCTION

Farah and Heverlein describe the importance of defining "Personhood [as it] is a foundational concept in ethics, including both pure philosophical ethics and the applied field of bioethics." They go on to say "nevertheless, defining criteria for personhood have been elusive" (Farah and Heverlein 2007, 37-48). For the purposes of this work, a human being refers to a biologically human entity, and human person constitutes a moral category. Two competing hypotheses that constitute a philosophical dilemma in defining personhood are presented. The first of the two hypotheses is that a human being has existed since fertilization and that personhood is always inherent in a human being at all stages of development. A human being does not become a person at a particular stage of development following fertilization. It follows that a human person is in continuous development of potentialities and a human being has been a person since he or she began to exist at fertilization. Furthermore, the terms "zygote," "embryo," and "fetus" describe stages of biological human development and as such, do not describe the development *into* a human person. Proponents of the first hypothesis claim that personhood is

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attained from the moment of fertilization when a new zygotic genome is assembled, or even earlier when a spermatid penetrates an ootid. As in the case of death, proponents of the first hypothesis select a point in time for personhood that is absolute and does not vary among individuals.

The second of the two hypotheses is that a biologically human entity becomes a human person at some point after fertilization. That is, that not all human beings are human persons and as a result not all human beings have moral status. Proponents of the latter may believe that a zygote, embryo, or fetus are developmental stages of human life and have potential to become a human being or person, but may not yet be a person. Some proponents of this hypothesis may believe that personhood status is designated at an arbitrary point in time after fertilization by meeting certain criteria. Some of these times coincide with developmental milestones such as implantation, certain stages of embryonic or fetal development, birth, or even after birth. As some of these developmental stages constitute a continuum or process rather than an absolute end or beginning point, attainment of personhood necessarily varies among subjects, unlike the first hypothesis.

Legislation is in place to protect citizens with rights, such as safety, security, and freedom, and to endow us with privileges, for example, privacy and autonomy. In some instances, two or more laws may conflict or contradict resulting in the need to decide which laws have precedence over others. Some argue that the rights of the unborn and the pregnant mother are necessarily in conflict if the same rights are granted to pre- and post-birth humans. Warren writes that "extend[ing] … rights to fetuses is necessarily to deprive pregnant women of the rights to personal autonomy, physical integrity, and sometimes life itself" and that "there is room for only one person with … rights inside a single human skin" (Warren 1989, 46–65). However, this position conflicts with the personhoods of conjoined twins in which two separate heads and brains are within "a single human skin." Recommendation 10 to primary care physicians in the Canadian Medical Association Committee on Ethics's "The Status of the Human Foetus" states that "when there is the intention or reasonable expectation that the foetus will become a person, the physician has an obligation to try and prevent harm to the foetus" and "the physician's duty towards the foetus during the third trimester … require[s] that the physician … try to ensure the survival and well-being of the foetus" (Canadian Medical Association 1991, Recommendation 12). The recommendations thus support the notion for personhood of a fetus after about twenty-six weeks gestational age. Recommendation 12 further states that the physician may "resort to the judicial process [if conflict between maternal and foetal interests arise]." The judicial process may be necessary as the principle of autonomy and respect for persons "enables every person, irrespective of gender, age or other qualitative distinction … the right to insist on such integrity against all others" (Canadian Medical Association 1991) and the obligations of physicians to pre-infants may infringe on the autonomy of the pregnant mother.

This discussion focuses on distinguishing the physical human being from the ontological human person having moral status, if there is such a distinction. The human person refers to the ontological individual: "a single concrete entity that exists as a distinct being and is not an aggregation of smaller things nor merely a part of a greater whole; … its unity is … intrinsic" (Ford 1988). Boethius's traditional definition of personhood stipulates an individual substance bearing rational

nature (Boethius n.d., chap. 3), thus avoiding extension of personhood to non-humans. This work explores whether a human being formed at fertilization becomes a human person at some point of development versus the notion that personhood is inextricably interrelated and inherent from the point of fertilization or fusion of egg and sperm. The stages of human life relevant to discerning personhood include, but are not limited to: fertilization (sperm/egg penetration), zygote (assembly of new genome), morula, embryo, fetus, and birth (extra-uterine survival). While the beings at these developmental stages are irrefutably considered human and mammalian life, there is no clear consensus in regard to determining when personhood is established. A human life may be considered a human person at fertilization. On the other hand, others attribute personhood once the physical appearance of a fetus resembles the mature human form at about week 9 of gestation during embryogenesis. Alternatively, a human being may come to be a person when the central nervous system is developed and organs are functioning, or at a point where vital functions, such as breathing and kidney filtration, are established or can be maintained by mechanical equipment at about twenty-six weeks gestation (Moore 1988). Philosophers, bioethicists, and legislators consider aspects of biologic human development such as these in defining and establishing personhood.

Prenatal development

The sperm and the egg combine to form a zygote. In human gestation, the zygote undergoes development into an embryo and fetus. Parturition usually occurs at a full-length term of about thirty-eight weeks. The following subsections outline human prenatal development and serve as necessary background for the personhood arguments in the Thesis section.

Human gametes

Spermatogenesis is the process of germ cell maturation in males. Oogenesis is the process of germ cell maturation in females. In contrast to spermatogenesis in males which begins at puberty, oogenesis begins before birth. In prenatal development of females, primordial germ cells form oogonia. These cells divide, and some arrest in prophase of meiosis I to form primary oocytes. A surge in luteinizing hormone in the days prior to ovulation stimulates completion of meiosis I and completion of the cell cycle up to metaphase in the second stage of meiosis. The secondary oocyte is arrested at this stage of meiosis until about three hours before ovulation, and it does not complete the meiotic cycles unless fertilized (Sadler 2012, 3–129).

Pre-embryonic development: Fertilization, implantation

Prenatal development occurs in a precise manner with several very highly regulated steps. In sexual reproduction, the haploid spermatozoon makes contact with the ovum (Duncan et al. 2016, 24737). A fertilized ovum is formed when the cell pronuclei have fused. The zygote begins a series of divisions called cleavage before migrating to the uterus. The human cells are referred to as blastomeres, and they exist as such until the 16-cell stage when the cell mass is then known as the morula. In the uterus, the cells of the morula continue to divide until about four days post-fertilization (Moore 1988). The zona pellucida sheds about five days after fertilization, and on the sixth day, implantation may begin. After implantation, capillaries extend to the syncytiotrophoblast creating a network of arteries and veins or lacunae (Fitzgerald and Fitzgerald 1994).

Embryogenesis

Gastrulation marks the beginning of embryogenesis at the start of the second week after fertilization. At the beginning of the third week, cells present in the primitive streak migrate to form the three layers, which give rise to all human tissues in the body: endoderm, ectoderm, and mesoderm. Muscle and connective tissue are derived from the mesoderm; epidermis and nervous system are derived from the ectoderm; and digestive and respiratory tracts arise from the endoderm. Neurulation, formation of gut, and development of cardiovascular system start shortly thereafter. Embryo development continues until the end of the eighth week when "the embryo has unquestionably human characteristics" (Moore 1988; Fitzgerald and Fitzgerald 1994) with respect to appearance as major internal and external structure formations have begun and the transition to the fetal development period occurs (Moore 1988).

Fetal development and functional milestones

The period of fetal development is centered on body growth and differentiation of tissues. External genitalia are mature by the end of the twelfth week. Body growth and bone ossification are rapid between 13 and 16 weeks. Lung development occurs between twenty-one and twenty-five weeks. There is evidence that all five senses are developed *in utero* (Hepper and Shahidullah 1994, 143–54). In the two months preceding birth, light elicits a reflex from the pupils (Moore 1988). Fetuses respond to auditory stimuli between twenty and twenty-eight weeks of gestational age. Olfactory and smell stimuli yield a response in swallowing and heart rate, but the exact gestational age at which this happens is unknown. The fetus responds reflexively to touch at eight weeks gestational age. Visual function is believed to be operational in a fetus by about week 26 of gestation (Jones 2004, 22–31). These milestones are important as the functioning of the brain is what some believe denotes human consciousness and capacity for cognitive sapient awareness. Others believe that consciousness encompasses fetal awareness through fully developed sensory function and, therefore, cannot occur before developing of peripheral nerves, spinal cord, brainstem, thalamus, and cerebral cortex at about twenty-six weeks of gestation (Jones 2004, 22–31).

Role of genes in development

The development of a zygote into a blastocyst, then to morula, and finally into an embryo and fetus occurs in a very highly regulated, precise, and specific fashion. This is due to transcriptional and translational regulation of genetic material. Certain genes in the genome are only active at precise stages of a developing human organism. These genes may only be required for a certain step in orientation (primitive streak) or differentiation. After the specific function of the gene has been completed, it may be silenced or turned off in specific tissues by epigenetic modification for the duration of a human life.

Human prenatal development in relation to personhood

In light of cloning, stem-cell research, and other advances in assisted fertilization, defining personhood takes on several new challenges. A totipotent cell can differentiate into any cell type. Pluripotentiality is attributed to a cell that has the capacity to develop into many other cell types, but not another human organism. A study compared development of mouse and human zygotes. The human and mouse zygote

DNA were replaced with somatic cell DNA of human and mouse respectively. While the mouse zygote was able to reprogram to a pluripotent state, division of the human cell halted at the morula stage (Egli et al. 2011, 488). Human zygotic DNA and cytosolic components specifically within the human zygote plasma membrane appear critical for cellular proliferation and development past the morula stage.

The experiment by Egli et al. (2011) proposes two assertions. The first is that DNA of the human zygote is uniquely programmed to develop through the prenatal milestones and that the genetic material of a fully differentiated human cell, although it is of the same genome, cannot be easily reprogrammed to develop into a human organism. Egli et al. (2011) show that the zygote genome is crucial for prenatal development and that this is unique to humans versus another mammalian species. The study also suggests that the developmental potential of the human zygote genome is unique in some respects from that of the murine zygote genome. Furthermore, the uniqueness of the human from the murine zygote genome likely extends to other mammalian species and other human cell types in its totipotent and pluripotent properties for early human development. There are features of the zygotic DNA that are unique to the development of a human organism. While some believe that humans are distinct from other animals due to attributes of self-reflection, cognitive sapient awareness and advanced reasoning, there are also fundamental distinctions in the biology of humans that stem from initial development at the one-cell stage. One could thus propose that certain features appearing in embryogenesis and fetal progression that are uniquely human (i.e., cognitive sapient awareness) are uniquely reliant on human zygote DNA (and its division and subsequent development). This argues strongly that the human being at the one-cell stage already possesses the status for personhood.

There is evidence which surmises that maternally derived, extra-embryonic factors play a necessary role for human development; and this has implications regarding the autonomy of a pregnant mother and the status of a human zygote, embryo, and fetus. A study by Hall et al. (1993, 001 S1) demonstrates that the human zygote does not develop into a multicellular organism without the zona pellucida, which surrounds the oocyte plasma membrane. Bozzato interprets this to mean "that the pellucid membrane is not and cannot be an extraneous 'zone' of the embryo' because 'the zygote and pre-implantation embryo … skinned of their own pellucid membrane, do not absolutely develop new embryos; (they soon die)'" (Bozzato 2008, 245–56). The maternally derived zona pellucida would appear to be a necessary part for the developing human, and so the personhood status of a conceptus independent of its mother is necessarily in question. On the other hand, the zona pellucida can also be artificially produced (Hall et al. 1993, 001 S1) to support early human development, and other evidence in an *in vitro* setting suggests that damage to and loss of oocyte zona pellucida does not impair fertilization or birth rates (Ueno et al. 2014, 1602–607). These findings are a factor in the debate regarding the autonomy of pregnant mothers and personhood status of the human zygote, embryo, and fetus.

Thesis

Several philosophers have developed "personhood criteria" that pertain to human capabilities, physical development, and psychosocial and reasoning capacities. Joseph Fletcher writes that for "the purposes of biomedical ethics," the "profile of man" or personhood includes criteria such as self-

awareness, self-control, the capability to relate to others, and curiosity, among a total of fifteen criteria (Fletcher 1979, 7–19). Daniel Dennett's six themes of personhood include rationality, intention, attitude, reciprocation, verbal communication, and self-consciousness (Dennett 1976, 175–98). John Locke suggested that the criteria for defining human personhood consist of rationality, self-awareness, and the use of memory to link self-awareness across time and space (Locke 1997). Immanuel Kant also specified a criterion of intelligence, as it would enable one to act morally. Kant specified that the importance of this was such that a human person could distinguish between people and things as people have dignity (Kant 1948). A human person is human life, but among philosophers there is no consensus as to whether all human entities including the zygote, embryo and fetus constitute human persons.

Personhood begins at fertilization

Several noted authors and works support the claim that the life of a new human being and the life of a person begin at fertilization. John Gallagher states that after "look[ing] at all of the likely evidence suggested in the literature … none of it gives reason to believe that the human person begins to exist at any other point than fertilization" (Gallagher 1984). Other works hold the similar simple and parsimonious economical explanation—one that is economical as it does not necessitate that exhaustive criteria be met for personhood. Specifically, human personhood is inherent in the zygote and does not only come to be at some arbitrary point later than fertilization. Pope John Paul II stated that "the mere probability that a human person is involved would suffice to justify an absolutely clear prohibition of any intervention aimed at killing a human embryo" (John Paul II 1995). This statement equates basic human rights to the early developing human being and recommends that laws that govern the born also govern the unborn from the point of fertilization. By corollary, the burden of proof lies on those who oppose this view to provide sufficient evidence beyond a reasonable doubt that no human person is present. This stance is often debated, and critics present a list of personhood criteria and suggest an alternative position as to when human personhood should be recognized. Gallagher's position is not based on particular physical characteristics or development of capacities like intelligence or awareness. Instead, he argues that the single-celled zygote is not only a life of the human species, it is also a human person entitled to human rights. In the following subsections, other personhood positions are reviewed and critiqued in relation to Gallagher's and the economical stance on personhood (Gallagher 1984).

Cell and tissue differentiation

Others choose a stage of appearance of complete organ and tissue formation when "status and viability solidify" "in the third trimester" in which to ascribe moral status and personhood (Little 2008, 331–48). The complete and full biologic formation of a human being includes all organs (brain, heart, lungs, kidney[s], etc.), and a more minimalist definition may preclude "accessory" organs; those which are present but do not serve a purpose, for example, caecum and appendix. Even in using a minimalist definition, the argument of personhood at the third trimester on the basis of fully formed organs and ability to survive in an extra-uterine environment encounters issues. The issue is that whatever point of biologic development is deemed sufficient for personhood is arbitrary and cannot be generally assessed in an efficient or highly accurate manner, and the corresponding time associated with development milestones in

humans can vary. The second issue is elaborated here. It is well known that the human system does not reach a definite point of terminal differentiation until death, at which point livings cells die (Bernat 1998, 14–24). Even when all organs are formed and organ systems are intact, bodily tissues continue to be remodeled. This occurs in instances where the function of a tissue may change depending on its location and immediate physiological demands.

Consider the common condition of gastroesophageal reflux disease (GERD). It is generally characterized by dysfunction of the gastroesophageal sphincter. Stomach acid can regurgitate into the lower esophagus as a result of impaired sphincter function. The lower esophagus, however, is not equipped to deal with the acidic challenge from the stomach. Either the cells lining the lower esophagus succumb to cell death and the esophagus spirals into the onset of chronic disease or the cells lining the lower esophagus differentiate and take on a phenotype similar to the stomach in order to aptly handle the acid challenge. Humans bear the capacity to achieve the latter, as in this example, to allow for re-differentiation of esophagus into stomach (Vakil et al. 2013, 2–14).

The issue of de- and re-differentiation raises a problem in defining personhood based on the gross appearance of a human characterized by formation of organ systems. In cases where organs are contiguous and interconnected like the gut, tissue phenotype may change (as in the case of GERD). The appearance and development of organs cannot be a criterion for personhood since the continued differentiation of tissue in the adult human means that there is a risk of having personhood status revoked from an individual if and when an organ may take on the appearance (and function) of another organ (see Capacities section for further discussion). Although, due to the constant de- and re-differentiation of tissues, who can say which features or at which time a human being actually becomes a human person? Human biology is not static, and humans are in a continual state of organ and tissue turnover. Proposing that personhood relies on achieving certain biologic milestones would mean that personhood status too would not be static and would be a "moving target." It would not serve to have personhood as a concept loosely bound to philosophical arguments based on arbitrary criteria whereby a human can cyclically gain and lose personhood repeatedly.

Personhood of non-humans and speciesism

Personhood is mainly debated in the context of applying moral status to humans at a time point in human development. However, some ethicists and animal rights activists consider extending personhood beyond humans. Laitinen writes that "typical persons are human beings, but membership in the species *Homo sapiens* is not necessary. Other kinds of animal, or Martians, will be persons once they have the relevant capacities to the sufficient degree" (Laitinen 2007). Similarly, Singer states "membership of the species *Homo sapiens* is not ethically relevant, any characteristic or combination of characteristics that we regard as giving human beings a right to life or as making it generally wrong to end a human life, may be possessed by some nonhuman animals" (Singer 1994). Some hold the contention that "[most] of our genome consists of the genes we share with other species—chimps, fruit flies' and that 'barriers between the species begin to blur and blend" (Glenn 2002, 9). Accordingly, proponents for personhood of non-humans reason that the similarity among human and non-human genetic codes may qualify non-humans as persons too. While the focus of this section and this work is not to debate whether

personhood of non-humans is reasonable, we explore the faulty reasoning of the suggestion and expand on the negative implications that would ensue if a similar genetic code was sufficient criterion for personhood.

Wall and Brown say that we must be careful to write our genetic definition of human personhood in a way that we may "include within this category other nonhuman primates … whose genetic composition is [similar] to that of humans, or we must be prepared to accept them as our moral brothers and sisters and grant them personhood too" (Wall and Brown 2006, 602–10). While the primate or murine genome may be 98 percent similar to that of humans, it does not mean that the expression of genetic material in humans and similar animal species are 98 percent identical. Expression refers to the processes or transcription and translation in which DNA is converted to RNA and then into protein. Although the genetic sequence within the human genome may bear striking resemblance to many nonhuman species, the regulation of human genome expression occurs in vastly different manner among species.

Epigenetic modification affects DNA expression in several manners. For example, histone acetylation controls the extent to which chromosomes fold and package, and this markedly affects gene expression (Sadler 2012, 3–129). These epigenetic modifications vary greatly among species and make humans considerably unique from other animals, plants, bacteria, and so forth. In fact, histone modification alone accounts for almost 40 percent of interspecies gene expression differences (Gilad et al. 2012). Components of diet also influence epigenetic regulation (Gerhauser 2016, 73–132). As a result, gene expression varies vastly among humans and other animals as each obtain nutrients in varying quality and quantity. Use of a minimal karyotype to define personhood ignores the complexity of regulation of DNA expression. Extending personhood to non-human species on the basis of genetic similarity (i.e., 98% identical genetic material of a species to the human genome) would potentially mean denying personhood to those with serious chromosomal anomalies (i.e., Turner or Downs syndromes). In the case of a chromosomal anomaly such as trisomy, an entire extra chromosome is present, and thus the difference in genetic material between a person with and without trisomy would be slightly greater than 2 percent (less than 98% similar). The argument that genetic sequences and/or similarities should be a criterion for personhood is not only insufficient in proposing personhood of non-humans, but for the reasons herein, it is an insufficient justification for human personhood since it would mean revoking personhood of many human beings and may promote a potentially dangerous culture of discrimination for or against phenotypic traits associated with very minor genetic differences.

Spontaneous abortion

A miscarriage is the spontaneous loss of a fetus prior to twenty weeks gestation. Spontaneous abortion occurring specifically before the implantation of the embryo may occur as a result of viral infection, intake of teratogenic drugs, or deficient function of the corpus luteum (Fitzgerald and Fitzgerald 1994). The fact that there is some spontaneous abortion rate compels the argument that human life is not all that precious at the stage of the zygote or preimplantation embryo and it is "highly unreasonable to call these entities 'persons'" with moral status (Rahner 1972, 225–52). Proponents of this view see that the higher the "wastage" rate of preimplantation embryos, the greater the evidence there is to support

the argument that a fertilized zygote, blastocyst, or human conceptus prior to implantation is not yet a person. In discussing an estimated spontaneous miscarriage rate of 55 percent, Shannon and Wolter contend that "such vast embryonic loss intuitively argues against the creation of a principle of immaterial individuality [ontological personhood] at … conception" (Shannon and Wolter 1990, 618–9). These are examples, yet again, of a judgment for personhood status made on biologic data at an arbitrary point. Would Shannon and Wolter (1990) contend differently if the spontaneous miscarriage rate was 10 percent? What if neonate death rate was 55 percent as it has been at times historically; would personhood status then not be attained until later in infancy? The reasoning in suggesting that pre-implantation embryos are not persons due to estimated spontaneous abortion rates is flawed.

Judging personhood on the basis of estimated spontaneous miscarriage rate is problematic since suggesting an approximate rate is considerably difficult and has a very large margin of error. There is considerable difficulty in accurately discerning the true proportion of blastocysts that will implant (and eventually be born), to that of total fertilized zygotes. Estimates of spontaneous abortion rates occurring before fertilization vary greatly, from 15 percent to 60 percent (ArmMed Media). The rate of spontaneous abortion before fertilization can be estimated by the ratio of the sum of unsuccessfully implanted blastocysts to the total number of fertilized zygotes. The estimate necessarily encounters a problem when there are multiple successive failures at becoming pregnant within the same couple (by sexual intercourse). Subsequent fertility consultation and testing may reveal that a couple is incapable of reproducing. For example, several early-stage embryos are lost because there are such severe chromosomal defects that some stage of embryogenesis is prevented (Bracken 2001). Serle et al. found decreased levels of mucins in the endometrium of women who have recurrent miscarriages (Serle et al. 1994, 989–96). These women may adequately bear a zygote and pre-implanted embryo but may be considered infertile. In this case, the estimate for spontaneous abortion prior to fertilization would erroneously overestimate the number of unsuccessfully implanted blastocysts by continually tallying data from infertile couples; those that can regularly produce a fertilized zygote that never reaches the stage of implantation. The consequence to this lies in providing false support to the notions discussed above in the works by Rahner (1972), and Shannon and Wolter (1990) that personhood is not inclusive of the zygote and pre-implantation blastocyst.

James also cautions that in producing an accurate estimation, the "[subject is] of prove[n] fertility." He also states the importance of "Absen[t] pathological conditions in the tubes, ovary, and uterus" (James 1970, 241–5). Ultimately, a biopsy of the fallopian tubes, ovaries, and uterus is needed to confirm infertility for recurrent spontaneous abortion. These measures however may risk injuring the prenate in a pregnant mother or damaging the female reproductive organs. Thus, the true spontaneous abortion rate arguably cannot be attained with current methodologies. Rather than tally each individual failure to become pregnant, the ratio should consider only men and women who are not infertile and do not recurrently miscarry. These data should otherwise be omitted from estimates regarding the failure to implant as they necessarily overestimate the true proportion of spontaneous abortion rates prior to implantation.

Moreover, one could respond to the contention that the loss of many preimplantation embryos suggests that they

could not be persons, by pointing out that all birthed human persons die too. For example, most humans die before the age of 100, but the subset of human beings less than the age of 100 are not lesser persons than those above the age of 100. The fact that many pre-birthed humans die is thus in itself no real argument that they are not persons.

Intelligence

Daniel Dennett and Joseph Fletcher are among many who specify that intelligence is a key component of defining human persons. Although definitions vary, intelligence may include but is not limited to the ability to create memories, attain or retain knowledge, use logic, employ abstract thought, and communicate. In his "Conditions of Personhood" essay, Dennett requires humans to have a certain level of intelligence (Dennett 1978, 267–85). Without it or without a "sufficient" level of intelligence, a human being lacks personhood, and he argues thus that a fetus is not a person. Fletcher also argued for the criterion of intelligence in describing "humanhood" among his personhood criteria. In fact, he explicitly states exact, albeit arbitrary, intelligence quotient scores he believes necessary for personhood (Fletcher 1979, 7–19).

The theory of intelligence is often debated among psychologists. Some experts believe in the "nurture" component of intelligence; that environment and upbringing contribute more to the intelligence of humans than "nature." The alternative view is for the genetic or "nature" component for intelligence; that human cognitive capacities for thought and reasoning stem more from the genetic code than from environmental factors. Both are plausible arguments and evidence exists in support of both stances (Horn, Loehlin, and Willerman 1976, 195–7). The following argument will primarily focus on the "nature" component of intelligence as it pertains to personhood.

In the dawn of molecular diagnostics and genomics, several scientific studies have shown links between specific genotypes or gene expression to intelligence. One study found that gene expression of RFK, RPL12, and RMRP genes influence intelligence, as measured by an intelligence quotient test (Yu et al. 2012, 270–85). Another study found that variants in the HMGA2 gene also had an impact on intelligence (Stein et al. 2012, 552–61).

The studies support the notion of the contribution of specific genes to human intelligence. Given the genetic component of intelligence, it stands that a combination of numerous genes is expressed to produce the intelligence phenotype. It is likely that many of the genes that contribute to intelligence have yet to be discovered. Shi and Wu describe the expression of genes at several stages in the preimplantation embryo: fertilization, cleavage, morula, and blastocyst (Shi and Wu 2009). Genes are not expressed solely after birth; genes including those related to intelligence are expressed in parental gametes, at the single-cell zygote stage, and throughout all prenatal stages. Intelligence then is a capacity that is developing and present in an individual even before birth and potentially as early as fertilization. Thus, the intelligence criterion does not preclude personhood status before birth, at fertilization, or at an earlier stage of development.

Potentiality and actuality

Potentiality and actuality are two concepts central to the debate regarding whether a fetus or pre-fetus are considered human persons. A fully mobile human adult has an actualized capacity for walking, whereas a fetus has the potential to walk. A zygote may be considered a potential person, but

not yet a person according to some. Alternatively, it is possible to consider that an actual person was never a potential person and thus, that a fetus, embryo, or zygote were always persons.

Ford uses an analogy of temperature and water that is misleading to describe the concepts of potentiality and actuality (Ford 1988). In a simple observation, it can be said that water at a temperature of 25°C is "actually" water at 25°C. Before adding heat to the same water, it can "potentially" be considered water at 30°C. We argue that "potentiality" and "actuality" are not as inherently different as the analogy may make these concepts seem. When we measure the temperature of water, we are obtaining the average temperature of water, that is, 25°C. The entire liquid is not 25°C, however. Some groups of water molecules may be 24°C and others 26, or 23 and 27°C, and so on. These (thermal) fluctuations are inherent to the definition of temperature as described by Boltzmann in 1872 (Khinchin 1960, 70). The given temperature of an object or solution is not entirely uniform. In the case of water, the liquid measured to 25°C already bears characteristics of water at 30°C. We argue thus that actuality and potentiality need to be considered as two interrelated concepts on the same continuum and not in a distinctly discrete, dichotomous fashion. In the case of the prenatal and postnatal human being, change is only in regard to the continuum of development.

This notion is supported by George and Tollefsen (George and Tollefsen 2008) in stating that "the difference … is merely a difference between stages along a continuum" (119). As personhood is an ontological concept, then exhibiting actual characteristics is inherent in the "potential" being. The ontological person is not a sum of its parts, so exhibiting qualities of an actualized person in the "potential" state qualifies a being as a human person. In the case of an "embryonic human [being] and that same human [being] later in life … there is only a difference of degree" and "the changes from embryo to fetus to infant to adolescent … are merely changes in degree of natural development of the entity" (George and Tollefsen 2008, 120, 123) that constitute the ontological person.

Capacities

Some capacities include self-consciousness, rational thought, and feeling pain. McMahan holds the notion that self-consciousness is a requirement for personhood (McMahan 2002). There is risk in allowing exercisable capacities to define personhood, as doing so may confer more or less moral status to some persons over others. For example, if self-consciousness was deemed an essential characteristic for personhood, it can be said that some persons have more self-consciousness than others and thus have more moral status than others (Lee and George 2005, 13–26). In this example it can easily be seen how bestowing personhood on the basis of capacities necessarily conflicts with the right to equality among people as some persons develop more or greater capacity than other persons and would thus have a higher moral status than others. Extending the argument for personhood on the basis of any other capacity is subject to the same rebuttal. It follows then that all humans are deserving of personhood irrespective of the degree of development of capacities.

Proponents for personhood on the basis of capacities (i.e., McMahan and self-consciousness) may also argue that personhood can be revoked upon the loss of capacities. We argue, however, that even if there was a capacity that was deemed necessary for personhood and this capacity was lost, revoking personhood would be erroneous since capacities can often be restored. Consider that Jones describes the "brains of human beings [as] far from fixed" in relaying the concept of plasticity

of brains (Jones 2004, 22–31). In the case of neurodegenerative cell death in Parkinson's disease (Gaillard and Jaber 2011, 124–33), neurological restructuring of the brain for new synaptic connections potentially allows some functionality to be restored. The brain is able to create new connections to restore abilities. For example, if the capacity for speech is hindered or lost, it is possible that the brain can restore some or all of the ability for speech by creating or restructuring neural networks. The range of plasticity for which the brain is capable of restoring capacities (and which specific capacities) which have been lost is unknown. Thus, defining personhood by capacities encounters an ethical incongruency in clinical decision making and associated healthcare provision. Revoking personhood upon loss of capacities, when the capacities may be restored would be erroneous and, thus, defining human personhood using any criteria for capacities is flawed.

Ensoulment

The foundation of human knowledge stems from empirical evidence to which humans are restricted to observation via sensory perception. Often referred to as the "mind-body problem," mental state, intention, and subjectivity of conscious experiential quality cannot be interpreted solely by the physical operation of an individual (Nagel 1993, 1–7). Many hold the view that we exist as physical, mental, and spiritual beings and that "the soul or organizing principle of the human person that gives life to the body is itself spiritual" (Ashley and O'Rourke 2006, 227–40). Some philosophers lend insight into the time at which a soul is present in human life in an attempt to unequivocally confer the precise time at which human personhood is endowed. Aristotle identified the beginnings of life in his theory of progressive ensoulment or delayed hominization. In it, the formation of the pre-fetus and heart occurs via mixing of semen with maternal menstrual blood (Ashley and O'Rourke 2006, 227–40). The process by which a human life is formed and receives a soul occurs forty days after conception for males and eighty for females (Dyson 1991, 82–105). The position of Thomas Aquinas on human personhood paralleled that of Aristotle (Aquinas 1948). Aquinas however, states that vital embryonic functions are derived from the soul, not the mother or semen. He states too that the soul created by God gives the organic body potential for activity. Donceel attempts to pinpoint that exact time at which ensoulment occurs. He states that the developed cerebral cortex is capable of receiving the soul at the twentieth week of gestation (Donceel 1970, 76–105). Advances in technology have allowed for novel insights into the development of human beings. For example, it is known that the maternal blood does not mix with semen to produce the fetus or person as Aristotle thought. The human zygote contains all necessary genetic programming for development (of heart, brain, etc.) associated with mechanical function, rational thought, and cognitive sapient awareness that takes time to develop but are "present (albeit in radical, i.e., root, form) from the beginning" (Lee and George 2005, 13–26). The instruction *On Respect for Human Life* explicitly states that "no experimental datum can be in itself sufficient to bring us to the recognition of a spiritual soul" (Congregation for the Doctrine of the Faith 1987) and, therefore, the philosophical nature of the topic of ensoulment is generally extrinsic to defining personhood on biological bases; and as such, the appeal to personhood made herein is solely an appeal to reason. Lee and George explain that having moral status "belongs to a human being at all times that he or she exists, not just during certain stages of … existence." There is continuity to the

existence and identity of a person throughout their biologic lifespan. Moral status is not transient or dependent on the principle or accrual of attributes (Lee and George 2005, 13–26).

Conclusion

All human beings have an end to their lives as persons in this world. In this article, the question of when personhood begins is posed. This work reviewed the economical stance that personhood begins at fertilization, as well as several other stances which argue for personhood at an arbitrary point after fertilization. The merits and criticisms of the positions which argue against personhood at fertilization were discussed herein. The arguments that challenge fertilization as the event at which human personhood begins do not sufficiently compel opinion due to several semantic discrepancies. Some of these discrepancies include extending personhood to non-human mammals and introducing discrimination among human beings by conferring "higher" personhood status to some people. Other proposed criteria for personhood discussed are fundamentally flawed. In light of the biological evidence and philosophical arguments discussed herein, it is most reasonable to support the notion that personhood status is present at the point of human fertilization.[1]

Note

1. One exception to this would be the case of a second identical twin. Our view is that the first twin began at fertilization, but if and when a totipotent cell or group of cells separates to form a new human entity then at that time another human person begins to exist.

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