

Totipotency, Twinning, and Ensoulment at Fertilization

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From fertilization to approximately the sixteenth day of development, human embryonic cells are said to have the capacities of totipotency and monozygotic twinning, both of which are problematic to a theory of ensoulment at fertilization. In this article I will address the problems which these capacities pose to such a theory and present an interpretation of the biological data which renders ensoulment at fertilization more plausible. I will then argue that not only is an ensoulment theory consistent with current biological data on the human embryo, but it may offer an explanation for the phenomenon of monozygotic twinning.

Keywords: *Aquinas, ensoulment,hylomorphism, monozygotic twinning, totipotency*

I. INTRODUCTION¹

The potency of cells is said to be restricted as an embryo develops.² In the case of the developing human embryo, it is claimed that embryonic cells are “totipotent” to approximately four days after fertilization: if placed in the proper environment each cell has the unicellular zygote-like capacity to form into a new human being (NIH, 2000). At approximately four days after fertilization of the human egg, however, the cells of the developing embryo become restricted and are “pluripotent”: they may form many types of cells, but not *all*, for they cannot become a zygote. During this time frame, ending during the third week of development, a single embryo may also divide into two or more distinct but genetically identical embryos. These capacities of the human embryo to divide into two or more of its kind, either naturally

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(in the case of monozygotic twinning) or artificially (with the removal of totipotent cells or clumps of cells) are typically considered sufficient grounds for claiming that none of us existed during the time frame that twinning is possible (e.g., Smith & Brogaard, 2003).

The main purpose of this article is to address the question of when we human beings begin to exist, given the capacities of totipotency and monozygotic twinning. The answer to the question of when we begin to exist entails a conception of what human beings are essentially; I will contend here that human beings are hylomorphic composites of form and matter. A position that I will ultimately try to advance is that a combination of a reinterpretation of biological data and a Thomistic hylomorphic account of ensoulment at fertilization can avoid twinning puzzles that are typically considered sufficient grounds for denying that we existed as zygotes and so-called “pre-embryos.” A hylomorphic account of ensoulment at fertilization, I will argue, not only avoids the problems that monozygotic twinning is typically thought to give rise to, but may offer an explanation for the unified growth and development of the embryo during the first two weeks after fertilization.

In the second section of this article I will offer a brief review of the problems which totipotency poses to the existence at fertilization of the human being and offer in the third section a solution which entails a reinterpretation of biological data on the human embryo. I will then offer a hylomorphic account of embryological development. In section VI, I will offer a hylomorphic account of ensoulment at fertilization to counter the claim that monozygotic twinning renders implausible the existence (or at least persistence) of the human being during the earliest stages of embryological development. Sections VII and VIII will focus on the explanatory power that a hylomorphic theory has for the embryological data on human beings and conclusions that can be drawn from the article.

Ethical concerns are obviously of import here since the topic of this article refers to the time frame in which procedures and methods that result in the wide-scale destruction of human embryos are legalized throughout much of the world (e.g., in-vitro fertility-assistance procedures, early abortions, stem cell research, and contraceptives which prevent implantation [i.e., “The Pill” and IUDs]). However, the scope of my inquiry extends only to whether, given current findings in embryology and interpretations thereof, it is possible and plausible that our origins were at fertilization.³

II. THE PROBLEM OF TOTIPOTENCY

In scientific literature on embryology there is a dual use of “totipotency.” One sense refers to the capacity of early embryonic cells to replace any other embryonic cell, with regard to function. The functional plasticity of

these early cells is due to a lack of differentiation; none of the cells are at this point destined to become a specific kind of body cell. These totipotent cells are *stem cells* and given a second sense of “totipotency,” it is more appropriate to refer to these as “pluripotent.”⁴ The second sense of ‘totipotency’ refers to the capacity a cell has, if separated from the embryo, to become a complete separate embryo. This second sense is ascribed to the cells of the human embryo until approximately the fourth day post-fertilization and is what I would like to examine.

This sense of totipotency poses problems to a theory which posits that the ensouled human being persists from fertilization onwards. Simply put, if any of the cells of the early embryo are totipotent, or able to develop into a human being, each of these eight cells must be an ensouled, albeit unicellular, human being. A consequence of this is that advocates of ensoulment at fertilization must admit to one of the following possibilities:

1. the presence of one or more new souls each time a cell divides into two new totipotent cells. With each of these mitotic cellular divisions comes the possibility of the cell that divided (by stipulated definition, a human being) “fissioning out of existence”; coupled with this possibility is the dilemma of eight totipotent cells (i.e., eight human beings) developing, under normal circumstances, into one human being; or
2. one soul is present at fertilization and if any of the totipotent cells are removed from the embryo, a new soul is infused.

The first possible account entails that a soul is infused into matter (here, the unicellular egg) at fertilization *and* at each cellular division. Upon the first mitotic division, then, the zygote divides into two new totipotent “daughter cells.” These new cells are totipotent and on this account each an ensouled human being; hence the capacity to be removed from the (two-celled) embryo and develop into a distinct or viable human being. But one problem with this is that if a new ensoulment occurs with each mitotic division, it is intuitively implausible that the cell that divides into two human beings is itself a human being. On standard theories of personal identity, human beings do not have the capacity to divide into two or more human beings. And on an ensoulment account that stipulates an indivisible soul, this would be metaphysically impossible.

What is likely, however—and what is typically said to be the case with living beings that do divide into two of their kind, such as amoebas—is that the original entity “fissioned out of existence.”⁵ The original embryo, A, it could be argued, simply “fissioned out of existence,” with daughter cells B and C ensouled upon the division of A. But, if it is the case that the unicellular human being that divides mitotically into totipotent daughter cells does fission out of existence, then the natural process of mitotic division produces several generations of human beings, with the existence of each

human being necessitating the demise of at least one genetically identical sibling. An additional complication is that if it is the case that each totipotent daughter cell is the descendant of a sibling who fissioned out of existence, it cannot be the case that *our* origins were at fertilization.

Problems related to fissioning cease at approximately four days post-fertilization, when the embryonic cells are said to “restrict” and so are no longer totipotent. But the multicellular embryo is now several human beings, for it consists of several totipotent (i.e., ensouled) daughter cells; from this point, the division of embryonic cells merely produces new body cells, just as those produced by the division of adult human somatic cells. But, although the cells are no longer totipotent, a second problem arises: although at day four or so the embryo consists of several human beings (each a totipotent cell), normal development will produce one human being. So for reasons thus unknown, in the course of natural human embryonic development several human beings develop into one. On this account, each of us came to into existence at the cost of several genetically identical siblings.

This first solution poses significant difficulties to an account of ensoulment at fertilization. If the result of mitotic division is that the original cell fissions out of existence, the human being that exists as the fertilized egg would not survive natural mitotic division, nor could any of those that divide into totipotent cells. So if this is the case, then totipotency precludes, at the least, *our* existence at fertilization (although we all have genetically identical siblings who preceded us and whose demise was necessary for our existence). And, to claim that we did exist at fertilization and persisted through these mitotic divisions is not only arbitrary, but is complicated by the additional dilemma of the course of normal development (i.e., a singleton birth, the technical name given to the birth of a single human being) necessitating the loss of several human beings. So it seems that a theory of ensoulment at fertilization has difficulties in accommodating current understandings of human embryological development.

The second possible solution perhaps offers a more palatable reconciliation of an ensoulment theory to totipotency: if a cell is removed *then* a new soul is infused into the matter (e.g., Ashley, 1992). On this account, each totipotent cell is potentially a human being, rather than actually one, with this potency actualized *upon* separation. This solution differs from the first since here the dividing cells are not human beings dividing; rather, the developing embryo is a human being, persisting from fertilization onwards, and yet, a cell of this body can be removed and a new soul infused into it. The totipotency of these unrestricted cells is essentially a *capacity* to receive a new soul: it is only upon separation from the rest of the embryo that cell will have the potential functional capacity of the ovum. Since on this account, the original human being (the zygote) persists from fertilization onwards, it is not impossible, nor is it implausible, that *we* have existed

from fertilization onwards. However, an unwelcome consequence may be that it is possible that we began to exist *after* fertilization, when a cell from our older, genetically identical sibling was removed and subsequently ensouled.

Although both of these solutions render ensoulment at fertilization more plausible, the problems of fissioning out of existence, the many being subsumed into one and varying origins may complicate matters to the extent that there appears to be little if any philosophical appeal to an account of ensoulment *at* fertilization. This is especially true, it seems, if ensoulment *at* fertilization only occurs in some instances but not in others. And so an alternative may be to offer an account of delayed ensoulment, so as to avoid being charged with making ad hoc adjustments in order to accommodate the totipotency (and monozygotic twinning) related puzzles.

Perhaps the most frequently cited attempt to reconcile totipotency with a delayed ensoulment theory is Fr. Norman Ford's 1988 *When Did I Begin? Conception of the Human Individual in History, Philosophy and Science*. Echoing an Aristotelian/Thomistic "succession of souls" theory given recent prominence by Donceel (1970), Ford argues that the embryo, from fertilization to approximately 16–21 days, is "animated" with a non-rational soul: although there is a "teleological unity" that is manifested by the usual development into an embryo, fetus, neonate, etc., totipotency and the natural capacity for division into monozygotic twins is each a sufficient ground for denying that the embryo satisfies conditions for being a human being. One of the conditions that are not satisfied, Ford argues, is "ontological individuality" or "the capacity to maintain, or at least begin, the process of the human life-cycle without loss of identity" (1988, p. 85). It is not until the embryo loses the capacity to divide into monozygotic (MZ) twins, either artificially or naturally, that this condition is satisfied and, on Ford's account, a human being comes into existence. The early embryo, then, although it has a teleological individuality, is, at best, potentially a human being: *we* did not exist at fertilization, although the ancestral cells of our body did.

The upshot of recent literature on the timing of our origins is that an argument for our originating at fertilization and persisting through the next two weeks appears to be significantly challenged by the biological data on totipotency. What I offer in response to the puzzles that totipotency poses to our origins at fertilization, though, is not an attempt to reconcile the two; rather, I will argue that that current biological data on the human embryo does not provide sufficient evidence for the totipotency of human embryonic cells. The next section of this article will address whether the claim that human embryonic cells are totipotent, is, in fact, justified. My conclusion will be that the literature which refers to totipotency as sufficient grounds for denying the plausibility of ensoulment at fertilization does not cite biological evidence to substantiate this claim. In fact, the current findings in human embryology do not appear to be at odds with claims of ensoulment

at fertilization, so that attempts to reconcile the two, like the arguments given above, may prove unnecessary.

III. THE BIOLOGICAL FACT OF TOTIPOTENCY

A seminal article referring to the problem which totipotency poses to the “ensoulment status” of the human embryo is Fr. Joseph Donceel’s 1970 “Immediate Animation and Delayed Hominization.” Donceel writes:

We are told now that what makes an organism a human person is not merely the possession of the human genetic capital, but the virtuality, the power of developing into a human person. The trouble is that, if this is true, every single cell of the zygote, of the morula or the blastula, is a human person; for at the earliest stages of embryogeny each cell resulting from the division of the fecundated ovum possesses such a power and virtuality. All these cells are totipotent; each of them may, if separated early enough from the others, turn into a human being.

Hans Driesch, Hans Spemann, and their successors in experimental embryology have many times performed this experiment on the embryos of lower organisms. With infinite care they separated one or a few cells from the zygote and allowed them to develop in isolation. In many cases, these cells developed into complete, though smaller adult organisms (p. 98).

The “supporting evidence” for this capacity of human cells, however, is not provided. Rather, Donceel turns to the studies of lower organisms in which the separation and cultivation of cells from the zygote resulted in complete organisms. Furthermore, Donceel admits to the lack of evidence concerning *human* cells, for he states, “to my knowledge, such an experiment has **not yet** been performed on a human ovum. Who will make bold to assert that it will never be feasible?” (1970, p. 98).

This, of course, is precisely what ought to be shown as feasible, and better yet, actual, *before* it is asserted; a leap from claims concerning the essence of non-human species to that of the human species is not only unwarranted, but ignores the crux of the issue at hand. The central issue is what kind of being the human embryo is; therefore, to assign to human embryos significant functional capacities of beings which are considered, by some, as essentially different from humans, begs the question. And underlying this move is the claim that we are essentially animals, which is but one theory of personal identity. This assumption is particularly problematic, since rendering it as fact (rather than theory) is key to rendering implausible ensoulment at fertilization (which itself would rest on an otherwise viable theory of personal identity).

It is interesting to note that this article was a primary source for Ford's *When Did I Begin? Conception of the Human Individual in History, Philosophy and Science*, which presents the widely accepted argument, referred to above, for delayed hominization/individuation. Yet, like Donceel, Ford offers no studies or literature that effectively support a reference to the problem which totipotency poses to ensoulment at fertilization. And Donceel's presuppositions are echoed in other significant articles pertaining to the ontological status of the human embryo. The following passage is found in Fr. Richard McCormick's 1991 frequently cited "Who or What Is the Preembryo?":

Several things should be underscored here. First, at this stage we know from **other mammals** that each cell or blastomere has the same potential as the zygote. If separated from the others, it can produce a complete adult. Furthermore, if the two 8-cell stages of different parentage are fused, a single adult still results. As the AFS (American Fertility Society) committee put it:

Current scientific interpretation of these and other results from animal experiments is that first cleavage divisions in animals produce a packet of cells, each of which still has the full developmental potential of the zygote, i.e., to produce a complete adult. Stated another way, at the 8-cell stage the developmental singleness of one person has not yet been established (p. 3).

It is unclear here whether McCormick is unaware of the presuppositions used to support the claim that early human embryos are totipotent. It seems reasonable, though, to expect that scientifically proven facts concerning one species would not to be applied, without empirical evidence, as fact to another. This is arguably not only flawed science, but flawed philosophy (and the readiness of the three ordained scholars—Donceel, McCormick, and Ford—to accept our continuity with the animal kingdom is surprising, given their theological belief in our distinctiveness). And what complicates matters (and has led, I believe, to repeated reference to human embryonic totipotency) is that these articles are used to substantiate other arguments in the field for the preclusion of a human being at fertilization, with no mention made that the totipotency is simply hypothetical rather than confirmed (e.g. Grobstein, 1988, p. 27; Singer et al., 1990, p. 67; Ashley & Moraczewski 1994; Shannon, 1996; Johnson, 1995, 1997; Shannon, 1997; Olson, 1997, p. 90; Smith & Brogaard, 2003).

The issue, however, is not so much whether there are fallacies in current argumentations over ensoulment, but whether totipotency actually poses a significant difficulty to ensoulment at fertilization. What would provide evidence of this capacity are repeated instances of "forced twinning,"

in which human embryonic cells are separated from the embryo and, given the proper environment, develop into a fetus and eventually what is commonly accepted as a human being. In fact, an unsuccessful attempt was made to “force twin” a human embryo in 1993, involving the use of genetically abnormal embryos which could not have become viable (Hall et al., 1993). A year later, the National Advisory Board on Ethics and Reproduction published the following statement (emphasis mine):

The number of viable human embryos that can be produced by blastomere of a single embryo ranges up to four. This procedure has been used to successfully increase the pregnancy rate of cattle, **but no reports of its use in normal human cells have been presented in the literature.** (1994, p. 251)

And, a 2000 study on monozygotic twinning of the human embryo stated (emphasis mine):

While MZ twins are thought to result from the division of a single fertilized egg to form two genetically identical embryos, the precise mechanism(s) responsible for this division are not known. However, several observations have yielded **theoretical** explanations of the process. This splitting hypothesis was supported by **animals** showing that mechanical cleavage of mammalian embryos *in vitro* could produce MZ or “identical” twins. While these microsurgical approaches proved effective in the laboratory, the de-novo embryonic fission required for spontaneous twinning **has never been directly observed** (Sills et al., p. 893).

The most conclusive evidence for the totipotency of human embryo cells—published results of an interventive study in which a human embryo is artificially divided, producing more than one individual fetus—does not, to my knowledge, exist.

Indirect evidence of the totipotent capacity of cells may be derived, however, from studies performed on human embryos. In the recent past, as ethical regulations have permitted manipulation at the microscopic level (“micromanipulation”) of human embryos, studies involving IVF procedures which subject human embryos to artificial procedures have produced a significantly high rate of monozygotic twins (see Edwards et al., 1986; Da Costa et al., 2001; Tarlatzis et al., 2002). A relationship between IVF procedures, which involve micromanipulation of the zona pellucida (ZP) (the thick, transparent, non-cellular membrane that encloses the zygote and multicellular embryo and is discarded at approximately 2 weeks post-fertilization) and monozygotic twinning has been hypothesized to be causal: it is theorized that small holes in the ZP, either accidentally or purposefully done with micromanipulation, caused the inner cell mass of the embryo to unexpectedly split, resulting in one or more new embryos. This relationship may, it is

argued, provide indirect evidence of totipotency: it is hypothesized that increased twinning is the result of artificially made openings in the ZP allowing for early embryonic cells to escape, the results of which are new human beings. In other words, the increased chance of monozygotic twins resulting from IVF procedures may be due to totipotent cells separating from the rest of the embryo during micromanipulation procedures and developing into separate but genetically identical human beings.

A frequently cited 1994 study addressing this correlation proposed a significant relationship between “structural features of the zona pellucida and the occurrence of MZ twinning in the human” (Alikani et al., p. 1319). In this non-interventive study, the researchers reported 6 cases of monozygotic twinning, over a period of three years, among 2163 cases of IVF which reached embryo replacement (i.e., implantation of the embryo within the body of the woman). Of the total number of cases, 1648 involved one or more forms of micromanipulation, and 737 clinical pregnancies occurred (a clinical pregnancy is one in which one or more gestational sacs (with a beating heart) are confirmed in a woman’s uterus by ultrasound examination). Six cases of twinning resulted, 4 of the “micro-manipulated” population and 2 of the non-micromanipulated; it was noted that the 2 non-micromanipulated embryos had zona pellucidas below the average thickness for the mother’s respective age group. Overall, the rate of MZ twinning was twice that of the natural rate (.84 percent). The search for a common cause of the MZ twinning sub-group led the researchers to propose that *artificially induced* or naturally occurring structural features of the zona pellucida may be associated with inner cell mass splitting during hatching and thus monozygotic twinning in the human (Alikani, 1994, p. 1320) (emphasis mine); supporting a totipotency hypothesis, micro-manipulation of the embryo was proposed as causally associated with monozygotic twinning.

The published results of the study, however, which posited a relationship between twinning and the “architecture” or structure of the ZP, are debatable, for it cannot be deduced from the findings that the thinness and subsequent porosity of the ZP, be it artificially or naturally induced, is *causally* related to MZ twinning. As this was not an interventive study, the relationship was not repeatedly demonstrated. More importantly, it was not stated whether a possible confounding factor, the measured thickness of the zona pellucida of the 6 MZ pregnancies, was the same in other non-micromanipulated case. What researchers reported is that 6 cases of twinning, viewed retrospectively over a period of three years, had the common characteristic of an “unnaturally thin zona pellucida.” They then hypothesized that the thinness of the zona pellucidas of four of these six cases were artificially induced through micromanipulation and concluded that the naturally or artificially induced ZP thickness allowed for the totipotent cells to seep out, the result more than one embryo.

What are not provided, however, are data that would help determine whether a larger class of embryos which also had approximately the same

“minimal thickness” ZPs, yet *did not* twin, existed. If it is the case that other embryos had same thickness of the ZP but did not twin, the relationship between ZP thickness and MZ twinning may not be significant, at least in providing indirect evidence of totipotency. It may be the case that cells seeped out of many embryos (due to porosity of the ZP) and for other reasons these 6 were predisposed to twin. This last possibility may be supported by studies given below, as well as the third section of this paper which points towards an ensoulment theory of twinning. What is important here, however, is that the conclusions reached in the above studies are arguably weaker than they initially appear, as are the findings of this next study which offers a hypothetical relation between artificially induced openings of the ZP and MZ twinning.

In a frequently cited second case-control study, conducted from 1996–2000, Schieve et al. examined the association between a form of micromanipulation, “assisted hatching” (AH), and MZ twinning. Of 11, 247 clinical pregnancies, 22 cases resulted in fetal heartbeats exceeding the number of embryos transferred. It was hypothesized that each of these cases contained at least one set of MZ twins. Thus the rate of twinning following AH (.33 percent), occurred at more than twice that of non-AH IVF cycles (.13 percent), with the association not explained by possible confounding variables such as age and number of embryos transferred (possibly altering the denominator).

The statistical findings were altered, however, by the “test” of live-births: although .33 percent of the AH-IVF cases had heartbeats which exceeded the number of embryos transferred, only 6 of these pregnancies resulted in live births. It is possible then, that errors occurred in the measurements; at the least, the necessary empirical evidence of twinning for all 22 cases was not provided. As well, these findings (regarding the loss of 36 embryonic heartbeats) may also reflect a high rate of miscarriage in the “natural pregnancy” population, thereby reducing the significance of studies’ results that propose an increase in IVF-related MZ twinning. This hypothesis is substantiated by a 1977 study in spontaneously aborted twin conceptions: given the use of diagnostic ultrasound, researchers noted that of 30 diagnosed “natural” twin conceptions, 6 aborted and 10 gave birth to singleton infants (Robinson & Caines, 1977). Although a distinction was not made between monozygotic and dizygotic twins in this study, researchers concluded that, “the actual incidence of (natural) twin conceptions could only be satisfactorily resolved if a large and unselected group of patients were to be scanned serially and with great care from the early weeks of pregnancy”; twin conceptions in the human are more common than is generally appreciated “it is probable that the figure is 1 in 60 or even higher” (p. 25).

A further problem, regarding statistical power and the interpretation of data in studies positing an indirectly derived association between zona

pellucida micromanipulation and subsequent MZ twinning, is inadequate sample size. This is addressed by Sills et al.:

When MZ twinning frequency as a function of zona micro-manipulation was compared among patients in the largest study group (IVF only), no significant difference was identified. These latter findings must be interpreted with caution, however, because the low natural frequency of MZ twinning necessitates a very large sample (>10,000 cases) to achieve satisfactory statistical powers (2000, p. 893).

Interestingly, contrary to the findings of the above studies, Sills et al. (2000) concluded from their 3-year non-interventive study that “among IVF study patients the frequency of MZ twinning was not statistically different between zona manipulated and zona intact subgroups” (2000, p. 89). The researchers offered a hypothesis similar to Robinson’s and Caines’ (given above): the apparent association between MZ twinning and IVF patients may be a function of the high number of embryos transferred (thus increasing the “population size”) as opposed to discrete zona manipulations. That is, the percentage of IVF embryos which are MZ twins may actually be smaller if the number of embryos which do not survive are taken into account since the high number of failed attempts at clinical pregnancies involves a high number of lost embryos. This number is perhaps exponentially higher than the data currently allows for, since many IVF procedures implant several embryos, with the hope that one will survive.

Other interpretations of the data concerning the greater overall frequency of MZ twinning for IVF patients, particularly with procedures that utilize zonal manipulation techniques, have attributed the increase in twinning to treatment of the gametes. If this is the case, the high rate of twinning with IVF would not pose totipotency puzzles to ensoulment at fertilization. Blickstein et al. (1999), observing no twins in 94 pregnancies involving micromanipulation and a 4.9 percent twinning rate among 82 IVF pregnancies which *did not* involve micromanipulated embryos, attributed the increase in twinning to treatment of either the sperm or the egg rather than to the puncturing of the zona pellucida in vitro. A relationship between ovulation induction and MZ twinning was also suggested in a 3-year retrospective analysis of pregnancies achieved after various assisted reproductive techniques, including but not limited to micromanipulation, which revealed that the rate of MZ twinning was “consistently increased, irrespective of treatment modality or micromanipulation” (Schacter et al., 2001, p. 1264). Confirming Derom’s (1987) hypothetical causal relationship between ovulation induction therapy and an increase in MZ twinning, Schacter et al. stated that “the ovulation induction stimulus could be a major influence promoting MZT in assisted reproduction, **as opposed to the current thinking implicating zonal manipulation**” (emphasis mine) (2001, p. 1269).

These studies, while certainly not conclusive with regard to when and if ensoulment occurs, arguably undermine some of the arguments that render ensoulment at fertilization implausible, since they weaken even the hypothetically based arguments for the totipotency of human embryonic cells. Science, as of yet, has not firmly established that alteration of the environment is causally related to MZ twinning, and so even indirectly supports the totipotency hypothesis. So although published studies by no means provide evidence *for* an ensouled embryo, a review of studies on artificially induced twinning affords more plausibility to ensoulment at fertilization than is offered in philosophical literature on our origins.

IV. HYLOMORPHIC EMBRYOLOGY

Readers may argue that an acknowledgement of the hypothetical status of totipotency is largely irrelevant, since the genetic differences between animals and human beings are quite small; therefore an inference from animal studies is warranted. But, although the difference in genotype might be slight, the phenotypical manifestations reveal notably large mental differences between animals and humans. Even if there are strong grounds for extrapolation, it should nonetheless be admitted into argument that the ascription of totipotency to human embryonic cells is based on extrapolation rather than biological fact. And it is not part and parcel of every metaphysical theory that we are essentially animals; the view that we are animals—the “animalist view” or Biological Account of Personal Identity, advanced perhaps most famously by Eric Olson (1997)—is but one mainstream account of personal identity. On other mainstream accounts of personal identity, although we have animal bodies we are not identical to these bodies and so are not essentially animals (e.g., Swinburne, 1984; Unger, 1992; Baker, 2000). And on Aquinas’ hylomorphic metaphysics which I will advance here, the “soul,” or substantial form, of the animal is lacking special faculties of the human soul (*Summa Contra Gentiles* [SCG] II 89; *Quaestiones de Anima* [QDA] q. 1). The kind of soul that we have distinguishes us from animals in a significant way that not only supports ensoulment at fertilization but is compatible with the current data available on the human embryo’s capacity to be divided.

On Aquinas’ hylomorphic metaphysics, plants, animals, and human beings are “animated beings,” or composites of matter and a substantial form. The forms, or souls, of animated beings are immaterial, actual, and united with physical matter that is being in potency. When matter is united to a substantial form, the form “makes the matter exist” in a composite substance: human beings, for example, are a composite of a rational form and matter (Aquinas also refers at times to the matter as the “body” for reasons that do not commit himself in any way to a Platonic/Cartesian metaphysics).

The form is the actualizing principle of the substance; when form and matter unite as a composite, the matter with which the form unites is the potential principle of being and so “receives” the form. To manifest its capacities a form actualizes or “configures” the potential matter with which it is united; this configuration is teleological and is a viable explanation for the growth and development of animated beings. There is also a general hierarchical distinction between beings in virtue of their form, so that the forms of more “complex beings” have functions in addition to those of “lower beings”: plants (a unity of form and matter) have vegetative growth, and animals have *both* vegetative growth and perception. Human beings, as we shall see below, have, in virtue of our form, both vegetative growth and perception *and* additional powers of intellect and free will.

The function of a being is not only used by Aquinas to determine the hierarchy of beings; he also claims that it is from the functions of a being that we can determine the metaphysics of its origins. Since non-human souls (those of plants and animals) do not exist apart from the matter, Aquinas argues that they do not originate via supernatural intervention (*Quaestiones Disputatae de Potentia Dei* [QD] I q. 3 a. 11). That this is so can be inferred “by their function, which cannot be exercised without a bodily organ, wherefore absolutely speaking they have no being independently of the body” (QD I q. 3 a. 11). Because the vegetative and sensible souls of plants and animals are functionally correlated to the matter with which they are united—they do not “transcend the matter”—they are said to originate with the “natural powers of the generator,” as opposed to the supernatural intervention of God. In brief, his argument is that there is not a lack of material explanation for the functions of these beings, since these functions (such as vegetative growth, sentience, and some cognitive functions) can be spatially located in the body; hence, the forms of these beings will not “exist apart from the body, nor be brought into being except insofar as the body is brought into being”. So, on an account of the origin of these beings, there is no reason to require anything outside of the natural generation of body, be it asexual reproduction (or fissioning) as is the case with plants (and lower animals), or a fusion of gametes, as is the case with sub-human higher animals.

The rational soul of the human being, however, is an exception: the human form is a “subsistent substance wherefore its being does not consist solely in its union with the body”; although it originates in union with the body, it can exist on its own without the matter, albeit in an imperfect state (QD I q. 3 a. 11; a. 9). Its independence from matter is a function of its nature: Aquinas claims that operations of the rational soul, such as intellect and will, are *not* restricted to any part of the body (although many of our intellectual powers, such as imagination and sensibly based thoughts, necessitate union with matter (SCG II 68). Because of this, the rational soul, unlike the vegetative and sensible souls found in plants and “dumb” animals, by its

very nature functionally “transcends” matter; it is not confined within the limits of corporal nature (QD I q. 3 a. 11: 8; see also *Summa Theologia* [ST] I q. 76 a. 2). And it is because all of the faculties of the human being are not reducible to informed matter that Aquinas argues the rational soul necessitates supernatural origins, *viz.*, the infusion by God of the soul into matter. This is because a form whose “operation is independent from matter cannot be produced from corporeal matter”; whereas the forms of non-human animals and plants are functionally correlated with the body and therefore originate by the same means as the body, such as the fusion of gametes or fissioning of a body, the human form functionally transcends matter and so its generation requires an immaterial agent (ST I q. 90 a. 3 p. 2).

It is in virtue of the transcendent nature of the human form that I will argue ensoulment at fertilization is metaphysically possible (I will argue later why a transcendent form in conjunction with current biological data favors ensoulment at fertilization). What I offer is that the matter (or “body”) into which the human soul is infused is the fertilized egg and that the development of this zygote into a multi-cellular embryo, fetus, neonate, etc. is the development of a human being. An anticipated objection to this claim is perhaps best articulated by Donceel, who in his arguments against ensoulment at fertilization or “immediate hominization” writes:

a substantial form can only exist in matter capable of receiving it. In the case of man’s soul this means: the human soul can only exist in a highly organized body . . . Soul and matter are strictly complementary; as the soul stands higher in the hierarchy of beings, the matter which receives it must be more highly organized. Even God cannot put a human soul into a rock, a plant, or a lower animal any more than He can make the contour of a circle a square . . . these conclusions have been reached or could have been reached on the basis of sound philosophical principles . . . the main philosophical principles are as follows. The soul is the substantial form of man. A substantial form can exist only in matter capable of receiving it. In the case of man’s soul this means: the human soul can exist only in a highly organized body (1970, p. 82).

An account of ensoulment at fertilization that he finds metaphysically possible would not be an arrangement of matter and form that *results* in a body but, rather, a body and a soul in union with each other, and this is not a hylomorphic account, but a Cartesian one. Donceel makes no mention, though, of the qualifications that Aquinas makes for the *human* soul: that, because of its transcendent nature, it will never have a complete functional correlation to matter, since there is never an organ for the will or for some mental capacities. Therefore, it *can* (and always does) exist as “united” to matter in a fashion that is not strictly complementary. Because of this special feature of the human soul, the fertiliz(ing) egg cannot be ruled out as an improper receptacle simply in virtue of the fact that it is not functionally

correlated with the form, since even the “fully developed” human body does not have this feature. In fact, Aquinas argues that “now though form and matter have one being, it does not follow that matter always equals the being of the form. In fact, the more noble the form, the more it surpasses matter in its being” (SCG II 68). And it is the human form alone that “is not wholly encompassed by and merged in matter, as are other material forms. This is indicated by its operation, in which corporeal matter has no part” (SCG II 68).

In a similar vein, Donceel argues that “the least that we may ask before admitting the presence of the human soul is the availability of these organs: the senses, the nervous system, the brain, and especially the cortex” (1970, p. 101). This, too, is based on a misinterpretation of the rational form/soul that Aquinas describes. Although Aquinas allows that the brain is necessary for some modes of thought, he does not reduce, nor even make dependent in a non-reductionist manner, *all* thought (or free will, for that matter) to physical processes or even physical realms. So, again, if matter configured in any way is incapable of being functionally correlated to the form, then a body *with* a brain is, on theoretical grounds, as insufficient a receptacle for the human form as a brainless body. What *is* special about the matter of the zygote, and what renders it a proper receptacle for the human form, is that it has the potential to develop into—or be configured into—a body that has a brain and nervous system. Therefore, it is able to manifest the faculties of the form that are dependent on configured matter. This development of the unicellular body into one with a brain, nervous system, etc., is due to the teleological function of the form: the form configures the matter so that the body is ultimately able to manifest its rational functions. This teleological function of the form not only distinguishes the hylomorphic soul from a Cartesian soul but can account for how we could have once been the “undeveloped” body that is the zygote and pre-embryo.

A second objection that may be raised is that by Aquinas’ own admission we human beings do not come into existence until some 40 days after fertilization (90 days for females). Prior to this, the body which exists, is, he argues, not a proper receptacle for the *human* form, and so is animated by a succession of souls until it is “properly organized.” My response to Aquinas’ argument for delayed ensoulment is that his (mis-) understanding of what took place biologically prior to 40 days post-fertilization played a significant role in his argument for our origins. On his account, it is the male seminal power that, for the first 40 days, organizes the undifferentiated and wholly unorganized matter provided by the female menstrual blood. At 40 days the matter is organized into a body and so is a proper receptacle for the human form. We can ignore his flawed science, though, since we now know that a definitive body comes into existence not at 40 days but at the fertilization of the human egg; the unicellular zygote is not undifferentiated and unorganized matter but a highly organized unicellular being. And

although this unicellular body does not have the organs by which the operations of the rational form can be accomplished, the teleological function of the form will configure the matter into a body that does. The significance of this potential to develop a brain and nervous system and so certain capacities to reason also supports our intuitions: few would deny that the neonate is a human being, and yet it has merely the potential for the rationality that is the hallmark of the human being. If this rationality, then, is a *potential* capacity of a neonate, and even a 5-month-old fetus, it is not difficult to imagine that the zygote has the same potential. So, although Aquinas' biology is wholly inaccurate, the basic tenets of his metaphysical account of the origins of the human being withstand his scientific errors.⁶

A hylomorphic ensoulment is not only metaphysically possible but is compatible with and can offer an explanation for the interpretation of biological data offered above. In his discussion of our origins (which is somewhat intertwined with his erroneous embryology), Aquinas argues the human soul did not begin to exist by transmission with the semen since this would entail that the soul is "severed from the soul of the generator, just as the semen is severed from the body" (SCG II 86). If this were the case, Aquinas argues, we would be like "annulose animals, that live after being cut in two, and in which there is one soul actually and several potentially: for when the body of such an animal is divided, the soul begins to be actually in each living part" (SCG II 86). On the contrary, "since the intellect, which is the proper and principal power of the intellectual soul, is not the act of any part of the body, it cannot be accidentally divided through the body being divided: and consequently neither can the intellectual soul" (SCG II 86). The reason Aquinas gives for why the "intellective" soul cannot be divided with the body is that "Every form that is brought into being through the transmutation of matter, is brought forth from the potentiality of matter. . . now the intellectual soul cannot be brought forth from the potentiality of matter: for it has been shown above that the intellectual soul surpasses the whole potentiality of matter, since it has an operation apart from matter. . . ." (SCG II 86). And what has "been shown above" is that the human form is transcendent and so not "wholly encompassed by and merged in matter, as are other material forms"; therefore, it can never be divided with the body being divided.

I offer, then, that Aquinas' metaphysics withstands not only his scientific errors but more contemporary ones as well. On his account, the forms of all other animated beings (viz., plants and animals) *are* wholly encompassed by and merged in matter, so it is possible that these forms can be divided when the body is divided. But this is not the case for the transcendent human form. And, interestingly, what embryology offers to us are cases in which animals, including primates, can be divided at an early stage of development (e.g., Chan et al., 2000). There is no evidence yet, however, for the artificial division of human embryos, and a reason for

this may be that these embryos are ensouled human beings, the division of which is not possible. And this follows from Aquinas' theory with no ad hoc stretch of resources.

V. A HYLOMORPHIC SOLUTION TO THE POSSIBILITY OF TOTIPOTENCY

But readers may object that the data do not offer evidence that embryos *cannot* be divided. Rather, the studies that I cite are merely inconclusive as far as determining the division and survival capacities of the human embryo. I think, though, that even should human embryonic cells be removed and demonstrated to be totipotent (i.e., develop into a new embryo), a hylomorphic account of ensoulment can still be defended. If this is the case, though, ensoulments of identical twins may not always occur at the same time. What I offer is that *if* totipotency is a capacity of human cells, as Ashley and Moraczewski (1994) have pointed out, it appears to be externally induced—if this were not the case, it would seem that multiple births, rather than single births, would be the norm. So should isolated human embryonic cell develop into human beings, it may be the case that the embryonic cell that is removed and placed in the proper environment then has the features of the fertilized egg. It is a single unicellular organism that contains the necessary genetic code for the development of a human being. And it is not only unspecialized (i.e., it is not yet destined to become a specific type of body cell, but could become any at all), but its isolation may also be an important factor in its becoming totipotent, since this is also a feature of the unicellular zygote, which stands alone immediately after fertilization. Since the unicellular body has the essential features of the unicellular zygote, it would be the proper body for the human soul and so a soul would be infused.⁷

A problem with this concession is that it comes at the cost of varying origins, since some sets of identical twins will have come into existence on separate days. Thus it may be argued that the ensoulment account is weakened, since varying origins are usually considered sufficient grounds for denying our origins during the period of time that the division of the embryo into two (either through forced or natural twinning) is possible. However, although the timing of ensoulments of genetically identical multiples would vary (so that one identical twin would be older than the other), the metaphysical principles of a hylomorphic account of ensoulment would not be compromised. On the hylomorphic account offered here, the fertilized egg is the proper matter for the human form. If the removed totipotent cell is essentially a fertilized egg, then it would be infused with a rational soul; the means by which the egg is fertilized is irrelevant to the creation of the human being.

Aquinas was faced, I think, with the analogous ethical problem of the case of adultery that results in pregnancy. His methodology in solving this puzzle may be useful in reconciling ensoulment with totipotency to the extent that the metaphysical principles of an ensoulment account are shown to be uncompromised. In the case of a pregnancy that results from adultery, there appears to be some tension between the moral Christian law (which forbids adultery) and God's authorship of this law (since He appears to participate in the act and so may condone it). Aquinas' response to this problem was to claim that the adulterous act is not a part of the essentially good act of fertilization, or what corresponds to fertilization on his account; rather there are two separate acts that are accidentally related to each other. One of these acts is that of fertilization itself; the other is the adulterous act, the result of which is fertilization. Now, it is obvious that fertilization is not necessarily related to adultery, but only contingently so, since some fertilizations occur without adulterous acts and some adulterous acts occur without fertilization. The fertilization that occurs is thus an act that is separate and distinct from adultery and it is this act that God "responds" to; "in the action of the adulterer, what is of nature is good; in this God concurs" (ST I q. 118 a. 2). This method of isolating one act from another may be useful in demonstrating that varying origins do not compromise an ensoulment account. The isolation of the act of fertilization from the adulterous act is analogous to isolating the ensoulment of a totipotent cell from the accidental features of the ensoulment, such as how the fertilization actually came about. If the removal of an embryonic cell results in a single totipotent cell that is essentially identical to a fertilized egg, the necessary and sufficient conditions for the infusion of a soul are satisfied. The timing and means by which these conditions are brought about (even should they be ethically undesirable, as in the case of adultery) are, like the act of adultery, features that are accidental to the origin of the single "cell" that can receive a rational form.⁸

It should be kept in mind, however, that totipotency is but a hypothetical capacity of human embryonic cells. Because of this, the solution offered above is only needed if human embryonic cells are shown to be totipotent. There are good reasons, however, to think that they will not be shown to be so: if ensoulment occurs at fertilization, the human embryo, like us, could not be divided into two or more surviving human embryos.

A final problem remains, however, with cases in which what appears to be single human embryo divides naturally into two separate but genetically identical embryos, or monozygotic twins. I will argue that ensoulment at fertilization not only avoids the puzzles that allegedly accompany monozygotic twinning, but actually has explanatory power for this that is lacking in other theories.

VI. THE PROBLEM OF MONOZYGOTIC TWINNING

Natural monozygotic twinning, in which single zygote gives rise to genetically identical siblings, is commonly conceived as posing the same problem that totipotency does (e.g., Olson, 1997, pp. 90–91; Van Inwagen, 1990, pp. 152–154). Amongst others, Donceel makes this charge: immediately following his statement (quoted above) regarding the totipotency of human and animal embryos, he writes:

As a matter of fact, nature frequently performs it on man. Identical twins . . . start life as one ovum fecundated by one spermatozoon. For the proponents of immediate hominization, this fecundated ovum is one human person. Very early in the pregnancy this ovum splits into two (or more) parts, each one of which develops into an adult. This fact is difficult to reconcile with immediate hominization. A human person does not split into two or more persons . . . the philosophical definition of individual, which explains it as 'undivided in itself' is not yet realized, at least not as strictly as the individuality of the human person demands (p. 98).

What is frequently overlooked, however, is that induced twinning (which would occur with totipotency) is not necessarily the same as the natural twinning which gives rise to genetically identical twins. The differences between natural twinning and artificially induced twinning are essential, for whereas totipotency might render a theory of ensoulment at fertilization implausible or in need of some modifications, natural twinning does not. One difference is that one could make the charge that totipotency entails the early embryo consisting of several human beings which are, in the normal course of development, subsumed into one human being. The understandable response on the part of the soul theorists who have mistaken totipotency as empirically given is to posit *our* origins at some point after the possibility of division. What is typically argued, then, is that since natural monozygotic twins (triplets, etc.) also result from the division of the developing single fertilized egg, it would be problematic to claim that these pre-twinning entities were human beings since they have to cease to be such if twinning didn't occur and the cells were integrated into one human being that became a fetus. Monozygotic twinning, however, does not entail that *any* early cell can be removed and develop as though it were a fertilized egg; rather, what we have evidence of is that, on occasion, a single fertilized egg divides naturally into two or more beings. There are no totipotency-like problems here, for the multicellular embryo is not *necessarily* actually or even potentially several human beings. On the contrary, the biological evidence that we have offers cases in which only some *apparently* single embryos divide into two or more new embryos that are monozygotic twins.

What I offer as a solution to monozygotic twinning is that when two genetically identical embryos develop from what appears to be a single fertilized egg, this is not a case of a single human being dividing into two, but of two human beings separating. These two human beings are each composites of a soul and body (matter) and each came into existence at fertilization when two souls were infused into the unicellular body. Upon infusion, the souls of each of these human beings are colocated, sharing the same matter.⁹ Each of these twins, though, is a composite of matter and form, and so each is a human being (this maintains that each human being is essentially an individual soul united to a material body). As the matter is configured by each form, the two human beings usually separate (but in some cases fail to and are “conjoined”). And so on this account, monozygotic multiples were both (or all) present at fertilization, and, in typical cases separate during the first two weeks or so after fertilization. Since it is only in some cases (for whatever reasons) that two or more human souls are infused by God into the unicellular human egg, my account is supported by the embryological data available: when a zygote or embryo is artificially divided, it is most probable that this is a single human being. Because most ensoulments bring into existence a single human being, attempts to induce twinning are most often attempts to divide an ensouled individual.

Although my co-location solution to monozygotic twinning is not advanced by Aquinas, it is arguably permitted by his argument for the transcendent nature of the human form. On Aquinas’ account, the human form has an existential independence from matter in virtue of its transcendent nature and so is not reducible to the arrangement or organization of matter. In fact, Aquinas argues that although the human form begins to exist in its natural state of configuring matter, it will exist when separated from matter at death, albeit in a deprived state. (ST I q. 76; q. 90 a. 4).¹⁰ Because of this existential independence, it seems that the human form could maintain its distinction as an individual, even if co-located, in virtue of what will individuate it when separated from the body: what would allow for this distinction as an individual after death would also allow for the distinction as a co-located individual. (The individuality of the soul, however, does not render it a Cartesian soul. Aquinas argues that even though the soul can exist apart from the body, the soul is not identical to the human being (or the person), but is a very important *part* of the human being).

Perhaps the most problematic objection is that Aquinas makes repeated references to “material dimensions” as the principle of individuation for material beings (*On Being and Essence* [BE] II 4; QDA q. 20). The human form is special, however, since it is on the “boundary between corporeal and separate substances” (QDA q. 1). We are “metaphysical amphibians”: like the pure intelligences that exist without matter, the soul of the human being can (and will) exist apart from the body.¹² In virtue of the special

features of the human form, arguments have been advanced which interpret Aquinas as attributing some kind of individuation to the human form. In fact, among others, this is Joseph Owens' understanding of the Aquinas' writings on the human soul:

Where a substantial form exists in itself, as in the case of pure spirits, it is an individual of itself. This doctrine allows form to be something that is individualized by itself in the case of angels. . . But the same criterion holds in the case of the human soul, despite the differences in the two types of spirit. . . Even without the body the soul continues to be an individual. The individuality stays with the form, and in that way it can be said to come from the form (1994, p. 178).¹²

And in his Commentary on *De Trinitate* of Boethius, Aquinas explicitly states that "one can at least mentally conceive of two bodies being in the same place" (q. 4 a. 3). In the context of the twinning discussion above, each twin, a unity of form and matter, is colocated—"in the same place"—at least for a short while until the forms configure the matter to separate. So, although a discussion of Aquinas' concept of individuation is beyond the scope of this article, the twinning solution offered above is supported by the special features of the human soul, as well as by other metaphysical principles that Aquinas puts forth.

A further strength of a hylomorphic solution to twinning is that it can accommodate the anomalous cases of monozygotic twinning in which the twins fail to separate and so are "conjoined twins." In most cases, each conjoined twin is an individual organism; even though they share body parts to some extent, the point at which they are joined is not one that would make it so they share a single organism. And so on a Biological Account of human beings, which identifies the human being as an organism, conjoined twins seldom pose a problem; a Biological Account can usually accommodate our intuitions that despite having single material dimensions (i.e., a unified boundary) there are nonetheless two human beings (see, for example, Van Inwagen, 1990, p. 152–154; see also Smith and Brogaard (2003) for whom conjoined twins pose a puzzle). What is problematic, though, is the case of the dicephalus, an extreme version of conjoined twins that share all of their organs beneath the cerebrum (upper brain) (see McMahan, 2002, pp. 35–39). On any plausible account of biological individuation, this is one organism. But the two cerebrums make possible two distinct streams of consciousness which lead us to say that there are two persons (or human beings). Since this is a case of two persons where there appears to be just one organism, it makes it much more plausible to believe that two persons (or two human beings) can share the material dimensions of a pre-embryo, or even the unicellular zygote which is, by any biologist's definition, an organism. This renders plausible a soul theorist's claim that both twin human persons, and thus

both souls, are present from fertilization in the same cell(s) prior to the fission which takes place with monozygotic twinning.

VII. THE EXPLANATORY VIRTUE OF A HYLOMORPHIC EMBRYOLOGY

I have argued that many of the puzzles that arise with totipotency disappear when the embryological data on human embryos is presented without extrapolations from animal studies. When the “raw” data on the human embryo are analyzed under a hylomorphic metaphysics, the differences between animals and human beings (and their respective embryos) can be explained without an ad hoc stretch of resources. (And even should human embryonic cells be demonstrated as totipotent, the metaphysical principles of a hylomorphic account might avoid being compromised). Monozygotic twinning can also be explained on a hylomorphic account of our origins: the souls of twins (triplets, etc.) are spatially coincident at fertilization, each united to matter. There are two human beings (each a form united to matter) that appear as a single zygote and embryo, and the souls of these two human beings configure the matter to separate into monozygotic twins. In some instances, separation fails and the twins are conjoined. While a Biological Account cannot obviously accommodate the case of the extreme dicephalus, a hylomorphic metaphysics can appeal to the same metaphysical principles that allow colocated souls at fertilization: although there appears to be a single organism, there are actually two human beings.

There is one last point that is to be made in favor of a hylomorphic ensoulment at fertilization. This is that the configuring activity of the soul can provide metaphysical explanation for the regular growth and development of the embryo from fertilization onwards. On a hylomorphic metaphysics, the soul “configures” matter, so that the special powers of the soul can be accomplished. In the case of the human being, the special powers of the soul are the rational powers of will and intellect, both of which, Aquinas claims, are found without a corporeal organ. These special features not only render the soul transcendent—and so provide a solution to twinning and totipotency without a stretch of resources—but the configuring power of the soul can account for the regular development from fertilization to the more developed human being that manifests these powers. An account of this regular growth and development is lacking in theories that deny that the pre-16 day embryo is a human being (e.g., Smith and Brogaard, 2003; Olson 1997). In these accounts, there is little to no explanation for the regular development of the unicellular zygote into the multi-cellular organism that is, on these accounts, a human being. This is usually in part because the very early pre-16 day embryo is not an organism, by standard biological definitions, and so it is argued, not a human being. But twinning and totipotency are also considered

strong grounds for denying our existence during this time frame. The solutions offered to twinning and totipotency render it more plausible than is usually acknowledged that we could exist from fertilization onwards. And the explanatory power that a hylomorphic account has for the regular growth and development, even in cases of monozygotic twinning, renders *ensoulment* at fertilization more plausible than is *prima facie* evident. (Delayed ensoulment accounts, such as Ford's, that do account for a teleology with the "succession of souls" theory cite twinning and totipotency as grounds for delaying a *rational* ensoulment. If these puzzles are solved with a hylomorphic analysis of re-interpreted biological data, advocates of delayed ensoulment accounts would, I think, admit to the infusion of a rational soul at fertilization).

VIII. CONCLUSION

I have argued that an interpretation of the biological data on the human embryo under a hylomorphic metaphysics not only renders ensoulment at fertilization more plausible than is typically acknowledged in the literature, but can also offer explanatory power for the twinning capacities and regular growth during the first 16 days after fertilization. Additionally, although the data on the totipotency of human cells are not conclusive, it should be reassessed apart from extrapolations from animal studies. The hylomorphic account offered here may provide some metaphysical basis for considering the totipotency of human embryonic cells to be not simply undemonstrated, but not even a capacity of these cells.

NOTES

1. I would like to thank David Hershenov for very helpful comments on earlier drafts. I would also like to thank Todd Bindig and Dick Hull for suggestions.

2. In this paper I use "embryo" to refer to the stage from the first mitotic division of the fertilized egg to eight weeks post-fertilization. This includes what is typically labeled the "preembryo", which is from fertilization to approximately two weeks after when the embryo can no longer twin.

3. For an application of the metaphysics of ensoulment to the ethics of abortion see Hershenov & Koch (2005).

4. The claim that human cells are totipotent in the primary sense is not biological "fact." As John Gearhart states, "Assuming that the currently available human ES (embryonic stem) cells (or those derived in the future) are similar to their mouse counterparts (an assumption by no means certain), it is likely that they will eventually be used in cell and tissue replacement therapy. Mouse ES cells are pluripotent—that is, they can differentiate into *many* cell types—but whether they are totipotent (capable of developing into all cell types) is unknown. The same is true for human ES cell differentiation." (Solter & Gearhart, 2000).

5. Even should it be admitted that we, like amoebas, can divide, as with any entity that fissions, it is difficult to discern, either prior to or post-division, which of the post-fission entities (in this case, the daughter cells of a totipotent cell which divided) is the original human being. In fact, a judgment of whether the original unicellular being (A) is either of the descendants (B or C) is arbitrary (Wiggins, 1980).

6. See Haldane & Lee (2002) for a discussion of potentiality, embryology, and Aquinas' metaphysics.

7. This same analysis can be used for somatic cell cloning: the placement of a full genetic code into a denucleated egg followed by the administration of an electric shock produces, I would argue, what is essentially a fertilized egg. And this would call for the infusion of a rational soul.

8. A second way to reconcile totipotency with ensoulment is to argue that God's foreknowledge allows him to infuse multiple souls into an embryo that will be force twinned. In order to preserve a traditional account of free will, this use of God's foreknowledge could appeal to a compatibilist account of free will (see Baker, 2003).

9. For arguments against the Lockean claim that colocated entities cannot be of the same kind see David Hershenov (2003), Christopher Hughes (1997), and Kit Fine (2000).

10. The form does not exist *prior* to its unity with matter since if this were so, the soul's "union with the body would be an accident of the soul: and consequently, the man resulting from this union will not be *per se* but an accidental being" (SCG II 58).

11. The term "metaphysical amphibians" is from Eleanor Stump (1995).

12. See also Etienne Gilson (1956). The argument that is made by Gilson (and, in part, by Owens) is that the individuation of a being is ultimately due to its act of existence, as opposed to its material dimensions. Gilson writes:

It becomes true to say, then, that every subject has individuation in the same way it has existence. This is why the individuation survives the death of the body just as surely as the soul itself does. When the body dies, it is because the soul ceases to make it exist. But why should the soul cease to exist because of this fact? It does not receive its being from the body but only from God. And if it keeps its being, how could it lose its individuation? "The act-of-being and of individuation always belong together". . . No doubt, St. Thomas adds, in a significant remark, the individuation of the soul has some relation to its body, but the immortality of the soul is the immortality of its *esse*. The survival of its *esse* involves as a consequence that of its individuation (p. 190 fn 10).

REFERENCES

- Alikani, M., Noyes, N., Cohen, J., & Rosenwaks Z. (1994). 'Monozygotic twinning in the human is associated with the zona pellucida architecture,' *Human Reproduction*, 9, 1318–1321.
- Aquinas, St. Thomas. (1923). *Quaestiones disputatae de potentia dei*. Trans. English Dominican Fathers. London: Burns, Oates and Washburn.
- Aquinas, St. Thomas. (1923). *The Summa Contra Gentiles of St. Thomas Aquinas, Book II* Trans. English Dominican Fathers. London: Burns, Oates and Washburn.
- Aquinas, St. Thomas. (1948). *Summa Theologiae I*. Trans. English Dominican Fathers. New York: Benzinger Brothers.
- Aquinas, St. Thomas. (1968). *On Being and Essence*. Trans. A. Maurer. Toronto: Toronto Pontifical Institute.
- Aquinas, St. Thomas. (1984). *Quaestiones de anima*. Trans. J. H. Robb. Milwaukee: Marquette University Press.
- Aquinas, St. Thomas. (1986). *Faith, Reason, and Theology*, Questions I–IV of the Commentary on Boethius' *De Trinitate*. Trans. A. Maurer. Toronto: Pontifical Institute of Mediaeval Studies.
- Ashley, B. (1992). 'Delayed hominization Catholic theological perspective,' in *The Interaction of Catholic Bioethics and Secular Society*. Proceedings of the Eleventh Bishops Workshop, Dallas, Texas; Russell E. Smith (Ed.). Braintree, MA: The Pope John Center.
- Ashley, B. M. & Moraczewski, A. S. (1994). 'Is the biological subject of human rights present from conception?' in P. J. Cataldo & A. S. Moraczewski (Eds.),

- The Fetal Tissue Issue: Medical and Ethical Aspects*. Braintree, MA: Pope John Center.
- Baker, L. (2000). *Persons and Bodies: A Constitution Approach*. Cambridge: Cambridge University Press..
- Baker, L. (2003). 'Why Christians should not be libertarians: An Augustinian challenge.' *Faith and Philosophy*, 20, 460.
- Blickstien, I., Verhoeven, H., & Keith, L. (1999). 'Zygotic splitting after assisted reproduction,' *New England Journal of Medicine*, 340, 738–739.
- Chan A. W. S., Dominko, T., Luetjens, C. M., Neuber, E. Martinovich, C., Hewitson, L., Simerly, C. R., & Schatten, G. P. (2000). 'Clonal propagation of primate offspring by embryo splitting,' *Science*, 287, 317–319.
- Da Costa, A. L. E., Abdelmassih, S., de Oliveira, F. G., Abdelmassih, V., Abdelmassih, R., Nagy, Z. P., & Balmaceda, J. P. (2001). 'Monozygotic twins and transfer at blastocyst stage after ICSI,' *Human Reproduction*, 16, 333–336.
- Derom, C., Derom, R., Vleitnick, R., Van den Berghe, H., & Thiery, M. (1987). 'Increased monozygotic twinning rate after ovulation induction,' *Lancet*, i, 1236–1238.
- Donceel, J. (1970). 'Immediate animation and delayed hominization,' *Theological Studies*, 31(1), 76–105.
- Edwards, R. G., Mettler, L. & Walters, D. E. (1986). 'Identical twins and in vitro fertilization,' *Journal of In Vitro Fertilization. Embryo Transfer*, 3, 14–17.
- Fine, K. (2000). 'A counterexample to Locke's thesis,' *Monist*, 83, 357–361.
- Ford, N. (1988). *When Did I Begin? Conception of the Human Individual in History, Philosophy and Science*. New York: Cambridge University Press.
- Gilson, E. (1956). *The Christian Philosophy of Saint Thomas Aquinas*. New York: Random House.
- Grobstein, C. (1988). *Science and the Unborn: Choosing Human Futures*. New York: Basic Books.
- Hall, J. L., Engel, D., Motta, G. L., Gindoff, P. R., & Stillman, R. J. (1993). 'Experimental cloning of human polyploid embryos using an artificial zona pellucida,' *The American Fertility Society conjointly with the Canadian Fertility Society and Andrology Society, Program Supplement. Abstracts of the Scientific Oral and Poster Sessions*, Abstract 0-001, S1.
- Haldane, J. & Lee, P. (2003). 'Aquinas on ensoulment and abortion and the value of life,' *Philosophy*, 78(304), 255–278.
- Hershenov, D. (2003). 'Can there be spatially coincident entities of the same kind?' *Canadian Journal of Philosophy*, 31, 1–23.
- Hershenov, D. & Koch, R. (2005). 'How a hylomorphic metaphysics constrains the abortion debate,' *National Catholic Bioethics Quarterly*, 5(4), 751–764.
- Hughes, C. (1997). 'Same-kind coincidence and the ship of Theseus,' *Mind*, 106(421), 53–67.
- Johnson, M. (1995). 'Delayed hominization: Reflections on some recent Catholic claims for delayed hominization,' *Theological Studies*, 56(4), 743–763.
- Johnson, M. (1997). 'Delayed hominization: A rejoinder to Thomas Shannon,' *Theological Studies*, 58, 708–713.
- McCormick, R. (1991). 'Who or what is the preembryo?' *Kennedy Institute of Ethics Journal*, 1(1), 1–15.

- McMahan, J. (2002). *The Ethics of Killing: Problems at the Margins of Life*. New York: Oxford University Press.
- National Advisory Board on Ethics in Reproduction. (1994). 'Report on human cloning through embryo splitting: An amber light,' *Kennedy Institute of Ethics Journal*, 4(2), 251–282.
- NIH Statement Before the Senate Appropriations Committee. (2000). [On-line]. Available: <http://www.nih.gov/news/stemcell/State.htm>. Accessed March, 2004.
- Olson, E. (1997). *The Human Animal Without Psychology*. Oxford: Oxford University Press.
- Owens, J. (1994). 'Thomas Aquinas,' in J. J. E. Gracia (Ed.), *Individuation in Scholasticism: The Later Middle Ages and the Counter-Reformation, 1150–1650* (pp. 173–194). Albany, NY: SUNY Press.
- Robinson, H. P. & Caines, J. S. (1977). 'Sonar evidence of early twin pregnancy failure in patients with twin conceptions,' *British Journal of Obstetrics and Gynecology*, 84, 22–25.
- Schacter, M., Raziel, A., Friedler, S., Strassburger, D., Bern, O., & Ron-El, R. (2001). 'Monozygotic twinning after assisted reproductive techniques: A phenomenon independent of micromanipulation,' *Human Reproduction*, 16, 1264–1269.
- Schieve, L., Meikle, S. F., Peterson, H. B., Jeng, G., Burnett, N. M., & Wilcox, L. S. (2000). 'Does assisted hatching pose a risk for monozygotic twinning in pregnancies conceived through in vitro fertilization?' *Fertility and Sterility*, 74, 288–294.
- Shannon, T. (1996). 'Delayed hominization: A response to Mark Johnson,' *Theological Studies*, 57, 731–734.
- Shannon, T. (1997). 'A further postscript to Mark Johnson,' *Theological Studies*, 58, 715.
- Sills, S., Moomjy, M., Zaninovic, N., Veeck, L. L., McGee, M., Palermo, G. D., & Rosenwaks, Z. (2000). 'Human zona pellucida micromanipulation and monozygotic twinning frequency after IVF,' *Human Reproduction*, 15, 890–895.
- Singer, P., Kuhse, H., Buckel, S., Dawson K., & Kasimba, P. (Eds.). (1990). *Embryo Experimentation*. Cambridge: Cambridge University Press.
- Smith, B. & Brogaard, B. (2003). '16 days,' *Journal of Medicine and Philosophy*, 28, 45–78.
- Solter, D. & Gearhart, J. (2000). 'Biomedicine: Enhanced: Putting stem cells to work,' *Science*, 283, 1468–1470.
- Stump, E. (1995). 'Non-Cartesian substance dualism and materialism without reductionism,' *Faith and Philosophy*, 12, 505–537.
- Swinburne, R. (1984). *Personal Identity*. Oxford, England: B. Blackwell.
- Tarlatzis, B. C., Qublan, H. S., & Sanopoulou, T. (2002). 'Increase in the monozygotic twinning rate after intracytoplasmic sperm injection and blastocyst stage embryo transfer,' *Fertility and Sterility*, 77(1), 196–198.
- Unger, P. (1992). *Identity, Consciousness and Value*. New York: Oxford University Press.
- Van Inwagen, P. (1990). *Material Beings*. Ithaca: Cornell University Press.
- Wiggins, D. (1980). *Sameness and Substance*. Cambridge: Harvard University Press.