I am not the zygote I came from

because a different singleton could have come from it

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Abstract

Many people believe that human beings begin to exist with the emergence of the 1-cell zygote at fertilization. I present a novel argument against this belief, one based on recently discovered facts about human embryo development.

I first argue that a human zygote is *developmentally plastic*: A zygote that naturally develops into a singleton (i.e., develops into exactly one infant/adult without twinning) might have naturally developed into a numerically different singleton. From this, I derive the conclusion that a human infant or adult is numerically distinct from the zygote she came from and so did not begin to exist at fertilization. This implies that a zygote does not have a "future like ours" and strongly suggests that it is not a human being.

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1 Introduction

When do we human beings begin to exist?[1] A common answer is that we, members of *Homo sapiens*, begin to exist with the emergence of the 1-cell zygote at fertilization. I present a novel argument against this belief and conclude that a zygote has no "future like ours" and is probably not a human being.

I first argue that a human zygote is *developmentally plastic*: A zygote that naturally develops into a singleton, i.e., naturally develops into exactly one infant/child/adult without twinning, could have naturally developed into a numerically distinct singleton.[2] I argue for this claim by utilizing facts concerning human embryo development. The cells of an early human embryo differentiate into two distinct types, namely, the *inner cell mass*, from which the cells of the infant at birth originate, and the *trophoblast*, which produces no tissues of the infant but only part of the placenta. I argue that if you are a singleton, the cells which actually yielded the trophoblast of the embryo you came from could have formed the inner cell mass and naturally developed into a singleton numerically distinct from you (Section 3).

The developmental plasticity of human zygotes has many interesting consequences of moral and metaphysical import. One of them is that we did not begin our life as a zygote, i.e., we are numerically distinct from the zygotes we came from. This then implies that a zygote has no "future like ours" and strongly suggests that it is not a human being (Section 4).

The arguments are formulated employing standard Kripke-style modal semantics and the

[1] *Human beings* are biological organisms, members of the genus *Homo* or the species *Homo sapiens*. They are often distinguished from *persons*, who are thinking intelligent beings that can be held accountable for their actions. The paper is about human beings, not about persons. I use, for convenience, personal pronouns like 'I,' 'you,' 'she,', or 'we' to refer to human beings, but no part of the paper depends on the assumption that we are biological organisms.

[2] More precisely, a zygote develops into a *singleton* if it develops into exactly one infant/child/adult without fusing with other cells and without twinning or twinning-like events such as separation or destruction of some (significant) part. So one is only an apparent, but not a genuine, singleton if an embryo e splits into two, e_1 and e_2, each of which has a potential to develop into an infant, and e_1 develops into her while e_2 gets destroyed right after the split. It can be easily shown that a zygote that develops into an apparent singleton could have developed into a numerically different apparent singleton: If e_2 had developed into an infant with e_1 destroyed, then that infant would have been numerically distinct from the infant coming from e_1. Unlike this, *Developmental Plasticity* is about genuine singletons. And unlike *Developmental Plasticity*, that a zygote which develops into an apparent singleton could have developed into a numerically different apparent singleton does not show that a zygote is numerically distinct from the genuine singleton it develops into.

endurantist theory of persistence on which an object is wholly present at every moment of its existence. Whether they can be reformulated persuasively in modal counterpart theory and the four-dimensionalist theories of persistence is an interesting topic, but it requires in-depth discussions of several issues and so is left for a separate discussion.[3]

The claim and argument that human zygotes are developmentally plastic are, I believe, novel. And my argument against the view that human life begins at fertilization is more compelling than some previous arguments against it. To illustrate this and explain the distinctive features of the arguments, I start by discussing the so-called *arguments from twinning* advocated by many philosophers and scientists.

2 Arguments from twinning and branching

Let a *zygote* be a 1-cell embryo that is formed as a result of the fusion of a human ovum and sperm—an embryo that has two or more cells in it or is formed as a result of cloning, division, or partial destruction (even if it has only one cell in it) will not be called a zygote. *Conceptionism* is the view that human beings begin to exist with the formation of the zygote at fertilization.[4] It implies that every zygote is a human being, a member of the species *Homo sapiens* (cf. *Declaration on Procured Abortion*, Sections 12–13). It also implies that a zygote is not something that goes out of existence and gets replaced by another human being as it develops into a fetus, infant, and adult. Instead, "[t]he adult human being that is now you or me is the same human being who, at an earlier stage of his or her life, was an adolescent, and before that a child, an infant, a fetus, and an embryo" (George and Gómez-Lobo 2005, 202). Thus conceptionism consists of the following two theses (besides the one that human life does not begin before fertilization):

[3] I believe that the argument for the claim that human zygotes are developmentally plastic goes through in modal counterpart theory and the four-dimensionalist theories of persistence as well (cf. fn. 15). Yet, counterpart theory and the four-dimensionalist theories have machineries to block the argument for the claim that a zygote is numerically distinct from the singleton coming from it (cf. fn. 20). I believe that it is still better for counterpart theorists and four-dimensionalists to accept the argument, for employing such machineries yields undesirable consequences.

[4] Some use 'conceptionism' more broadly to include the view that human life begins not at fertilization but at some later (but still fairly early) developmental stage (cf. Burgess 2010, 62).

A-zygote-is-a-human: Every (normal) zygote is a human being.[5]

A-human-was-once-a-zygote: Every infant, child, adolescent, or adult is numerically identical with the zygote she came from.[6]

Then there is a simple argument against *A-human-was-once-a-zygote*. Consider identical twins, *Betty* and *Chloe*, who came from the same zygote z. Since Betty and Chloe are numerically distinct from each other, they cannot both be identical with z. Thus at least one of them is numerically distinct from z, and so *A-human-was-once-a-zygote* is false.

And the argument can be expanded. Suppose that there are no significant differences between the way Betty came from z and the way Chloe did. Then it is unmotivated to insist that only one of them is identical with z. So, z is identical with none of the twins it develops into. From this, many draw the conclusion that z is not a human being. Some go on further to argue that because of the *possibility* of twinning, even a zygote that develops into a singleton is numerically distinct from the singleton and so is not a human being. For example, Lynn Rudder Baker argues: "[T]he view that a human organism comes into existence at ... fertilization is logically untenable ... because a fertilized egg may split and produce twins. If it is physically possible for a fertilized egg to produce twins (whether it actually does so or not), a fertilized egg cannot be *identical* to an organism" (2007, 72–73). These are the *arguments from twinning* against conceptionism. They are influential arguments advocated by many renowned scholars.[7]

These arguments, however, leave much room for objections, one of which is as follows. Even if a zygote that develops into twins is numerically distinct from one or any of the twins, how can the mere possibility of twinning show that a zygote that actually develops into a singleton is

[5] Conceptionists might deny that a seriously defective zygote that cannot develop into an infant is a human being. And the claim that a zygote is a human being can be understood to mean that a zygote is numerically identical with a human being or that a zygote *constitutes* a human being (see Oderberg 1997, 265–66). My arguments are designed to refute the former claim but can be modified to refute the latter, too.

[6] These two claims are logically independent. Even if every zygote is a human being, the zygote you came from might be not you but a different human being. And 'human being' might be a phase sortal like 'infant' and 'adult', which applies only to an individual during a certain stage of development, so that a zygote is not a human being (in the same way that it is not an adult) though it is numerically identical with the infant/child/adult it develops into.

[7] Some notable proponents of the arguments are Anscombe (1985), Baker (2007, 72–73), Burgess (2010), Geach (1977, 30), Kuhse and Singer (1990, 67), and Smith and Brogaard (2003, 66–69).

numerically distinct from the singleton? Indeed, this is a question of a general character: Given a seemingly continuous series of stages existing at different times such as the series of stages from a zygote to the singleton it develops into, how can the mere possibility of branching such as twinning, division, and duplication show that the series belongs not to one object persisting through time but to two or more objects one of which is replaced by the other(s)?

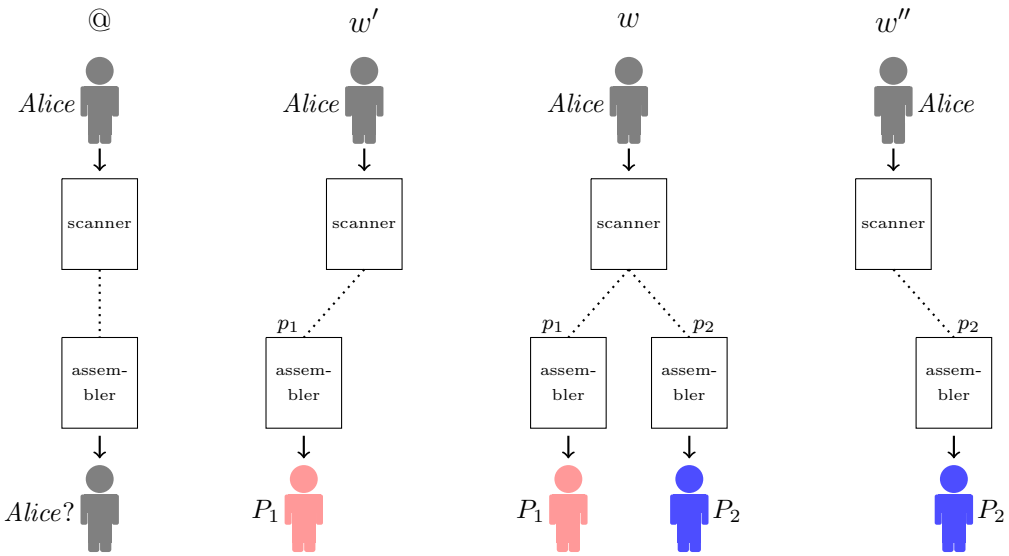

Fig. 1 Branching Argument Regarding Teleportation

A hypothetical instance where the possibility of branching reasonably shows that a seemingly continuous series of stages belongs to two or more objects is teleportation, as follows. Suppose that in the actual world, a person, *Alice*, enters a teleportation scanner, which records the exact states of all the cells of her body and then destroys the body while transmitting the information wirelessly.[8] The information is received at a distant place by a molecular assembler, which creates a new body qualitatively identical with the scanned one out of new matter using the information. Is the person who has the newly created body (numerically identical with) Alice? To answer the question, consider a possible world, w, where the information sent by the scanner is received by two qualitatively identical assemblers at different places. That is, one assembler receives the information at a place p_1 and creates out of matter m_1 a body, which is qualitatively identical with the scanned one and belongs to a person P_1, while another assembler receives the

[8] See fn. 1.

information at a different place p_2 and creates out of different matter m_2 a body, which is qualitatively identical with the scanned one and belongs to a person P_2, who is numerically distinct from P_1 (Fig. 1). Note that these two assembling processes at p_1 and p_2 (and the assembling process in the actual world) are of the same type and differ only in that different hunks of matter are used to create bodies at different places (and times). And the assembling process at either of p_1 and p_2 does not causally affect that at the other. It is then reasonable to believe that the two assembling processes are *ontologically independent* of each other in the sense that either could have proceeded without the other, producing the same body belonging to the same person. That is, there are a possible world w', which is the same as w except that only the assembler at p_1 creates the body belonging to P_1 out of m_1 while the assembler at p_2 does nothing and another possible world w'', which is the same as w except that only the assembler at p_2 creates the body belonging to P_2 out of m_2 while the assembler at p_1 does nothing. Note that there may or may not be an absolute temporal order between the two assembling processes: One may occur absolutely later than the other, or the two processes may be so-called spacelike separated so that neither is absolutely earlier or later than the other. So, if the identity of the person possessing the body at p_1 depends on whether or not the assembling process at p_2 happens, that means that the identity of the person possessing the body at p_1 is affected by an event occurring later, or neither absolutely earlier nor absolutely later, than the creation of the body at p_1. This seems implausible. It is thus reasonable that such possible worlds w' and w'' exist (i.e., the descriptions regarding w' and w'' might have been true).

Thus, numerically distinct persons could result when Alice enters the scanner and exactly one body is created by some assembler using the information sent by the scanner: It is possible that only the assembler at p_1 receives the information and creates a body belonging to P_1, and it is also possible that only the assembler at p_2 receives the information and creates a body belonging to P_2, numerically distinct from P_1. Now, *Interworld Symmetry* holds for w' and w'': Since there is no difference between these two worlds except that numerically distinct, though qualitatively identical, assemblers use numerically distinct and qualitatively identical hunks of matter at different places (and times), Alice is identical with P_1 in w' if and only if she is identical

with P_2 in w''. And Alice cannot be identical with both P_1 and P_2. Therefore, she is identical with neither. *Interworld Symmetry* between the actual world and w' (or w'') also implies that the person who has the new body created by the assembler in the actual world is not Alice.[9]

Some other cases are different. Suppose that in the actual world, there is a fully grown cell ready to start cell division at any time, but it does not divide during the time interval from t_1 to t_2. In this case, we ordinarily think that the continuous series of the stages from t_1 to t_2 belongs to one cell, i.e., the cell existing at t_1 (call it C_1) is numerically identical with the cell existing at t_2 (call it C_2). Consider then a possible world, w, which is the same as the actual world except that at some time between t_1 and t_2, the cell divides into two cells, *the left cell* and *the right cell*. Unlike the teleportation case, this possibility of cell division does not show that C_1 is numerically distinct from C_2 in the actual world. For the continuous series of the stages from C_1 to the left (or right) cell in w is significantly different from the series from C_1 to C_2 in the actual world: Unlike C_2 in the actual world, the left cell in w consists of only half of the matter in C_1, and many internal events like duplications and separations of chromosomes and cell organelles that happen in w do not happen in the actual world. That is, *Interworld Symmetry* fails to hold for the actual world and a possible world w' where somehow only the left cell forms while the right cell fails to form (and another possible world w'' where only the right cell forms while the left cell fails to form). Even if C_1 is numerically distinct from the left cell in w', therefore, it provides no good reason to believe that C_1 is numerically distinct from C_2 in the actual world. Instead, it not only is logically consistent but also seems reasonable to conclude that C_1 is identical with C_2 in the actual world whereas the event of cell division destroys the cell that splits and creates two new ones in w.[10]

[9] If the goal is to show this conclusion only, then there is a simpler argument. But the above arguments are presented as parallels of the arguments for *Developmental Plasticity* and *Zygote-Infant Distinctness* in Sections 3 and 4.

[10] The following Ship-of-Theseus-style case can be understood as one in which two processes in question are not ontologically independent. Suppose that in a possible world w, a ship S existing at time t_1 is continuously connected to a ship R by the process of gradual replacement of its parts (so that R has no material parts in common with S), while the original parts removed from S are reassembled into a ship A. And in a possible world w', only the replacement process happens, and S is continuously connected to a ship R' by replacement. And in a possible world w'', only reassembly happens, and the original parts are removed from S without any replacement and then reassembled into a ship A''. Note that unlike the teleportation case, the replacement and reassembly processes are of different types. So, Nathan Salmon (2005, 225–227) claims that the matter

And twinning is more like cell division than teleportation. Suppose that in the actual world, an embryo e with two cells b and c in it naturally develops without twinning into a singleton infant, *Lea*, so that half of her cells at birth come from b and the other half from c. Consider then a possible world, w, which is the same as the actual world except that b and c get separated, and b develops into an infant, *Betty*, and c into another infant, *Chloe*. Then the series of the stages from e to one of the twins is significantly different from the series from e to the singleton infant Lea in the actual world: Betty's cells come only from b (and Chloe's cells only from c) in w whereas Lea's cells come from both b and c in the actual world. So, *Interworld Symmetry* fails to hold for the actual world and a possible world w' where somehow only Betty develops from b while Chloe fails develop from c (and another possible world w'' where only Chloe develops from c while Betty fails develop from b). So the possibility of twinning does not show that Lea is numerically distinct from e in the actual world. Rather, one can reasonably claim that e is identical with Lea in the actual world while it is identical with neither Betty nor Chloe when b and c develop into the twins or only b (or c) develops into Betty (or Chloe). Furthermore, conceptionists can defend *A-zygote-is-a-human* by holding that even when twinning happens as in w, e is a human being numerically identical with Lea. Thus, all that conceptionists need to concede is that twins (or multiples) do not begin to exist at fertilization (but right after the division of an embryo) though singletons do—this just means that twinning destroys the splitting embryo and creates two new ones. This is a very minor revision, which conceptionists, I believe, would not refuse to make. If this is all that the arguments from twinning show, they achieve little.

My arguments are different. I first argue in Section 3 that human zygotes are *developmentally plastic*: A zygote which develops into a singleton, *Lea*, in the actual world develops into a

constituting R has a *dominant* claim to constitute the same ship as S when it is continuously connected to the original matter of S by the replacement process while the matter constituting A has a *recessive* claim to constitute the same ship as S by the reassembly process. This means that the reassembly process is not ontologically independent of the replacement process: In w'' where only the reassembly process occurs, the ship A'' resulting from it is identical with S, whereas in w where both the replacement and reassembly processes happen, the ship A resulting from the reassembly process is numerically distinct from S. If this is right, the possibility of branching as in w does not show that only when the replacement process occurs, the ship resulting from the replacement process is numerically distinct from S: One can insist that $S = R = R' = A'' \neq A$.

numerically different singleton, *Mae*, in some possible world. Like the teleportation case, this argument appeals to the ontological independence of two processes in question: The development of z into Lea and that into Mae are two ontologically independent processes one of which can proceed without the other. This then leads to the conclusion in Section 4 that a zygote, whether it twins or not, is numerically distinct from any infant/child/adult it develops into: *Interworld Symmetry* holds for the actual world where z develops into Lea and a possible world where z develops into Mae, and so z is identical with Lea if and only if it is identical with Mae. But z cannot be identical with both Lea and Mae, and so it is numerically distinct from Lea.

3 Developmental plasticity

An embryo is formed as a result of the fusion of an ovum and a sperm. Henceforth, 'embryo' and other biological terms refer to *human* embryos and entities unless otherwise specified. And a zygote is a 1-cell embryo. After the chromosomes of the ovum and sperm come together, the embryo starts a series of cleavages without growth. After the first cleavage, the embryo has two cells, or *blastomeres*, in it, and after the second round of cleavages, four. When the embryo consists of eight blastomeres, a process called *compaction* occurs: The blastomeres huddle together, maximizing their contact with one another, and one or two of them are pushed to the inside. After the fourth round of cleavages, a few of the sixteen blastomeres are positioned inside and surrounded by neighboring blastomeres. And before the 64-cell stage is reached, the outer membrane of the embryo, or the *zona pellucida*, gets degraded, fluid is pumped in, and a cavity begins to form. Then two types of cells become quite clearly distinguished: the *inner cell mass* coming from the inner blastomeres of the 16-cell embryo and the *trophoblast* (or *trophectoderm*) which is the outer layer coming from the outer blastomeres. And when an infant is born, her cells come from the inner cell mass while the trophoblast produces no tissues of the infant but only part of the placenta—the umbilical cord is not a part of the placenta and comes from the inner cell mass (Fig. 2, cf. Dawson 1990).

Regarding this process of embryo development, two points are crucial to my argument. First,

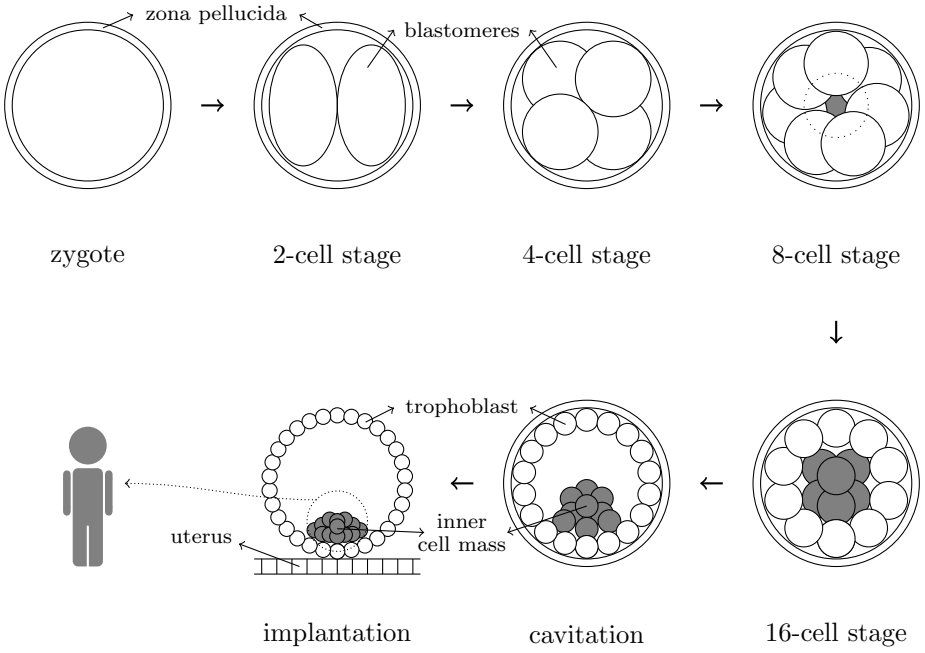

Fig. 2 Schematic Diagram of Human Embryo Development

studies estimate that a 16-cell mouse embryo contains 6–7 inner blastomeres and 9–10 outer ones on average and that a 32-cell mouse embryo has 12–13 inner and 19–20 outer blastomeres (Marikawa and Alarcón 2009). The important point is that it is usually a minority of the blastomeres in a 16-cell embryo that are positioned inside and eventually develop into an infant; the majority form the trophoblast, which yields part of the placenta. Second, though there may be differences regarding the distribution of molecules regulating cleavage divisions and cell differentiation between inner and outer ones, blastomeres of a 16-cell embryo are not differentiated but homogeneous. In recent studies, blastomeres of a 16-cell mouse embryo were separated apart and then reaggregated at random so that they switched their positions, and the reconstituted embryo was observed to develop into a normal fertile mouse; even when only outer (or inner) blastomeres from two or more 16-cell embryos were aggregated, they also developed into a normal fertile (chimeric) mouse (Suwińska et al. 2008). I assume that the same results hold for human embryos.[11] If they do, it is technically possible to artificially change the positions of

[11] A similar experiment has been conducted on human embryos, where the reaggregated outer (or inner) blastomeres from human embryos have been observed to form the inner cell mass with various markers showing the potential to develop into a normal fetus (De Paepe et al. 2013). The manipulated human embryos have not been transferred to the uterus to develop into a fetus for ethical and legal reasons.

the inner and outer blastomeres of a 16-cell human embryo so that the blastomeres originally positioned outside get repositioned inside and develop into the inner cell mass.

Furthermore, a blastomere (of a 16-cell human embryo) that is actually positioned outside could have been positioned inside *naturally*, i.e., without any artificial intervention, if the environment in which the embryo develops had been different—I argue for this later. It is thus possible for a zygote to *naturally* develop into a 16-cell embryo in which some of the actual outer blastomeres are positioned inside to yield the inner cell mass. I claim that if a zygote had developed in that way, then it could have developed into a singleton numerically distinct from the singleton it actually develops into.

My argument is as follows. Suppose that in the actual world, a zygote z is formed as a result of the fusion of an ovum o and a sperm s and naturally develops into a singleton infant, *Lea*. Let b_1, b_2, ..., and b_{16} (in short, b_1–b_{16}) be the blastomeres of the 16-cell embryo into which z develops. Suppose that b_1, b_2, ..., and b_6 (or b_1–b_6) are positioned inside and yield the inner cell mass from which (almost) all of Lea's cells at birth originate while the rest of the cells, b_7–b_{16}, yield the trophoblast which becomes part of the placenta (Fig. 3, *first diagram*). To make the argument more general, I allow the possibility of a small number of Lea's cells coming from b_7–b_{16} as long as almost all of her cells come from b_1–b_6.

Then a possible world w_1 is the same as the actual world up to the moment at which z develops into the 16-cell embryo. Then, blastomeres b_9–b_{16}, which are positioned outside, are removed from the embryo, and eight other blastomeres are put in their place (Fig. 3, *second*). Note that when the outer cells of a 16-cell embryo are replaced by other cells, the reconstituted embryo can grow into a normal infant, all of whose cells at birth come from the inner cells. So, b_1–b_6 still can develop into an infant with b_9–b_{16} replaced by other cells. Furthermore, we can make these other cells that replace b_9–b_{16} have the same genetic makeup as b_9–b_{16}. *Embryonic stem cells* are undifferentiated cells usually derived from the inner cell mass. They can be cultured to multiply in a potentially unlimited number in the undifferentiated state while retaining the potential to differentiate into any embryonic cell type. Recent studies show that human embryonic stem cells with the potential to form the trophoblast can be derived from a single blastomere of an 8–12-

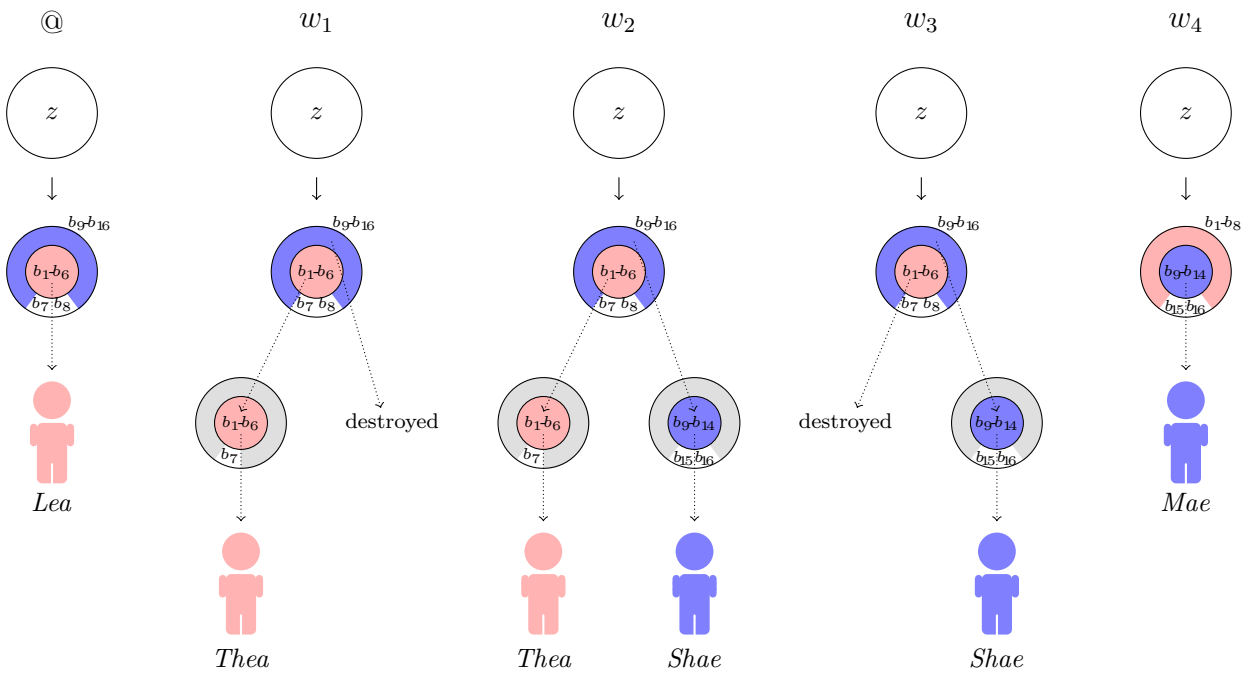

Fig. 3 Five Worlds

cell embryo (Zdravkovic et al. 2015, cf. Klimanskaya 2006). Thus, it seems physically possible, even if it has not been experimentally demonstrated yet, to artificially culture one blastomere of a 16-cell embryo to obtain many copies of it, which share the same genetic makeup. In w_1, thus, when z develops into the 16-cell embryo, we extract b_8 and artificially culture it to produce many copies (while, if necessary, the embryo without b_8 is frozen), put nine copies of b_8 in place of b_8–b_{16} to form a 16-cell embryo, and then let the reconstituted embryo develop into an infant.

In w_1, b_1–b_6 develop, in an environment identical with the actual one except for the replacement of b_8–b_{16}, into an infant, *Thea*, whose cells at birth come *only* from b_1–b_6.[12] More specifically, b_1–b_6 divide into the same cells as they do in the actual world, so do their daughter cells, and so on, forming the same organs. This is possible because blastomeres divide without growing until implantation, and so cleavage divisions of b_1–b_6 are unaffected by the replacement of the outer cells. And after implantation, the same nutrients are supplied to the descendant cells of b_1–b_6 so that they divide into the same daughter cells as they do in the actual world.

[12] 'Thea' is not a proper name but an abbreviation of a description, namely, 'an/the infant into whom b_1–b_6 might have developed, had the world been as described.' So are 'Shae' and 'Mae' introduced below (see fn. 18).

Consequently, Thea is composed of exactly the same matter, cells, and organs in exactly the same way as Lea is in the actual world in the case where Lea's cells come only from b_1–b_6 in the actual world. If a small number of Lea's cells come from b_7–b_{16} in the actual world, Thea is composed of almost the same cells and (almost) the same matter and organs in the same way as Lea is in the actual world. Meanwhile, b_9–b_{16} are destroyed some time after they are removed, and the matter constituting them is kept isolated so that it does not affect the development of b_1–b_6 into Thea.

There is then a possible world, w_2, which is the same as w_1 except that b_9–b_{16} are not destroyed but put together with eight copies of b_8 so that b_9–b_{14} are positioned inside while b_{15}, b_{16}, and the eight added blastomeres are positioned outside (Fig. 3, *third*). And b_1–b_6 develop into Thea in the exact way they do in w_1, while b_9–b_{14} develop into an infant, *Shae*, whose cells at birth come *only* from b_9–b_{14}. This is possible because the development of b_1–b_6 into Thea in w_1 is independent of what happens to b_9–b_{16} after their removal, and so b_1–b_6 can develop into Thea regardless of whether b_9–b_{16} are destroyed or put together with other blastomeres to develop into an infant (as the creation of the body belonging to P_1 is independent of that of the body belonging to P_2 in the teleportation case of Section 2). Thea and Shae are of course numerically distinct from each other. Furthermore, their bodies are composed of completely different matter, cells, and organs—they do not share any matter, cell, or organ. Consequently, Shae is composed of matter, cells, and organs (almost) completely different from those Lea is composed of in the actual world.

Then a possible world w_3 is the same as w_2 except that b_1–b_6 are destroyed some time after the separation of b_9–b_{16} and never develop into an infant (Fig. 3, *fourth*). Still, b_9–b_{14} develop into Shae in the exact way they do in w_2. This is possible because the cells of Shae at birth originate only from b_9–b_{14} in w_2, and so the destruction of b_1–b_8 does not necessarily prevent b_9–b_{14} from developing into Shae. The creation process of Thea and that of Shae are thus *ontologically independent* of each other. Thea and Shae have different origins in the sense that Thea comes only from b_1–b_6 whereas Shae comes only from b_9–b_{14}, and so either of the development of b_1–b_6 into Thea and that of b_9–b_{14} into Shae can proceed with or without the other (like the two

assembling processes at p_1 and p_2 in the teleportation case of Section 2). Like identical twins, only one of whom could have existed without the other if one of the embryos developing into the twins had developed into an infant while the other failing to develop after separation, it is possible for either of Thea and Mae to exist without the other as in w_1 and in w_3.

Finally, w_4 is a possible world where z *naturally* develops into a 16-cell embryo with b_9–b_{14} positioned inside. Although it remains largely unknown how blastomeres of a pre-implantation embryo differentiate into the inner cell mass and trophoblast, studies suggest that the fate of blastomeres is not determined solely by the intrinsic properties of the embryo at its 1-cell stage. Instead, various environmental factors affect how blastomeres divide and differentiate.[13] For example, blastomeres move and rotate within the zona pellucida, and their relative positions and orientations change considerably (Kurotaki et al. 2007). And it seems that their relative positions and orientations affect whether they become precursors of the inner cell mass or trophoblast (Biggins et al. 2015). Let us thus suppose that in w_4, z develops into the same 8-cell embryo in the exact way it does in the actual world. Consider the moment at which the embryo is about to start the fourth round of cleavages. One of the eight blastomeres is the mother cell of b_9 in the actual world, i.e., the one that splits into two blastomeres, one of which is b_9. Suppose that in the actual world, the mother cell of b_9 is in contact with the zona pellucida and divides so that the plane of cleavage is perpendicular to the side of the zona, and so the resulting blastomeres, one of which is b_9, are equally in contact with the zona (Fig. 4). As a result, b_9 is positioned outside and becomes a precursor of the trophoblast. In w_4, by contrast, the mother cell is rotated 90 degrees compared to its orientation in the actual world. As a result, when it divides in a way intrinsically identical with the way it actually does, the plane of cleavage is parallel to the zona, and so b_9 is positioned inside and becomes a precursor of the inner cell mass.

And the mother cells of b_{10}–b_{14} behave similarly, and as a result, b_9–b_{14} are all positioned inside while b_1–b_8 are positioned outside in w_4. Note that I do not claim that the way an embryo

[13] In a review of many studies on this issue, Rossant and Tam (2009) conclude: "Our critical review of the current data supports a stochastic model of lineage specification, in which cell-cell interactions and position effects reinforce and can override any underlying cell fate bias" (701).

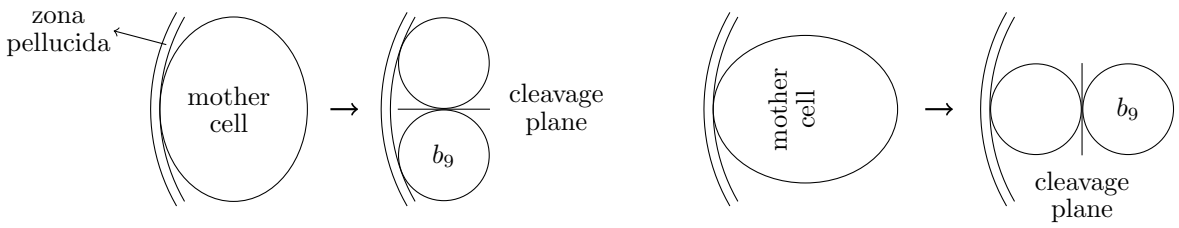

Fig. 4 Perpendicular (left) and Parallel (right) Cleavage

develops is completely random. Even if an embryo has some disposition to develop in a particular way rather than others, my argument holds as long as it is *possible* for z to develop in the way it does in w_4. Since b_9–b_{14} are initially positioned outside in w_3 whereas they are positioned inside in w_4, there may be some small differences in their intrinsic features between w_3 and w_4 at the moment of creation. Such differences soon disappear, after which b_9–b_{14} develop into an infant, *Mae*, in the same way as they do in w_3 (Fig. 3, *fifth*). Consequently, the matter, cells, and organs Mae is composed of in w_4 are exactly the same as those Shae is composed of in w_3 (and in w_2) while being (almost) completely different from those Lea is composed of in the actual world. Mae and Lea are like identical twins living in different possible worlds: Though they have the same genetic makeup, their bodies are composed of different matter, cells, and organs coming from different inner cell masses.

Now let me argue that Mae is not Lea in w_4 (i.e., in *some* possible world where the above description of w_4 holds, the infant coming from b_9–b_{14} is numerically distinct from Lea). First, it is a plausible view that Thea is Lea in w_1 (i.e., in *some* possible world where the description of w_1 holds, the infant coming from b_1–b_6 is Lea). In the case where all of Lea's cells at birth come from b_1–b_6 in the actual world, b_1–b_6 yield exactly the same cells, tissues, organs, fetal body, and infant body in the actual world and in w_1. That is, the series of the stages including zygote z, b_1–b_6, the main body (i.e., the head, torso, and limbs) of the fetus, and the body of the infant at birth in w_1 is completely identical (molecule by molecule, cell by cell, organ by organ, and so on) with the series of the stages including z, b_1–b_6, the main body of the fetus, and the body of the infant at birth in the actual world. It is thus reasonable to conclude that Thea is Lea in w_1.

If Thea is Lea in w_1 for the above reasons, then Shae is Mae in w_3 for the same reasons.

The series of the stages including zygote z, b_9–b_{14}, the main body of the fetus, and the body of the infant at birth in w_3 is completely identical with the series of the stages including z, b_9–b_{14}, the main body of the fetus, and the body of the infant at birth in w_4. Moreover, the relation between w_1 and the actual world is essentially the same as that between w_3 and w_4. The actual world and w_4 are symmetrical: The only difference between them lies in which blastomeres are naturally positioned inside the 16-cell embryo and develop into an infant. And w_1 and w_3 are very similar: Six blastomeres are selected to be positioned inside a reconstituted 16-cell embryo and then develop into an infant. So, Shae is Mae in w_3 if Thea is Lea in w_1.[14]

Then, the conclusion follows. If Thea is Lea in w_1, and Shae is Mae in w_3, then Mae is not Lea in w_4, for Shae (i.e., Mae) is not Thea (i.e., Lea) in w_2. This can be justified by the *necessity of identity/distinctness* that if x and y are numerically identical with (or distinct from) each

[14] Some might object to this by insisting that the initial positions of the six blastomeres that are positioned inside a reconstituted 16-cell embryo make a difference: In w_1, b_1–b_6 are initially positioned inside as in the actual world and so Thea is Lea, but in w_3, b_9–b_{14} are initially positioned outside unlike in w_4 and so Shae cannot be Mae. But this objection does not hold. Consider possible worlds, w_5 and w_6, in each of which z develops into the same 16-cell embryo as it does in w_4 so that b_9–b_{14} are positioned inside and b_1–b_8 outside. Then we artificially rearrange the blastomeres so that the rearranged 16-cell embryo is configured in the exact same way as the 16-cell embryo in the actual world, so that b_1–b_6 are positioned inside and b_7–b_{16} outside. In w_5, the rearranged 16-cell embryo develops into an infant in the exact way it does in the actual world. In w_6, b_9–b_{16} are removed from the rearranged embryo and put together with eight copies of b_8, and b_9–b_{14}, which are positioned inside, develop into an infant in the exact same way as they do in w_3. It is reasonable to believe that the resulting infant in w_5 is Lea: Compare the rearranged 16-cell embryo in w_5 with the 16-cell embryo in the actual world. They have exactly the same blastomeres configured exactly the same way. The only difference between them is that the blastomeres are *naturally* positioned in the actual world whereas they are *artificially* positioned in w_5. Considering that it is merely coincidental whether a blastomere is naturally positioned inside or outside, this difference does not necessarily affect the identity of the resulting infant. Moreover, suppose that Mae is identical with Lea in w_4—if Mae is not identical with Lea in w_4, then the conclusion of the argument holds. This means that z develops into Lea regardless of which blastomeres are positioned inside and eventually yield the body of the resulting singleton infant. If so, artificially changing the positions of inner and outer blastomeres should not affect the identity of the resulting infant, either, and so the infant in w_5 is Lea. And if the infant in w_5 is Lea, then the infant in w_6 is Shae because in w_6, b_9–b_{16} are removed from the rearranged embryo and put together with eight copies of b_8, and b_9–b_{14}, which are positioned inside, develop into an infant in the exact same way as they do in w_3.

Consider then a possible world, w_7, which is the same as w_4 up to the formation of the 16-cell embryo with b_9–b_{14} naturally positioned inside. Then b_9–b_{16} are put together with eight copies of b_8, and b_9–b_{14}, which are positioned inside, develop into an infant in the exact same way as they do in w_3 and w_6. This infant in w_7 is Mae if Thea in w_1 is Lea since the relation between w_4 and w_7 is completely symmetrical with that between the actual world and w_1. Now, compare w_6 and w_7: In w_7, b_9–b_{14} are initially positioned inside, removed from the embryo, and then put together with eight copies of b_8 so that they develop into Mae, while in w_6, b_9–b_{14} are initially positioned outside, repositioned inside, removed from the embryo, and then put together with eight copies of b_8 so that they develop into Shae. The only difference between w_6 and w_7 is that b_9–b_{16} are repositioned before getting removed from the embryo. This repositioning would not necessarily change the identity of the resulting infant, and so Shae is Mae.

other in a possible world, they are so in every possible world.[15] Therefore, zygote z naturally develops into a singleton, Lea, in the actual world and naturally develops into a numerically distinct singleton, Mae, in some possible world.

Let me now address some possible objections to the argument. It may be denied that Thea is Lea in w_1 for three different reasons. First, some might claim that Thea must be numerically distinct from Lea in w_1 (i.e., in every possible world like w_1, the infant coming from b_1–b_6 is not Lea) because b_8–b_{16} are replaced by copies of b_8 in w_1, and as a result, the fetus that develops into Thea in w_1 has a placenta somewhat different from that of the fetus that develops into Lea in the actual world. But this difference is minor: The placenta plays only a supportive, not constitutive, role in the formation of the infant's body, and so if the placenta of the fetus that develops into Lea had been replaced by a substitute, the fetus would have survived the replacement and still developed into Lea, with the same nutrients supplied by the substitute. Likewise, if b_8–b_{16} had been replaced by substitutes as in w_1, b_1–b_6 could still have developed into Lea, with the same nutrients supplied by the placenta formed by the substitutes.

Second, if a small number of Lea's cells come from b_7–b_{16} in the actual world, there is a slight difference between the series of the stages from the zygote to the infant at birth in the actual world and that in w_1: None of Thea's cells come from b_7–b_{16} in w_1 whereas a small number of Lea's cells come from b_7–b_{16} in the actual world. Nevertheless, it is reasonable to believe that Lea could have come into existence in a way slightly different from the way she actually does, and so it is possible for Lea to have a body all of whose cells come from b_1–b_6. That is, there is a possible world that is the same as the actual world except that Lea's body at birth comes only from b_1–b_6. If so, it is also possible for Lea to come into existence as in w_1.

Still, some may have a metaphysical position that imposes more stringent conditions on possible property variations of an object and so individuate objects more finely than the above, concluding that Thea is not Lea in w_1 because of the differences described above. Those who

[15] The necessity of identity/distinctness may not hold in Lewis's counterpart theory of modal semantics. This does not mean that the argument must fail in counterpart theory. Instead of the necessity of identity/distinctness, we can appeal to similarities and differences among Lea, Thea, Shae, and Mae to reasonably conclude that Mae is not (a counterpart of) Lea in w_4.

have such a metaphysical position would accept the conclusion of the argument, for the more stringent conditions one imposes on possible property variations of an object, the more reasons one has to conclude that Mae is not Lea in w_4. If Thea is not Lea in w_1 because of because of the difference that none of Thea's cells at birth come from b_7–b_{16} in w_1 whereas a small number of Lea's cells come from b_7–b_{16}, then Mae is not Lea in w_4 because of the much greater difference in cellular origin between them: All of Mae's cells come from b_9–b_{14} in w_4 whereas (almost) all of Lea's cells come from b_1–b_6 in the actual world. Similarly, if Thea is not Lea in w_1 because the reconstituted 16-cell in w_1 has outer cells different from those of the 16-cell embryo in the actual world, and as a result, the fetus in w_1 has a placenta somewhat different from that of the fetus in the actual world, then Mae is not Lea in w_4 because the outer cells of the 16-cell embryo that develops into Mae in w_4 are also different from those of the 16-cell embryo in the actual world, and as a result, the fetus in w_4 has a placenta different from that of the fetus in the actual world. More importantly, the 16-cell embryo that develops into Mae in w_4 has inner cells different from those of the 16-cell embryo in the actual world, and consequently, the cells, tissues, organs, and body of Mae at birth in w_4 are (almost) completely different from those of Lea at birth in the actual world.

Third, conceptionists might deny both that Thea is Lea in w_1 and that Mae is not Lea in w_4, appealing to the following intuition. Let us say that an embryo *continuously* develops into an infant *without disruption* if it develops into exactly one infant without any fission, fusion, rearrangement, partial loss or destruction, etc. For example, z continuously develops into an infant without disruption in the actual world and in w_4, but not in any of w_1–w_3. Instead, each of the reconstituted 16-cell embryos continuously develops into an infant without disruption in w_1–w_3. Conceptionists and many others would have the intuition that if an embryo continuously develops without disruption into an infant, it is numerically identical with the infant. On this intuition, the identity of an embryo completely determines the identity of the infant it continuously develops into without disruption: An embryo develops into the same infant in all the possible worlds where it continuously develops into an infant without disruption, and two distinct embryos always develop into two distinct infants if each of them continuously develops

into an infant without disruption. Consider then the reconstituted 16-cell embryo with b_1–b_6 inside and nine copies of b_8 outside in w_1. It has less than half of the blastomeres (namely, only b_1–b_7) in common with the 16-cell embryo in the actual world. So, the reconstituted 16-cell embryo in w_1 seems to be numerically distinct from the 16-cell embryo in the actual world. If so, the infant it continuously develops into without disruption in w_1, namely, Thea, is numerically distinct from Lea in the actual world. And Mae is Lea in w_4 because z continuously develops without disruption into Lea in the actual world and into Mae in w_4—it also follows that Shae is not Mae in w_3 because the reconstituted 16-cell embryo that continuously develops into Shae without disruption in w_3 is numerically distinct from the 16-cell embryo in w_4.

Yet this intuition cannot be maintained. Consider the case of chimerism, in which two embryos f and m with different genetic makeups fuse together to form one embryo, e, which continuously develops without disruption into one infant whose cells at birth come from both f and m—it has been reported that a healthy chimeric rhesus money can be created with a high success rate by aggregating early embryos (Tachibana et al. 2012), and human chimerism

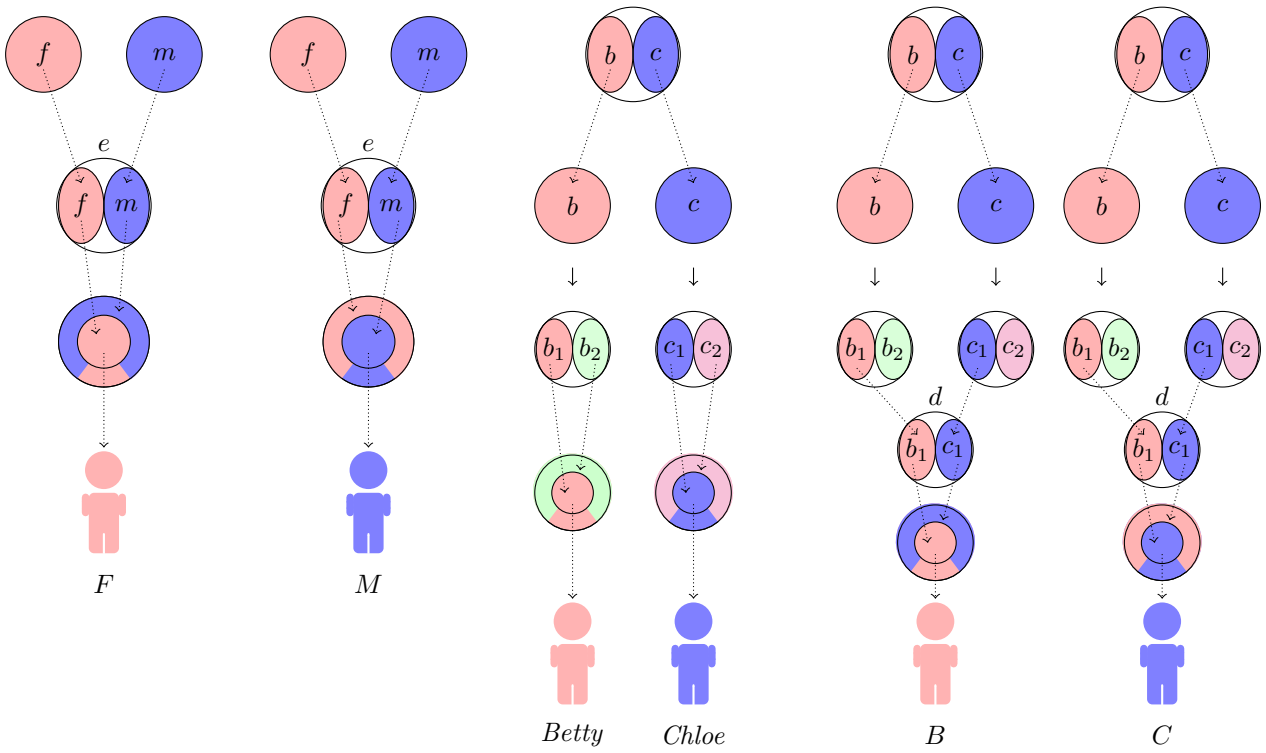

Fig. 5 Chimeras and Twins

occurs naturally (Yu et al. 2002). At the moment at which e is formed as a result of the fusion of f and m, it is possible that only f yields the inner cell mass, which develops into an infant F whose cells at birth come only from f, and it is also possible that only m yields the inner cell mass, which develops into an infant M whose cells at birth come only from m (Fig. 5, *first and second*). Embryos f and m may even be of opposite sexes (Tachibana et al. 2012), and so e may continuously develop into a completely normal female or male infant, depending on which of f and m yields the inner cell mass. If an embryo is identical with the infant it continuously develops into without disruption, we have to conclude that e is identical with both F and M, and so F is identical with M, despite the fact that their bodies are composed of completely different cells and organs, and they are of opposite sexes. This seems unacceptable. Instead, it is better to conclude that F and M are numerically distinct, and so e is numerically distinct from any of F and M.

And the same conclusion holds for non-chimeric embryos. Suppose that in the actual world, a 2-cell embryo is divided into two embryos, b and c, which develop into identical twins, Betty and Chloe, respectively. More specifically, b develops into an embryo with two cells b_1 and b_2 in it, and b_1 yields the inner cell mass so that Betty's cells at birth come only from b_1, while c develops into an embryo with two cells c_1 and c_2 in it, and c_1 yields the inner cell mass so that Chloe's cells at birth come only from c_1 (Fig. 5, *third*). Then, imagine the possibility that when b and c develop into 2-cell embryos, we create a 2-cell embryo d by combining b_1 and c_1. This 2-cell embryo d may continuously develop without disruption into an infant B, whose cells, organs, and body are completely identical with those of Betty if b_1 yields the inner cell mass; d may continuously develop without disruption into an infant C, whose cells, organs, and body are completely identical with those of Chloe if c_1 yields the inner cell mass (Fig. 5, *fourth* and *fifth*). B and C are as different from each other as Betty and Chloe are. So, it is reasonable to conclude that B and C are two distinct infants, and consequently, d is numerically distinct from either of B and C.

It is thus untenable that an embryo is always identical with the infant it continuously develops into without disruption. It is not which embryo develops into an infant but which blastomeres

in an embryo yield the body of an infant that is much more important to the identity of the infant. So, Thea is Lea in w_1. Consequently, Mae is not Lea in w_4—Mae and Lea are as different from each other as identical twins are.

Now, an analogy would help to understand the argument more intuitively. A 16-cell embryo is a collection of undifferentiated blastomeres such that only (about) six of them eventually yield the cells of the singleton infant it develops into though any six have a potential to do so. So a 16-cell embryo is like a block of wood that is big enough to be made into two (or more) tables. When we have such a block, we can make either exactly one table using only, say, the left half of it or make two tables, one from the left half and another from the right one. And the production process of making a table from the left half is ontologically independent of the production process of making a table from the right one: The former process can yield the same table with or without the latter undergoing. So a numerically different table could have been made out of such a big block of wood depending on which portion of it is used. Likewise, when a zygote develops into a singleton, a numerically different singleton can develop from it depending on which six among the sixteen blastomeres are positioned inside and eventually yield the body of the resulting infant.

Let us then see exactly what the argument shows. Say that a human zygote *develops into a singleton in a typical way* if and only if (i) it develops into a 16-cell embryo, (ii) about six of the blastomeres of the 16-cell embryo are positioned inside and yield the inner cell mass, (iii) the inner cell mass develops without twinning into exactly one infant (almost) all of whose cells at birth originate from it, and (iv) the infant naturally grows, if she does, into exactly one adult. And say that a zygote is *developmentally plastic* if and only if it develops into a singleton x in some possible world and develops into a singleton y numerically distinct from x in another possible world. Then the argument so far shows that every zygote that develops into a singleton in a typical way in the actual world is developmentally plastic. Furthermore, the argument can be modified (by taking the description of the actual world in the argument to hold for some nonactual possible world) to show that every possible zygote that develops into a singleton in a typical way in some possible world is developmentally plastic. A normal healthy

zygote that actually gets destroyed could have developed into a singleton in a typical way and so is developmentally plastic. And zygotes that actually develop into multiples (such as twins), it seems, could have developed into a singleton in a typical way.[16] We thus reach the following:

> *Developmental Plasticity*: Every zygote that can possibly develop into an infant or infants is developmentally plastic.[17]

Developmental Plasticity has many interesting consequences.[18] One of them is that it leads to the refutation of conceptionism, as we see in the next section.

4 The zygote I came from was not me nor a human being

Conceptionists claim that zygotes are human beings, and every infant, child, or adult is numerically identical with the zygote she came from. But proponents of the arguments from twinning object that a zygote that develops into twins is identical with none of the twins and so is not a human being. Twinning, however, does not seem to pose a serious threat to conceptionists. They can accept that identical twins begin to exist not at fertilization but right after the split of

[16] Even zygotes that are preprogrammed to develop into twins, if there are such, could have been reprogrammed to develop into a singleton in a typical way.

[17] This does not mean that all or most zygotes are developmentally plastic. It may be the case that most zygotes are seriously defective and so cannot develop into any infant.

[18] *Developmental Plasticity* directly opposes the following thesis:

> *Sufficiency*: If a singleton h comes from a zygote z, then necessarily, any singleton coming from z is h (roughly speaking, being a singleton coming from z is sufficient for being identical with h).

This principle and its generalization to artifacts and natural inanimate objects are explicitly advocated by many proponents of origin essentialism such as Nathan Salmon (1987; 2005, 209f, 374) and Graeme Forbes (1985). It is a main premise in the most well-known argument for origin essentialism (namely, Salmon's reconstruction of Kripke's argument in footnote 56 of *Naming and Necessity*). And Salmon says, "The intuition that [*Sufficiency*] is true is very widely shared" (1987, 98), and many philosophers who do not explicitly defend origin essentialism and *Sufficiency* nonetheless accept and rely on them to make their cases (see Williamson 2013, 128).

There is another consequence. Direct reference theory in the philosophy of language, which roughly says that the meaning of a proper name lies only in what it refers to, has difficulties in how we can use (if we can) proper names (not descriptions) to refer to merely possible individuals, which do not actually exist but might have existed. David Kaplan (1973, 517, fn. 19) proposed the view that a merely possible object can be uniquely specified in certain rare cases, where a thesis like *Sufficiency* holds. So assuming *Sufficiency*, Salmon introduces a proper name 'Noman' to refer to the merely possible human who would have developed from the union of a particular egg and sperm neither of which is actually united with any gamete, and from this, he draws various interesting metaphysical and language-theoretic consequences such as the one that "[r]eference precedes existence" (1987, 94). But such consequences do not follow, for the name 'Noman' picks out no unique individual if *Developmental Plasticity* is true.

the embryo while still maintaining that singletons begin to exist at fertilization, i.e., maintaining the following thesis:

> *A-singleton-was-once-a-zygote*: Every zygote that develops into a singleton is numerically identical with the singleton.

This weaker thesis (weaker than *A-human-was-once-a-zygote*), however, cannot be defended if *Developmental Plasticity* is true. Suppose, as argued in Section 3, that a zygote z naturally develops into a singleton, Lea, in the actual world and also naturally develops into a numerically different singleton, Mae, in a possible world w_4. Note that there is no significant difference between the way z develops into Lea in the actual world and the way z develops into Mae in w_4: The only difference between them lies in which blastomeres are naturally positioned inside the 16-cell embryo and develop into an infant. Furthermore, it is not just the local features concerning the development of z into an infant but the whole global features of the two worlds (namely, the actual world and w_4) that are symmetrical: Besides the fact that z develops into Lea in the actual world and into Mae in w_4, we can assume, everything else is the same in these two worlds. Thus, no features of the two worlds, local or global, make one of the development of z into Lea in the actual world and that into Mae in w_4 a continuous maturation of one being and the other a discontinuous replacement of one being by another.[19] So, z is numerically identical with Lea if and only if it is identical with Mae. If *A-singleton-was-once-a-zygote* is true, then, z is identical with both Lea and Mae, which is impossible.[20] *A-singleton-was-once-a-zygote* is

[19] As mentioned in Section 2, this symmetry between the two worlds makes the above argument fundamentally different from the arguments from twinning. As explained in Section 2, we cannot conclude that a zygote is numerically distinct from the singleton it actually develops into just because it can develop into twins. The development of z into Lea in the actual world is not symmetrical with that into twins or into one of them in some possible world, and so it is consistent to take the development of a zygote into a singleton as a continuous maturation of one being while taking the development into twins as a replacement of one being by two.

[20] Advocates of four-dimensional theories of persistence might respond that we can take z to be a common temporal part or counterpart of Lea and Mae, and so it is still true that both Lea and Mae, though numerically distinct from each other, began to exist at fertilization when the zygote came into existence. This maneuver is similar to the one Lewis (1976) makes regarding fission: When a person divides into two, the pre-fission stage is a common temporal part of the resulting two humans. Note that these maneuvers do not logically follow from four-dimensionalism. Four-dimensionalists can deny conceptionism and accept that humans begin to exist long after fertilization, and they can also consistently claim that at least in some cases of fission, the pre-fission stage is not a common temporal part of the two post-fission objects. *Developmental Plasticity* provides an interesting case where new implications of these maneuvers can be explored. In cases of fission, the most discussed problem of Lewis's maneuver is the so-called counting or multiple occupancy problem: Before fission, there already exist

thus false.[21]

Some might object to this argument by claiming that the actual world is privileged because it is actual, and so if a zygote z develops into a singleton s in the actual world, then z is identical with s, whereas had z developed into a singleton s^* numerically distinct from s, z would not have been identical with s^*. But there is no good reason to privilege the actual world this way: It is due to some contingent factors that a zygote develops in the way it actually does. Had the environment and the cleavage divisions been different, the zygote could have developed into a numerically distinct singleton, and no particular environmental factors or cleavage patterns are privileged such that a zygote is identical with the singleton it develops into just in case those environmental factors or cleavage patterns obtain.[22]

So, a zygote could not have developed into a singleton identical with it. Furthermore, if a zygote could not have developed into a singleton identical with it, then it could not have

two objects instead of one. Unlike fission/fusion cases where one object or stage is connected to two objects in one world, *Developmental Plasticity* is about a case where one zygote is continuously connected without fission/fusion to different infants in different possible worlds. Thus, if both Lea and Mae began to exist at fertilization by having zygote z as a common temporal part in the actual world and in w_4, then which human z is a temporal part of is determined by what happens the future, i.e., by whether z develops into Lea as in the actual world or Mae as in w_4. This dependence of identity on the future seems problematic.

[21] This argument is more compelling than previous arguments for the same conclusion. Many have argued for the numerical distinctness between a zygote and the infant/adult it develops into (i) with the arguments from twinning introduced in Section 2, (ii) by appealing to various qualitative differences between zygotes and adults (Lane 2003), or (iii) with a theory of composition on which a 2-cell embryo (or multi-cell embryo before implantation) is not an object because it lacks unified life activities (van Inwagen 1990, 152–153). But the arguments from twinning do not show that a zygote is numerically distinct from the singleton it develops into; the appeal to various qualitative differences between zygotes and adults is disputable because those differences are counterweighed by the apparent developmental continuity, as Tacelli (2006) argues; and the theory of composition denying the objecthood of a 2-cell embryo is not widely accepted and whether a multi-cell embryo before implantation lacks any unified life activity is disputable (see also Tacelli 2006).

[22] Furthermore, it violates conceptionism to privilege the actual world as above. Consider a zygote z that is destroyed right after its formation in the actual world. It is either possible or impossible for z to develop into a singleton s identical with z. Suppose that it is possible. Since it is possible for z to develop into a singleton s^* numerically distinct from s, and it is impossible for z to be identical with both s and s^*, it is both possible for z to develop into a singleton s identical with z and possible for z to develop into a singleton s^* numerically distinct from z. But there is no difference between the way z develops into s and the way z develops into s^*, and so there is no good reason to believe that z is identical with s but numerically distinct from s^*. Thus, we should conclude that it is impossible for z to develop into a singleton identical with z. If if it is impossible for z to develop into a singleton identical with z, then it is impossible for z to develop into twins or multiples one of whom is identical with z. And no infant or adult not coming from z can be identical with z. It is thus impossible for z to be identical with any infant or adult, and so z is an entity that cannot ever mature. And an entity that cannot ever mature is not a human being, as I argue later. We thus should conclude that a zygote z that is destroyed right after its formation is no human being. This violates conceptionism that all (non-defective) zygotes are human beings.

developed into twins or multiples one of whom is identical with it. And a zygote is not identical with an infant or adult who does not come from it—you, for example, are not identical with the zygote I came from. We thus reach the following:

> *Zygote-Infant Distinctness*: Every zygote is numerically distinct from any actual or possible infant, child, or adult (or any full-fledged human being).

Zygote-Infant Distinctness provides good reason to conclude that no zygote is a human being. First, note that conceptionists present *A-singleton-was-once-a-zygote* as the most important ground for *A-zygote-is-a-human*, as follows:

> [F]rom the time that the ovum is fertilized, a life is begun which is neither that of the father nor of the mother; it is rather the life of a new human being with his own growth. ... [F]rom [this] instant there is established the programme of what this living being will be: a man, this individual man with his characteristic aspects already well determined. ... 'The one who will be a man is already one.' (*Declaration on Procured Abortion*, Sections 12–13)

The argument is that a zygote is a human being because it will be a "man," i.e., it is numerically identical with the "man" it will develop into. But a zygote is not identical with the "man" it develops into and so will never be a "man." The above argument fails.

Second, note that the above argument is based on the idea that the possibility of being numerically identical with a full-fledged human being is *sufficient* for being a human being. On the other hand, that possibility seems *necessary* for being a human being. Ford (1988), for example, defines "the human person" to be "a living individual with a human nature, i.e., a living ontological individual that has within itself the active capacity to maintain, or at least, to begin, the process of the human life-cycle without loss of identity," and claims that "a human person begins as a living individual with the inherent active potential to develop towards human adulthood without ceasing to be the same ontological individual" (84–85).[23] On this definition, a zygote is not a human being since it cannot possibly develop towards human adulthood without

[23] Ford uses 'human individual,' 'human being,' and 'person' interchangeably to refer to the members of *Homo sapiens* (1988, 67).

ceasing to be the same individual. A zygote is more like an ovum and sperm, which go out of existence as they fuse to form a zygote and hence are no human beings.

Even if it could somehow be defended that a zygote is a human being, the moral significance of the claim that a zygote is a human being is significantly diminished if *Zygote-Infant Distinctness* is true, for many influential arguments against destroying zygotes appeal directly to *A-singleton-was-once-a-zygote*. Consider, for example, the famous argument by Marquis (1989) that abortion is as seriously immoral as killing an infant or adult because in both cases killing deprives them of a "future like ours," i.e., all the goods of life they would have experienced had they not been killed.[24] Still, Marquis claims that his argument does not imply the immorality of contraception, as follows:

> The future of value of which I would be deprived by being killed is the valuable life of a later stage of me, of the same individual that I am now. ... [Likewise,] if my parents had failed to conceive me, their inaction would have been wrong only if the sperm and the [unfertilized ovum] that were my precursors were earlier stages of the same individual I am now. ... They were not. It follows that the future of value theory does not imply that if my parents had failed to conceive me, their inaction would have been wrong. This argument can be generalised to show that the future of value theory does not imply that either contraception or decisions not to conceive are wrong. (2005, 120)

Marquis's point is that preventing an ovum and a sperm from fusing is morally wrong only if an ovum and a sperm are the same individual as some human being who enjoys all the goods of life. But an ovum and a sperm are, Marquis claims, not identical with any such human being, and so his argument does not imply that contraception is wrong. If Marquis is right, then his future of value argument cannot show that killing a zygote is wrong, either. A zygote does not have a future like ours regardless of whether it is a human being or not, for it is numerically

[24] Marquis seems to leave it open whether his argument applies to zygotes. He eliminates "from consideration cases whose ethical analysis should be controversial and detailed for clear-headed opponents of abortion," namely, cases including "abortion during the first fourteen days after conception when there is an argument that the fetus is not definitely an individual" (1997, 91). Mills (2008) claims, however, that "[a]bsent moral certainty that zygotes aren't identical with later fetuses, moral caution requires us to act as though they are, ... given Marquis's principles" (340).

different from any human being who can enjoy all the goods of life. Sure, killing a zygote prevents some possible human being who could have enjoyed a valuable life from coming into existence, but if this is the only reason we should not kill a zygote, then killing a zygote is no more morally objectionable than contraception.

Finally, some might claim that though a zygote is not identical with the singleton it develops into, the inner cells of a 16-cell embryo constitute a human being identical with the singleton coming from the embryo, and so a 16-cell embryo contains a human being. Some might go on to claim that the part of the zygote that later composes the inner cells of the 16-cell embryo constitutes a human being identical with the singleton coming from the zygote, and so even a zygote contains a human being.

But at the moment at which a zygote z is formed, it is undetermined (at least by the intrinsic features of z) which part of z will later compose the inner cells of the 16-cell embryo: Depending on circumstances, some part p of z could later compose the inner cells, or some other part q non-overlapping with p could later compose the inner cells. If every part of z that can possibly compose the inner cells constitutes a human being, then both p and q constitute a human being, and so z contains two or more human beings, which is implausible. If, on the other hand, someone insists that the part of z that actually composes the inner cells later, whatever that part is, constitutes a human being at the moment of fertilization, that means that whether a given part of z constitutes a human being at fertilization depends on what will happen in the future. This is implausible, too. Furthermore, consider a zygote that is destroyed right after its formation. No part of it actually composes the inner cells later, and it has two or more non-overlapping parts each of which can possibly compose the inner cells. So, there is no particular part of a zygote that can be reasonably claimed to constitute the one human being the zygote is alleged to contain. Thus, a zygote that is destroyed right after its formation does not contain a human being. And the claim that a zygote that develops into a singleton contains a human being whereas a zygote that is destroyed right after its formation does not is not only implausible but also deprives conceptionism of moral significance, for it implies that the very act of destroying a zygote makes z contain no human being. So, a zygote does not contain a human being whether

it develops into a singleton or is destroyed right after its formation. We thus did not begin to exist at fertilization.

Then, do the inner cells (but not the outer cells) of a 16-cell embryo constitute a human being identical with the singleton coming from the embryo?[25] This claim might be defensible if a 16-cell embryo is not developmentally plastic, i.e., it develops into one and the same singleton in all the possible worlds where it develops into a singleton. But there is another important cell fate decision after the differentiation into the inner cell mass and trophoblast. The inner cell mass generates two layers of cells called the *bilaminar disc*. One layer of the disc is the *primitive endoderm* that lies in contact with the (blastocyst) cavity mentioned in Section 3, and the other is the *epiblast* that lies deeper (cf. Bruce and Zernicka-Goetz 2010). And it is the epiblast that forms the body of the infant. The primitive endoderm forms the yolk sac, which provides nutrition and gas exchange for the developing embryo until the placenta takes over. And it has been observed that the epiblast of a mouse embryo takes up less than half of the bilaminar disc.[26] And studies suggest that the fate of cells in the inner cell mass is not (completely) determined at the time of their formation: Cells in the inner cell mass show extensive movement and have a potential to form either of the epiblast and the primitive endoderm, even if some cells are more disposed to develop into one type rather than the other (Bruce and Zernicka-Goetz 2010). Then, the argument in Section 3 applies to an embryo prior to the formation of the bilaminar disc: Numerically different singletons could result, depending on which cells of the inner cell mass form the epiblast, and so such an embryo is developmentally plastic. If so, we can also conclude that an embryo prior to the formation of the bilaminar disc does not contain a human being.

Then, when do we begin to exist? The arguments so far do not give a precise answer. But they at least show that a human being does not begin to exist until cell differentiation has proceeded enough to determine which cells of an embryo at a given developmental stage will

[25] Or some might claim that a 16-cell embryo constitutes a human being identical with the singleton coming from it while 16-cell embryos a and b that share the same inner cells (like the 16-cell embryos in the actual world and the possible world w_1 in Section 3) constitute the same human being.

[26] Saiz et al. (2016) reports a stabilization of the inner cell mass composition at around 60% primitive endoderm and 40% epiblast in mouse embryos over 100 cells.

eventually form the body of the resulting infant. And this does not happen at least before the formation of the bilaminar disc, which occurs in human embryos at approximately day 8 after fertilization.

5 Conclusion

A human zygote that naturally develops into an infant without twinning could have naturally developed into a numerically different infant without twinning. For the zygote yields cells that do not actually produce any tissues of the infant but could have developed into a different infant. This implies that a zygote is not identical with any infant/adult it develops into and so does not have a "future like ours." And it strongly suggests that a zygote is not a human being.

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