Journal of Medicine and Philosophy, 31:165–175, 2006

ISSN: 0360-5310 print/1744-5019 online
DOI: 10.1080/03605310600588707

Routledge
Taylor & Francis Group

Sixteen Days? A Reply to B. Smith and B. Brogaard on the Beginning of Human Individuals

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When does a human being begin to exist? Barry Smith and Berit Brogaard have argued that it is possible, through a combination of biological fact and philosophical analysis, to provide a definitive answer to this question. In their view, a human individual begins to exist at gastrulation, i. e. at about sixteen days after fertilization. In this paper we argue that even granting Smith and Brogaard's ontological commitments and biological assumptions, the existence of a human being can be shown to begin much earlier, viz., with fertilization. Their interpretative claim that a zygote divides immediately into two substances and therefore ceases to exist is highly implausible by their own standards, and their factual claim that there is no communication between the blastomeres has to be abandoned in light of recent embryological research.

Keywords: *embryo, fetal development, fetus, substance, twinning*

I. INTRODUCTION

When does a human being come into existence? In their recent article "Sixteen Days" Barry Smith and Berit Brogaard (2003), henceforth "S&B,"

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argue that a human individual that is trans-temporally identical to a future human adult comes into existence no earlier than at day sixteen after conception.

In this article we shall argue that even granting S&B's ontological commitments and biological assumptions, the existence of a human being can be shown to begin much earlier, viz., with fertilization. In what follows, we briefly introduce the main claims of S&B and the grounds adduced for them. We then propose reasons to reject those claims and argue for an alternative view of the beginning of human existence.

II. SMITH AND BROGAARD'S CLAIMS

S&B argue that "through a combination of biological fact and philosophical analysis" (2003, p. 45) it is possible to provide a definitive answer to the question of when a human being begins to exist. Since their main focus is on "the sense of individuality that is peculiar to higher organisms like ourselves" (p. 45 f.), the question at stake really is: When does a human *individual* begin to exist?

S&B explain that their project is "an exercise in ontology", and they add (and rightly so) "no conclusions of an ethical sort can be drawn directly from the answer to any ontological question" (p. 46). They grant, though, that the reply to the ontological question "can be of some help" (p. 46) in settling the ethical problems surrounding beginning of life issues such as abortion and embryonic stem cell research. Whether this is an accurate assessment or an ironic understatement will depend, of course, on how those problems are articulated. If respect is due to a human being from the beginning of his or her existence, then the ontological question is not of marginal importance, but quite decisive.

The starting point of S&B is that "human beings and other organic individuals are three-dimensional spatially extended entities which exist *in toto* at any time at which they exist at all" (p. 47). This entails, in their view, that each of them is a substance in Aristotle's sense. The challenge for them is to establish the point at which an Aristotelian substance begins to exist, and this requires them in turn to specify the conditions that have to be satisfied for something to count as a substance. A substance begins to exist at the point at which those conditions are first satisfied.

S&B lay out a set of conditions the first six of which, if satisfied, imply that something is a substance:

1. Each substance is a bearer of change. (. . .)
2. Each substance satisfies the condition that it cannot continue to exist and become a different substance. (. . .)
3. Each substance is extended in space, and thus it has spatial parts. (. . .)

4. Each substance possesses its own complete, connected external boundary (. . .) which divides its interior from its exterior and at the same time separates it spatially from other substances. (. . .)
5. Each substance is connected in the sense that its parts are not separated from each other by spatial gaps. (. . .)
6. Each substance is an independent entity in the sense that is does not require the existence of any other entity in order to exist (. . .) (p. 47 f.).

Though there might be room for minor disagreements, we do not intend to quarrel with these first six conditions. It is not enough, however, to list only those six conditions, because many things that are not organisms satisfy them. More specific conditions for individual organisms need to be introduced. Hence, S&B propose four further conditions which, if satisfied, imply that something is a "*unified causal system that is relatively isolated from its surroundings*" (p. 49, emphasis in the original):

7. The external boundary of the entity is established via a physical covering or membrane which extends continuously across all or almost all of its surface ('almost all' because it typically contains small apertures—such as pores, mouth or nostrils—which allow interchange of substances such as air and food between interior and exterior).
8. The events transpiring within the entity are subject to a division between those whose characteristic magnitudes (of temperature, pressure, chemical composition and so on) fall within a certain spectrum of allowed values and those where corresponding magnitudes fall outside this spectrum. The former fall within a restricted family of types of sequences of events (for example digestion), which are often cyclically repeated. The latter are distinguished by the fact that they will, in cumulation, lead to the entity's ceasing to exist.
9. The external membrane or covering serves as a shield to protect the entity from those causal influences deriving from its exterior which are likely to give rise to events which are outside its spectrum of allowed values.
10. The entity contains within itself its own mechanisms which are able to maintain (or, in cases of disturbance, to reestablish) sequences of events falling within the spectrum of allowed values. The entity also contains within itself mechanisms for reconstituting or replacing its external membrane or covering in case of damage. (p. 49 f.)

The basic strategy of S&B, from then on, is to show that some of these four conditions are not satisfied by the early embryo (from day 0–15 or so). This implies that the early embryo is not a unified causal system that is relatively isolated from its surroundings and, *a fortiori*, not a human individual. Later two more conditions are added to the effect that a human individual must not only be a substance and a unified causal system that is relatively isolated from its surroundings, but must also be of human descent and a product of normal fetal development (p. 51).

After a descriptive section (pp. 54–58) devoted to the development of what they call "the foster" (a Danish term adopted to cover all stages of an unborn human organism), they turn in section VIII. to the actual proof of their thesis.

S&B draw up a list of possible thresholds beginning with the stage of the single-cell zygote and ending with the development of self-consciousness. They then ask at what stage a foster satisfies the 10 conditions mentioned earlier. According to their interpretation, a human individual does not come into existence before gastrulation (around day 16) because it is then "that the foster ceases to be a cluster of homogenous cells and is transformed into a single heterogenous entity" (p. 62). They actually try to paint a more complex picture of a "foster" at this stage the details of which, however, can be omitted for our present purposes. In any event, the chief reason given to show that gastrulation has the aforementioned effect seems to be that from then onwards twinning is no longer possible.

In what follows, we would like to challenge these claims and hold that in fact, if one follows strictly the conditions set forth by S&B, the threshold for human existence has to be set much earlier. The life of a human individual, we shall argue, begins as a single-cell zygote.[1]

III. THE THRESHOLD OF HUMAN EXISTENCE

Between the stage of the single-cell zygote (day 0) and gastrulation there is the stage of the multi-cell zygote (days 0–3), the stage of the morula (day 3), the stage of the early blastocyst (day 4), and implantation (days 6–13).[2] All of these stages or steps are in principle possible thresholds for the existence of human individuals, so let us examine these thresholds and the reasons S&B adduce to reject them.

As we shall see, there are two recurring themes in S&B's line of thought. They are, first, the claim that the zona pellucida, i. e., the thin permeable membrane that surrounds and protects the cell or cells, plays no substantial role and, second, that at the early stages there is no internal causal interaction within the zygote (p. 55). Both these claims, we shall argue in what follows, are false. Their falsehood in turn shows that the denial of the substantial unity of an embryo is untenable.

For S&B, *fission* is one of several forms of substance formation. It occurs when an entity divides into new entities that then have separate existence, such that the former entity is destroyed (e. g. the fission of an amoeba generating two new amoebas). Fission is different from *separation* in that in the latter kind of substance formation there are two relatively isolated causal systems before and after division (e. g. the separation of Siamese twins) (p. 53).

S&B contend that the single-cell zygote "cannot be transtemporally identical to the human being which will exist after birth on the grounds that it is predestined to undergo fission, and this means that it will cease to exist almost immediately after it has been formed. Two zygotes inside the thin

membrane are not one but rather two substances. Thus the two-zygote whole is, in our terminology, the result of a substantial change" (p. 59).

It is interesting to see that S&B hold the one-cell zygote to be a substance which fulfils the 10 conditions for being a substance as well as a relatively isolated causal system mentioned above (p. 59). The one-cell zygote is an individual human being. This individual human being, however, ceases to exist when it undergoes fission, and then a new individual human being begins to exist not before day 16. To some extent we cannot avoid arguments from plausibility here. At first glance we would press the claim that the aforementioned destruction and reconstruction of the individual human being is so implausible that an interpretation that leads to it (as that by S&B) should be rejected. But what is then the systematic weakness behind this implausible result?

We think it is a mistake to understand the division of the single-cell zygote into two cells as an instance of fission.[3] The main reason is that when a zygote divides a very important item is retained. Both at the initial stage and at the resulting two-cell stage there is not only a complete, connected external boundary, but, more precisely, a membrane or a physical covering—the *zona pellucida*—surrounding the cells. This membrane does not divide or disappear. The division takes place *within* its boundaries.

It is striking that S&B first understand a zygote to be a fertilized egg-cell, "an unusually large cell which has the same membrane as the egg-cell before fertilization" (p. 54), but then speak of "*two* zygotes *inside* the thin membrane" (p. 59, our emphasis), of a "two-zygote whole" (p. 59), or of a "multicellular zygote-bundle," respectively (p. 60). From a biological point of view, this is not only terminologically highly unusual, but also unjustified. For the claim that, despite its common membrane, the two-cell or multi-cellular zygote is not really *one* zygote (it is not a unified causal system) but rather a "bundle" of zygotes,[4] is grounded on the false assumption that "this membrane merely helps to keep the cells together in the spatial sense" (p. 60).

S&B are well aware that there is flow of nutrients from the outside to the inside of the membrane (p. 60), but they argue

i. that the nutrients are used only for cell division and not for growth, and that there is no flow of nutrients or signal molecules from one cell within the bundle to another (p. 60). In addition, S&B claim
ii. that the zygote or cell bundle "has no stability-restoring mechanism of its own of the sort which is required in order for the whole entity to be a single causal system" (p. 60); they also contend
iii. that the cells in the "multi-cellular zygote" divide "independently of each other" (p. 60).

These contentions are surely wrong. We shall address them in order.

First, the fact (if it is a fact) that the nutrients are "used only for cell division, not for growth" is irrelevant for the question whether the zona pellucida

is a membrane in S&B own terms (not to mention that the difference between "division" and "growth" seems artificial, because organisms normally grow by internal division and proliferation of their cells). In the case of the morula, of course, internal division leads to compaction, not to growth, but this is surely required for the embryo to be able to make its way through the fallopian tube. Some form of over-all coordination may be assumed. On the other hand, according to S&B's own definition, the zona pellucida "extends continuously across all or almost all of the surface of the system and allows interchange of substances between the interior and exterior" (cf. p. 49) and thus meets their own definition of external boundary. The assertion that there is no exchange of nutrients or signal molecules between the cells is, of course, quite independent of the question whether the zona pellucida is a membrane. As a matter of fact, the zona pellucida might even be a necessary condition for the totipotency of each cell and the complex of cells.[5] It may play as well the role of a "mailbox" for the exchanges between the embryo and the mother.[6] These functions, if empirically confirmed, will further strengthen the case for the substantial unity of the embryo.

Second, since the claim that the zygote has no stability-restoring mechanism of its own is taken to be based on the assertion that i.) the nutrients flowing in only contribute to division and not to growth, and that ii.) there is no flow of nutrients or signal molecules from one cell within the bundle to another, that claim turns out to be false because the underlying assumptions are incorrect. Also, even if there were really no internal stability-restoring mechanism (which is not clear given the fact that the removal of a blastomere for PGD does not seem to harm an embryo), it would still be fair to ask whether such a mechanism is a necessary condition for a relatively isolated causal system. Perhaps a substance is already a system of that sort if it satisfies conditions 7–9. Condition 10, or at least one element of it, appears to have been arbitrarily chosen.[7]

Third, if each cell within the zona pellucida really were a zygote dividing independently of each other, what would be the membrane that is necessary for each of them to be a unified causal system? If, as we shall show, there is causal interaction within the zona pellucida, and the latter is a membrane in S&B's terms, then the reply that each cell has its own membrane granting it its independence is inadequate.

It is undisputed that around day 4 the "inner cell mass" (also called "embryoblast") can be distinguished from the "outer cell mass" (also called "trophoblast"). Setting aside further steps and details, it is only from the embryoblast that the embryo proper will develop, and that the trophoblast, itself a part of the early embryo, will give rise to extraembryonic membranes and tissues (e.g. the placenta).[8] This poses a serious problem to any attempt to understand the early embryo as one individual. But this problem is not of concern here.[9] What is interesting, however, is the fact that from the moment the sperm penetrates the egg, the point at which the penetration takes

place seems to determine which part of the zygote will develop into the embryoblast and which part into the trophoblast. Recent research on mice embryos suggests that the subsequent functional specialization depends on where the sperm entered the oocyte in the first place. This clearly implies that there must be some kind of exchange of information both within the single-cell zygote and within the multiple-cell zygote, and subsequently within the "morula" and the "blastocyst."[10]

The biological claim by S&B, then, that the "membrane merely helps to keep the cells together in the spatial sense" (p. 60) is as incorrect as the assertion that the cells in the multi-cellular zygote divide "independently of each other." But this also means that the early embryo does *not* fail to satisfy the conditions necessary to be a unified causal system that is relatively isolated from its surroundings, and hence does not fail to meet the conditions to be a human individual: Conditions 7 and 9 are fulfilled by the nature and function of the zona pellucida since it is a membrane in the required sense; conditions 8 and 10 (if necessary at all) are fulfilled because there is causal interaction among the internal parts of the zygote (shown by the fact that there is from the start a tendency to differentiate along lines that require coordination to avoid redundancy; not all cells should end up being part of the trophoblast or of the inner cell mass). This also entails that the divisions within the embryo should not be understood in terms of fission or separation; they are rather cell-divisions that result (maybe right away) in a *hierarchical structure* (and its development). That structure will later contain within itself numerous further relatively isolated causal systems. Hence, the division of an amoeba by fission is *not* an adequate analogue to the division of a one-cell zygote. Amoebas do not retain a common external boundary or membrane after they divide, nor do they start to specialize into amoebas with different, yet coordinated functions.

S&B, it seems, have to face a further objection. Since they assume that at the stage of the dividing zygote we have a multiplicity of substances, they would have to explain how and when this plurality becomes a unity. Their "official" thesis, as we have seen, is that this happens at gastrulation: "it is with gastrulation . . . that the foster ceases to be a cluster of homogenous cells and is transformed into a single heterogeneous entity" (p. 62), and they defend this view from the possible claim that "singularity" might be achieved later "in the process of neurulation." (p. 63). But if one looks back in the article, it is surprising to discover that already at the stage of the blastocyst S&B had claimed that "[t]he inner cell mass constitutes a single substance, rather than many substances, insofar as its cells together form a connected whole with a common physical boundary" (p. 61). This single substance, however, they add, "still lacks its own internal mechanisms in virtue of which its several parts would in case of disturbance work together as a whole to restore stability" (p. 61).

Apart from the fact that extraction of cells at this phase is readily compensated by the organism, the basic claim about the inner cell mass remains problematic. The trophoblast is surely at this stage an integral part of the

developing organism. In fact, it is the whole blastocyst that is contained within a common physical boundary, not the inner cell mass alone. The whole blastocyst constitutes a discrete organism that can be counted along with other blastocysts in a Petri dish.

But, if unity has been achieved by the inner cell mass at the blastocyst stage, what is the point of making the same claim for the "transformation" at the gastrulation stage? Is unity or singleness achieved twice or should we assume that two different kinds or forms of unity are envisaged?

S&B, in fact, mention "a new type of integration of the foster" brought about by gastrulation that was not there before. It is the integration "manifested in the fact that twinning is from this point no longer possible" (p. 63). The importance of twinning for the view defended by S&B is clear. They devote a separate section to it (IX) in which they introduce a further condition to be satisfied by a substance if it is to be a human individual.

The added condition (No. 11) is non-divisibility. It is defined as the property of an entity that makes it impossible for it to divide "in such a way that it goes out of existence and is replaced by two or more entities which themselves satisfy conditions 1–10" (p. 66).

There can be no doubt that adult humans satisfy this modal condition and they satisfy it all the way back to gastrulation. It is not satisfied by human embryos before that stage. In other words, the new condition is tailored to fit the phenomenon of twinning, and this, we suggest, *begs the question*, for it amounts to treating a property that human organisms have after they have reached a certain point of development as if that property were co-extensive with the existence of an individual human being. But this is precisely what is in dispute. It does not seem implausible to think that very young organisms have properties linked to the enormous plasticity they need to grow into highly differentiated organisms, and that they lose those properties when the plasticity is no longer needed.[11]

The divisibility or possibility of twinning of the early human embryo, then, should not be invoked, by itself, to prove that there is no human individual before that property is lost. The possibility of twinning deserves a closer, independent look.

IV. TWINNING

First, it should not be forgotten that twinning is a rare phenomenon. The natural rate of monozygotic twins does not rise above 0.25%,[12] so that for the vast majority of humans the possibility of twinning is never actualized. It is an old insight of Greek philosophy that if something is potentially two (or more) does not logically follow that it is not actually one. A stick in my hand is potentially two sticks. I can break it into two parts, but before I do so, it is just one stick. The fact that out of a single morula two blastocysts *could* arise,

does not entail that the morula is not actually one. In fact, as we argued earlier, its being surrounded by the zona pellucida and its taking first steps in internal differentiation are good indications of its unity. The vast majority of adults, we may conclude, are trans-temporally identical to the morula and zygote they once were, despite the fact that twinning *could* have occurred. The possession of the same genome then and now is a good indication of their trans-temporal identity with the man or woman they grow into.

But what about twins, those humans that result from the actualization of the possibility of twinning? Let us assume the existence of James and John, two monozygotic twins, and let us grant that their twinning might have occurred, as S&B suggest, by budding, separation, or fission. Our examination of each of these hypothetical scenarios will yield conclusions quite different from those of S&B. It is important to note, however, that they examine the *possibility of twinning*, whereas we concentrate on the possible paths *actual twinning* may have taken.

A. Budding

Assume there is a morula developing as a unified embryo that starts to divide internally into an increasing number of blastomeres. We indicated the reasons we have to treat these blastomeres as parts of a substance (as standard biology texts do), not as a plurality of substances. Assume that after two or three days one blastomere (or more than one) branches off from the original morula and is genetically reprogrammed so that it becomes totipotent and starts to develop on its own as a different embryo. If this is how twinning happens, then it is plausible to say that James is continuous with the initial morula and John started to exist some days later after him.

B. Separation

According to this hypothesis, the zygote really contains two individual embryos, presumably from the first cleavage onwards, that later separate into two individuals. If this is the case (which seems rather implausible because separation is a model for Siamese twins and Siamese twins are thought to separate much later than normal twins, and thus share the same amnion, chorion, and placenta), then James and John would be continuous with each of the original embryos, respectively. They would have started to exist simultaneously shortly after a normal embryo would have started to exist.

C. Fission

In this scenario there would be an original embryo, let's call him Peter, that splits more or less evenly into two embryos. This anomaly entails that Peter

ceases to exist when James and John begin to exist. The demise of Peter, we suggest, does not pose any specific philosophical difficulty, and would have to be taken as a fact about which there isn't much we can do. James and John on the other hand, are continuous with each of the embryos that arose through fission, respectively.

How twinning *in fact* occurs is for empirical embryology to decide, but a hypothetical examination of the three most plausible alternatives allows us to conclude that although twinning entails a slightly later-than-normal beginning for at least one of the embryos, twins do cross "the gastrular divide." Each twin, as a singular organism, moves towards implantation and continues to develop independently, unless there is a dramatic anomaly. The overwhelming majority of human embryos, the ones merely exposed to a possibility that is never realized, definitely cross the divide. To use a comparison mentioned by S&B, they are like the United States before the Civil War: one entity that could have split into two but never did.

V. CONCLUSION

In conclusion, we have attempted to show that the thesis advocated by S&B that human lives begin at about 16 days after fertilization is untenable. Their interpretative claim that a zygote divides immediately into two substances and therefore ceases to exist is highly implausible by their own standards, and their factual claim that there is no communication between the blastomeres has to be abandoned in light of recent embryological research.[13] Finally, the argument from the possibility of twinning has been shown to be inconclusive. In sum, the vast majority of humans begin to exist at fertilization, and some twins shortly thereafter, at any rate much earlier than sixteen days.

NOTES

1. For our present purposes we will assume that the underlying ontological framework is (more or less) acceptable. So let us assume that we know what a "border" is, what a "membrane" is, and what a "causal connection" is. However, it is noteworthy that ontological commitments, which might imply severe ethical consequences, are indeed ontological *commitments*. As such they are grounded in philosophical decisions that in turn cannot be exhaustively accounted for. Hence, the so-called precautionary principle should be taken into account; for a detailed discussion cf. Damschen & Schönecker (2003, pp. 250–263).

2. To designate the first day as 0, following S&B's nomenclature, does not entail that the day in which egg and sperm fuse should not count when considering the life of the new organism. Cf. Gilbert (2000, p. 212).

3. Neither can this division be understood as separation because before splitting it is clear that there is one and not two relatively isolated causal systems.

4. Cf. Smith & Brogaard (2003, p. 60): "They are not one but many."

5. Cf. Hall et al. (1993); Kollek (2002, 69 f.).

6. Cf. Herrler & Beier (1999, p. 271): "Since human embryos . . . until shortly before implantation are surrounded by the zona pellucida, all signals of the embryonal-maternal dialogue have to penetrate

it or else be present in it. Hence one can regard the ZP as a mailbox in the dialogue between the pre-implanted embryo and the mother" (translation by Allen W. Wood).

7. Condition 10 is two-fold. The first part refers to mechanisms to maintain or re-establish internal "order" after disturbances. The fact that a blastomere can be extracted without producing a mutilation points to the existence of such mechanisms. The second part refers to a very specific kind of restoration: replacement of the external membrane. It is unknown whether this mechanism exists or not. With regard to the first part, consider the case of a dying human being: Such a human being is no longer 'able to maintain or to re-establish' the unity as a whole *while* it is dying. Would this imply that it is no longer such a unity or rather human individual? Clearly not.

8. Cf. Gilbert (2000, p. 356).

9. For a discussion of this problem cf. Damschen & Schönecker (2003, pp. 246–250).

10. Cf. Pearson (2002).

11. Perhaps this is why the discovery of non-embryonic stem cells was so surprising. These cells do not fully differentiate, and are thus functionally closer to embryonic cells than to the somatic cells surrounding them. They retain properties that were expected to have been shed long ago.

12. Gilbert (2000, p. 362).

13. S&B arguments *entirely* rest upon the assumption that the zona pellucida plays no substantial role and that there is no internal causal interaction in the early embryo. As we have seen, there is new evidence that this is not the case, that is, that the zona pellucida *does* indeed play a substantial role and that there *is* internal causal interaction in the embryo. As a matter of fact, S&B themselves refer to this new evidence. First they conclude that "empirical considerations" (p. 69) show that only at the end of day sixteen a human individual comes into existence. But then they add the following footnote: "*Or perhaps earlier*. See the new evidence, summarized in Pearson (2002), to the effect that the mammalian body plan begins to be laid down already from the moment of conception." (p. 77 n. 14, our emphasis). But if this new evidence is conclusive, then the claim that a human individual comes into existence no earlier than at day sixteen can hardly be correct.

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