A Diversified Approach to Fission Puzzles

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1. Introduction

There are many notorious puzzles about material objects, including human beings. Prominent among them are so-called fission puzzles, where an object of some sort divides into two or more objects, each of which is continuous with the original object in ways that make it challenging either to identify, or at least to explain, the original object's fate.[1] In particular, there are difficulties for the hypothesis that the earlier object is identical to both of the later objects; the hypothesis that the original object is identical to one of the later objects but not the other; and the hypothesis that the original object is identical to neither of the later objects. That does not leave much wiggle room.

[1] This is my own characterization of fission, no doubt influenced by others in the literature (for example, perhaps Thomas Sattig, *The Double Lives of Objects: An Essay in the Metaphysics of the Ordinary World* (Oxford: Oxford University Press, 2015), at p. 104.

So understood, fission puzzles come in many shapes and sizes: there are cases of fission by dividing down the middle,[2] fission by brain transplant,[3] fission by teletransportation,[4] fission by reassembly,[5] and so on. Solving these fission puzzles will require either addressing the difficulties facing one or more of the foregoing hypotheses, or finding some less obvious alternative to those hypotheses. And any solution is likely to teach us something about the nature of material objects. For example, one popular solution to fission puzzles entails that material objects have temporal parts; another entails that distinct material objects can be co-located; and another entails that material objects can be multi-located. The solution that I will defend shortly has implications for the persistence conditions of material objects - specifically, the conditions under which dividing a material object into parts suffices to destroy that object.

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[2] For example: Denis Robinson, "Can Amoeba Divide Without Multiplying?" *Australasian Journal of Philosophy* LXIII, 3 (1985): 299-319; Peter van Inwagen, *Material Beings* (Ithaca, NY: Cornell University Press), at sec. 16; David Wiggins, *Sameness and Substance Renewed* (Cambridge: Cambridge University Press), at pp. 72-73); and Kristie Miller, "Travelling in Time: How to Exist in Two Places at the Same Time." *Canadian Journal of Philosophy* XXXVI, 3 (2006): 309-334.

[3] For example, David Wiggins, *Identity and Spatio-Temporal Continuity* (Oxford: Basil Blackwell, 1967), at. p. 52ff); Derek Parfit, "Personal Identity," *The Philosophical Review* LXXX, 1 (1971): 3-27; David Lewis, "Survival and Identity," in Amelie Oksenberg Rorty, ed., *The Identities of Persons* (Oakland, CA: University of California Press, 1976), pp. 17-40; Thomas Sattig, "The Paradox of Fission and the Ontology of Ordinary Objects," *Philosophy and Phenomenological Research* LXXXV, 3 (2012): 594-623.

[4] For example: Derek Parfit, *Reasons and Persons* (Oxford: Oxford University Press, 1984), sec. 75; and Simon Langford and Murali Ramachandran, "The Products of Fission, Fusion, and Teletransportation: An Occasional Identity Theorist's Perspective." *Australasian Journal of Philosophy* XCI, 1 (2013): 105-117.

[5] For example: Brian Smart, "How to Reidentify the Ship of Theseus," *Analysis* XXXII, 5 (1972): 145-148; Robert Nozick, *Philosophical Explanations*, (Oxford: Oxford University Press, 1981), at pp. 29-47; Harold W. Noonan, "Wiggins, Artefact Identity and 'Best Candidate' Theories," *Analysis* XLV, 1 (1985a): 4-8. Harold W. Noonan, "The Only X and Y Principle," *Analysis* XLV, 2 (1985b): 79-83; and Christopher Hughes, "Same-Kind Coincidence and the Ship of Theseus," *Mind* CVI, 421 (1997): 53-67.

The usual approach to solving fission puzzles is to introduce a revisionary metaphysical idea which can be used to handle all fission cases in more or less the same way. For example, Sider uses momentary temporal parts or stages and (inter alia) casts cases of fission as cases of partially overlapping sequences of stages.[6] Call this the Unified Approach to fission puzzles. The Unified Approach has its virtues, but in this paper I want to begin developing an alternative approach to fission that I believe is equally worthy of attention.

The alternative I propose claims that there are different kinds of fission, and those different kinds of fission can and should be handled in different ways, so I will call it the Diversified Approach. The Diversified Approach seeks to assimilate each kind of fission to some ordinary phenomenon that is already present in our pre-philosophical picture of the world, such as breaking apart, duplication, or part loss. Each kind of fission should resemble the ordinary phenomenon to which it is assimilated. Other things being equal, the more a kind of fission resembles the ordinary phenomenon to which it is assimilated, the more plausible the assimilation. But since different kinds of fission resemble different kinds of ordinary phenomena, the Diversified Approach will end up giving them different treatments. One important upshot of this approach is that we cannot expect, as some do, that the various problems of personal fission in particular all have the same, or similar, solution(s).

This paper will illustrate the Diversified Approach by applying it to one of the many fission puzzles that has been discussed in the literature: the puzzle of amoebic fission. The result of applying the Diversified Approach to this case will be a novel solution to the puzzle that has a number of notable virtues. Of course, to illustrate the Diversified Approach is not to argue that it should be adopted. But it is where any such argument must begin. In order to determine whether the Diversified Approach should be preferred, all-things-considered, to the Unified Approach, we will need to

[6] Theodore Sider, *Four-Dimensionalism* (Oxford: Oxford University Press, 2001), at pp. 140-208.

explore how it solves various fission puzzles and compare those solutions to the solutions offered by the Unified Approach. This paper can only take a first step toward carrying out that project, but I will finish by indicating briefly how the Diversified Approach might be applied to other varieties of fission.

In section 2 I expand on the philosophical problem posed by cases of fission, with particular attention to the case that will be my primary focus, namely: the fissioning of an amoeba. Then, in Section 3, I develop an account of amoebic fission according to which the original amoeba ceases to exist because it breaks apart. In Section 4 I highlight some of the virtues of my account of amoebic fission by comparing it with alternative theories of fission in literature. And finally, in Section 5, I show how the diversified approach can be extended to other kinds of fission, particularly those which are prominent in the literature on personal identity.

2. The Puzzle of Fission: An Example

In some cases of fission, an object of a certain sort divides down the middle in such a way that it produces two or more objects of that same sort. One well-known example is amoebic fission: when an amoeba fissions, it divides into two amoebas.[7] In addition to real-world examples like amoebic fission, it is easy to construct imaginary cases too, like the fictional symmetric organism conceived by van Inwagen (1990: sec. 16).

I will focus on the case of an amoeba that fissions into two amoebas. Call the pre-fission amoeba 'A', and call the two fission products 'B' and 'C'. What becomes of A when it fissions? Assuming (a bit controversially) that there is a determinate answer to this question, there seem to be three possibilities.

[7] Amoebic fission is discussed by: Robinson, "Can Amoeba Divide Without Multiplying?" *op. Cit.*, pp. 299-319; Wiggins, *Sameness and Substance Renewed*, *op. cit.*, at pp. 72-73; and Miller, "Travelling in Time," *op. cit.*, pp. 309-334.

(1) A is both B and C.
(2) A is either B or C, but not both.
(3) A is neither B nor C.

The problem is that all of these options run into difficulties. Option (1) seems to require that one thing can be identical to two things, which is inconsistent with the orthodox position that identity is both symmetric and transitive. Option (2) seems arbitrary, especially if we imagine a (perhaps fictional) case of fission that is perfectly symmetric, so that B and C are qualitative duplicates. In virtue of what is A identical to B, but not C? It is hard to think of a plausible answer. What about option (3)?

Perhaps option (3) is the most commonsense answer.[8] A is neither B nor C, because A ceases to exist when it fissions, leaving behind two new amoebas in its place. But even if that is the commonsense answer, it turns out to be difficult to explain *why* A ceases to exist when it fissions. We can see this by comparing it to a case in which an organism does survive division. To borrow an example from Robinson,[9] suppose a human organism, H, loses both legs and arms simultaneously but survives this loss thanks to adequate medical support.[10] In this scenario, we start with one object, H, and then a division occurs, leaving multiple separate objects: four limbs and a further object composed of H's torso and head. Moreover, H survives as one of the post-division objects, namely, the torso-head composite. So any explanation we offer as to why the amoeba ceases to exist when it fissions should not lead us to conclude that H ceases to exist when it loses its limbs.

[8] A referee expressed this view. Simon Evnine endorses this view about fissioning worms (Simon Evnine, *Making Objects and Events: A Hylomorphic Theory of Artifacts, Actions, and Organisms* (Oxford: Oxford University Press, 2016), at p. 101).

[9] Robinson, "Can Amoeba Divide Without Multiplying?" *op. Cit.*, pp. 299-319.

[10] I make no assumptions here about the relationship between human organisms and human persons.

This constraint on explanations of A's demise rules out a number of candidate explanations. For example, we cannot say that A ceases to exist because it is one thing, while B and C are two things. After all, the same reasoning would entail that H ceases to exist when it divides, since H is one thing, and the body parts into which it divides are many things. Yet H survives as one of the multiple post-division objects. Likewise, A could survive as one of the two objects into which it divides. Nor can we say that A ceases to exist because there are differences between A and the objects into which it divides, whether those objects are taken collectively or individually. For there are also differences between H and the objects into which H divides, whether taken collectively or individually, and yet H survives. In fact, when we ask why H survives as the torso-head composite, at least one of the plausible answers seems to be that the torso-head composite retains all of the parts and properties needed for H to go on living. But, prima facie, this also seems true of A and B. B retains all of the parts and properties needed for A to go on living. Similarly for A and C.[11]

Could the fact that there are two amoebas continuous with A be the culprit? The thought here is that A does not survive as (say) B precisely because there is another fission product, C, that also retains everything A needs to survive. This suggestion has received a fair bit of attention in the literature, but the attention is not usually positive, and for good reason. It entails that A persists through all of the changes involved in going the way of fission product B unless there is another object continuous with A. So A can survive all of the intrinsic changes in size, shape, mass, parts, and so on involved in going the way of B, but it is destroyed by a purely extrinsic change: the coming into being of C, a different object altogether. This strikes many philosophers as implausible.[12]

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[11] This paragraph and the preceding paragraph expand on a point from Robinson, "Can Amoeba Divide Without Multiplying?" *op. Cit.*, pp. 299-319, and are indebted to comments from a referee.

[12] For example: Wiggins, *Sameness and Substance Renewed*, *op. cit.*, at pp. 96-102; Noonan, "Wiggins, Artefact Identity and 'Best Candidate' Theories," *op. cit.*, pp. 4-8; Noonan, "The Only X and Y Principle," *op. cit.*, pp. 79-83; E. J. Lowe, *A Survey of Metaphysics* (Oxford:

So each of the three options runs into difficulties, and yet, on the assumption that there is a determinate fact of the matter what happens to A when it fissions, the options also seem to be exhaustive. What to do? In the next section I will apply the Diversified Approach to the puzzle of amoebic fission, resulting in a new solution to that puzzle.

3. The Breakup Theory of Fission

The Diversified Approach instructs us to seek a solution to the puzzle of amoebic fission by classifying it as an instance of some ordinary phenomenon that it resembles to a non-trivial degree. I propose to classify amoebic fission as a case of *breaking apart*, and for that reason, I will call my view the Breakup Theory. But what does it mean for an object to break apart?

Material objects frequently undergo division, where division consists in the parts of an object separating from each other in such a way that at least some of them cease to be parts of that object. In some cases of division, the dividing object merely sheds some parts and goes on existing without them. That is what happens when hairs are separated from my head. In other cases of division, the dividing object ceases to exist in virtue of the division. That is what happens to a vase when it shatters. In cases of the latter kind, *all* of the dividing object's parts cease to be parts of it when they separate because the object itself ceases to exist altogether. I will reserve the term 'breaking apart' for cases of division where the dividing object ceases to exist in virtue of the division. So breaking apart is a specific kind of division.

Both division in general and breaking apart in particular may be either binary or non-binary. Suppose a board splits in two. This is a binary case of division, since it involves one object being divided into two objects. And if the board ceases to exist when it splits in two, then this is also a binary case

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Oxford University Press, 2002), at pp. 25-33; and Sattig, *The Double Lives of Objects*, *op. cit.*, at p. 105-115.

of breaking apart. Compare this to a shattering window. This is a non-binary case of division, since it involves one object dividing into many more than two objects. And if the window ceases to exist when it shatters, this is also a non-binary case of breaking apart.

Just as breaking apart is a specific kind of division, I propose that amoebic fission is a specific kind of breaking apart. When an amoeba fissions, the division that it undergoes is the sort of division that destroys the object. For this reason, we can explain why the amoeba ceases to exist by giving an account of breaking apart which encompasses amoebic fission. I will develop such an account in this section.

What exactly does it take for a case of division to be a case of breaking apart? It might be tempting to say that x breaks apart if and only if the parts that compose x cease to compose anything. In that case, the correct answer to the question of what exactly it takes for a case of division to be a case of breaking apart will follow from the correct answer to van Inwagen's Special Composition Question.[13] But this tempting thought is not correct. Suppose p_1 - p_n are the particles that compose me before a certain hair falls off of my head. On my view of composition (and on van Inwagen's own view, for that matter), when the hair falls off my head, p_1 - p_n no longer compose anything. But I still exist - losing a hair does not destroy me - so I have not broken apart. Therefore, an account of breaking apart cannot just piggyback on an answer to the Special Composition Question.

That said, composition is not entirely irrelevant to breaking apart. It is plausible that, for a composite object, O, to survive division, two conditions have to be satisfied: first, some of the particles that were parts of O when O divided compose something after the division, and second, the object that they compose after the division is identical to O. Because of the first condition, it is necessary for O's survival that relevant particles satisfy the conditions specified by the correct answer to the Special Composition Question after O divides.[14] But it is not sufficient. The mere fact that some

[13] van Inwagen, *Material Beings*, *op. cit.*, at sec. 2.

[14] Thanks to an anonymous referee for this point.

relevant particles satisfy the correct answer to the Special Composition Question does not entail that the second condition is satisfied, for it does not entail that the post-division composite object those particles compose is identical to O in particular. What we still need is an account of the conditions under which a post-division composite object is identical to the original, pre-division composite object. An object breaks apart when no post-division composite object satisfies those conditions.

To see what those conditions are, we can begin by consulting some intuitions. Suppose a boulder crumbles into many small bits of rock. This is a paradigm case of breaking apart. The boulder divides into many separate parts, and because it divides in this way, it ceases to exist. Compare this to a case where half of a boulder crumbles into bits, while the other half of the boulder remains intact. I think this is a borderline case of breaking apart. On the one hand, it is somewhat plausible that the intact half of the boulder is the original boulder, and therefore the boulder has not been destroyed. On the other hand, I do not find it difficult to suppose that the loss of such a large portion of the original boulder leaves us with only a piece (albeit a large piece) of the original. And so, by my lights, it is at least somewhat plausible that the original boulder has been destroyed, making this a case of breaking apart. I will call this the Borderline Case.

Now consider a boulder that splits cleanly in half, resulting in two smaller boulders. Call this the Division Case. Is the Division Case also a case of breaking apart? I think that hinges on what we say about the Borderline Case. If we say that the remaining half in the Borderline Case is the original boulder, then we are faced with a puzzle in the Division Case, since each half is just as qualified to be the original boulder as the half that remains in the Borderline Case. If instead we say that the remaining half in the Borderline Case is only a piece of the original boulder, and not the original boulder itself, then we should say the same of the two separated halves in the Division Case. After all, the latter do not seem any better qualified to be the original boulder than the former.

The upshot is that we can solve a fission puzzle by coming down on one side of the border in the Borderline Case. And, ceteris paribus, if we can

solve a puzzle by coming down on one side of the border, we should. So I propose that, when half of the boulder crumbles, the boulder breaks apart. And therefore, when the boulder splits in half, it likewise breaks apart. Here is a naive account of breaking apart that entails all of these claims about the boulder:

> *Breaking apart (naive account)*: x breaks apart if and only if x divides into multiple objects, none of which has substantially more than half of the matter that made up x immediately prior to division.[15]

(Of course, "substantially more than half" is vague, but so is the concept of breaking apart.) There are a few things to notice about the naive account. First, notice that it does not specify how many objects x divides into. That is because it is meant to encompass both binary and non-binary cases of division. Notice also that the account also does not tell us which post-division object is identical to the original in cases where the original does survive. Nevertheless, it is natural to add that, when an object, x, divides into multiple objects, one of which, y, *does* have substantially more than half of the matter that made up x immediately prior to division, x is identical to y. Finally, this account coheres nicely with material continuity conditions on persistence.[16] It is natural to suggest that the reason x is destroyed when it divides in the way specified by the naive account is that the division

[15] David Wiggins (Wiggins, *Sameness and Substance Renewed*, *op. cit.*, at pp. 100) and Eli Hirsch (Eli Hirsch, *The Concept of Identity* (New York: Oxford University Press, 1982), at pp. 18-19) propose similar requirements on persistence for some objects. I will not take a position here on whether matter should be understood as stuff, or as a plurality of things (such as particles), or as a set of things, or as a fusion of things. All of these views have been defended.

[16] Concerning material continuity conditions on persistence, see: Peter Unger, *Consciousness, Identity, and Value* (Oxford: Oxford University Press, 1990), at pp. 123-125; and David B. Hershenov, "Van Inwagen, Zimmerman, and the Materialist Conception of Resurrection," *Religious Studies* XXXVIII, 4 (2002): 451-469. And see Wiggins, *Sameness and Substance Renewed*, *op. cit.*, at pp. 100 for a material connectedness condition.

creates a material discontinuity between x and each of the objects into which x divides.

On the naive account, all of the boulder cases we just considered turn out to be cases of breaking apart, since in each of them the boulder divides into objects which do not have enough of the boulder's matter. But this account is a naive one because, although it works well for boulders and their ilk, it is not especially plausible for what I will call *teleological objects*. Teleological objects are objects with functions or functional parts: organisms, parts of organisms (like hands and kidneys), and artifacts. It is very plausible that teleological objects do not conform to the foregoing naive account of breaking apart. For example, suppose an octopus has all eight of its tentacles bitten off at once by a shark. We can imagine this division occurring to an octopus with proportions such that, by the naive account, the octopus is destroyed. But it does not seem to be destroyed. It may go on living for a long time and even regrow its lost tentacles (as octopuses do). So although I think the naive account is getting something right, it cannot be the whole story. The notion of breaking apart must be sensitive to teleological properties.

We can handle teleological objects with a *dominance* account of breaking apart. The rough idea is that, when an object divides, it survives division if and only if the division leaves some dominant portion of the object intact, where dominance may concern either matter or teleology. *Material dominance* consists in being an immediate post-division object with substantially more than half of the matter that made up the divided object immediately prior to division. *Teleological dominance* consists in being an immediate post-division object that inherits the central teleological parts and properties of the divided object. For organisms, these are the parts and properties necessary to sustain the organism's critical life processes; for artifacts, they are the parts and properties needed for the artifact to perform the function it was designed to perform.

Notice that these dominance relations are diachronic relations linking a pre-division object to a post-division object, not synchronic relations between post-division objects. Whether a dominance relation holds

between a pre-division object and a post division object does not depend on whether there are other post-division objects, or what features they have. So an account of breaking apart can appeal to dominance relations without running into the much-maligned view that an object's survival hinges on extrinsic changes concerning other objects.

Using the notions of material and teleological dominance, we can formulate an official statement of the dominance account of breaking apart as follows:

> *Breaking apart (dominance account)*: x breaks apart if and only if x divides into multiple objects, none of which is teleologically dominant and none of which is materially dominant.[17]

Once again, this account does not specify how many objects x divides into, because it is meant to encompass both binary and non-binary cases of division. And again, it is natural to suggest that this sort of division destroys x because it creates relevant discontinuities between x and each of the objects into which x divides. But in this case, the continuity requirement that is being violated is not a simple material continuity condition. It is a disjunctive condition that requires either enough material continuity for material dominance or the kind of teleological continuity that makes for teleological dominance.

On the dominance account of breaking apart, all of the boulder cases still qualify as cases of breaking apart, since none of the objects into which the boulder divides are materially or teleologically dominant. But the octopus does not break apart when its tentacles are bitten off because, although none of the parts into which the octopus is divided has substantially more than half of its pre-division matter, one of those parts -

[17] This account owes a debt to Wiggins, *Sameness and Substance Renewed*, *op. cit.*, at pp. 100, who suggests that an artifact persists only if it retains more than half of its original matter, or some key part that serves as a kind of nucleus, throughout its entire career.

the non-tentacle part - has everything it needs to continue living, so it is teleologically dominant. By contrast, if this part of the octopus were divided in half, it is likely that neither half would be teleologically dominant, and so this would be a case of breaking apart. On the other hand, if the octopus has one of its important internal organs removed, but its body is otherwise left intact, the octopus might die, but it does not *break apart*, since the octopus-minus-the-removed-organ is at least materially dominant (and the removed organ is not teleologically dominant). I think all of these consequences are intuitively correct, or at least not implausible.

The difficult cases of division for the dominance account are fission cases. It is natural to say that, when x divides into multiple objects, one of which is dominant (whether teleologically or materially), then the dominant object is identical to x. But what happens when more than one of the post-division objects is dominant? This can happen in two ways. First, there are possible cases where x divides into multiple objects, one of which is materially dominant and another of which is teleologically dominant. I find it tempting to say that the teleologically dominant post-division object is the original. One way to secure this verdict is to say that, when a teleological object divides, mere material dominance is not enough for a post-division object to be identical to the original; the materially dominant object must take at least some of the original object's essential teleological parts with it too. This does not happen in cases where one post-division object is materially dominant and another is teleologically dominant.

More relevant to my purposes in this paper are fission cases like that of the amoeba. When the amoeba divides, both of the objects into which it divides are teleologically dominant. So the dominance account entails that the amoeba survives, contrary to my position that it breaks apart, and it does not tell us which of the teleologically dominant objects is identical to the original amoeba. So the original puzzle still stands. We can solve this puzzle by making a tweak to the definition of teleological dominance. Let a teleologically dominant plurality, p, of x's parts be any plurality of x's parts such that (i) p includes all the parts necessary to sustain x's critical life processes, (ii) those parts instantiate all the properties necessary to sustain

x's critical life processes, and (iii) every other plurality of x's parts which satisfies these conditions shares parts with p. And now we can revise the definition of teleological dominance to say that teleological dominance consists in being a post-division object that inherits a teleologically dominant plurality of parts from the divided object.

Here is how this helps. Recall our Amoeba, A, which divides into two fission products, B and C. Before A divides, it undergoes certain preparatory changes in virtue of which it has two non-overlapping pluralities of parts, each of which include all the parts and properties necessary to keep the amoeba alive. By condition (iii) on being a teleologically dominant plurality, it follows that neither of these pluralities is teleologically dominant. For that reason, none of the objects into which A divides is teleologically dominant. And if A splits at least approximately in half, as in an ordinary case of amoebic fission, then neither B nor C has substantially more than half of the matter that made up A immediately prior to division, so neither of them is materially dominant either. It follows by the dominance account that A breaks apart and so ceases to exist when it divides.

Here is an important objection to the account I have sketched.[18] Recall the Borderline Case, in which half of a boulder crumbles while the other half remains intact. I claimed that it is unclear whether the original boulder survives, but that we should say it does not, because in doing so we avoid a fission puzzle about what happens in a case where the boulder splits in half. The Borderline Case has an analogue involving the amoeba. Suppose that an amoeba undergoes the preparatory changes that precede fission, so that it has two distinguishable halves, each of which will be its own amoeba when they separate from each other. But suppose that, instead of the two halves separating, the right half suddenly disintegrates, leaving only the left half of the amoeba. While my intuitions about the survival of the boulder in the Borderline Case are weak at best, in this case I have a clearer intuition that A survives as the remaining half of the original amoeba. But

[18] My thanks to a referee for this objection.

if A survives in this case, then it is hard to see why it would not survive fission.

My response to this objection is to insist that A does cease to exist when its right half disintegrates. To the extent that this is counterintuitive, I am biting a bullet. But once we have said that the boulder breaks apart in the Borderline Case, I think it is more plausible than it would otherwise be to say that A ceases to exist when its right half disintegrates. After all, these two cases resemble each other in non-trivial ways. In both cases, the original object loses one of two highly symmetric halves. And the symmetry is both material (each half consists of a similar amount of matter) and teleological (while each half of the boulder is alike in lacking teleological parts and properties, each half of the amoeba possesses similar teleological parts and properties). Even though the two cases are also disanalogous in important ways, it seems to me that the features they share make it less of a stretch than it would otherwise be to say that the amoeba case is a case of breaking apart. It is certainly more plausible than suggesting that the amoeba ceases to exist when it loses, say, a single organelle.

In fact, the symmetry of amoebic fission enables me to say that amoebic fission is destructive because of the discontinuity it creates. Just prior to fission, the amoeba has two non-overlapping pluralities of parts sufficient to sustain its life processes, and any one post-fission amoeba inherits only one of those pluralities. So when the amoeba divides, or when half of it disintegrates, any remaining amoebas differ significantly from the original, not only in respect of properties like size and shape, but also in respect of their teleological parts and properties, including the teleological parts and properties most central to sustaining an amoeba's critical life processes. By contrast, in Robinson's case where a human organism loses its limbs and survives as a torso-head composite, the torso-head composite inherits all of the teleological parts and properties most central to sustaining the human organism's critical life processes. So if continuity in respect of those central teleological parts in particular is a condition of survival, then maybe it is fundamentally discontinuity that destroys the amoeba.

How exactly does the Breakup Theory solve the puzzle about identity posed by amoebic fission? Recall that the trilemma we face when an amoeba, A, fissions into a pair of amoebas, B and C. There seem to be three things we can say about A's fate:

(1) A is both B and C.
(2) A is either B or C, but not both.
(3) A is neither B nor C.

The Breakup Theory embraces the third horn of the trilemma: A is neither B nor C. For A ceases to exist when it splits in two, and B and C are the two halves that it splits into. Recall that the problem with embracing this horn was that we lacked a good explanation why A ceases to exist. I have tried to provide a good explanation: A ceases to exist because A divides in the way specified by the dominance account of breaking apart, and dividing in that way is, in general, sufficient for ceasing to exist. It may also be true that, fundamentally, dividing in this way is sufficient for ceasing to exist because of the kinds or degrees of discontinuity imposed by that sort of division.

4. Advantages of the Breakup Theory

There are a variety of interesting suggestions in the literature about how to solve the puzzle posed by fission cases. I am going to bring out some of the advantages of the Breakup Theory by comparing it with some of the alternatives in the literature. These advantages all stem from the fact that the Breakup Theory instantiates the Diversified Strategy: it assimilates amoebic fission to an ordinary phenomenon (breaking apart), rather than introducing something exotic like temporal parts or co-location. But I will not argue that the Breakup Theory is all-things-considered better than its rivals. That would require a comprehensive evaluation of the broader metaphysics in which each rival view is situated, and I cannot do that here.

The first alternative to the Breakup Theory casts material coincidence in the starring role. It claims that there are actually two coincident objects prior

to fission, and when fission occurs, those two objects go their separate ways. So in the case of the amoeba, the name "A" is ambiguous. To disambiguate it, we can call the two pre-fission amoebas A and A*, and then we can say that A is identical to B and A* is identical to C. Problem solved.[19] This idea can be taken in a three-dimensional or a four-dimensional direction, resulting in two candidate solutions to the puzzle.

According to the three-dimensional solution, A and A* are three-dimensional objects which are wholly located at exactly the same regions until they fission, at which point they go their separate ways. But the idea of distinct objects wholly located in the same region is an affront to common intuitions, and to that extent it is a costly commitment. The bizarreness of material coincidence is brought out acutely by what the three-dimensional version of the story entails about the total number of amoebas that have ever existed. According to the three-dimensional story, that number peaked around the time amoebas first evolved, and has only declined since then, because fission does not produce any new amoebas; it merely separates amoebas that already exist. Robinson describes this consequence as "entertaining".[20] I am inclined to say it is a reductio.

Probably the best response to this worry is to embrace Baker's view that constitution is a kind of numerical sameness weaker than identity, and so distinct but coincident objects are the same object despite being distinct.[21] But even if you are sympathetic to this view of numerical sameness, there will remain a sense in which something very odd is true about the world's amoebas. Each of them has been around since amoebas first evolved, and their spatiotemporal paths overlap in surprising ways. There is no getting

[19] This solution is suggested by Robinson, "Can Amoeba Divide Without Multiplying?" *op. Cit.*, pp. 299-319.

[20] Robinson, "Can Amoeba Divide Without Multiplying?" *op. Cit.*, p. 319.

[21] See Lynne Rudder Baker, *The Metaphysics of Everyday Life* (New York, NY: Cambridge University Press, 2007), at pp. 37-43 and pp. 166-180. Robinson says that we count coincident objects as one, but he does not go as far as Baker, who claims that coincident objects really are numerically the same object, despite being distinct.

around the fact that A*, though classically distinct from A, was located in exactly the same place as A prior to fission.[22] By contrast, The Breakup Theory does not require that any distinct objects ever occupy exactly the same region at once, so it does not have these counterintuitive consequences.

What about the four-dimensional version of the story? This candidate solution exploits the perdurantist brand of four-dimensionalism to claim that A and A* are four-dimensional objects that partly overlap. Prior to fission, they share their temporal parts in common. After fission, they have their temporal parts to themselves.[23] This story is supposed to be an improvement over its three dimensional cousin because, although it entails that distinct amoebas are coincident prior to fission, coincidence turns out to be a special case of the innocuous phenomenon of partial overlap.

However, perdurantism entails that only a small part of a typical persisting object is present at any one time, rather than the object as a whole, which is counterintuitive. That is a cost. But it also has the same unfortunate consequences as its three-dimensional cousin regarding the world population of amoebas. Once again, if we are counting by identity, the total number of amoebas that have ever existed peaked around the time amoebas first evolved, and has only declined since.[24] At least some four-dimensionalists deal with this by declining to count by identity, but this

[22] Here is another worry. For each time an amoeba like A is going to fission in the future, there must be another amoeba coincident with A right now that can part ways with A when fission occurs. But what ensures that this is so? What happens if A runs out of coincident amoebas? Should we say that it just cannot fission anymore, despite being perfectly biologically equipped for the task? I do not find that suggestion attractive. Compare Rebecca Roache, "Fission, Cohabitation and the Concern for Future Survival," *Analysis* LXX, 2 (2010): 256-263.

[23] This solution is proposed by Lewis, "Survival and Identity," *op. cit.*, pp. 17-40. However, Lewis focuses on personal fission, not amoebic fission.

[24] See Roache, "Fission, Cohabitation and the Concern for Future Survival," *op. cit.*, 256-263, for another interesting worry about the perdurantist view of fission.

strategy has its drawbacks.[25] Moreover, even if we decline to count by identity in cases of four-dimensional coincidence, there will again remain a sense in which something very odd is true about the world's amoebas. All amoebas existing now have been around since the time that amoebas first evolved, and their spatiotemporal paths overlap in surprising ways. By contrast, The Breakup Theory allows that amoebas genuinely *reproduce* by fission: when an amoeba fissions, new amoebas come into existence.

Not all four-dimensionalists think that ordinary objects are temporally extended. Stage theorists identify ordinary objects with momentary three-dimensional objects, and they say that these objects persist by having counterparts at other times. If stage theory is true, then a third solution to the fission puzzle is available. In a case of fission there is a series of three-dimensional object stages that branches into two separate series of such stages. So A's fission consists of a series of three-dimensional amoeba stages branching into two separate series of amoeba stages. Call the pre-fission stages the A-stages; call the stages in one of the post-fission series the B-stages, and call the stages in the other post-fission series the C-stages. Once we conceive of the situation this way, the salient relation between A, B, and C is the counterpart relation rather than identity. Since the counterpart relation is not transitive, we can say that the A-stages are counterparts of the B-stages and the C-stages, but the B-stages are not counterparts of the C-stages. Problem solved.

However, stage theory counterintuitively claims that persistence is a matter of representation by counterparts, rather than a matter of numerical identity over time. That is a cost I would rather not pay. We can bring out just how counterintuitive this view of persistence is by considering, from an atemporal perspective, how many ordinary objects there are according to stage theory. For example, in the case of fission we have been discussing, each of the A-stages, B-stages, and C-stages is an amoeba. So, from an atemporal point of view, there are well over two or three amoebas - indeed,

[25] See Theodore Sider, "All the World's a Stage," *Australasian Journal of Philosophy* LXXIV, 3 (1996): 433-453.

there are continuum many - involved in this one case of fission. That is too many amoebas.

I think the stage theorist's best response to this worry is that stages which are counterparts stand in a sameness relation to each other in virtue of which they qualify as the same amoeba. Then the members of a series of amoeba stages stitched together by counterpart relations will in some sense count as just one amoeba (Hawley 2001: 64).[26] But this just relocates the problem, as it amounts to a quite bizarre view about what it takes to be one amoeba. The idea that a series of infinitely many objects, each of which is an amoeba, can itself be one amoeba, is counterintuitive. So it is an advantage of The Breakup Theory that it does not have to resort to this sort of maneuver.

The final rival to The Breakup Theory that I will consider involves multi-location, by which I mean being wholly located in two or more distinct regions simultaneously. It does not matter for my purposes whether that simultaneity is absolute or reference-frame relative. The proposal is that, when an object fissions, no new objects are produced. Instead, the original object simply begins to be multi-located. So in the case of the amoeba, A, its fission products B and C are not two distinct objects after all, but rather one multi-located object, and that object is A. Therefore A is identical to both B and C, and yet there is no need to say anything unorthodox about identity, because it is also true that B is identical to C and vice versa. Problem solved.[27]

Though some demur, I am inclined to say that synchronic multi-location is metaphysically possible. But it is another matter altogether to suppose

[26] Katherine Hawley, *How Things Persist* (Oxford: Oxford University Press, 2001), at p. 64, offers this as one possible response to the worry (among others). Thanks to David Turon for discussion of this point.

[27] On the multi-location approach to fission, see: Miller, "Travelling in Time," *op. cit.*, pp. 309-334; and Barry Dainton, *The Phenomenal Self* (Oxford: Oxford University Press, 2008), at. p. 378ff.

that it is also *actual*. Even though I think multi-location is metaphysically possible, I have a harder time with the suggestion that, say, the chairs in the auditorium might be one multi-located chair, or that the particles composing the universe might be one multi-located particle.[28] The counterintuitiveness of the multi-location theory of amoebic fission is again brought out acutely by its numerical consequences. If the multi-location view is correct, then the total number of amoebas in the world has not changed since amoebas first evolved, for amoebas never really reproduce; they merely acquire increasingly scattered locations. Indeed, if all amoebas have a common amoeba-ancestor, then there is only one amoeba! That consequence threatens to be a reductio of this view.[29] The Breakup Theory does not have the same consequence, since it entails that two distinct amoebas are produced when an amoeba fissions, thereby increasing the total number of amoebas in the world.

In sum, the Breakup Theory does not fall prey to the problems which afflict its main rivals, often because it follows the Diversified Approach's procedure of assimilating amoebic fission to an ordinary phenomenon rather than introducing something exotic to our ontology. The central notion in the theory is that of breaking apart, which is a perfectly mundane phenomenon, unlike material coincidence, temporal parts, stage theory, and multi-location. As we have seen, these exotic alternatives end up having bizarre consequences concerning how many amoebas there are.

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[28] On which, see: Hud Hudson, *The Metaphysics of Hyperspace* (Oxford: Oxford University Press, 2005), at pp. 113-116; and Justin Mooney,"Multilocation and Parsimony," *Thought: A Journal of Philosophy* VII, 3: 153-160.

[29] Another worry I have about this view is that, if fission is an object becoming multi-located, then it is natural to say that fusion is an object ceasing to be multi-located. But then we might be forced to say that any two objects which could possibly fuse are actually one multi-located object. That's not something I want to say. An alternative would be to say that objects become multi-located when they fission and coincident when they fuse. But that view would inherit the problems of both multi-location and coincidence, and would be even worse.

While none of this shows that The Breakup Theory is correct and its rivals are not, these are all advantages of The Breakup Theory.

5. Other Fission Cases

The Breakup Theory illustrates the Diversified Approach to fission puzzles. But carrying out the Diversified Approach successfully will require more than just applying it successfully to one kind of fission case. It is likely that the Breakup Theory can be extended to some other cases of fission, such as fraternal twinning.[30] But what about fission by teletransportation, fission by brain transplant, fission by reassembly, and so on? This is where the diversity component of the Diversified Approach emerges: different kinds of fission are assimilated to different ordinary phenomena. Some are cases of breaking apart, but others are not.

In my remaining space, I will try to show that the prospects for a broader application of the Diversified Approach are bright by indicating briefly how it could be applied to two other kinds of fission. For reasons of space, I will limit my remarks to fission by teletransportation and fission by brain transplant - both of which are commonly discussed in connection with personal identity - and I will not argue that the suggestions I am about to make about these two kinds of fission are in fact correct. I merely want to illustrate how the Diversified Approach might, in principle, be carried out. I will recommend different solutions to these two kinds of fission despite the fact that the cases I will consider are all cases of personal fission.

So consider fission by teletransportation. Parfit discusses fission puzzles that arise in conceivable but exotic sci-fi scenarios where teletransportation goes wrong in some way.[31] Suppose I step into a teletransporter on Earth. The teletransporter takes a careful scan of my body, destroys it, and then constructs an intrinsic, qualitative duplicate of it on Mars. If the teletransporter lives up to its name, the Martian duplicate is me. But if the

[30] My thanks to a referee for suggesting this potential application of the Breakup Theory.

[31] Parfit, *Reasons and Persons*, *op cit*., sec. 75

Martian duplicate is me, then fission puzzles arise in conceivable scenarios where the teletransporter malfunctions in certain ways. For example, suppose the teletransporter creates a Martian duplicate of me, but fails to destroy the terrestrial one. Now there is both a Martian person and a terrestrial person with a claim to being me. Or suppose the teletransporter destroys me on Earth but performs the reconstruction on Mars twice over, resulting in a pair of Martian people, each of which is equally qualified to be me. Again, we have two candidates for identity with the original.

However, I am inclined to agree with those who think that the teletransporter fails to live up to its name. The truth is that it is just a glorified copy machine: it takes the people and other objects placed inside it on Earth and makes copies of them, or replicates them, on Mars. And since the Martian creations are mere copies or replicas of the originals, there is no fission puzzle. But if the teletransporter is in fact a glorified copy machine, then something is missing from the teletransportation process that is necessary for the Martian person to be identical to the terrestrial one. What is this missing ingredient?

I am inclined to say that the missing ingredient is an immanant causal connection. Peter van Inwagen has argued that a duplicate of a deceased and decomposed person - even a duplicate made of the same atoms as the original - would not be that person because there would not be suitable causal connections between the original and the duplicate.[32] Olson and others take the missing causal connections in question to be so-called immanent causal connections: roughly, causal connections which are immanent within the persisting person or object.[33]

So, just as we can solve some fission puzzles by assimilating them to cases of breaking apart, we may be able to solve cases of fission by

[32] Peter van Inwagen, "The Possibility of Resurrection," *International Journal for Philosophy of Religion* IX, 2 (1978): 114-121.

[33] See Eric T. Olson, "Immanent Causation and Life After Death," in George Gasser, ed., *Personal Identity and Resurrection* (Surrey: Ashgate Publishing, 2010), at. pp. 51-66. For a detailed study of immanent causation, see Dean Zimmerman, Dean, "Immanent Causation." *Philosophical Perspectives* XI (1997): 433-471.

teletransportation by assimilating them to cases of another mundane phenomenon: mere copying or replication. Of course, the particular cases of replication involved in Parfit's thought experiments are not mundane in one sense; they involve an impressive bit of technology that may or may not ever be achieved. But if what the technology does is merely replicate, then there is no need to introduce exotic metaphysics like material coincidence, stage theory, or multilocation to make sense of them.

Something similar can be said for fission by brain transplant. Suppose we have a person, Sarah, whose left brain hemisphere is transplanted into another body, and whose right brain hemisphere is transplanted into yet another body, resulting in two people, Lefty and Righty. Prima facie, it seems that people can survive both hemispherectomies and brain transplants. But then each of Lefty and Righty seem to have what it takes to be Sarah. And yet they cannot both be Sarah.[34]

The Breakup Theory does not seem well-equipped to handle this puzzle. True enough, Sarah is divided, and it is doubtful that any of the objects into which Sarah is divided are teleologically dominant, since none would live long without artificial assistance. But one of the objects into which Sarah is divided - the object that consists of all of Sarah apart from her two brain hemispheres - has most of the matter that made up Sarah immediately prior to her division, and therefore it is materially dominant. So by my dominance account, Sarah does not break apart. What then is Sarah's fate?

I am inclined to accept animalism: the view that we are human organisms or animals.[35] Animalists usually contend that, because we are human animals, and human animals do not go where their brains go in brain transplants, we do not go where our brains go in brain transplants.

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[34] This case is usually associated with Parfit, "Personal Identity," *op cit.*, pp. 3-27. But Parfit attributes it to Wiggins, *Identity and Spatio-Temporal Continuity*, *op. cit.*, at. p. 52ff.

[35] Animalism has been championed in recent years by Olson (Eric T. Olson, *The Human Animal: Personal Identity Without Psychology* (Oxford: Oxford University Press, 1997); Eric T. Olson, *What Are We? A Study In Personal Ontology* (Oxford: Oxford University Press, 2007)); and Paul F. Snowdon, (Paul F. Snowdon, *Persons, Animals, Ourselves* (Oxford: Oxford University Press, 2016)), among others.

Instead, when our brains are transplanted, they cease to be part of us. So when Sarah's brain hemispheres are transplanted, Sarah is left behind, and therefore neither Lefty nor Righty is Sarah. This approach solves the double transplant puzzle by assimilating it to the ordinary phenomenon of mereological change. Losing a brain is like losing a heart or a liver: it is a case of part loss, albeit perhaps a deadly one (Olson 2007: 41-42).

Animalism is controversial, to say the least, and this is not the place to mount a defense of the view. But it is a serious contender in the contemporary debate about personal identity and it shows that there is at least one way to extend The Diversified Approach to cases of fission by brain transplant. This might even make animalism more attractive to those drawn to The Breakup Theory and The Diversified Approach to fission.

Either way, it seems to me that the Diversified Approach to fission has promise. No doubt, some philosophers will find it unattractive. While the Unified Approach treats all fission puzzles in more or less the same way, the Diversified Approach is more piecemeal and so might seem inelegant. But I think that this is an illusion. Although the Diversified Approach looks like a mess when we consider only the handful of puzzles under discussion and see that it is tackling each of them in a different way, things look different - even elegant - when we zoom out to see the bigger picture in which fission cases are situated. The Diversified Approach does not unify fission cases with each other, but it does unify them with the larger world in which they are found by assimilating them to familiar phenomena that we already believe in. To the extent that this approach succeeds, it does not paint a more complicated picture of the world than the one we start with; it just sheds light on parts of the picture that were already there.[36]

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