

What it is to die

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1. The Paradox of Cryptobiosis

The term **cryptobiosis** was coined by the biochemist David Keilin for ‘the state of an organism when it shows no visible signs of life and when its metabolic activity becomes hardly measurable, or comes reversibly to a standstill’ (1959: 166). Cryptobiosis can be achieved artificially, as when a human embryo is frozen in a lab, later to be thawed and implanted, or naturally, as when a tardigrade (a tiny insect-like animal with eight legs and a multi-lobed brain) dehydrates and later, in response to normal environmental changes, rehydrates and returns to an active state.

Consider a cryptobiotic tardigrade — call it Grady — that will return to an active, obviously living state in a few months. Let’s assume that the metabolisms in cryptobiotic organisms have not merely slowed, as in dormancy or hibernation, but ceased. (More on this later.) Then we can ask: What is Grady’s status now, while cryptobiotic? Is Grady alive? Dead? Both? Somewhere in between?

These questions about Grady give rise to a **paradox**, a set of propositions each of which is plausibly true, or at least tempting, when considered on its own, but which are collectively inconsistent: it is impossible for them all to be true together. The propositions are:

- (1) Grady is not alive.
- (2) Grady is not dead.
- (3) Everything is either alive or dead. (Call this **Exhaustivism**).

This is the **Paradox of Cryptobiosis**. To see why this obviously inconsistent set counts as a *paradox*, we need to see why each proposition is at least tempting on its own. (1) might seem plausible, on the grounds that Grady is not undergoing any of the processes that are constitutive of life: for example, Grady is not moving, growing, reproducing, eating, or metabolizing. And (2) might seem plausible, on the grounds that if a thing is not badly damaged and will be alive in the future, then it is not dead now. Finally, one might take it to be obvious that ‘dead’ means the same thing as ‘not alive’, hence that Exhaustivism is true by definition. So, all three propositions have something going for them (and some of the arguments for them will be improved upon later). But since they’re inconsistent, at least one of them must be false.

A *solution* to the paradox will correctly identify the false proposition(s), and will justify its verdicts. Paradoxes are important not because they evoke a feeling of mystery, but because they offer an opportunity to identify and correct a mistaken belief (or tendency to believe), and thereby to learn something. We begin with a tendency to believe each of the relevant propositions and without any clear

awareness of their inconsistency. By the end, if all goes well, we know that the propositions are inconsistent, and we know which ones are false.

My goal here is to defend accounts of what it is to be alive, and what it is to die, that solve the Paradox of Cryptobiosis. I will argue that (1) and (2) are true and that Exhaustivism is false: Grady is neither alive nor dead. To a first approximation, to be alive is to be undergoing certain vital processes, and to die is to cease to be capable of undergoing those processes, in a sense of 'capable' that, in section 9, I attempt to clarify without reductively defining. This opens up space for things, such as Grady, that are not undergoing the relevant processes, and so are not alive, but have not lost the capacity to do so, and so have not died and are not dead.

2. Applications to Human Death?

Thinking carefully about what it is to be alive and what it is to die, in abstract and general terms, can be useful in making progress on more concrete, practical issues.

Consider the case of a twenty-year-old car accident victim who has suffered 'brain death' (complete and irreversible loss of function of the entire brain, including the brain stem), but many of whose physiological processes continue, with some artificial support, and many of whose organs are in excellent condition and could be used for transplantation. For example, although the patient's brain stem no longer regulates breathing, a ventilator blows air into her lungs, which remain healthy and continue to perform the complex task of oxygenating her blood; her heart continues to beat without any artificial stimulation; her body successfully fights off infection; its wounds heal.

This patient is legally dead in the U.S. But that is a question of law, which is separable from the biological question, 'Is she alive or is she dead?' Ordinarily we assume that there is no third alternative. But a careful examination of the properties of being alive and being dead, which attempts to be fully general and so pays attention to non-human as well as human cases, may call that assumption into question. Perhaps there is reason to think that the patient is neither alive nor dead. Even if not, the highly abstract project pursued here promises to give us a clearer 'big picture' of the theoretical landscape.

The current project may also shed light on questions about the moral significance of being alive and being dead. It may be tempting to assume that if someone has volunteered to be an organ donor, then it becomes morally permissible to procure their organs when they cease to be alive. But presumably it would be no less wrong to procure organs from a non-living, cryptobiotic patient (were such a case to arise) than from a still living patient. If so, then the distinction between being alive and not carries less moral significance than we may be tempted to assume. Perhaps the morally important distinction, then, is between being dead and not? Although I will not pursue this question here, a clearer understanding of what it is to be dead will obviously be helpful in addressing it.

3. What It Is To Be Alive: Activism Stated

Let's return to the topic of cryptobiosis. Three rival views about the status of cryptobiotic organisms have been defended in the scientific and philosophical literature:

Still-Alive: cryptobiotic things are alive (Luper 2009: 44).

Already-Dead: cryptobiotic things are dead (Wilson 1999: 101).

Neither-Nor: cryptobiotic things are neither alive nor dead (Wreen (1987), Feldman (1992: 60-62), Persson (1995: 500), Clegg (2001: 615), Belshaw (2009: 9), DeGrazia (2014: 83)).

In this section, I present Activism, an account of what it is to be alive. In section 4, I will use this account to argue that cryptobiotic organisms are neither alive nor dead.

Being alive, I will assume, is a property that is shared by things across the biological spectrum. Bacteria, human skin cells, trees, cats, and human beings can all be alive, in the same sense of 'alive'. Further, being alive is an **internal** property in the sense, roughly, that whether or not a cell or organism counts as alive at a given time t is purely a matter of what is going on within the boundaries of the organism at t , together perhaps with facts about the laws of physics and facts about what is going on inside the organism throughout any arbitrarily brief chunk of time whose midpoint is t . (Without the facts about how things are throughout a chunk of time around t , we might not have enough to determine the facts about, say, the motions of an organism's constituent particles at t . If its particles aren't moving in certain specified ways, it may fail to count as alive. But to determine how its particles are moving at t , we may need facts about their locations before and after t .)

Since being alive is internal, there is no possible situation in which two organisms are atom-for-atom duplicates throughout a given, say, tenth of second with t as its midpoint and are governed by the same laws of physics but in which one of them is alive at t and the other is not. (Henceforth by 'laws' I will mean laws of physics.) Not all properties are internal. *Being in the path of a falling boulder* is not internal. There is a possible situation in which two people, A and B, are atom-for-atom duplicates but A is in the path of a falling boulder at t and B is not. *Having existed for more than two days* is not internal. There is a possible situation in which two water molecules, C and D, are duplicates at a time t , but C has existed for more than two days, whereas D has not, because it was created in a chemical reaction just one day ago. Whether or not something has the property *having existed for more than two days* at a time t is a matter of the thing's history prior to t , not a matter of what going on within its boundaries at t . But many familiar properties are internal. Being two 2 kg in mass is internal. Having a temperature of 98.6 degrees F is internal. So is being alive.

That much is mostly common ground. **Activism** is somewhat more informative and controversial. We can think of Activism as a partially filled-in template, rather than a fully fleshed out account of what it is to be alive. Stated in simple terms, the idea is roughly this: for a thing to be alive is for that thing to

be using matter and energy from its environment to maintain itself. A more careful formulation of Activism is this: there are internal conditions (properties), *Cs*, and processes (process types), *Ps*, meeting the constraint *that the Ps are causal processes whereby a thing can acquire matter and energy from its environment and use this matter and energy to maintain and repair itself, thereby retaining a fairly stable large-scale structure despite gradual and nearly continuous turnover in its constituent matter*, but otherwise left open, such that for a thing to be alive is for it to be in one of the *Cs* and to be actively undergoing a mix of the *Ps* appropriate to that condition.

The reason for mentioning both *conditions* and *processes appropriate to those conditions* is to make room for the view that cells or organisms with different structures (for example, a bacterium and a human being, or an early human embryo and an adult human being) need to be undergoing different processes in order to count as being alive. One might want to say that (i) if a thing is in a condition characteristic of an adult human being, then it can't count as being alive without brain function, but that (ii) if a thing is in a condition characteristic of a normal early human embryo (with no brain), it can count as being alive without brain function. Our formulation of Activism allows for this. (See Persson (2002) for a helpful discussion of human death that takes early embryos into account.)

Let's abbreviate Activism as follows: for a thing to be alive is for it to be undergoing *the relevant vital processes*. I've said little about those processes. But it is plausible that, in all *actual* cases at least, and probably in any possible situation governed by the actual laws, if an organism or cell is not **metabolizing**, then it is not undergoing the relevant processes and so according to Activism is not alive (Dennett 1995: 127; Boden 1999).

What is it to metabolize? Roughly, it is to have molecular parts within cells that are undergoing certain chemical reactions – reactions in which energy is extracted from fuel and used to power various processes and activities, including the construction of organic material and the elimination of wastes. According to biologist James Clegg, 'a metabolism must consist of systematically controlled pathways of enzymatic reactions, governed in rate and direction, integrated and under the control of the cells in which they are found' (2001: 615). For now, the point is this: where these systematically controlled sequences of chemical reactions are absent, the relevant vital processes are absent.

4. Cryptobiotic things are neither alive nor dead

With Activism in place, we are in a position to argue that cryptobiotic organisms are neither alive nor dead.

First, we can argue that they are not dead. Cryptobiotic things are mostly intact and undamaged. They can resume their vital processes relatively easily, without first being repaired. Their internal condition ensures that they are capable of undergoing the relevant vital processes, and that they have a

disposition to resume those processes in response to appropriate stimuli. But if all of this is true of something, then it is not dead.

Next, we argue that they are not alive. Call this the No Metabolism Argument, which we set out in standard form:

- Premise 1 Cryptobiotic things are not metabolizing.
- Premise 2 Things that are not metabolizing are not undergoing the relevant vital processes.
- Premise 3 Things that are not undergoing those processes are not alive.
- Conclusion Cryptobiotic things — such as Grady — are not alive.

Working backward, Premises 3 and 2 were discussed in section 3. Premise 3 follows from Activism, our account of what it is to be alive. Premise 2 can be supported by enumerative induction, among other things. We have observed many things to be undergoing the relevant processes and metabolizing, but we have never observed something to be doing the former but not the latter. Finally, Premise 1 has been defended in different ways by biologists such as Keilin (1959), Clegg (2001: 615), and David Wharton. Wharton writes that

One of the most sensitive techniques for detecting metabolism is to feed an organism radiolabelled glucose and look for CO₂ production. This method is capable of detecting metabolism that is 0.01% of normal levels. Metabolism cannot be detected in anhydrobiotic [cryptobiotic due to dehydration] nematodes using this technique (2015: R1114). . . .

This does not establish the absence of metabolism with absolute certainty, but it makes it a reasonable position to hold pending further evidence.

It follows from the conclusions of the two arguments given above that cryptobiotic things are neither alive nor dead, i.e., that Neither-Nor is true.

5. The Capacitist Objection to the No Metabolism Argument

The argument above can be resisted by replacing Activism with **Capacitism**. A careful formulation of Capacitism would be parallel to our longer formulation of Activism, but we will work with a shorter version: for a thing to be alive is for it to be undergoing *or capable of undergoing* the relevant vital processes, in a sense of ‘capable’ discussed below. (See Luper (2009: 44-45) and, for a similar view, van Inwagen (1990: 146-149).) Activists and Capacitists can agree about which vital processes are relevant (for which internal conditions). For simplicity, I will assume that they *do* agree about this. What they disagree about is whether being *capable* of undergoing those processes is sufficient for being alive. Capacitists say ‘Yes’; Activists say ‘No’.

Cryptobiotic organisms are not metabolizing, or so I will assume. But they are *capable* of metabolizing and undergoing any other processes that might be relevant, as shown by the fact that they return to normal activity so easily. So, according to Capacitism, these organisms are alive. Capacitists

therefore deny Premise 3 of the No Metabolism argument, along with its conclusion. They say that cryptobiotic organisms are still alive. They think that the solution to the Paradox of Cryptobiosis is to deny proposition (1) and say that our tardigrade Grady is still alive, since it has the relevant capacities.

6. The Activist Reply

I now offer a brief defense of Activism. We can start by noting that some biologists have sided with Activism against Capacitism, at least with regard to cryptobiotic organisms. John Maynard Smith writes:

A freeze-dried insect is not alive: it was alive, and may be alive again in the future. Energy must be supplied in either the form of suitable chemical compounds or as sunlight, and in either case atoms are continuously entering and leaving the structure of the organism (1986: 2).

Clegg goes further and endorses Neither-Nor:

an organism in anhydrobiosis lacks all the dynamic features characteristic of living organisms, notably due to the lack of an ongoing metabolism to transduce energy and carry out biosynthesis. In that sense it is not 'alive,' yet neither is it 'dead' since suitable rehydration produces an obviously living organism. . . there are three states of biological organization: alive; dead; and cryptobiotic (2001: 615).

However, the dispute between Activism and Capacitism is not purely empirical. It cannot be settled in any direct way just by consulting the scientific data. Activists and Capacitists can agree about all this data. They can agree about the biochemistry of metabolism and about what is occurring at the biochemical level in cryptobiotic organisms. What they disagree about here is whether those organisms, which are not undergoing the relevant processes but have the capacity to do so, count as being alive. Maynard Smith and Clegg simply *presuppose* that the correct answer is 'No'. I happen to agree. But Maynard Smith and Clegg don't give any *argument* for this answer that has the potential to rationally persuade our target audience – namely, those (such as Luper and van Inwagen) who are informed of the relevant data and still accept Capacitism or remain undecided about it.

Can we do better? Here is a try. It is far from being a knock-down argument, but it may carry some weight. First, it is a necessary truth that a thing is alive at a time *t* if and only if it is *living* at *t*. Second, to be living is relevantly similar to many other less controversial biological properties, such as to be *digesting*, to be *photosynthesizing*, and to be *breathing*. Third, these latter properties all require biological activity, not merely the capacity for such activity. It is impossible for a thing to be digesting or photosynthesizing or breathing at given time without undergoing the relevant active processes at that time. So, by analogy, it is plausible that to be living, a thing must be undergoing the active processes relevant to living. But in that case, given my first premise, it follows that undergoing active processes, not merely being *capable* of undergoing them, is a necessary condition for being *alive*. So, contrary to what Capacitism says, cryptobiotic organisms are *not* alive.

7. The Exhaustivist Argument for Capacitism

Are there any arguments in *favor* of Capacitism? One such argument relies on some premise such as **Exhaustivism**: everything is either alive or dead. The argument continues: since cryptobiotic things are not dead (as indicated by the easy resumption of their vital processes), they must be alive, and the most plausible account of life that allows for this is Capacitism. This is the Exhaustivist Argument for Capacitism.

The problem with the Exhaustivist Argument is that Exhaustivism is false. It's not as if being alive and being dead are *contradictories*, like being green and being non-green, so that everything must have one or the other. Rather, they are *contraries*, like being green and being red. Nothing can have both, but many things (for example, yellow things) have neither. Many things – rocks, toasters – are neither alive nor dead.

This shows both that Exhaustivism is false and that 'dead' does not mean the same thing as 'not alive'. To be dead, a thing needs to have died, and to have died, a thing needs to have been alive or cryptobiotic, which toasters never have been. Being dead is a partly historical property and therefore not internal. An atom-for-atom duplicate of a dead thing need not be dead. In principle, with sufficiently advanced nanotechnology, scientists could manufacture an atom-for-atom duplicate of a dead bacterium. The bacterium was alive, then died, and is now dead. The duplicate was never alive, never died, and so is not now dead. And yet the two things are perfect duplicates. They have exactly the same internal properties.

One might try to fix the Exhaustivist Argument by replacing Exhaustivism with something like **Exhaustivism***: if a thing is alive at one time, t , then for any other time t^* , that thing is either alive at t^* or dead at t^* . Toasters, rocks, etc., aren't counterexamples to this principle, since no toaster is alive at any time. But Exhaustivism* is vulnerable to counterexamples as well. (I leave these as exercises for the reader.) In any event, such principles are dubious from the outset. Given that toasters are neither alive nor dead, there is nothing weird about this status.

We should pause to note that this solves the Paradox of Cryptobiosis. Propositions (1) and (2) are true, as I've argued, and so Exhaustivism must be false. But now we know that Exhaustivism should *also* be rejected for reasons that have nothing to do with cryptobiosis. Since being dead is a historical property that requires having died, all non-biological objects (such as rocks and toasters) are neither alive nor dead, despite the fact that they are not cryptobiotic. Exhaustivism never should have been tempting in the first place.

8. What is it to die? Cessation and Neutral Incapacitation

What is it to die? One constraint that any answer must respect is **Becoming-Dead**: necessarily, a thing dies at a time t if and only if the thing becomes dead at t . So far, so good. But it would be better to say something more informative, by spelling out the relationship between what it is to die and what it is to be alive. The simplest plausible account is **Cessation**: for a thing to die is just for it to cease to be alive. Unfortunately, Cessation is in tension with Neither-Nor.

To see the tension, suppose that Greta is a tardigrade that is undergoing the relevant processes, and is clearly alive, throughout some interval leading up to t_1 ; that Greta ceases to undergo those processes, and becomes cryptobiotic, at t_1 ; that Greta is cryptobiotic from t_1 to t_3 , when Greta's vital processes resume; and that Greta is alive from t_3 to t_4 , at which moment Greta is crushed by a falling rock. At t_4 , Greta ceases to be capable of undergoing the relevant vital processes. (The notion of a capacity is discussed in the next section.)

Let t_2 be a time between t_1 and t_3 . According to Neither-Nor, since Greta is cryptobiotic at t_2 , Greta is not *dead* at t_2 or at any time during the $t_1 - t_3$ interval. So Greta did not *become* dead at t_1 . So – by Becoming Dead above – Greta did not *die* at t_1 . However, again given Neither-Nor, Greta did cease to be *alive* at t_1 , when the relevant vital processes ceased. So Greta is a counterexample to Cessation. Greta ceased to be alive, but did not die, at t_1 (Feldman 1992: 60-62). Cessation is false.

A natural alternative, which can be accepted by Activists and Capacitists alike, is **Neutral Incapacitation** (NI): for a thing to die is for it to cease to be either undergoing or capable of undergoing the relevant vital processes. (A similar view is defended by Persson 1995.) More carefully: there are internal conditions, the *Cs*, and processes, the *Ps*, meeting the constraints given in the previous section, such that for a thing to die at t is for the thing to be in one of the *Cs* throughout some interval leading up to t , and for the thing to cease, at t , to be either *undergoing* or *capable of undergoing* the mix of *Ps* appropriate to that condition. Both Activists and Capacitists agree that Greta dies upon being crushed, not upon entering cryptobiosis. NI gives both camps a common explanation of why this is. Only when crushed does Greta cease to either undergo or be capable of undergoing the relevant processes.¹

9. What is it to be *capable of undergoing the relevant processes*?

The basic idea behind NI is that there are certain processes associated with life, and if a given organism ceases to undergo these processes but remains capable of undergoing them, the organism may or may not cease to be *alive*, but it doesn't then *die*. Instead, it dies when and only when it ceases to be capable of

¹ For the record, I reject NI, though for reasons that are not relevant here. For counterexamples to NI and the necessary repairs, see Gilmore (2013) and Gilmore (2016).

undergoing them. (A similar idea lies behind many accounts of death. Consider the Uniform Determination of Death Act: “An individual who has sustained either (i) **irreversible** cessation of circulatory and respiratory functions, or (i) **irreversible** cessation of all functions of the entire brain, including the brain stem, is dead” (1981: 73, boldface added). Compare that to a parallel statement framed in terms of capacities: an individual (i) who has ceased to engage in circulatory and respiratory functions and who **is not capable of** engaging in these functions again, or (ii) who has ceased to engage in all functions of the entire brain, including the brain stem, and who **is not capable of** engaging in them again, is dead. It is an interesting question whether these two statements disagree, and if so how.)

Given how much weight we are placing on the notion of a capacity, we should ask: ‘What is it to be capable of undergoing the relevant processes?’ Here are three tempting answers; each can be plugged in to NI to yield a more informative account of what it is to die. (Feldman 1992, Persson 1995, and Belshaw 2009: 31-38 cover similar ground.)

A1: Technological possibility. For a thing x to be capable at t of undergoing the relevant processes is for it to be technologically possible, at t , to cause x to undergo those processes.

A2: Physical possibility, holding fixed everything about the actual past and present. For a thing x to be capable at t of undergoing the relevant processes is for there to be nothing about the past or present that, together with the laws, rules out x ’s undergoing those processes at some later time.

A3: Physical possibility, holding fixed only x ’s current internal properties. For a thing x to be capable at t of undergoing the relevant processes is for there to be nothing about x or x ’s internal properties at t that, together with the laws, rules out x ’s undergoing those processes at some later time. (See Persson 1995: 506.)

A1 can be rejected on the grounds that it conflicts with the fact that *being capable of undergoing the relevant processes* is an internal property. Suppose that, in 2020, I fall into an icy lake and my vital processes come to a halt. Further, suppose that these processes can be restarted, but only with the help of post-1970s technology. Suppose also that exactly the same thing happened to my great-grandfather, in 1920. Suppose that he and I were atom-for-atom duplicates from the moment we fell into the lake until five minutes after we were pulled out. Then, according to A1, I still have the capacity to undergo the relevant processes when I am pulled out of the lake (because of the availability of the necessary technology) but my great-grandfather does not (the technology not being available in his day). And yet we have exactly the same internal properties at the given times. So, according to A1, the relevant capacity is not an internal property. Since that capacity *is* internal, A1 is false.

Relatedly, when A1 is plugged into NI, it yields the result that my great-grandfather dies while he is in the lake but I do not. But that can’t be right, given our perfect internal similarity throughout the process. Whether an organism dies at a time t is, in the relevant sense, internal (Hershenov 2003). It is

purely a matter of what is going on in the organism throughout any arbitrarily brief chunk of time with t as its midpoint. So the version of NI associated with A1 should be rejected as well.

A2 can be ruled out for similar reasons. Let O be some cryptobiotic organism located on a ledge near the base of a sheer granite cliff. Suppose that, at t_1 , O is not undergoing the relevant processes, but nothing about the past or present, together with the laws, rules out O's undergoing those processes in the future. Now suppose that, at t_2 , an atom of uranium, embedded within the cliff face about 300 feet above O, non-deterministically decays. Prior to t_2 , nothing about the universe or the laws guaranteed that the atom would decay at t_2 . But it did decay then. Its decaying triggered several other small changes in the surrounding rock, which were just enough to dislodge a house-sized block of granite which had been precariously attached to the wall. Once the atom decayed, the total state of the universe, together with the laws, guaranteed that the block would fall, hit the ledge below, and pulverize O so completely that O would never undergo the relevant processes again. So it was at t_2 that it became physically impossible, in the relevant sense, for O ever to undergo the relevant processes again. However, the block did not actually hit O until t_4 , a few seconds later.

Now consider a time t_3 during the block's fall, and suppose that O has exactly the same internal properties at t_3 that it had at t_1 . Given that the capacity to undergo the relevant processes is internal, it follows that O has that capacity at both t_1 and t_3 or at neither time. A2 conflicts with this. According to A2, O has the capacity at t_1 , when it remained open that O might undergo the relevant processes again in the future, but O does not have the capacity at t_3 , after it has been settled by changes in O's surroundings that O will never undergo the processes again, but before O is damaged by the block. So A2 should be rejected. (This argument presupposes the falsehood of determinism, the thesis that the internal state of the universe at any one time, together with the laws, guarantees everything about the internal state of the universe at all later times. Exercise: show that A2 is false on the assumption that determinism is true.)

Relatedly, when A2 is plugged in to NI, it yields the result that O dies at t_2 , when the far away uranium atom decays (despite the fact O does not undergo any internal damage at that time). This shows that we should reject the relevant version of NI as well (Feldman 1992: 65; Gilmore 2013: 20).

A3 faces a different problem. Let Beta be a bacterium. At t_1 , Beta is actively alive. At t_2 , Beta is frozen and cryptobiotic. At t_3 , Beta suffers internal damage while frozen: its cell membrane remains intact, but its chromosome is broken up into several parts, as are many of its ribosomes and proteins. Before Beta suffered this damage, it was true that if Beta were thawed and otherwise left alone, it would have resumed normal activity. After the damage, at t_4 , this is no longer true. What is true instead is that if Beta were thawed and otherwise left alone, it would decompose. Given all this, it seems that Beta died at t_3 , when it was damaged, and that, at t_4 , Beta is dead and not capable of undergoing the relevant vital processes.

However, I strongly suspect that A3 conflicts with these verdicts. According to A3, in order for it to be true that

(i) Beta is not capable, at t_4 , of undergoing those processes,

it must be true that

(ii) Beta's internal condition at t_4 , together with the laws, rules out Beta's undergoing those processes at any later time.

I say that (i) *is* true. But (ii) seems extremely unlikely. Granted, Beta is in bad shape internally at t_4 . Left alone, Beta will not return to an active state. But presumably, with the intervention of sufficiently advanced nanotechnology, Beta could be repaired, and the damage to Beta's constituent molecules could be reversed – all without the violation of any laws (Gilmore 2007: 25; 2013: 23-26).

When a car, parked with the engine off, is damaged and loses the capacity to run, it does not then become physically impossible for the car ever to run again. The car can be repaired and made to run again. I can't prove that the same is true of organisms in cases like Beta's, but it would be very surprising if it weren't. Organisms are more complex, so when they 'break' and lose the relevant capacities, they are harder to repair. But it doesn't follow – and it seems highly unlikely – that in *all* cases, when they lose the relevant capacity, it becomes *physically impossible* for them to return to activity. So my view is that A3 is almost certainly false.

Likewise for the version of NI that results from plugging in A3. (Here I depart from Feldman (1992) and Persson (1995), who take the equivalent of NI, spelled out in terms of A3, to adequately address problems about cryptobiosis.) If what I've said about Beta is right, then the 'A3 version' of NI yields the (I think false) result that Beta does not die at t_9 , when it suffers the specified damage.

I've said what the relevant capacity is *not*. I haven't said what it *is*. Unfortunately I don't have a reductive account to offer. But all accounts have to stop somewhere. And even where no further reductive account is given, one can still clarify – by, among other things, offering examples, constraints, and analogies. To that I now turn.

Examples: The relevant capacity is had by all actively living things and also by cryptobiotic things, but not by clearly dead things (Lenin) or non-biological objects (rocks). Constraints: the relevant capacity, whatever it is, should turn out to be: (i) internal, (ii) a property that, when lost, is at least *difficult* to regain without advanced technological help, and (iii) a property that a thing can lose even though it remains physically possible, at least with the help of advanced technology, for the thing to be actively alive in the future. Analogies: consider a cryptobiotic organism; it is capable of undergoing the relevant processes but is not currently undergoing them. It is like a car or computer that is turned off but in perfect working order. If the organism is damaged and loses the relevant capacity, in the manner of Beta, it is like

a car or computer that is broken and won't turn on. These things all lack the disposition to become active in response to the appropriate stimuli, and it is extremely improbable that they will ever become active again unless they are first *repaired*. Such repairs may be difficult. For most organisms, even the most 'freshly incapacitated', the needed repairs may exceed the reach of any future human technology. But that's a far cry from being physically impossible.

10. Conclusion

In section 2 it was suggested that a 'brain dead' patient might turn out to be neither alive nor dead. But now we can see that, while cryptobiotic organisms are neither alive nor dead, 'brain dead' human beings are quite different: they are either alive or dead (though Activism and NI do not say which). The key feature of cryptobiotic organisms that allows them to be neither alive nor dead is that they have an *unexercised* capacity to undergo certain vital processes. Typical 'brain dead' patients do not. When it comes to the relevant processes, they are doing everything they are capable of doing. They are capable of metabolizing, circulating their blood, oxygenating their blood, and so on, and they are in fact doing those things. They are not integrating and controlling these processes with their brains, they are not consciously thinking or experiencing anything, and indeed, they are not even capable of doing any of that. So, if there is an argument to be made that these individuals are not dead, it will have to be made by appeal to the processes that these patients are actively undergoing. If this argument is successful, it will show not only that these individuals are *not dead*, but further, that they are *alive*.²

References

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