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Draft - comments welcome

Conjoined Twinning & Biological Individuation

Abstract: In dicephalus conjoined twinning, it appears that two heads share a body; in cephalopagus, it appears that two bodies share a head. How many human animals are present in these cases? One answer is that there are two in both cases – conjoined twins are precisely that, *conjoined twins*. Another is that the number of humans corresponds to the number of bodies – so there is one in dicephalus and two in cephalopagus. I show that both of these answers are incorrect. Prominent accounts of biological individuation, which treat the organism as an integrated whole, reveal that in both cases the 'twins' share a single human animal. This has a number of consequences for the debate about what we are. First, if animalism is true, individuals of our kind can be – and are – profoundly psychologically divided. Second, cephalopagus twinning does not divide animalism from its rivals, as has been claimed. Finally, animalists can reply to a vicious species of the 'too many thinkers' problem to which they are allegedly uniquely vulnerable.

0. Introduction

In dicephalus conjoined twinning, it appears that two heads share a body. In cephalopagus conjoined twinning, it appears that two bodies share a head. How many animals are involved in these cases of conjoined twinning? One answer is that both dicephalus and cephalopagus conjoined twins are precisely that – *conjoined twins* (Snowdon, 2014). In both cases, there are two human animals fused together. Another is that the number of animals corresponds to the apparent number of bodies – so, dicephalus is a two-headed animal, whilst cephalopagus is two animals sharing a head (Campbell & McMahan, 2016). In this paper, I appeal to accounts of biological individuation to show that neither of these answers is correct: both cephalopagus and dicephalus involve a single human animal.

This has a number of consequences for the personal identity debate. Dicephalus and cephalopagus twinning are supposed to make trouble for animalism, the view that we are human animals, by showing that 'the number of us can differ from the number of human animals' (Olson, 2014). In dicephalus, it looks as though two of us share an animal. If each of us were identical to an animal, as animalists claim, the two of us in dicephalus would be identical to the one animal. But then they would be identical to one another – which they are not. In cephalopagus, it looks as though two of us share a brain. But then animalists must say that there are two thinkers for every thought in cephalopagus – rather than one, as it appears. This allegedly presents animalism with a 'too many thinkers' problem more vicious than similar problems facing its rivals (Campbell & McMahan, 2010, 2016). Animalists have responded by

arguing that dicephalus involves more than one animal, either in all actual or all possible cases (Blatti, 2007; Liao, 2006; Olson, 2014; Snowdon, 2014), but accepting that cephalopagus involves two (Olson, 2014). This paper shows that this response is a mistake: both dicephalus and cephalopagus are one animal. But it also provides animalists with a reply to their vicious 'too many thinkers' problem.

I begin with dicephalus. In §1, I explore existing arguments for the 'two animal' construal of dicephalus, and find them wanting. In §2, I argue that on any prominent account of biological individuation, the biological particular naturally referred to as 'both twins' will qualify as an organism. In §3, I argue that these same accounts of biological individuation rule out the possibility that the two 'twins' are organisms. So, dicephalus is a single organism. In §4, I show that the same considerations motivate the claim that cephalopagus is a single animal. In §5, I draw out implications for the personal identity debate. §6 concludes.

1. More Than One Animal

In this section, I consider five existing arguments for the claim that there is more than one animal in dicephalus, and conclude that none is successful. First though, it will be helpful to introduce labels for the candidate animals in dicephalus. First, there is the particular we might naturally refer to as 'both twins'. I will call this 'Fusion'. Next, there are the two 'twins' – call them 'Lefty' and 'Righty'. Assume for the time being that Lefty comprises the left head, anything exclusively controlled or regulated by the left brain, and anything which is shared with Righty – and that Righty is analogously composed. Since the two overlap and share single circulatory and immune systems, there is no sharp boundary between them. But they are not entirely coincident: minimally, neither has the other's head as a proper part.[1] According to the 'one animal' construal of dicephalus I will defend, Fusion is an animal, whilst Lefty and Righty are not.

First, Stephan Blatti (2007) argues that dicephalus is a 'borderline case' for the application of the concept HUMAN ANIMAL. He takes this to support the claim that the number of animals present is 'more than one but less than two'. A borderline case is something which qualifies as a candidate instance in virtue of possessing several paradigmatic properties of the kind in question, but fails to qualify as a clear instance in virtue of lacking others. Blatti writes that dicephalus twins 'fail to qualify as a paradigmatic instance in virtue of […] the

[1] I revisit this assumption later, in §3.

presence of two distinct subjects of experience, as well as the overabundance of various organs and appendages', and concludes that they are a borderline case. Since Fusion is the particular housing the overabundance of organs, appendages and subjects, the claim must be that Fusion is a borderline case. There are two problems here First, Blatti does not establish that Fusion is a borderline case – only that she is not paradigmatic. Something can fail to be a paradigmatic human animal whilst still clearly being one. Blatti writes that something counts as a clear instance of a concept if it instantiates 'enough' of the relevant properties, or resembles the paradigm to an 'adequate' degree. This, admittedly, is somewhat vague – but it is unclear why we should think that Fusion resembles the paradigm so little that she is not a clear instance of HUMAN ANIMAL. Second, and more importantly, even if it were established that Fusion was a borderline case, this would not support a 'more than one animal' verdict – rather, it would call into question whether there was *even one* animal present.[2]

A second consideration appeals to the number of organs in dicephalus. Tim Campbell and Jeff McMahan take the 'limited duplication of organs' in dicephalus to indicate that Fusion comprises one organism. They note that in the well-known case of the Hensel twins, there are two hearts, two oesophagi, two stomachs and three lungs, but a single liver, a single small and large intestine, and single urinary, circulatory, immunological and reproductive systems (Campbell & McMahan, 2016, p. 230). Moreover, we can imagine an 'Extreme Case' (Liao, 2006) with no duplication of organs below the neck. Against this, defenders of the 'more than one animal' view claim that Campbell and McMahan's organ count is unduly selective. Paul Snowdon (2014), for instance, notes that even in the Extreme Case it is not only the brain which is duplicated. There will also be four eyes, two noses, four ears, and so on. Blatti (2007) proposes that, if having fewer than two sets of organs supports the view that there are fewer than two animals, then having more than one set of organs ought equally to support the view that there is *more* than one.

The underlying thought on both sides seems to be that organisms correspond approximately one-one to complete organ sets. Campbell and McMahan defend the one animal view on the grounds that there's closer to one organ set than two; whilst animalists point to the fact that there's more than one complete organ set as a reason to think there's more than one animal. But this claim about the correspondence between organs and organisms simply seems wrong. Splenectomies do not create partial animals; nor does possession of an accessory

[2] Campbell and McMahan (2016) offer further criticisms of this view.

spleen qualify one as one-and-a-bit animals. Moreover, we can easily imagine someone born with a nearly full set of accessory organs – an accessory heart, stomach, spleen, liver and intestine, say. It doesn't seem, though, that the presence of these organs would be evidence we were facing more than one animal. Taking inventory of the organs in dicephalus is not a promising strategy.

Third, Eric Olson (2014) proposes that at least in actual cases of dicephalus, where there are two brainstems, there are two organisms – because 'if it were possible for one organism to die while the other survives, there would have to be two organisms'. Olson thinks that where there are two brain stems, it is possible for one twin to die whilst the other survives. This proposal presumably rests on the thought that the brainstem stands in an important relationship to *life*. In earlier work, Olson (1997a) takes the brainstem's function to be coordinating an animal's 'life-sustaining functions'. On this basis, he takes the death of the brainstem to be sufficient for biological death: without the brainstem coordinating life-sustaining functions, an organism's parts will cease to 'work together as a unit in the manner characteristic of a living organism'. This, I think, underwrites his claim that in cases of dicephalus with two brainstems, there are two organisms.

But these claims about the brainstem have been called into question. Alan Shewmon (2001) has argued that the majority of life-sustaining or 'somatically integrating' functions are not directed by the brain, or localised to any particular area of the body – somatic integration is a 'holistic phenomenon involving mutual interaction of the parts'. He proposes that the brain functions to modulate and fine-tune the life-processes of an already living organism. On this basis, he denies that brain-death suffices for biological death – and his arguments have been very influential (Brugger, 2013). Acknowledging this, Olson (forthcoming) has recently rejected the connection between the brainstem and the 'continuation of a human life'.

Moreover, even if it were true that in typical humans the death of the brainstem was sufficient for biological death, this would not show that a human could not have two brainstems, or that the destruction of a human brainstem always brings about the cessation of a human life. If total heart failure were normally sufficient for death, this would not show that a human could not be born with two hearts – or that if such a human was born and one heart stopped, somebody would die. Claims about what typical humans can and cannot survive do not license claims about the correspondence between human lives and functioning body parts of a particular kind.

Olson might reply that this misses his point: that if the left brainstem were destroyed the result would 'look much like the death of an organism' - the organs under its control would stop functioning, the limbs on that side would be paralysed, and the spinal cord on that side would atrophy. By contrast, whatever complications might be brought about by the failure of an accessory heart would not look like death. But whilst Olson may be right about which complications would be brought about by the destruction of a brainstem, to say that they would 'look like' death is just not true – since, if the right heart continued to circulate oxygenated blood, the 'anti-entropic mutual interaction of all the cells and tissues of the body' (Shewmon, 2001) constitutive of life would continue. In this respect and others, the result would look very *unlike* the death of an organism. Moreover, framing the case as one in which Fusion, an animal with two brainstems, suffers the destruction of a brainstem, immediately presents a better description of the result. Fusion suffers multiple organ failure and partial paralysis, but remains alive. This description seems perfectly adequate, is entirely consistent with the continued supply of oxygenated blood to the failed organs and paralysed limbs and explains the ongoing medical complications Fusion would experience. With this in mind, the 'death of an organism' description does not look apt.

Fourth, S. Matthew Liao (2006) proposes in a similar vein that dicephalus involves two animals because it involves two distinct capacities for the regulation and control of life processes such as metabolism, growth, assimilation, responsiveness, movement and reproduction – call these 'L-capacities' for short. He proposes that organisms have L-capacities essentially. Liao argues that in dicephalus, one can identify two distinct L-capacities, and so that there are two animals.

Liao suggests there are two L-capacities in dicephalus because 'one can identify which twin is controlling which organ or body part'. Presumably what this means is that one can trace control of certain organs and appendages to one brain, and control of certain others to the other. But if the fact that control over certain body parts can be traced to two spatially discrete regions of a biological particular is sufficient to show that the particular houses two L-capacities, each of us must house a multitude. In each of us, control and regulation of some life processes can be traced to discrete spatial regions, which are functionally specialised. If this is how L-capacities are individuated, the claim that they correspond one-one to organisms is doubtful. Liao cannot have in mind that L-capacities are localised to brainstems – so we have one and dicephalus has two. He claims that there are two L-capacities even in the Extreme Case, in which there is a single shared brain stem – and that embryos have L-capacities even

at the early stage at which twinning occurs, when they lack brainstems. This leaves it entirely mysterious how Liao's L-capacities are to be individuated – and correspondingly unclear why we should think each organism has precisely one.

Finally, it has been argued that developmental facts support the 'two animal' construal of dicephalus. Of the Extreme Case, Liao claims that it involves two organisms because it results from 'incomplete division' – dicephalus happens when a single egg splits in to two embryos, each of which has an L-capacity and so is an organism, but when cleavage is not complete. Similarly, Snowdon (2014) claims that dicephalus involves two animals because this is how it 'starts out' – it begins with two embryos, each of which is an organism.

An initial problem is that we can imagine cases of dicephalus lacking the relevant aetiology – perhaps ones produced in a lab. Liao acknowledges this, in considering what he calls the 'Genetic Engineering Case' – in which an intrinsic duplicate of the Extreme Case is artificially produced. He claims that in virtue of being an intrinsic duplicate, the result would be two organisms – since it would have two 'distinct capacities for co-ordinating and regulating life processes'. But this suggests that, really, the aetiology is irrelevant: it is the intrinsic properties of the organic matter with which we are now faced which determine how many organisms should be counted in it. It also reveals Liao's reasoning to be circular, since the only reason offered for thinking the Extreme Case *had* two L-capacities was that it began life as two embryos.

Moreover, there are counterexamples to the underlying idea that, if a biological particular was produced from two embryos, two organisms are to be counted in that particular. Take very asymmetric cases of conjoined twinning, such as those producing what might naturally be described as a person with an extra leg. These do not seem to involve two organisms. Even if they do, there are other counterexamples. Sometimes, dizygotic twins fuse altogether, resulting in a genetic chimera – an otherwise ordinary looking animal which has different genomes at different parts of its body (Dupré, 2012). To claim that a genetic chimera is really two animals is a stretch. In this kind of chimerism, we might say that whilst there were at one point two organisms, at some point they fused to create a single organism. Why might the same not be true of dicephalus? That biological particular was produced from two embryos is consequently no guarantee that it constitutes two organisms now.

2. Biological Individuation

Ordinarily, it is not difficult to tell how many organisms we are faced with – but there are a number of notable problem cases, among them aspen groves and the Portuguese man o'war. Various accounts of the organism have been offered with a view to solving these individuation problems. In this section and the next, I appeal to these accounts to show that there is only one animal in dicephalus.

These accounts address individuation questions in two ways. They provide criteria for 'organismality', which determine whether a biological particular counts as an organism. And they provide 'criteria of inclusion', which determine what does and does not count as a part of an organism. As noted in §0, to show that there is one animal in dicephalus requires showing both that Fusion is an animal, and that Lefty and Righty are not. I take these issues in turn – dealing with Fusion in this section, and turning to Lefty and Righty in §3.

The appeal to accounts of the organism is complicated somewhat by the multiplicity of accounts on offer (Clarke, 2010). Broadly speaking, these accounts can be divided into two approaches, which disagree on which biological theory should provide our account of the organism. According to physiological approaches, physiology should tell us which biological particulars are organisms. According to evolutionary approaches, it should be evolutionary theory. There are variations on these two broad approaches – but as I outline below, all deliver the verdict that Fusion is an organism. I take it for granted that if Fusion is an organism, she is a human animal – it is difficult to see what other kind of organism she might be.

One physiological approach appeals to immunogenicity. Thomas Pradeau (2010) offers such an account, according to which an organism is a 'functionally integrated whole, made up of heterogeneous constituents that are locally interconnected by strong biochemical interactions and controlled by systemic immune interactions that repeat constantly at the same medium intensity.' In saying that the organism is made up of heterogeneous parts, Pradeau means that things which originally come from outside the organism – most obviously gut bacteria – can become parts of the organism. They count as parts of the organism when they are connected to its other parts by strong biochemical interactions, and remain parts as long as they are not rejected by the immune system. The immune system, on Pradeau's account, responds not to what is foreign, but to what is unusual – it detects sudden or large molecular changes in the things it comes into contact with (hence, the mention of repetition at 'the same medium intensity' in his definition). Against this definition, it seems clear that Fusion qualifies

as an organism. Her parts are functionally integrated, strongly biochemically related, immunologically tolerated.

Another physiological approach appeals to metabolism, rather than immunogenicity. On this view, an organism is a system 'comprised of diverse parts which work together to maintain the system's structure, despite turnover of material, by making use of sources of energy and other resources from their environment' (Godfrey-Smith, 2012) – a 'metabolic whole' (Dupré & Malley, 2009). Again, this account seems to qualify Fusion as an organism – since her parts function together as a unit to maintain her overall structure, making use of energy-sources from the environment, which are supplied to all her parts by a single circulatory system.

More generally, it seems likely that any physiological approach will deliver the verdict that Fusion is an organism. Physiological accounts treat organisms as complete, unified systems comprising specialised parts functioning together as a unit. Fusion just seems to be such a system – as Campbell and McMahan (2016), in pressing the dicephalus objection, note.

The alternative evolutionary approaches treat the organism as the 'evolutionary individual' (Godfrey-Smith, 2012): the biological unit which bears adaptations and responds to natural selection. One version of the approach appeals to sexual reproduction: it views any and all particulars which proceed from the fertilisation of a single egg to be parts of a single organism (Janzen, 1977). Often, this means that an organism will be a scattered object. What might appear to us to be many dandelions or a large group of aphids may, on this criterion, be a single scattered organism, since both dandelions and aphids sometimes reproduce asexually. Not only does this account support the view that Fusion is an organism (and that Lefty and Righty are not), it suggests the same is true of all cases of monozygotic twinning: these will be cases of two thinkers sharing a single, scattered organism. The view also suggest that genetic chimeras resulting from dizygotic embryonic fusion will comprise two organisms. These results are unattractive – and so this account is not widely accepted.

More plausible evolutionary approaches avoid this result by noting that what matters for evolution is that there be a population whose membership exhibits heritable variance in fitness (Godfrey-Smith, 2012). This condition can be satisfied even in asexually reproducing populations, so we need not accept the claim that whatever proceeds from a single fertilised egg is a single organism. Godfrey-Smith proposes that something is an evolutionary individual to the extent that it has certain features which enable it to participate in natural selection. He points to three key features. First, a bottleneck life-cycle – one in which reproduction produces

something the size of a single cell or a few cells, which then grows to the size of an adult. Second, germ-soma separation. Third, integration: individuals should be composed of specialised, mutually dependent parts exhibiting a division of labour beyond germ-soma separation, and they should maintain 'a boundary between a collective and what is outside it'. Against this standard, Fusion again appears to qualify as an evolutionary individual: she has bottleneck origins, exhibits reproductive specialisation and is highly integrated. Her parts are specialised, mutually dependent and exhibit a division of labour, and her skin forms a clear boundary between Fusion and what is outside.

Finally, Ellen Clarke (2013) defends a functionalist account of the evolutionary individual. On this picture, individuals need not have any specific feature, like bottleneck origins. But they must possess both 'policing mechanisms' and 'demarcation mechanisms'. A policing mechanism is any mechanism which inhibits the capacity of an object to undergo within-object selection. A demarcation mechanism is one which increases or maintains the ability of the object to undergo between object selection. Possession of these mechanisms is what enables an object to exhibit the heritable variance in fitness required of evolutionary individuals. Because these definitions are functional, both types of 'individuation mechanism' are multiply realisable. Reproductive specialisation, a bottleneck life-cycle, spatial contiguity and the immune system can all function as policing mechanisms; sexual reproduction and physical boundaries can all function as demarcation mechanisms. Against this functional definition, Fusion qualifies as an evolutionary individual. She possesses policing mechanisms in the form of reproductive specialisation, a bottleneck lifecycle, spatial contiguity and an immune system. She possesses demarcation mechanisms in the form of clear physical boundaries and sexual origins.

More generally, it seems likely that any plausible evolutionary account will deliver this verdict. Those which avoid counting monozygotic twins as one, or genetic chimeras as two, avoid these implausible results by appealing to the physiological characteristics possessed by the individual twins, or the individual chimera. But these are physiological characteristics Fusion, too, possesses – so these accounts will count Fusion as an organism.

At this stage, it is worth addressing a potential objection. It appeals to a maximality principle: that organisms cannot be proper parts of other organisms. This, together with the claim that Lefty and Righty *are* organisms, could generate the conclusion that Fusion is 'excluded' from organism-hood. This maximality principle about organisms may appear unmotivated. But the above accounts do suggest something close to this. For instance,

Godfrey-Smith (2012) writes if the parts of a system are metabolically autonomous, then the larger system of which they are parts must have a lower degree of integration, and so this 'reduces the degree to which the larger system counts as an organism'.

But it seems unlikely that this sort of view will establish the claim that Fusion is not an organism. The claim is that satisfying the various criteria for organism-hood reduces the extent to which one can function as part of an organism - and that being a part reduces one's ability to express the properties characteristic of organisms. Fusion is an excellent candidate for organism-hood, and Lefty and Righty are undeniably parts of Fusion. This immediately makes them worse candidates for organism-hood. Neither forms an integrated whole – each has parts engaged in metabolic exchange and biochemical interaction with parts which are not its own. Neither is self-sufficient, with both depending upon the other for some vital life processes. Neither maintains a clear physical boundary with what it outside. Because of this, both are less well 'demarcated' than Fusion. So, even if this sort of maximality principle is correct, the result will be that Fusion's organism-hood excludes Lefty and Righty rather than vice versa.

In short, both of the prominent approaches to biological individuation indicate that Fusion is an organism. This rules out the possibility that there are two animals in dicephalus – since if there were two animals in dicephalus, Fusion would not be one of them. But Fusion qualifies as an organism on any prominent account of what being an organism involves.

3. Biological Inclusion

If the maximality principle considered above were correct, my argument for the 'one animal' view would be complete: Fusion's organism-hood would exclude Lefty and Righty from being animals, and there would be one animal in dicephalus. But in fact, this principle is not warranted. Most accounts tie organism-hood to traits a biological particular might possess to a greater or lesser degree. In this light, a graded picture seems appropriate – against which an organism might have organisms as parts but where those parts, in virtue of being parts of an organism, express a lower degree of 'organismality'.[3] Against this background, there remains

[3] The developing mammalian foetus might be thought of in these terms. As Kingma (forthcoming) argues, the foetus is better construed as a part of its mother than as something merely spatially contained by the mother – it is functionally integrated with the mother and lacks clear spatial boundaries. But the facts which speak in favour of the 'part-whole' claim also indicate that the foetus possesses a lower degree of organismality than the mother.

the possibility that there are three organisms in dicephalus, two of whom overlap and are proper parts of the third. In this section, though, I argue that this cannot be right: the supposition that Lefty and Righty are animals generates absurd consequences.

Assume, for *reductio*, that Lefty and Righty are animals. This proposal is not obviously ruled out by anything above. Lefty and Righty possess many characteristics of organisms – bottleneck origins, specialised parts which are functionally integrated with one another (as well as, admittedly, with parts of the other twin), and reproductive specialisation. They engage in metabolism and exhibit immune responses. It is not clear that these are especially compelling reasons for proposing that Lefty and Righty are organisms in their own right. But they at least suggest that this claim has legs.

The assumption, though, requires us to revisit the assumption I made in §0 about Lefty and Righty's composition: that they are not entirely coincident. I glossed that minimally as the claim that neither had the other's head as a proper part – but there may be other parts they do not share, depending on the particulars of the case. In effect, the criteria of inclusion I employed were: (a) if a body part is exclusively controlled and regulated by one brain, it will belong solely to the twin whose brain that is; (b) any parts which are not exclusively controlled and regulated by one brain will belong equally to both twins.

Biological particulars are cheap – so for the purpose of delineating a biological particular, these criteria were fine. But on the assumption that Lefty and Righty are animals, the criteria are problematic. The accounts of the organism considered in §2, in defining the organism thereby provide criteria of inclusion, with which my earlier criteria conflict. For instance, on the immunogenic account, anything which is strongly biochemically interconnected with an organism's parts and is tolerated by its immune system will thereby be a part of the organism. Similarly, on the metabolic approach, anything will be a part which collaborates with the other parts in metabolism. And any plausible evolutionary account, which makes room for the idea that an organism is a functionally integrated physiological *whole,* will treat as a part of the organism any element with which its parts are functionally integrated in the relevant way.

If Lefty is an animal, then, it seems wrong to exclude the right head (or anything else) as one of her parts, on the grounds that it is not controlled or regulated by the left brain. The right head is integrated with all of Lefty's parts in a number of relevant ways. Food or

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Nevertheless, there are reasons to think of the developing foetus as an organism in its own right.

medication ingested by the right head affects all of Lefty's parts, just as if it were ingested by the left head. Hormones secreted in the right brain affect Lefty's organs. The right head is immunologically tolerated, and connected to all of Lefty's parts by a single circulatory system, on which it depends (together with all of Lefty's parts) for energy and waste transport. So the right head collaborates with Lefty's parts in metabolism. For all these reasons and more, the right head (and all of Fusion's parts) should be counted as a part of Lefty, *if she is an animal*. And the same goes for Righty. In short, claiming that Lefty and Righty are animals reveals our original assumption to be in error: considered as organisms, Lefty and Righty are entirely coincident, with one another and with Fusion.

This consequence – that dicephalus involves three distinct but entirely coincident organisms – is absurd. As Olson notes, even those who accept that two things can coincide 'deny that this is possible for two things of the same kind' (1997b). So, the claim that generated it – that Lefty and Righty are animals – should be rejected. This completes the argument for the 'one animal' construal of dicephalus: on prominent accounts of biological individuation, Fusion is an organism, whilst Lefty and Righty are not.

4. Cephalopagus

Cephalopagus twins are fused at the brain, face, thorax and upper abdomen (Hovorakova, Peterkova, Likovsky, & Peterka, 2008; Sabih, Ahmad, Sabih, & Sabih, 2010). There are few documented cases and, as with dicephalus, there is some variation in the degree of fusion and the distribution of organs. In an imaginary case described by Campbell and McMahan (2016) there is a single cerebrum, a single face, mouth and throat, two cerebella and brainstems, two oesophagi and stomachs, and the 'normal complement of organs and appendages in each half of the total bodily mass below the neck'. In this section, I argue that cephalopagus, like dicephalus, involves a single animal.

To begin though, why might one think that cephalopagus involves two animals? Campbell and McMahan offer two reasons. One is that in the case they describe, as in dicephalus, there are two brainstems, each of which uniquely controls and regulates processes occurring in one half of the body mass below the neck. Since Campbell and McMahan reject, as I do, the view that human brainstems correspond one-one to human lives, the crucial idea here must be that each brainstem has a proprietary relationship to a certain part of the biomass below the neck. But it is not clear why this should be significant: after all, if an organism can have two brainstems, why should these brainstems not divide their labour?

Their second reason is that, given the right technology, the twins would be 'separable' – they could be surgically separated, leaving us with 'two self-sustaining organisms'. But the fact that such an operation would leave us with two organisms shows that there are two animals beforehand only on the assumption that animals cannot be created by fission – that it is impossible to end up with two animals by 'splitting' one. Campbell and McMahan offer no reasons for thinking that this is impossible.[4] Of course, it must be acknowledged that fission is not something which occurs in post-birth humans naturally; nor is it likely that any splitting operation performed on a species-typical human would produce two organisms. But if the particular corresponding to 'both twins' in cephalopagus is a human organism, it is not a species-typical one – it has an unusual complement of organs, in virtue of which if it were split in the correct way, two living organisms could result. Moreover, the production of organisms by fission has precedent elsewhere in nature. Single-celled organisms reproduce by binary fission. And as Madden (2016a, 2016b) points out, plant-cutting is another case of organismic fission – through surgical separation, we create two plants where previously there was one. So, the possibility of surgically separating cephalopagus twins does not show that two animals are present pre-operatively.

A third reason one might offer for thinking cephalopagus involves two animals is that, unlike in dicephalus, it involves two sets of reproductive organs. Of course, there being two sets of reproductive organs no more shows that there are two organisms than there being two hearts does. But if it were possible for cephalopagus to result from the fusion of dizygotic embryos, and so the gametes produced by one set of reproductive organs were genetically distinct from those produced by the other, its offspring could fail to be genetically related to one another as siblings. This might motivate the thought that there were two organisms here, with distinct evolutionary fates.

But it is not unheard of for the offspring of a single organism to exhibit precisely this kind of genetic divergence, as a result of genetic heterogeneity in the parent. Genetic chimeras can carry genetically distinct gametes, and as a result their children can fail to be related to one another as siblings typically are, and can appear to be unrelated to the parent. In fact, one well-

[4] In another part of their paper, Campbell and McMahan (2016, p. 245) consider and reject the view that severing the head of a typical human can be described as a case of fission, resulting in two organisms. But this rejection concerns the severed head case specifically, and does not speak to the possibility of human fission in general.

known case of genetic chimerism was revealed in just this way – after genetic testing found that a woman was apparently not genetically related to two of her three children as a mother would typically be (Yu et al., 2002). I take it that we should not say, in defiance of both appearances and the above accounts of the organism, that this woman in fact comprises two organisms. By the same token, we should not take the potential for genetic heterogeneity in the offspring of cephalopagus to indicate two organisms are present.

Against the two animal construal, the accounts of biological individuation appealed to above indicate that cephalopagus is a single organism, for exactly similar reasons. In cephalopagus, as in dicephalus, three particulars compete for animal-hood: the one comprising 'both twins', call it F, and the 'twins' themselves, L and R. There is one animal just in case F is an animal and L and R are not. That F is an animal is suggested by both physiological and evolutionary accounts of the organism. F's parts are functionally integrated, strongly biochemically related and immunologically tolerated. They collaborate together in metabolism, making use of energy supplied by a single circulatory system. F exhibits the three features Godfrey-Smith emphasises in evolutionary individuals – a bottleneck lifecycle, germ-soma separation and integration. And like Fusion, F has both policing and demarcation mechanisms – reproductive specialisation, a bottleneck life-cycle, spatial contiguity, an immune system, clear physical boundaries and sexual origins.[5]

The same considerations which speak against Lefty and Righty being organisms indicate that L and R are not organisms either. Initially, in thinking of L and R it is natural to think of each as constituted by the shared cerebrum, face, mouth and throat, together with one brainstem, and the organs and appendages controlled and regulated by that brainstem. So, we take it that L and R are not entirely coincident. Each has only one heart, one stomach, one pair of lungs, and so on. As before, it is perfectly legitimate to stipulate that L and R are so constituted, if we are in the business of picking out biological particulars. But on the assumption that they are organisms, we cannot simply decide what parts they do and do not have. If L is an organism, then the accounts discussed in §3 will treat as one of her parts anything which is integrated with her other parts in the relevant way. Since her parts are strongly biochemically connected to the right heart, stomach, lungs etc. and since her immune

[5] It is hardly decisive, but is perhaps worth noting that a recent report of a terminated cephalopagic pregnancy describes what was delivered as *a* cephalopagic twin (Sabih et al., 2010). So the claim that F is an animal hardly seems to strain credibility.

system tolerates these organs, they will count as parts of her on the immunological approach. On the metabolic approach, they will count as L's parts because they collaborate with her other parts in metabolism. And plausible evolutionary accounts which make room for the idea that an organism is a functionally integrated physiological *whole* will also treat these as parts of L, since they are integrated and spatially contiguous with her other parts, and fall, together with her other parts, within a clear physical boundary. So, there are no grounds for denying that the organs on the right are part of L, if she is an organism. But this, together with the parallel reasoning about R, generates the absurd result that if L and R are organisms, they are entirely coincident. So, L and R are not organisms – and cephalopagus, like dicephalus, involves a single human animal.

5. What We Are

How, then, do these cases of conjoined twinning bear on the question of what we are? Campbell and McMahan (2010, 2016) argue that dicephalus and cephalopagus make trouble for animalism. They take dicephalus to be a counterexample to animalism: a case in which there are two of us, but only one animal. The animalists cited in this paper have attempted to resist this by arguing that dicephalus involves more than one animal – either in all actual cases (Olson, 2014; Snowdon, 2014), or in all possible cases (Blatti, 2007; Liao, 2006). I have shown that this response is unavailable: in all actual and possible cases of dicephalus, there is only one animal. This means that animalists can accommodate dicephalus only by saying that it involves one of us, so profoundly psychologically divided that they can 'communicate and carry on an intelligent conversation' on two fronts simultaneously (Liao, 2006).

Campbell and McMahan (2016) take this to refute animalism. But as Olson (2014) argues, it does so only on the assumption that our individuation conditions are psychological – an assumption which, if granted, would refute animalism without the assistance of conjoined twins. If animalism is true, 'there is simply no room for two of us within one human being' (Olson, 2003). I consequently do not take myself to have revealed that the possibility of such psychological division is a startling consequence of animalism. Rather, I have shown that if animalism is true, such psychological division is not merely possible, but actual – and that this is not a consequence any animalist can resist. If there is a surprise in the vicinity, it is just how common animalists must take this phenomenon to be. Although I have focussed in this paper on dicephalus and cephalopagus, it seems likely that the same 'one animal' verdict will be

appropriate in many other cases of conjoined twinning – and any of these which involve two heads will, for animalists, be cases of a profoundly psychologically divided individual.

Cephalopagus presents a different problem. Campbell and McMahan take this to be a case of two animals sharing a cerebrum. If thinking is localised to the cerebrum, they think, this will be a case of two animals but only one of us. Animalists, though, must say that if there are two animals, there are two of us – and since neither has a better claim to the cerebrum than the other, the two must share a cerebrum. This means that there are two thinkers for every thought in cephalopagus – so, animalists have a 'too many thinkers' problem. This variant on the too many thinkers problem is made vicious by the fact that both of the candidate thinkers are animals. In general, a too many thinkers problem arises when two spatially coincident or overlapping particulars can plausibly be said to think the same thoughts. Standard responses exclude one of the thinkers either on the grounds that it does not exist, or on the grounds that it is of the wrong kind to think the relevant thoughts. Because the two thinkers in cephalopagus are both animals, these responses are unavailable: animalists are already committed to the claim that animals exist, and can think the relevant thoughts. I'll call this the 'too many thinking animals' problem.

I have shown that cephalopagus, like dicephalus, is a single animal – so, animalists need not accept that it is a case of two of us with our mental states in common. They, like everyone else, can describe cephalopagus as just one of us. This means that cephalopagus does not divide animalism from its rivals – and so does not motivate rival views of our nature, as Campbell and McMahan (2016) suggest.

More broadly, the argument here suggests that animalists may not be vulnerable to the sort of 'too many thinking animals' problem Campbell and McMahan describe. For a 'too many thinking animals' problem to arise, there must be two overlapping animals, which could plausibly be thinking the same thoughts, but which are not spatially coincident – since it is absurd to say that two things of the same kind are simultaneously constituted out of the same matter. In both cephalopagus and dicephalus, however, where it looked as though there were two overlapping but non-coincident organisms, appearances turned out to be deceptive. The criteria of inclusion provided by the above accounts of biological individuation reveal that any part which seems to belong to one 'twin' also belongs to the other, and vice versa. The 'two animals' are entirely coincident – so, there is only one animal after all.

It seems likely that the same will be true in any case where it appears that 'two animals' overlap sufficiently to think the same thoughts: when the criteria of inclusion are applied, they

will reveal the 'two animals' to be entirely coincident, and so only one after all. If two animals overlap sufficiently for their parts to collaborate in metabolism, to immunologically tolerate one another, to function as a unit and to fall within a single boundary, they will be one animal. Plausibly, any putative case of two animals sharing a cerebrum will match this description – and so they will in fact be one. I don't know how to show that this goes for all possible cases of shared-cerebrum twinning. But even if it doesn't, I have shown that a 'too many thinking animals' problem is harder to generate than Campbell and McMahan appreciate. To establish that animalism has such a problem, its opponents must show that it is possible for one animal to share its thinking parts with a second, without either animal's non-thinking parts becoming entangled in the life processes of the other such that 'they' constitute a single animal.

6. Conclusion

Both physiological and evolutionary accounts of the organism treat an organism as a physiological whole – and treat as parts of the organism anything with which it is appropriately physiologically integrated. On this basis, I have argued that dicephalus and cephalopagus twinning do not involve two fused human organisms – each involves a single, unusual human organism. This shows that both animalists and their critics are mistaken about the import of conjoined twinning for personal identity. Dicephalus commits animalists to the existence of psychologically divided individuals – but cephalopagus presents them with no problem, and does not motivate rival views of our nature. Moreover, animalists have at their disposal a general reply to the 'too many thinking animals' problem Campbell and McMahan describe – given that an organism is a physiological *whole*, any two animals with overlapping thinking parts are likely, in fact, to be one. So, as far as 'too many thinkers' problems go, animalists are no worse off than their rivals.

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