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Journal of Cognition and Neuroethics

Hemispherectomies and Independently Conscious Brain Regions

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Biography

Much of Blackmon's work focuses on cognition, computation, and consciousness (as he suspects they might have something to do with each other) and on how they could be realized by physical things. He earned his doctorate at University of California at Davis. He teaches at San Francisco State University.

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Hemispherectomies and Independently Conscious Brain Regions

James Blackmon

Abstract

I argue that if minds supervene on the intrinsic physical properties of things like brains, then typical human brains host many minds at once. Support comes from science-nonfiction realities that, unlike split-brain cases, have received little direct attention from philosophers. One of these realities is that some patients are functioning (albeit impaired) and phenomenally conscious by all medical and commonsense accounts despite the fact that they have undergone a hemispherectomy: an entire brain hemisphere has been fully detached. Another is the Wada test, in which a patient has each hemisphere anesthetized, one after the other, while the other hemisphere is awake and functioning—again, phenomenally conscious by any standard. I will argue that hemispherectomies, Wada tests, and related procedures each present cases in which the minds that exist after the detachment (or anesthetization) of a hemisphere are surviving minds which must be associated with the surviving (or un-anesthetized) hemisphere. I will argue that such surviving minds existed before the medical procedure, instantiated by the then-intact hemisphere that was due to survive the loss of its complementary hemisphere. If so, then the typical subject has at least three minds: a "left hemisphere mind", a "right hemisphere mind", and a "whole brain mind". But the argument generalizes to cases in which smaller portions of the brain are lost, yielding a great number of additional minds, some overlapping. Some important ethical implications are raised and briefly examined.

Keywords

Hemispherectomy, Wada test, Consciousness, Supervenience, Split-brain

1. Introduction

An *anatomical hemispherectomy* is a medical procedure in which one entire brain hemisphere is surgically removed from the cranium and discarded, leaving the patient with the remaining hemisphere intact and functioning. In a *functional hemispherectomy*, some of a hemisphere is removed while the rest is disconnected and left *in situ*. In a *hemispherotomy*, a hemisphere's connections to the other hemisphere and to other brain centers are cut, but the hemisphere is left *in situ*. In each of these procedures, one hemisphere is disconnected from the other hemisphere, which remains connected to and functioning in the body. Anatomical and functional hemispherectomies and hemispherotomies are each specific cases of what will here be called *hemisphere*

disconnection, i.e., cases in which one hemisphere has its neural pathways to the other hemisphere and to the body severed.[1]

Hemisphere disconnection procedures have been performed on humans since before the 1930s.[2] They are now used on both children and adults, most commonly as a treatment for severe seizures brought on by unihemispheric damage such as that caused by Rasmussen's Encephalitis, Sturge-Weber Syndrome, and hemimegalencephaly (Bahuleyan et al. 2012). Hemisphere disconnections are fairly radical operations; nevertheless, some hemispherectomy patients, despite the lack of a functioning hemisphere, recover remarkably, going on to complete college, holding regular jobs (Vanlancker-Sidtis 2004), and commenting online on their experiences.

Importantly for our purposes, surgical hemisphere disconnections are distinct from the more familiar "split-brain" phenomenon in which both hemispheres, despite having their connection via the corpus callosum severed, are connected with the rest of the brain as well as with the body via functioning sensory and motor pathways.[3, 4] Split-brain patients have two functioning hemispheres which receive sensory data and send motor commands; hemispherectomy patients do not. Unlike split-brain phenomena, which philosophers have been investigating since Nagel's classic (1971), hemispherectomies and hemispherotomies have received comparatively little attention in philosophy.[5]

The intracarotid amobarbital procedure, commonly named the *Wada Test* after its originator, the Japanese Canadian neurologist Juhn Atsushi Wada, is a medical procedure which successively anesthetizes each hemisphere while the other hemisphere is awake

1. See de Ribaupierre and Delalande (2008) for an overview of these various surgical techniques which share as a "common goal" "the interruption of the corpus callosum, the internal capsule and corona radiata, and the mesial temporal structures as well as the frontal horizontal fibers."

2. Citing Dandy (1928), de Ribaupierre and Delalande (2008) report that anatomic hemispherectomy was first performed in the late 1920s.

3. For early papers on split-brain research, see Sperry (1964, 1966), Gazzaniga (1967) and Gazzaniga and LeDoux (1978). Gazzaniga (2000) provides a more recent overview.

4. Following Bayne (2008) we can refer to both the commissurotomy (in which the corpus callossum along with other connections are severed) and the callostomy (in which only the corpus callosum is severed) as "split-brain" procedures.

5. Although, see Marks (1981), Puccetti (1993), Schechter (2012).

and functioning (Wada 1949, Snyder and Harris 1997).[6, 7] The point is to determine the language and memory capacities of each hemisphere for people who may undergo hemisphere disconnection surgery to treat conditions such as severe epilepsy. In the Wada test, sodium amobarbital or another barbiturate is introduced to one hemisphere via the carotid artery while the other hemisphere is left awake and functioning. At this point the patient performs language and memory tasks, giving normal indications of consciousness albeit along with measurable cognitive impairment, so that clinicians can assess the cognitive capacities of a brain with one hemisphere anesthetized. Once this anesthetized hemisphere awakens, the process is repeated for the other hemisphere. As Snyder and Harris (1997) point out, the Wada test is in effect a "reversible lesion", and as such it provides additional proof that each hemisphere can cognitively function independently of the other. It is also evidence that such independent functioning can be temporary, starting abruptly and lasting only a brief period of time (often only a matter of minutes), and that it can be something that is consciously experienced by something that does not include the anesthetized hemisphere.[8] Philosophers appear to have given the Wada test virtually no attention. I will include the Wada test as another specific case of "hemisphere disconnection", even though in this case the disconnection is not surgical and is only temporary.

The medical literature makes clear that, medical tragedies aside, patients of hemisphere disconnection are conscious beings—at least insofar as one medically detects consciousness in living things.[9] Granting this much and assuming a fairly standard view about the mind-body relation, I will argue here for the thesis that any whole and functioning brain provides the supervenience base for many phenomenally conscious minds, some overlapping, some not.[10]

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6. Typically, the procedure perfuses only two (anterior and middle) of the three cerebral arteries and so does not normally anesthetize the entire hemisphere, although in some cases this does occur. This fact should be kept in mind when considering the data we get from most actual Wada tests. However, it should also be kept in mind that anesthetization of an entire hemisphere is possible, even if rare.

7. A similar procedure, though differing in methods and clinical goals, was independently developed by W. James Gardner (Snyder and Harris 1997).

8. Meador and Loring et al. (1997) employ a modified version of the Glasgow Coma Scale (Teasdale and Jennett 1974) in order to assess levels of consciousness in patients undergoing the Wada test.

9. The logical or conceptual possibility of philosophical zombies may remain, but if so, it is hardly any more of a problem in the case of patients of hemisphere disconnection than it is in the case of normal humans.

10. The argument given here is not intended to challenge particular arguments regarding the "Mental Problems

My argument depends upon a principle which, though widespread, remains controversial. This principle is a particular mind-body supervenience thesis (MBS).

MBS: The phenomenal properties instantiated by a physical thing supervene on its intrinsic physical properties.[11]

MBS is accepted by many theories of mind. The principle is trivially true if, as identity theory holds, mental properties are identical with physical properties.[12] Other views that deny the identity of these properties (emergentism, epiphenomenalism, property dualism, and a variety of forms of functionalism) can and often do accept MBS.[13] Because I argue here that if MBS true, then each functioning human brain hosts multiple minds, the foregoing reasoning works under the assumption of MBS except where otherwise indicated.

Before presenting the argument, I should say why, even with all the scrutiny that split-brains have received, hemisphere disconnection cases warrant more attention than they have been getting by philosophers. Granted, hemispherectomy cases are closely related to split-brain cases in many ways, so one might suspect that hemispherectomies just provide an additional medical instance of an issue that has been in the philosophical literature since Nagel (1971). For this reason, important differences between hemisphere disconnection cases and split-brain cases should be noted.

First, the cases of hemisphere disconnection permit a more direct interpretation of the research data they provide. For obvious reasons the data we have on hemispherectomy patients are unequivocally data about what the surviving hemisphere, not the removed or detached hemisphere, can do. As Schechter (2012) notes, the hemispheres are not entirely split in split-brain cases, creating etiological ambiguity. For example, the possibility of interhemispheric cortical transfer of information, by way of the superior colliculus, remains in split-brain cases (Savazzi et al. 2007; Roser and Corballis

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of the Many" or the "Many Thinkers Problem", although the thesis here obviously rejects the view that more than one mind per brain serves as a *reductio*. See Unger (2004), Kovacs (2010).

11. The supervenience relation I am using is *weak individual* supervenience: A-properties weakly supervene on B-properties if and only if for any possible world w and any individuals x and y in w, if x and y are B-indiscernible in w, then they are A-indiscernible in w. I take the term 'phenomenal' to rule out mental properties about which one can reasonably be an externalist; however, see Lycan (2001).

12. If A-properties are identical to B-properties, then (trivially) for any possible world w and any individuals x and y in w, if x and y are B-indiscernible in w, then they are A-indiscernible in w.

13. Granted, there are those who explicitly reject MBS; an externalist about phenomenal states (see Lycan (2001)) would count, and obviously an interactionist dualist would count, as well.

2001). Moreover, the outputs of each hemisphere may be integrated by some non-cortical structure (the cerebellum might coordinate bimanual actions) or by perceptual cues to which both hemispheres have access (Seymour et al. 1994; Ivry et al. 2002). Thus, determining exactly whether and how each hemisphere contributes to the behavior studied is a research problem in split-brain cases. But there is not even the possibility of interhemispheric transfer or non-cortical integration in the case of hemispherectomy; this is simply because there is no other connected hemisphere. Hemispherectomy cases, along with the other forms of disconnection, thus avoid much of the ambiguity that arises in split-brain research.

Second, related to the first point, cases of hemisphere disconnection avoid theoretical ambiguity. Regarding the data on split-brain cases considered in ignorance of hemisphere disconnection cases, it remains plausible that the split-brain patient has only one mind and that no mind could be associated merely with one or the other hemisphere. But in light of hemisphere disconnection cases, maintaining this view requires some reaching. I grant the epistemic possibility that a split-brain patient has one mind while a hemisphere disconnection patient has none, but I also think that this view requires (and will long await) additional empirical support, enough to outweigh the reasons we currently have to think otherwise.

Third, hemisphere disconnection introduces ethical issues which do not arise in split-brain cases. While both hemispheres of the split-brain patient continue to live and interact with the world, this is clearly not so with hemisphere disconnection. Recall that by an anatomical hemispherectomy, a hemisphere is removed from the cranium and discarded, while by a functional hemispherectomy or a hemispherotomy, most or all of a hemisphere is detached but left in the cranium. Thus, if these things can be independently conscious, then it is possible that conscious things are being killed or put into sensory-motor isolation. We will return to the ethical implications of letting an arguably conscious hemisphere or other brain region die or of leaving it isolated in a cranium. For now it should be clear that cases of hemispherectomy have an ethical dimension that split-brain cases do not have.

In light of these ways in which hemisphere disconnections are different from split-brain cases, and in light of the scientific, medical, and ethical ramifications considered here, we should be careful not to generalize too broadly from a philosophical literature focused largely on split-brain research. Much has been written about how split-brain cases bear on our notions of consciousness, minds, personhood, and agency. Not all of this literature is responsive to hemispherectomies, hermispherotomies, and Wada tests.

I should also be clear, before moving on, about what I am not trying to do here. For, because this investigation will look a lot like some more familiar investigations into split-brain cases and because those investigations are often concerned with other issues I will not be directly concerned with, there is the possibility that readers will expect this paper to adjudicate on these issues. So I will state upfront four things I am not trying to do with the arguments presented here.

First, I am not trying to advance a robust theory of what it is to have or be a mind. I use the predicate 'has a mind' here to identify conscious entities with sufficient cognitive capacities, leaving it open exactly what those capacities may be.[14] Admittedly, my thesis reveals that I am willing to think of things that have minds as things that can have proper parts that have minds, and this undoubtedly is a controversial claim resting on a controversial concept of the mind. For, some people hold that it is essential to the concept of a mind that minds cannot have minds as proper parts or that mind-having things cannot consist of mind-having proper parts.[15] However, I do not think much turns on this. If someone were to insist that for metaphysical, conceptual, or linguistic reasons the things I am talking about cannot be designated as "minds", I would propose replacing each instance of the term 'mind' with 'independent conscious (and cognitive) entity' or, if that sounds too much like a substance view, to limit myself to the predicate 'is independently conscious and cognitive' where I would have 'has a mind'. These issues are interesting, but I do not see that they bear on the current issue.

Second, I am not proposing to conceptually analyze personhood or agency. Whether the brain regions I will be talking about are associated with persons or agents is an important question in its own right, one which deserves investigation, but the concepts are matters of extensive controversy, and attempting to adjudicate on them here would introduce distractions and unnecessary burdens to my specific task, which is to argue simply that some brain regions are independently conscious entities.[16] Note that even if *S*

14. It will become clear that I do not think language capacity is a necessary condition for having a mind as I use the term.

15. A typical response to Block's (1978) "Chinese Nation" thought experiment is that even though the system is functionally equivalent to a brain, it does not have a mind. Perhaps this response is often driven by the intuition that either the whole system has a mind or certain of its parts have minds, but not both. Of course, Block's hypothetical system is composed of people, each of which has a mind, thus, according to this intuition, the entire system cannot have a mind.

16. Regarding new work on the issue of personhood for split-brain cases, see Tye (2003), Bayne (2005), and Schechter (2009).

is not a person or an agent on one or more of the many views of personhood or agency in play, *S* may nevertheless be conscious. We can of course ask whether, for example, dogs are conscious without asking whether they are persons or agents. Moreover, two philosophers can disagree on issues of personhood and agency regarding dogs while agreeing that dogs are conscious, and a third philosopher can take issue with their shared notion that dogs are conscious leading to a new debate among the three that might never mention personhood or agency. I think the same possibilities hold of hemispheres and some other brain regions, and I hope to advance my argument without relying on these concepts. I will eventually evoke the concept of personhood, but only in an opaque sense, simply noting that if a hemisphere is a person (leaving unaddressed whatever it is to be a person), then in addition to the ethical matters raised by the hemisphere's alleged independent consciousness are ethical matters raised by its personhood.

Third, I am not trying to address the issue of whether the entities I describe as conscious are conscious in a way that is unified.[17] Like personhood and agency, the concept of the unity of conscious is ambiguous and controversial. And, like personhood and agency, it is also secondary to my particular concern. After all, a unified consciousness presupposes consciousness. If my argument convinces people that typical human brains have many independently conscious regions, then perhaps we can move on to consider the question of whether those regions are conscious in a way that is unified or not. We can also perhaps move on to consider the question of how those independently conscious regions could compose a brain that allegedly has unified consciousness. But again, I think that this question is beside the present point, which is to determine whether these regions are conscious at all. Granted, it does sound like a threat to the concept of the unity of consciousness to say that each of us has many minds, and perhaps it is. But there is no question of the unity of an entity's consciousness, if there is no consciousness, so I propose to address this more basic question, leaving the rest for future investigation.

Fourth, I am not going to explore the question of independently conscious hemispheres with much of an eye to the asymmetries between the hemispheres. Undoubtedly, the hemispheres each tend to display differences in cognitive specialization (Gazzaniga 2000). However, nothing has shown that one hemisphere is less deserving of the designation *conscious mind*. What it is like to be a left hemisphere may be interestingly different than what it is like to be a right hemisphere, but there is nothing it's like to be a hemisphere unless hemispheres are conscious. So again, my aim is simply to address this more basic question.

17. See Bayne (2008).

2. The Arguments from Hemisphere Disconnection

These arguments all begin with the notion that there is some continuity of conscious experience which survives the disconnection of some region of the brain. The proposition might appear controversial until we consider that we are all in a position to know what it's like to lose at least some parts of the brain.[18] This is simply because we have all experienced phenomenally conscious life as our neurons naturally succumb to programmed cell death. I do not mean that we are necessarily in a position to detect and track the loss of neurons by attending to our conscious experience. For many of us, the experience of losing a few neurons over some period of time may seem no different than the experience of having the neurons we currently have. For others less fortunate—victims of stroke or traumatic brain injury—the differences between what is was like to have had those neurons and what it is like now to lack them is stark. Nevertheless, in both cases, conscious experience can continue.[19]

Particularly striking examples of knowing what it's like to lose neurons come from cases of surgical hemisphere disconnection in which the surviving subject is still phenomenally conscious and has the cognitive capacities to reflect on his or her current and prior phenomenal states. Many of these patients, incidentally, are awake and responsive during the procedure, this being the ideal condition for brain surgery of this kind. The argument can now be made regarding such patients.

Sometimes, there is something it's like to lose a brain hemisphere, a "detachment experience". But this detachment experience requires experiencing interaction with that hemisphere and experiencing subsequent lack of interaction with that hemisphere.[20] Experiencing interaction with that hemisphere supervenes on the intrinsic properties of some part of the brain that will survive the surgical disconnection—the other hemisphere or some proper part of it. After all, any part that includes any part of the hemisphere to be lost is not *interacting* with it and is not a thing that will lose it. Thus, the healthy hemisphere due to survive (or some proper part of it) supplies, prior to the disconnection,

18. Throughout, I follow Nagel (1974) in using the phase *what it's like* to capture the subjective or phenomenal nature of conscious experience.

19. In the same respect, we know what it's like to have a prefrontal cortex metabolizing glucose, even if we do not identify our experiences as such. Moreover, the phenomenal experiences of headaches, thumb aches, tinnitus, and *déjà vu* (to name only a few) each constitute what it's like to have a brain in a particular kind of physiological state even if we are ignorant about the neuroscience of those states.

20. Of course, as with a headache or tinnitus and the like, the experience doesn't have to be identified as corresponding to any neural phenomena.

the supervenience base of the experience of interacting with the other hemisphere. And therefore, the healthy hemisphere due to survive (or some proper part of it) has experience prior to the disconnection. A specific version of this general argument follows.

The Argument from Hemispherectomy

1. In some cases, there is something it's like to have a brain hemisphere detached, a detachment experience.

2. A detachment experience consists in an interaction experience and a subsequent lack of interaction experience.

3. This interaction experience supervenes on the intrinsic properties of some part of the brain that will survive the hemispherectomy—the other hemisphere or some proper part of it.

4. Thus, that other hemisphere or some proper part of it has experience before (and after) the hemispherectomy.

From this we can now conclude that a healthy typical brain gives rise to at least two additional and different phenomenally conscious minds: one associated with the left hemisphere, another associated with the right. The mind that would survive the detachment of the right hemisphere is the mind associated with the left hemisphere (or some part of it). The mind that would survive the detachment of the left is the mind associated with the right hemisphere (or some part of it).

One more specific argument is worth presenting in explicit form. Recall that in the Wada test, brain hemispheres are independently anesthetized so that clinicians can diagnose some of the cognitive capacities of the other hemisphere, which remains awake and functioning. Patients now post reports of their experiences online, commenting on what it was like, for instance, to attempt to name objects with one or the other hemisphere anesthetized.[21]

21. Current sources of patient reports can be found at sites such as www.epilepsy.com. Patients have also begun posting videos online in which they recount their experience.

The Argument from Wada Test

1. In some cases, there is something it's like to have a brain hemisphere anesthetized while the other hemisphere is not anesthetized.

2. Experiencing the anesthetization of a brain hemisphere requires having experienced interaction with that hemisphere and experiencing subsequent lack of interaction with that hemisphere.

3. Experiencing interaction with that hemisphere supervenes on the intrinsic properties of some part of the brain that will survive the hemispherectomy—the other hemisphere or some proper part of it.

4. Thus, that other hemisphere or some proper part of it has experience before (and after) the anesthetization.

In addition to the Argument from Hemispherectomy and the Argument from Wada Test, there is an analogous Argument from Minor Stroke, in which the premises involve what it's like to lose interaction with a small collection of neurons due to a minor stroke. Consider each region of your brain that you might lose to some stroke from which a conscious survivor would emerge. On the current view, for each such region, there is the complementary brain region associated with an independently conscious mind, many of these minds not yet aware of what it would be like to lose the region with which they are so intimately tied. There is also an analogous Argument from Cell Death, in which the premises involve what it's like to lose interaction with a perhaps small and scattered collection of neurons due to programmed cell death or some other cause. In one way, these arguments, which involve phenomena that are less extreme and more familiar, might be more convincing than those regarding hemispherectomies and Wada tests; after all, no one worries that the surviving and functioning brain, having shed a few neurons due to a minor stroke, programmed cell death, or the like, is not conscious.

Trivially, a generalization of these arguments concludes that there are far more minds—many billions, as absurd or unnerving as one might find that conclusion to be.[22] Enumerating neurons, there is the mind instantiated by the entire brain-minus-neuron-1,

22. Unger (2004) expresses such a reaction. This is addressed shortly.

the one instantiated by the entire brain-minus-neuron-2, and so on. And we can do this for the brain minus certain neuron pairs, neuron triplets, and so on up to whatever limits would preclude granting minds to something we might consider to have "insufficient brain matter or structure" for the instantiation of a conscious mind. Without worrying here about how we would draw the line between sufficient and insufficient brain matter or structure, we can at least extend the argument to the conclusion that each normal brain gives rise through its many proper parts to many minds.[23]

The view that each normal brain gives rise through its many proper parts to many minds will be used by some in a *reductio*. For example, Nagel (1971), in considering the possibilities raised by split-brain cases, writes:

> In case anyone is inclined to embrace the conclusion that we all have two minds, let me suggest that the trouble will not end there. For the mental operations of a single hemisphere, such as vision, hearing, speech, writing, verbal comprehension, etc. can to a great extent be separated from one another by suitable cortical deconnections; why then should we not regard each hemisphere as inhabited by several cooperating minds with specialized capacities? Where is one to stop? If the decision on the number of minds associated with a brain is largely arbitrary, the original point of the question has disappeared.

Nagel is concerned that if we accept the existence of more than one mind per typical human brain, then the number of minds we acknowledge is arbitrary. But this does not follow. What may follow from accepting the existence of more than one mind per typical human brain is that we do not yet know what counts as sufficient brain matter or structure for the realization of a mind. But this is nothing new. We already knew that we do not yet know what counts as sufficient brain matter or structure for the realization of a mind.

Unger (2004) finds the proposal that there are numerous minds or numerous "experiencings" associated with what we normally take to be one human individual to be "incredible", "absurd", and "disturbing". He holds that "there's nobody, I trust, who thinks there are many billions of experiencings physically promoted largely by the left hemisphere, and billions more largely promoted by the right," admitting that he doesn't

23. It is reasonable to suppose that the line should be drawn somewhere. Otherwise, one would have to defend the view that a single neuron instantiates a "mind" which could experience being detached from the rest of the brain. Not even a proponent of panpsychism has to embrace this conclusion.

think the view is "all that plausible". According to the arguments considered here, however, there are in deed many billions of "experiencings" promoted by parts of the brain.

The following objections will clarify the premises, hopefully preventing some objections that might be based on a misunderstanding of the argument.

2.1 Premise 1: The Existence of Such Experiences

How do we know there is something it is like to lose an entire brain hemisphere? After all, losing an entire brain hemisphere is drastically different, from a purely physiological point of view, than losing some neurons. In the latter case, we are left with what still counts (by all standards, medical, scientific, and common sense) as an entire functioning brain, while in the former, we are not. Perhaps then, there is nothing it is like to lose an entire brain hemisphere, just as there would be nothing it would be like to become a philosophical zombie, or much as there might be nothing it is like to lapse into unconsciousness, or to die.

Admittedly, in the strict spirit of philosophical skepticism, most of us do not know that there is something it is like to lose an entire brain hemisphere simply because most of us have not undergone a hemisphere disconnection and survived to contemplate the results. So, the first premise can be doubted by most of us, if we like. However, to doubt the first premise is to invoke a special application of the problem of other minds, an application which is perhaps a bit further justified by the fact that hemisphere disconnection patients exhibit diminished cognitive capacities. So, as with the standard problem of other minds, we have recourse to analogy from our personal experience to the experiences of others. And as previously established, we all know what it's like to lose some neurons. Many of us also know what it's like to have significantly diminished cognitive capacities due to exhaustion, illness, injury, medication, or age. Thus (or so I would argue), we have at least some way of gauging by analogy what it is like to move along the relevant physiological spectrum of possible states for a brain or any composite of functioning neurons.

But more importantly, for the purposes of our argument, we do not need to know what it is like to survive a hemisphere disconnection; we just need to know that it's like something. Given that some hemispherectomy patients are conscious by any operative standard, hemisphere disconnections do not present a special kind of problem.

Importantly, although Nagel's (1971) paper is almost entirely limited to split-brain phenomena, he does briefly consider the possibility of a person deprived of the

left hemisphere, which at the time was believed by many to be essential to language processing.[24] His point is that even if a person had only the hemisphere which does not predominantly process speech, there is no reason to deny that the person is conscious.

> There is no doubt that if a person were deprived of his left hemisphere entirely, so that the only capacities remaining to him were those of the right, we should not on that account say that he had been converted into an automaton. Though speechless, he would remain conscious and active, with a diminished visual field and partial paralysis on the right side from which he would eventually recover to some extent. In view of this, it would seem arbitrary to deny that the activities of the right hemisphere are conscious, just because they occur side by side with those of the left hemisphere, about whose consciousness there is no question.

Nagel's point stands today. While the capacity of a hemisphere for coherent, interactive speech may remove any empirical doubt about its consciousness, each hemisphere alone has capacities sufficient for the justified attribution of consciousness.

2.2. Premise 2: Experiencing Detachment of a Hemisphere

First, the argument treats the experience of detachment from *x* as a composite experience that must include some experience of being attached to *x* and some subsequent experience of not being attached to *x*. Such a composite experience obviously spans time. The argument does not require that the very moment of detachment itself be consciously experienced or identified as such.[25] In the same way, one might experience the loss of one's wallet simply by first experiencing the having of the wallet, then experiencing the lack of the wallet. The very moment of loss does not need to be identified as such in that moment or even afterward; one just realizes that at some point the wallet was lost, and this requires having experienced its presence followed by an experience of its absence.

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24. We now know that language dominance is only typically lateralized to the left hemisphere. While left-hemisphere language dominance is estimated to exist in well over 90% of right-handers, Knecht (2000) reports that left-hemisphere language dominance can reach up to 27%.

25. As previously noted, the procedure typically involves keeping the patient awake and responsive throughout, which is considered to be ideal because it allows surgeons to track the cognitive and functional results of the operation as it progresses.

Second, experiencing the detachment from *x*, as construed here, also involves not something's "losing a proper mereological part of itself", but something's detaching from that complement, *x*, which was once attached and interacting and later is not.[26]

Finally, my argument is not about entities that believe they have experienced loss, but about things that truly have experienced loss even if they have not acknowledged it as such. We may grant that we cannot truly know at any moment whether we have actually experienced loss. Confabulation, amnesia, and other forms of faulty memory may lead me to believe that I have experienced something that I have not experienced or that I have not experienced something I have experienced.[27] One's believing that one has experienced loss and one's experiencing loss are different things. Consider, for instance, the experience of coming to believe that you have lost some region of the brain, and suppose that, despite your belief, you never had the brain region in the first place. This is not a detachment experience, and as such it is not addressed by the argument. The present argument applies to entities that truly have had conscious experience of loss.

2.3 Premise 3: Supervenience and Causal Interaction

The phenomenal experience of interacting with some *x* supervenes on the intrinsic physical properties of something else that does not overlap *x*.[28] Brain hemispheres conjoined by a functioning corpus callosum causally interact with each other. According to this premise, each brain hemisphere, not the whole brain, instantiates the phenomenal experience of interacting with the other hemisphere.

Churchland (1981) muses about the possibility of linking human brains to each other much as hemispheres are linked to each other via the corpus callosum: "Once the channel is opened between two or more people, they can learn (*learn*) to exchange information and coordinate their behavior with the same intimacy and virtuosity displayed by your

26. One might invoke mereological essentialism in order to defend this view; however, that is not necessary. We need only accept that there is some y which once interacted (through physical attachment) with x and now does not.

27. As Russell famously point out, for all we know, we (along with everything else in the universe) have only just now popped into existence with false memories of having lost something which in fact we never had. In that case, we think we have lost something, but we haven't lost it.

28. Of course, the intrinsic properties of x help to determine the nature of the interaction and thereby can influence which phenomenal experiences are had by the thing that is interacting with x, but these properties of x are effective only insofar as they change the intrinsic physical properties of the thing that is interacting with x.

own cerebral hemispheres. Think what this might do for hockey teams, and ballet companies, and research teams!" Churchland soon after asks, "How will such people understand and conceive of other individuals?" His answer: "In roughly the same fashion that your right hemisphere 'understands' and 'conceives of' your left hemisphere—intimately and efficiently, but not propositionally!" For our purposes, we might ask what it would be like to become linked to another brain via a connection as complex as the corpus callosum. Perhaps we currently have no justifiable specific answer. Even so, we can at least grant that it would be like something.[29] Perhaps, then, whatever it would be like to be a brain linked to another brain is much like what it is like to be a hemisphere linked to another hemisphere. And even if not, we can acknowledge that just as there should be something it is be like to be a brain linked to another brain, there should be something it is like to be a hemisphere linked to another hemisphere.

None of this should be taken to mean that a human with both hemispheres connected by a healthy corpus callosum can report on what it is like for one hemisphere to interact with the other. Recall that all of us have lost neurons. This, of course, does not mean that prior to the loss we can report on what it is like for the overwhelming majority of the brain to interact with some small and scattered portion soon to be lost. Similarly, a stroke patient, prior to the stroke, cannot be expected to be able to make such a report. Reports are the product of complex causal relations holding among complex neural entities. Any reports an integrated hemisphere might be disposed to make about what it's like to interact with the other hemisphere are conceivably subject to being "washed out" by or combined with other activity, including any other reports that the other hemisphere would be disposed to make. We have good evidence for this. Differences in the dispositions of each hemisphere to report are in fact just what the split-brain research so famously shows.[30] And fortunately for our purposes, the Wada test provides additional evidence about what it's like for one hemisphere to experience disconnection from the

29. For, the alternative, that it is like nothing, requires that we implausibly decide that brains lose consciousness upon becoming linked to other brains.

30. In a paradigm example (Scientific American 2002), "Joe", a split-brain patient has the word 'toad' very briefly presented on his left visual field (processed by the right hemisphere) and 'stool' very briefly presented on his right visual field (processed by the left hemisphere). When Joe is asked to draw what he saw with his left hand (controlled by the right hemisphere), he draws something resembling a toad—certainly not a stool nor a toadstool. When asked to say what he saw, he says, "Stool" (this speech act processed by the left hemisphere). At this point, Joe's left hand (controlled by the right hemisphere which has now heard the left hemisphere's production of the world 'stool') draws a three-legged stool. Joe does not draw a toadstool.

other, and *vice versa*, this being largely the point of the Wada test. And unlike split-brain research, the Wada test also provides evidence about what it's like for one hemisphere to experience reintegration with the other hemisphere as it awakens, and *vice versa*. Thus we do have a promising window into what it's like to interact with the other hemisphere, for the Wada test allows one hemisphere to independently supply reports and behavior indicating what it can and can no longer see, identify, control, and remember. The deficits revealed presumably testify as to what the still-functioning hemisphere is accustomed to, even if it never independently considered what it was accustomed to prior to the Wada test.

3. Objections

Any argument that concludes that brains have an indeterminate and large number of minds associated with it, or that regions of the brain are independently conscious, is assured to encounter objections. Earlier, the hesitations of Nagel and the strong sense of bewilderment expressed by Unger were mentioned. The sense that this view is implausible or even absurd cannot easily be dismissed. For most of us, daily experience does not seem to involve a cacophony of minds, and that very fact appears to serve as a sufficient objection to the view. While I suspect that this kind of objection begs the question in simply assuming that there is a special single conscious mind which would somehow experience competing others if there were any, we will not examine it here. I accept the strange feel of the thesis that brains have many minds, but to the extent that this is an objection, it is so far only an objection to the conclusion of my argument. It does not tackle any step of reasoning along the way.

Other objections do however address the general argument presented here. We will consider three. Each of them is an objection to Premise 3, the claim that interaction experiences supervene on the intrinsic properties of some part of the brain that will (or would) survive a disconnection, that is, the other hemisphere or some proper part of it.

3.1 Objection from Considerations of Personhood

One might object that the functionally connected hemisphere is not independently associated with its own person, and because of this, it has no conscious experience. This objection to Premise 3 requires some nontrivial philosophical commitments to what it is to be a person, and among them must be a commitment to the proposition that a person cannot be associated with a brain hemisphere if it is functionally connected to

another brain hemisphere.[31] Clearly, the proposition itself is not *prima facie* part of our normal conception of a person, at least not in the sense that standard attempts to define personhood make any mention of brain hemispheres or their connectedness. Ideally then, the proposition would be compelled by something else in the concept of personhood.

While I reject the view that consciousness requires personhood (for the reasons previously indicated), I will try to make the most of this objection by considering what appears to be a reasonable version of it. Plausibly, the objection might include the proposition that persons cannot overlap or that one person cannot be a proper part of another person. After all, we do not typically think of persons as entities that can truly overlap in the physical sense considered here.[32] So perhaps there is some promise for the view that a connected hemisphere is not a person. I have two responses to this version of the objection.

First, even if a functionally connected hemisphere is not a person, this does not entail that it is not independently conscious. As previously noted, it is quite plausible that some animals are independently conscious without being persons according to any extant conception of personhood. The objection, then, puts the cart before the horse: Personhood requires at least the capacity for experience; the converse does not obviously hold. Thus we can concede this much of the objection—that a functionally connected hemisphere is not a person—and nevertheless retain the possibility of consciousness for such hemispheres.

Second, the thesis that a functionally connected hemisphere cannot be associated with a distinct person results in a dilemma: Either a hemisphere, functionally connected or not, cannot be associated with a distinct person, or a hemisphere, when functionally

31. Though see Schechter (2012).

32. Someone might want to champion alleged counterexamples to the proposition that persons cannot overlap: the pregnant woman, the conjoined twins, the "split personality", the soulmates... While this would not be the place for an extended argument, I will say that I do not think that, on closer inspection, any of these cases would count as counterexamples. Even in the normal cases of conjoined twins, while we must acknowledge that can they share organs, we typically think of them as two individual persons who are biologically connected, even dependent, on each other. However, there do seem to be reasons for rejecting the proposition that persons cannot overlap. Schechter (2012) makes a much more compelling case for overlapping persons associated with the brains and hemispheres of split-brain patients. There is also the possibility that conjoined twins share a brain region, as with the craniopagus conjoined twins Krista and Tatiana Hogan, whose brains are believed to be connected by a "thalamic bridge" and whose behavior suggests to some that they share sensory experience (Dominus 2011). Both Schechter's considerations and the anecdotal and anatomical evidence of Krista and Tatiana Hogen present stronger counters to the proposition that persons cannot overlap.

connected, cannot be associated with a distinct person. On the first branch, hemisphere disconnection patients are not persons. But our research and the behavior and reports of patients themselves clearly indicate otherwise. On the second branch, a hemisphere disconnection patient can be a person; however, should that hemisphere ever be functionally connected with another hemisphere, that original person associated with that hemisphere is *ex hypothesi* annihilated. Recall that the Wada test, in which brain hemispheres are independently anesthetized, one after the other, is a medical reality. Thus on the second branch of the dilemma, it would appear that various persons would have to come and go as the test progresses. The reader is left to weigh these options against the proposition that brain hemispheres have independently conscious minds.

3.2 Objection from Interactionist Substance Dualism

According to interactionist substance dualism, the mind is something that can be one way or another without any (immediate) differences in the brain but which interacts somehow with the brain. On this view, it may be the case that only single minds interact causally with brains or brain portions so long as the portion is functioning well enough. Perhaps then cases of hemisphere disconnection are cases in which there is only one mind, one which once interacted with a whole brain but now interacts only with a hemisphere.

This objection also rejects Premise 3. But it does so only by rejecting MBS, and as such, it is strictly not an objection to my view that under the assumption of MBS we have good reason to hold that typical brains host many minds at once. However, a response to this objection does not need to be merely dialectical; two further points can be made.

First, interactionism is *prima facie* an empirically testable claim. After all, showing that a brain or hemisphere exhibits physical effects that cannot be accounted for by any of the extant physical causes would count at least as evidence that the brain was affected by some nonphysical interaction. The brain, on this view, is like a remote-control toy, that toy being something that could be discovered to be under remote control even by scientists who had no conception of electromagnetism or any ability to directly detect it. Thus, unless one holds an empirically untestable form of interactionism, the view embraced by this objection can be placed among the scientific hypotheses awaiting empirical testing.

Second, interactionist substance dualism raises additional questions. One must eventually address the question of what would happen in a case in which two healthy hemispheres are entirely disconnected from each other. Does the single immaterial mind once associated with the whole brain now interact with one, the other, both, or neither?

Again, unless the alleged interactionism is untestable, we should expect some intriguing results. And if it is untestable, we should expect some independent reasoning to favor one option over the other, noting that three of these options entails the existences of "zombie hemispheres". Admittedly, I have not ruled out any of the options, but do hope to have shown where the burden lies.

3.3 Objection from Shared Anatomical Parts

Hemisphere disconnections leave shared brain structures, such as the brain stem, in place. Perhaps then the supervenience base of the mind that exists after the disconnection is not the properties of the surviving hemisphere, but of the brain stem. If so, then one might argue that a single mind is associated with one of these shared anatomical parts, and the loss of a hemisphere is just the loss of some peripheral, though elaborate, organ for processing information. Note that this objection does not simply argue that a mind can be associated with some non-cortical brain structure; it must further argue that no mind is associated with a hemisphere. Once again, Premise 3 is allegedly false. Like the appeal to interactionist substance dualism, this objection offers another way out. Unlike the appeal to interactionist substance dualism, it appeals only to the physical world. However, it faces two problems.

First, it is not clear that any empirical research supports the idea that our brain hemispheres are not conscious. According to this objection, there is nothing it is like to be a single hemisphere or both hemispheres, and consequently there is nothing it would be like to be a hemisphere or pair of hemispheres losing interaction with the brainstem. There are only conscious experiences that involve what it is like (for the brainstem) to be interacting with the hemispheres, and what it is like not to be interacting with them. This is a radical departure from our medical and neuroscientific understanding of the brain. Note how much cognitive processing would be unconscious on this view. For instance, all the executive control and inhibition performed by the prefrontal cortex would be entirely unconscious. This view might conveniently avoid some of the ethical considerations we will look at in the next and final section, for on this view, hemispheres are not themselves conscious; however, the idea that hemispheres are not conscious appears to be scientifically unfounded.

Second, even if it were true that conscious minds are associated not with any part of the cortex, but with some structure which survives disconnections of either or even both hemispheres, this only means that hemispheres (and their parts) are not independently conscious; it does not mean that there are not many minds associated with the brain

or that other proper parts of the brain are not independently conscious. Recall that the arguments about disconnection, along with those involving stroke and cell death, generalize. Thus, even if a subcortical structure, or some special part of it, is the true "seat of the mind", the possibility remains that that very thing can be divided in uncounted ways and that the main conclusion still holds: The brain hosts many minds.[33]

4. Ethical Considerations

The thesis that brains have many minds has fascinating implications for the nature of consciousness and personal identity. Right now, you are reading this sentence. However, at the very same time a "part of you" is experiencing what it is like to be conjoined and interacting with another part which together comprise the entity that is reading the sentence. In fact, there are many such parts. Some of them understand their role as part of the whole sentence-reading entity; others clearly do not, and yet they are conscious entities nonetheless. For they are parts which would survive as conscious experiencers of the loss of other parts, were those other parts to die or become surgically disconnected or anesthetized.

The thesis that brains have many minds also has implications for how we should treat other conscious entities in general. These implications are identified and briefly elaborated here.

As I have argued, each healthy hemisphere instantiates a conscious entity. If so, then the death of a healthy hemisphere instantiates the death of a conscious entity. Of course, actual medical hemisphere disconnections are performed only when doctors have decided that the hemisphere to be detached is significantly deleterious to the rest of the brain. One can hope that actual medical hemisphere disconnections involve only the detachment of hemispheres so unhealthy that there is not much of a conscious entity there to begin with. Nevertheless, we do acknowledge the possibility or actuality of consciousness even in those whose brains are significantly impaired. The question remains as to whether an impaired hemisphere instantiates a conscious entity, and if so, whether that conscious entity is a mind, a person, a potential person, or something else.[34] However it is that we might come to understand the status of such hemispheres,

33. One might try to avoid this second point by insisting that the shared anatomical part is such that it loses its associated mind upon losing any single physical part.

34. If one is inclined to reject out of hand the idea that this impaired hemisphere is conscious, one should consider how we should think of a patient who once had one healthy hemisphere and one significantly impaired hemisphere but, due to accidental traumatic hemispherectomy, lost the healthy hemisphere and

it should be clear that the decision to perform or to undergo a hemisphere disconnection is not necessarily just a decision to surrender some cognitive and physical capacities; it may instead be a decision that involves the death or extinction of at least one robust conscious entity, one we would recognize in other contexts as a real human person just as we recognize individuals with significantly impaired brains (hemispherectomy patients included) as real human persons.[35]

Furthermore, recall that not all hemisphere disconnections involve the removal and death of the detached hemisphere. In the cases of functional hemispherectomy and hemispherotomy, the hemisphere, or large parts of it, remains alive and in the cranium, but it is physically cut off from the other hemisphere, unable to transmit motor signals or to communicate in any direct way. If that brain hemisphere instantiates a conscious entity, however disabled it might be due to whatever condition was deemed to warrant the procedure, then this form of hemisphere disconnection amounts to putting a conscious entity into a perpetual "locked in" state. The experiencing subject merely rides along with the body (and the controlling other hemisphere) as a passenger. If sensory pathways are also cut off, then the experiencing subject is in a perpetual state of sensory deprivation, as well, consigned to live on without any ability to experience the world or take action in it.[36] Thus, the decision to perform or undergo such a hemisphere disconnection is possibly a decision to put an experiencing subject into a medically induced permanent state of solitary confinement.

By some lights, these considerations may seem too speculative or even too dark to take seriously. But they are actualities we already knowingly face in other contexts. Some serious cognitive impairments are now treated as if they leave room for yet an experiencing subject. Cases of "covert consciousness" such as locked-in syndrome and anesthesia awareness are now known medical realities (Stins, J. F. and Laureys 2009;

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continued to live with only the significantly impaired hemisphere.

35. Note that, when someone decides to undergo the procedure, the hemisphere due to be removed possibly takes part in this decision procedure, opening up the conceptual possibility of "partial self-sacrifice".

36. Conceivably, a mind associated with a single hemisphere in such a state drifts into unconsciousness or some kind of torpor in which at least there is nothing we could count as suffering being experienced. If so, then functional hemispherectomies and hemisphereotomies would be much like anatomical hemispherectomies. One might be tempted to suppose that this is so just for the psychological convenience of not having to worry about potentially isolated experiencers. But this would clearly be unjustified both rationally and ethically.

Cruse, D. et al. 2011). We must take seriously the epistemic possibility that some impaired hemispheres are conscious.[37]

Meanwhile, although the question of when it is morally permissible to sacrifice one experiencing subject for the sake of another has long been a central focus in ethics, hemisphere disconnections appear to introduce a new dimension to this old issue. For, unless it can be shown that only unconscious hemispheres are ever detached, we now have reason to believe that a hemisphere disconnection entails not merely a risk to the life of the patient and some assured loss of cognitive and physical capacities, but also, for all we know, either the death or the sensory-motor isolation of an experiencing subject (many such subjects) even in cases where the procedure is fully successful.

In broaching these ethical concerns, my aim is not to raise alarms about hemisphere disconnection procedures in themselves, which by all accounts have the obvious potential to greatly improve the lives of the surviving experiencing subjects. But I do think the preceding considerations raise the question of whether they affect other experiencing subjects who (or which) may also have moral standing. If so, it is important that we understand and heed the conditions under which hemisphere disconnections are morally permissible. This is, of course, an important question in its own right. Moreover, addressing this questions should help us shed new light on the old question of when it is morally permissible to sacrifice some conscious entities for the sake of others.

37. Basl (2013) has us imagine the case of a new device which reveals that some patients once thought to be in a persistent vegetative state are actually conscious. Considering the refusal to use this device on others thought to be in persistent vegetative states, Basl writes, "To do so would be to commit an inexcusable wrong, it would be to knowingly ignore a possible person, someone with the same moral status as ourselves. It would be as if we turned our back on a possible person who might be suffering greatly right in front of us when we had the ready means to alleviate that suffering."

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