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THE DEPTH OF THE BODY

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1. Introduction

There's a sense in which the individual water molecules in your body are part of your body, but there is another sense in which these water molecules are not really a part of your body. Consider, for example, the everyday effects that other people have on individual water molecules in your body through small gravitational and electromagnetic forces. There is a sense in which those forces don't affect you. The aim of this paper is to develop an ontological interpretation of this latter sense of the body. The core idea is that some objects and properties that make up a body are too specific or small–too *deep*–to properly count as parts of the body in a morally significant sense. The dimension of depth brings into focus the proper purview of the moral body—the body as it figures in questions of bodily ownership, integrity, and autonomy. [1]

The dimension of depth is easily ignored in organic bodies because we have little reason to consider minutiae like individual water molecules. Moral conflicts involving them rarely, if ever, arise. However, the age of wholly organic bodies is behind us. People have pacemakers to improve the function of their hearts and cochlear implants that enable them to hear. Brain-computer interfaces have moved from science fiction to reality, and the widespread use of neural enhancements is no longer a distant possibility. With the growing prevalence of artificial extensions of the body, the dimension of depth will become more salient and morally relevant. So, there is more than a theoretical need for a clearer understanding of the depth of the body.

The cutting-edge case of brain-computer interfaces raises new moral questions, and depth emerges as a key element of a systematic answer to these questions. One such question will figure centrally in the discussion to come: when a person uses a brain-computer interface (BCI), where portions of the computer are not merely external to the human form but are also legally owned and operated by some third-

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party, who has moral rights over that piece of hardware? If a person has moral rights over their body and the BCI is a part of the body, then the person's rights seem to extend to the external hardware. Yet, as the developer and/or legal owner of the hardware, a third-party may have a conflicting claim over parts of the BCI system. If the third-party's claim stands, then there is logical pressure to conclude that the BCI is not truly a part of the person's body. Otherwise, we would have to give up the compelling principle that persons cannot be owned to any extent by other entities (see, e.g., Bublitz 2024).

This moral tension should not be considered in isolation. Ordinary objects in the body that realize important organic functions, like individual water molecules, arguably raise questions similar to that of BCIs. Because the moral tension is not isolated to cases of artificial body parts, we should pursue a comprehensive answer. By using a notion of depth, we can resolve the moral tension in a principled manner without conceding that the BCI is not part of the person's body.

Recognizing the depth of the body helps us navigate the moral tension because it shows how aspects of the BCI can be a part of the body even though the "deeper" hardware that implements it is not. That is, depth allows us to distinguish two overlapping objects: a higher-level, less deep object and a lower-level, deeper object, where only the former is properly a part of the moral body. The same answer allows us to say that, while organs and blood are parts of the moral body, individual water molecules are not. We are then able to consistently maintain that the person has full moral rights over all of their body parts while also avoiding implausible moral implications.

Though it may seem bizarre at first blush, the notion of depth is not out of left field. Existing theories of the body not only accommodate depth, but also support the relevance of this dimension—even if they haven't explicitly acknowledged it. These include subjectivist, interest-based, and functionalist accounts of the body. Further, hylomorphism, a general theory of things and their parts, also accommodates the notion of depth. So, we can give a substantive ontological underpinning to the moral significance of depth.

The paper proceeds as follows. First, I discuss BCIs as parts of the body, ultimately suggesting that we need a nuanced ontology of the body to account for how BCI systems figure in it (section 2). I then develop an account of depth (section 3), discuss its relation to theories of the body (section 4), and provide two principles articulating its moral significance (section 5). I then apply the account to BCI ownership (section 6).

2. BCIs and Bodily Rights

2.1 BCIs as body parts

There is good reason to hold that a BCI can be a part of the body of the person who uses it (Ramachandran 2010; Aas and Wasserman 2016). Consider, for example, Neil Harbisson, a self-proclaimed cyborg who has an implanted antenna apparatus that allows him to sense colors through sound vibrations in his skull (Harbisson 2018). The antenna is important to Harbisson in a way that organic body parts are important to Harbisson and other people. So, it is plausible that the antenna counts as a part of Harbisson's body for moral purposes, such as for determining the realm of bodily rights (Aas 2021). More common forms of BCIs include interfaces that enable the use of motorized prosthetics or wheelchairs, or interfaces that enable communication by decoding neural activity (Shih et al. 2012; Brumberg et al. 2019).

Because BCIs can be essential to restoring basic functions such as sensation, movement, and communication, and because users often come to rely on them extensively for such purposes, it's reasonable to maintain that in such cases BCIs are body parts for moral purposes. I will assume as much in this paper.

However, complications arise when we turn our attention to the servers or other external pieces of hardware that are used to implement BCI software. Existing BCI systems sometimes utilize AI algorithms (i.e., artificial neural network models) or other computationally demanding software to translate brain activity into actionable instructions for external devices (Ali et al. 2024; Deo et al. 2024; Shah

et al. 2024). Because the software is computationally demanding, it is not easy to fully implement on small, implantable pieces of hardware. Then, implanted hardware may broadcast signals to external hardware–sometimes wearable, sometimes not–that performs a substantial part of the computation (Even-Chen et al. 2020; Simeral et al. 2021). In some cases, no part of the BCI hardware is implanted or otherwise permanently attached to the body, instead merely detecting brain activity via EEG sensors on the scalp (Edelman et al. 2019).

While we may expect that computational power and efficiency will increase and that BCI hardware will continue to shrink, the computational demands for BCIs are also likely to increase. Current BCIs generally only allow for single-effector control, and computational demands increase significantly for systems that allow people to control more than one effector, e.g., two prosthetic arms or digital cursors (Deo et al. 2024). Further, some people with BCIs may wish to replace processing components to maintain or adjust performance, perhaps even 'hot-swapping' parts while the BCI is in use (Ali et al. 2024, p. 10). Some of the computational processing may also be offloaded to the cloud, i.e., to remote servers, in order to maximize convenience and performance. So, it's highly plausible that BCI systems will continue to use hardware that is not easily implanted or worn.

The technological and medical constraints of BCIs complicate the view that these systems count as body parts. One problem is that, as discussed in the introduction, third-parties may have an independent moral claim of ownership over part or all of the BCI system, especially when that system involves the use of remote hardware such as cloud servers. If third-parties own the hardware, that may undermine or completely preclude the bodily ownership of BCIs by their users. A second problem is that, because some of the hardware is often separable or remote, it may not be integrated in the right way with the person's body to properly count as a body part. In particular, it's plausible that there are necessary modal and temporal conditions for embodiment. If so, perhaps an object can only be a body part if it is not easily replaceable or if it has been integrated with bodily processes for enough time. Such modal and temporal requirements may count against the inclusion of BCI components in the body.

2.2 *Two obstacles to BCI embodiment*

The two obstacles to claims of BCI embodiment are worth considering in more detail. Let us call them the problem of **ownership** and the problem of **transience**, respectively.

The problem of ownership arises when the person who uses the BCI system and the third-party who legally owns and manages a piece of the BCI hardware each have a prima facie moral claim of ownership over that piece of hardware. On the one hand, there is a compelling principle that holds that no part of a person may be owned by another entity (Quigley and Ayihongbe 2018; Bublitz 2024). On the other hand, the third-party, which may be a business or healthcare institution, may also have a moral claim to that hardware, such as if the third-party supplied the hardware and has not been compensated for relinquishing it.

While there may be good reasons to insist that the users' rights to bodily ownership override any third-parties' rights to property, there are reasons that cut against this position, too. For example, adopting that policy may strongly disincentivize the provision of BCI hardware by private businesses, ultimately hindering the practice. It may also entail implausible moral demands for the third-parties, such as that they are obligated to take extreme care to safeguard the hardware. This insistence may also generate implausible moral prohibitions, such as that cloud servers may not be updated or maintained without the consent of the BCI users—to their own detriment. After all, unconsented interference with the internal machinations of a body part would seem to be an infringement of bodily integrity. Finally, and perhaps most importantly, the problem of transience raises doubts about the robustness of the users' moral claims to that hardware.

The problem of transience provides reasons to doubt that some integral components of BCI systems, including external hardware that implements BCI software, are parts of users' bodies. It's plausible that

something can only be a body part, especially in the morally significant sense, if its involvement in bodily processes is neither fleeting nor easily replaced (Aas 2021). Consider, for example, the suggestion that a pencil and paper, being incorporated into extended cognitive processes, may count as body parts (Carter and Palermos 2016). The claim is rather implausible, at least with respect to the moral body. Do you infringe my bodily integrity by sharpening my pencil while I nap? Seemingly not. This result can be avoided by endorsing the plausible constraint that something cannot be a body part if it is incorporated into bodily processes too briefly or too intermittently, or if it is easily replaced (as a pencil is). Nor is the move ad hoc, as other theories of the body (de Vignemont 2011) and nearby theories of the extended mind (Heersmink 2015) adopt similar modal and temporal constraints. So, the transience of an object's involvement in the body plausibly precludes its moral significance as a body part.

However, there is a worry that this constraint is too restrictive. For example, cloud services for an individual user are rarely implemented on a single piece of hardware for long, and the hardware itself is replaceable. That suggests that the hardware that implements BCI software will typically be excluded from the moral body, just like the pencil or paper. Then, the user may have no bodily claims to the hardware or, importantly, to the execution of software. That verdict runs contrary to an important and I think desirable conclusion of Carter and Palermos (2016): that third-parties ought to take special care of BCI systems, over and above how they would treat (say) the storage of personal data or property.

The problems together point to a tension: there are reasons to include BCI systems as parts of the body and reasons to exclude them. It seems that BCI hardware should be subject to some bodily rights, but perhaps not the full suite of bodily rights in the full strength. Can we navigate this tension in a principled and plausible way?

2.3 Qualified rights over BCI body parts

One way to resolve the problems of ownership and transience is to identify qualified rights that users have over BCI hardware. Specifically, we might say that a user's bodily rights protect them from unconsented interference in their body if, but only if, that interference meets a further condition, such as that it harms them, flouts their wishes, sets back their interests, obstructs their autonomy, and/or disrespects them as persons. Then, the third-parties' property rights over BCI hardware may extend up to, but not overstep, the qualified bodily rights of users. In this way it may be possible to navigate apparently conflicting claims of ownership and to moderately discount the moral importance of parts according to their transience.

However, I suspect that any attempt to qualify the rights at issue will give implausible verdicts or will fail to resolve the moral tension. Implausible verdicts arise because some potential qualifications are too restrictive, while others are not restrictive enough. For example, a restriction of rights to harmful interferences is too narrow: many bodily rights prohibit harmless actions, such as the right not to undergo an unconsented pelvic examination while under anesthesia (Friesen 2018). In the other direction, if unconsented interference is prohibited whenever it sets back an individual's interests or flouts their wishes, that is too inclusive. Someone may have an interest in, or wish for, the sole use of a BCI-supporting cloud server, but that interest or wish does not suffice to generate a right to exclusive access to that hardware.

Other possible qualifications to bodily rights–such as obstructions of autonomy or disrespect to the person–fail to resolve the moral tension. If BCI hardware counts as a body part, then unconsented interference in that object may well obstruct a user's legitimate autonomy over their body and may well count as disrespect to them. Interference with an object can count as an obstruction to someone's autonomy simply because the object is a part of them. Since it is a part of them, their bodily autonomy entails a right to control what happens to it, including control over interferences. Similarly, an action that interferes

with an object may count as disrespect if the trespasser knows but does not care that the object is a body part. So, in many cases, whether there is obstruction to autonomy or disrespect will turn on whether the object is a body part in the first place. In difficult cases like those under consideration, these qualifications will not resolve conflicting moral claims. Further, even if qualified rights could coherently resolve conflicting claims, this attempted solution still violates the compelling principle already mentioned, namely that no third-party may own any part of a person. So, the moral tension persists.

Qualified rights fail to address the problems of ownership and transience not just because they get the conditions of bodily rights wrong, but also because they treat bodily rights as conditional in the first place. If it can be found, a better solution is to locate an independent but narrower condition of what counts as a body part. With a firmer ontological footing, we could then give a more plausible account of unconditional bodily rights.

2.4 Motivating a more discerning ontology of the body

The problem of transience is motivated by a requirement for what counts as a body part, and that requirement provides a sensible and helpful rule for deciding what falls within the purview of bodily rights. When an artificial object is only taken up in bodily processes (such as movement or perception) briefly or intermittently, or when that object is easily replaced by some commodity, then the object plausibly does not count as a body part (cf. Aas 2021). Examples include eyeglasses, contact lenses, tennis shoes, or BCI hardware. For something to count as a body part, it must figure in a lasting or irreplaceable way in someone's bodily processes. Let's call this the *intransience requirement*.

The intransience requirement applies not only to artificial parts of the body, but also to organic parts. In particular, we can explain why individual water molecules, as considered at the outset, are not integral parts of the moral body by appealing to this condition: individual water molecules (and other molecules too) are only involved in bodily processes in a highly temporary and replaceable way.

However, the intransience requirement calls for nuance. Even if every single water molecule in the human body is temporary and replaceable, *having a sufficient composition of water* is not temporary or replaceable. So even though individual water molecules fall outside the purview of bodily rights, there are rights against large, macrophysical interferences with the water in someone's body. Similarly, even if each cloud server only temporarily implements a person's BCI software, it's plausible that they have bodily rights against interference in those servers that would disrupt or manipulate the software processes that enable BCI functionality. Unlike the hardware, the software is not a temporary or replaceable part of the person's bodily functions.

It's plausible that water molecules or cloud servers are too temporary to count as parts of the moral body, but we must take care not to discount too much lest we throw out the baby with the baby's matter, as it were. For, when we consider the relevant objects, properties, or roles at a higher, more abstract level, we may identify something that is not temporary or replaceable like individual molecules and cloud servers are. This dimension of abstractness versus specificity (or 'determinateness') turns out to be an important dimension of the moral body.

2.5 The Dimension of Depth

Speaking loosely, the depth of an object, property, or role corresponds roughly to its degree of abstractness, microphysical specificity, or determinateness. A helpful initial characterization of depth is given by considering a functional role and realizers at different levels of abstraction.

Consider first a high-level, rather abstract characterization of the role of the heart as a *blood-circulator*. Something plays that role for each human body, and typically that role is played by the heart. When someone gets a heart transplant, a new object realizes the blood-circulator role in their body. So, while the heart is a realizer of the blood-

circulator role, something else could realize that role. However, replacing the realizer of the blood-circulator role is more common than heart transplants. Many atoms, molecules, cells, and pieces of tissue can be replaced even while the heart persists. After a long enough time, most or even all of the heart might have been replaced. In some sense, then, new matter realizes the *heart* role, not just the blood-circulator role. To put it differently, there's a sense in which the heart itself has a partly abstract, less than fully determinate nature. That is why it can lose small, specific properties or parts (like its exact mass, or the presence of some molecules) without ceasing to exist.[2]

The lesson is that we can consider body parts at different levels of abstraction: we can consider the blood-circulator, the heart, or the exact parcel of matter that constitutes the heart at a particular time. Indeed, we might even say these are different objects, similar to how a statue may be a distinct object from the clay that constitutes it (Thomson 1998; Paul 2010). These objects, or descriptions of objects, differ in 'depth' rather than spatial breadth. The highly determinate, specific object made up of exactly these microphysical parts arranged exactly this way is the deepest object. Abstracting from these specific, determinate properties gives us a higher-level, less deep object, such as something that needn't have precisely this shape or material constitution—like a heart.

Depth is morally relevant. I have an interest in continuing to have my heart, but I do not have an interest in continuing to have the *exact parcel of heart-shaped matter*. If an event makes it so that this parcel of matter no longer exists (such as when a molecule of glucose is metabolized), that is not bad for me. On the other hand, if an event makes it so that my heart no longer exists, then that sets back my interests considerably.

Depth is also relevant to a proper assessment of transience. This exact parcel of matter that circulates my blood for a moment is quite temporary and replaceable. Yet there is a higher-level object in its place that is far less temporary or replaceable, and that thing is far more morally significant. The same point can explain the moral significance of the hardware of BCI systems. The particular cloud server that implements some BCI software for a period of time is itself temporary and replaceable. Yet, there is a higher-level object in its place that abstracts from some of the determinate features of the particular server. This higher-level object is a kind of software object—a persisting, implemented computational process (Marr 1982; Chalmers 2019). The software object, unlike the server itself, is not a temporary or replaceable part of the body (at least when considered at the right level of abstraction).

Distinguishing between the software object and the hardware object along the dimension of depth allows for a clearer view of the true object of bodily rights and interests. The software object falls within the purview of the BCI user's bodily rights and interests, while the hardware belongs to the third-party. We can then say that the BCI user has unqualified bodily rights to the software object, even while these bodily rights do not place strict moral limits on a particular piece of hardware. For example, the third-party may perform maintenance of or even replace a server if that does not interfere with the software object. So, depth promises to resolve the problems of ownership and temporality. After developing a way of thinking about depth, I revisit the BCI case in more detail in section 6.

The general point that I aim to develop is that depth is a dimension of the body. To put the idea metaphorically, there is a kind of metaphysical "floor" in the mereological constitution of the body about which we should say: what happens below this floor does not really concern the body–*is* not really the body–at least for morally important purposes. Let's now see how we can make ontological sense of depth.

3. Defining Depth

How can we understand the dimension of depth in more precise terms? There are multiple options. I have informally characterized depth in terms of low-level versus high-level parts or properties, in terms of determinacy versus abstractness, and in terms of microphysical ver-

2. Compare this to the notion of variable embodiment of Fine (1999).

sus macrophysical properties. The general idea is that the dimension of depth begins, at the deepest level, with an utterly determinate description of a state of affairs. A determinate description of a state specifies in complete, tedious detail the microphysical properties of that state. Higher-level descriptions are less specific, less determinate, and more abstract. They abstract from microphysical descriptions to arrive at macrophysical descriptions that are neutral about many of the microphysical details.

I'll proceed by defining depth in terms of micro- versus macrophysical properties, but other options include the level of determinacy or level of metaphysical fundamentality. These distinctions often align. Microphysical properties tend to be more determinate and more fundamental than macrophysical properties. Determinate properties are more fundamental than their determinables (Rosen 2010). And, within a given determinable, determinates admit of a narrower range of microphysical realizers—for example, fewer possible things are crimson than red. Still, the distinctions don't always align. The property of being exactly one kilogram is perfectly determinate but neither fundamental nor microphysical. I will work with the micro/macrophysical version of the view with the caveat that there may be nearby versions that sometimes diverge.[3]

It's fairly straightforward to define the depth of a description, whether that is a description of an event, state, or object. A description is deeper to the extent that it is more committal about the microphysical properties of that event, state, or object. Conversely, a description is higher-level insofar as it is more neutral about the microphysical properties. High-level descriptions are committal at the level of macrophysical properties rather than microphysical properties.

The depth of a description isn't quite what we need. In examples discussed so far, I have spoken variously of the depth of water molecules, organs, and BCI hardware—various objects that are candidate body parts. So, to speak of the depth of the body or its parts, we need a sense of depth that is applicable to objects. Descriptions can be extended to objects by interpreting descriptions as the *real definitions* of objects (Rosen 2015). Then, the depth of an object will correspond to the depth of the primary constituents of its real definition.[4] For example, to be a water molecule is to be molecule composed of exactly two hydrogen atoms and one oxygen atom. Because the constituents of the definition pick out atoms, the definition is committal at a microphysical level and hence is rather deep. In contrast, the definition of a heart might be something like: the organ that circulates blood in an organism. The constituent elements of this real definition are rather abstract and high-level, and hence are neutral about the microphysical details. So, the definition of the heart is not deep, in contrast to that of a water molecule. By extension, we can say that the water molecule is deeper than the heart.[5]

There is a further benefit to using real definitions. Real definitions constrain or codify the identity and individuation conditions of the defined entity: when the definition is no longer satisfied, the entity ceases to exist. Its defining condition is a condition of its existence. So, real definitions play a role in determining how temporary an object is. For example, because the real definition of a heart is compatible with the replacement of individual molecules and cells (by virtue of being neutral about them), the heart can survive the loss or replacement of those molecules and cells. The heart is not as temporary as the parcel of matter that constitutes the heart at a particular time, which by definition cannot survive the loss of those molecules or cells. And this

3. While I'm sympathetic to ontologies that appeal to relative fundamentality, I don't think the view needs to rest on such a controversial foundation.

4. The primary constituents are the elements that literally figure in the real definition. On an account like that of Rosen (2015) where real definition is connected to grounding, the primary constituents of a definition are the worldly items that immediately ground facts about what is defined in terms of them. For theorists who endorse a grounding-theoretic picture of real definition, it would be especially natural to define depth in terms of the level of fundamentality rather than microphysical specificity.

5. Or, in terms of fundamentality: the water molecule is more fundamental than the heart.

difference is important to how we think about body parts: your heart is a body part while the overlapping parcel is not. After all, the parcel disappeared almost immediately due to chemical reactions as the cells in your heart respired, but you did not thereby lose a body part.

So, I will proceed on the assumption that we can make sense of the notion of the depth of an object, corresponding to the depth of its defining properties. We can also see how the depth of an object makes a difference to body parthood: objects that are too deep are not genuine body parts.

In what follows, it will also be helpful to have a notion of high-level neutrality in order to state various claims about the depth of the body, the purview of rights and interests, and so on.

> **Df**. *high-level neutrality*: an event e is high-level neutral with respect to a state or object just in case e does not change the high-level properties of that state or object.

(Where 'high-level' refers to macrophysical rather than microphysical properties, though alternative construals in terms of determinateness or fundamentality may have advantages.) As examples: respiration and cell division tend to be high-level neutral with respect to a human body because, while such events constitute changes at a low level, they do not constitute changes at a high level. In contrast, suffocation or the development of cancer are not high-level neutral because they involve changes to high-level features of the body, such as health or life itself.

The notion of high-level neutrality is not meant to give an absolute dichotomy. Rather, we can think of an event as being neutral down to a certain minimum level, corresponding to the sharpest granularity to which the event made no difference. It's natural to say that events that only change properties at lower levels are 'more' high-level neutral. Depth is a gradable notion, and high-level neutrality is meant reflect this gradability. Some events that are high-level neutral in the morally relevant sense may not be low-level in the sense of only affecting elementary particles, for example. What matters is that the event does not affect higher level, less specific properties, where that level of neutrality explains why the event does not affect the body.

One reason to leave the definition of high-level neutrality somewhat vague is so that it can take on different meanings in different contexts, corresponding to different thresholds (like the word "tall"). I suspect that context-sensitivity is apt for the normative roles that the notion is meant to fulfill. For example, the morally relevant level of depth may differ across organs or bodily functions. So, while the definition of high-level neutrality is superficially binary and absolute, its proper use should not plaster over contextual variation.

With the depth of body parts in mind, high-level neutrality provides a characterization of events that do not affect body parts. High-level neutral events, such as influences on the motions of individual water molecules, do not interfere with the body at all.

4. Theories that support a notion of depth

It may seem bizarre to claim that water molecules or glucose molecules are not parts of the body, but plausible theories of the body support the claim. (To be clear, I'm not saying that there is *no* sense in which water or glucose molecules are parts of the body. There is a run-of-the-mill conception of parthood that says they are.) On their own terms, these theories naturally accommodate depth as a defining dimension of the body.

First consider subjectivist theories of the body, broadly construed. Subjectivist theories hold that aspects of an individual's subjectivity determine what is a part of their body. Several types of subjective properties are on offer, and a subjectivist theory could define the body in terms of one or more such properties (De Preester 2011; de Vignemont 2011; de Vignemont 2024). Roughly, subjectivist views say that something is a body part if and only if it is represented, experienced, or felt as a body part. But notice: low-level objects and properties, such as those that are highly microphysically specific, are not represented, experienced, or felt to be body parts. Rather, one's subjective states are much more high-level, abstracting away from these low-level objects and properties. So, a subjectivist conception of the body pairs natu-

rally with the foregoing discussion of depth. The body as conceived by the subjectivist resides above a certain metaphysical floor.

An alternative theory of the body appeals to an individual's bodily interests (Aas 2021). On this view, what counts as a body part for moral purposes is any object that crucially supports an individual's experience and agency and to which they feel "profoundly attached" (ibid, p. 6526). This theory of the body is also highly amenable to depth. The precise motion of my water molecules is not important for my experience or agency, nor is a water molecule something I feel profoundly attached to. Ordinary electromagnetic fields from nearby bodies don't disrupt anything relevant to my experience or agency. So, these electromagnetic fields plausibly don't interfere with my body parts on this account. Similarly, when my heart metabolizes a glucose molecule, the parcel of matter that goes out of existence is not something in which I have interests. And so, those things are not parts of my body, properly understood. These low-level events are simply too deep to matter in the way that a body part does—they are below the floor of the body.

Other theories of the body are couched in functionalist terms, including biological views (Liao 2010; Pradeau 2012) or extended mind views (Carter and Palermos 2016). Whether the body is defined in terms of biological or cognitive functions, there is a question of the metaphysical depth of the realizers of the functional roles.

Biological views define the body in terms of physiological functions, such as metabolic or immunological processes that maintain physiological stability. While these views are not well positioned to account for the morally relevant notion of body parthood, they may have other uses for the notion of depth. In particular, depth is useful for identifying the processes or objects whose persistence is important for physiological stability. Recall the example of the collection of molecules that constitutes a heart, as contrasted with the heart itself. The biological conception of the body points to the latter rather than the former as relevant to stability. That the former goes out of existence very quickly is irrelevant, despite the fact that it does, for a brief time, realize the relevant functional role. Because biological views understand the relevant functions at this higher, more abstract level, they are implicitly making use of the dimension of depth.

On an extended mind view of the body, body parts are those objects that are functionally integrated with cognitive processes. When we consider a candidate object, there is a question of whether it is the role or the realizer (and if the realizer, at what level?) of the function that is included in the body. An instance of this question was a focus of section 2, i.e., at what level is a BCI-implementing cloud server a part of the body? To answer this question, we have to make use of the dimension of depth. The answer I have suggested sides with the higher-level, more abstract characterization of the object because the low-level, microphysically specific realizers are too determinate–too deep–to be part of the body.

There is a general connection here to hylomorphic theories of mereology, so it is worth briefly making this connection explicit. Hylomorphic theories hold that objects are composed of parts that are arranged according to a certain form, where the parts themselves may admit of variable embodiment over time (Fine 1999; Johnston 2002). The natures of hylomorphic objects can also be articulated in terms of depth: the high-level form is central to the nature of the object, while particular highly determinate low-level parts and properties are not. The natures of hylomorphic objects are reflected in the objects' real definitions, which then take the form 'x is an object constituted by $p_1 \ldots p_n$ arranged F-wise.' For such an object to be capable of variable embodiment, the parts $p_1 \ldots p_n$ must be somewhat high-level and not essentially maximally determinate.

5. Two moral principles

Having articulated a notion of depth and its relation to theories of the body, we can now move on to two moral principles that will help us put depth into practice. The moral principles use the concept of high-level neutrality, which is when an event does not affect the high-level properties of a state or object. The two principles concern bodily interests and rights respectively, viz:

Bodily interests are high-level. The bodily interests of an embodied creature, such as a human being, concern events that are not high-level neutral with respect to their body. For events that are high-level neutral, those events generally do not bear on the bodily interests of the individual in question.

Bodily rights are high-level. The bodily rights of an embodied creature, including rights to bodily integrity and autonomy, concern events that are not high-level neutral with respect to their body. For events that are high-level neutral, those events generally do not infringe on the individual's bodily rights.

Strictly speaking, these two principles don't depend on the ontological claim that body parts themselves have partly abstract, high-level real definitions. Even so, that ontological claim provides a simple and unified explanation and justification for these principles.

The principles provide conceptual resources for stating and explaining why some events are morally insignificant and why some actions are permissible. For example, when you walk through a metal detector at an airport, it induces tiny changes in the magnetic orientation of some of the molecules in your body. This event is not a morally significant intervention on your body. Why? Because the event is high-level neutral. Or, when someone near you makes a phone call, their cellphone may bombard you with radiation. The moral significance of this event greatly depends on whether it's high-level neutral. If it is, then it doesn't bear on bodily interests or rights. If it isn't high-level neutral, such as if it puts you at risk of developing cancer, then it may well bear on bodily interests or rights.

At this point, one might object that some high-level neutral events seem to infringe bodily rights. For example, if a patient were subjected to an MRI without their consent during a stay at the hospital, it seems that this intervention would violate their right to bodily autonomy and/or integrity.[6] This example runs contrary to the principles, as MRIs would seem to be high-level neutral, not unlike metal detectors.

I think the correct diagnosis of this case is that, if subjecting someone to an MRI is morally objectionable, that is not because of the high-level neutral aspects of that action. Several other aspects of this action may be morally objectionable: it seems to involve disregard for personal autonomy over medically significant tests; plausible versions of the scenario involve invading someone's personal space and moving them to another room without their informed consent; the process extracts information about them that is not in fact high-level neutral; and so on. So, not only can a depth-informed understanding of the body, bodily rights, and bodily interests accommodate this case, but it helps us properly appreciate why such an action may be morally objectionable in the first place.

In considering these principles, it's worth noting that they allow for context sensitivity as may be needed, perhaps depending on the bodily processes in question. To see this, consider that rights and interests regarding brain tissue plausibly reach deeper than rights and interests regarding other tissues, such as one's skin. Intuitively, the loss of some number of neurons may sometimes matter more than the loss of the same number of skin cells. In that case, we may want to allow that what counts as high-level neutrality in the cases affecting the brain has a lower floor than what counts as high-level neutral in cases affecting other tissues. On the other hand, it may also be possible to account for this difference in terms of a univocal, context-insensitive notion of high-level neutrality, noting in particular that small changes to the brain ultimately are not high-level neutral (at the level of memories or behaviors) in the way that similarly small changes the skin are high-level neutral. Another alternative is that the special rights and interests to do with neurons are best explained by mental interests and rights, such as a right to mental integrity. Indeed, Douglas (2020) suggests that this discrepancy supports the view that a right to mental integrity should be distinguished from a right to bodily integrity. To decide whether context sensitivity is ultimately needed, a more specific and elaborate investigation is required.

6. Thanks to Tom Douglas for suggesting this example.

At any rate, we have a sufficiently general understanding of the depth of the body and its moral significance to fruitfully revisit how BCIs figure as body parts, in particular regarding what that implies about our bodily rights and interests in those systems.

6. Depth and BCIs

Depth helps us to avoid the conclusion that BCIs are not body parts because depth allows us to draw an ontological distinction between the implemented software and the servers themselves.[7] The implemented software is an object that exists at a higher level than the server. The software object is defined in terms of algorithms or computations, while the server is defined in terms of transistors, circuits, and other hardware. On the proposed view, the former is a body part, while the latter is not.

The ontological distinction allows us to say that the server that implements someone's BCI system is not a body part, and so it provides resources to explain and justify why the software but not the hardware fall within the person's bodily rights and interests. To see how the explanation goes, let's revisit the problem of ownership discussed in section 2.

The user of a BCI system that is partly implemented on a cloud server and the operator of the cloud server both have a plausible, prima facie claim of ownership to that piece of hardware. There are reasons to insist that the BCI system is part of the person and hence falls within their rightful ownership. On the other hand, we also have reason to think that the server that implements the BCI system may properly belong to the company that legally owns and manages it. In this case, the ontological distinction between the implemented software and the server itself, defined by the difference in depth, enables a clearer explanation. Interference that merely affects the server and not the software object does not amount to interference in the BCI user's body. The server is not a part of the body even though the software object is a part of the body. Interference only affects the user's body when it also affects the software processing, which is a higher-level process. When an interference is high-level neutral, it does not affect the user's body.

Though the ontological distinction allows us to separate the rightful ownership of the server from the bodily ownership of the person who uses the BCI, it does not entail that every intervention on the server performed by the technology company is permissible. Some of these interventions would *also* affect the person's body if they affect certain high-level properties of the server. In that case, interventions would affect the user's body and may constitute infringements of bodily integrity and/or autonomy. Such interventions are generally impermissible, certain excusing conditions aside.[8]

The discerning ontology of depth enables more nuanced verdicts about which interventions are permissible and impermissible. With depth in hand, bodily rights can be consistently extended to objects and processes such as BCI software while maintaining that third-parties have a degree of ownership and authority over BCI hardware. This nuance also makes it more plausible that BCI systems count as genuine body parts because BCI embodiment does not impose implausible demands on third-parties. For example, the fact that a cloud server supports BCI software does not automatically impose strict duties of care or non-interference on the server-operators over the server itself. Rather, servers may permissibly be interfered with, such as for maintenance or replacement. Similarly, server-operators needn't go to great lengths to protect the servers from damage. In each case, these demands are mitigated or dissolved as long as there is some guaran-

7. Some small changes to the software may also count as high-level neutral, but for simplicity I will use these ordinary terms to mark the distinction of interest.

8. Interventions on someone's body are typically impermissible when they are unconsented. One plausible exception is when an intervention is medically necessary (Earp and Bruce 2023). Note that the present account is not designed to provide general principles of when bodily intervention is. Rather, it provides a novel conception of the body and, on that basis, gives novel verdicts about what kinds of interventions count as interventions on the body.

tee that interference or damage would not interrupt the relevant BCI software processes, which might be secured through backup servers.

The issue of duties connects to an important issue of *risk*, and here again the ontology of depth affords new insights.[9] It's plausible that server-operators acquire duties to protect and care for users' BCI systems, not unlike a healthcare institution's duty to care for its patients (Almond 2004). It's also plausible that these duties prohibit the imposition of undue risks (Zimmerman 2006). The depth of a body part makes a difference to its risk profile: events that are high-level neutral do not affect body parts, and so the possibility of such events does not impose any risk on the body. The theory of depth helps us properly appreciate the true risk profile of body parts, which then informs the moral duties and demands that BCI server-operators acquire. For example, server-operators may be morally obligated to ensure that risks to hardware do not also amount to risks to software processes by ensuring that suitable backup servers are available to provide uninterrupted BCI operability in case of fire or power blackout. Because organic body parts are not easily produced or duplicated, there is no analogous possibility of 'backup' organic body parts (at least currently). So, the unique risk profile of BCI software may generate an unprecedented species of moral obligation. Once this novel moral obligation regarding the body comes into view, we have reason to impose new legal requirements for BCI server-operators to mitigate these risks.

However, the possibility of providing backup servers to maintain BCI operability in case of fire or blackout raises a complication. Transferring a software process from one server to another is not necessarily high-level neutral. In general, such a transfer will change the location of the software process and perhaps other important high-level properties. So, while providing backup servers mitigates risks, it does not remove these risks altogether. The ethical significance of moving a BCI software process, or the risk thereof, is not obvious. Moving a BCI software process doesn't seem as significant as moving a whole person without their consent, but it also does not seem trivial. Do people have a right to know or control where their BCI software is implemented? A thorough discussion of the ethics of moving BCI software would need to address many issues that, due to limits of space, cannot be adequately discussed here. Still, we can see that depth is an essential concept for properly understanding the ethical and legal implications of these risks. Depth also enables us to identify the morally significant features of transferring software, such as the change in location, from the insignificant features, such as the change in the exact physical substrate. The latter is high-level neutral, and so the theory of depth tells us that it is not morally significant with respect to bodily rights and interests.

In sum, by introducing depth and the ontological distinctions it enables, we are able to preserve unqualified rights of ownership, and other bodily rights like a right to bodily integrity, while also avoiding the imposition of implausible demands on the owners and operators of the hardware. Moreover, we are able to better understand the unprecedented moral demands that are generated by new kinds of body parts, such as duties to address the unique risk profiles of BCI software.

7. Conclusion

BCIs should count as body parts for moral purposes, but treating every component of a BCI system as within the body is too inclusive. If we recognize depth as a dimension of the body distinct from its breadth, then we can distinguish a software object from a hardware object and include only the former within the purview of bodily rights and interests. The distinction is robust: it applies to all parts of the body, including organic parts; it can be backed by a metaphysics of real definition; and, it is accommodated by existing theories of the body. The view promises to clarify our understanding of bodily ownership, integrity, and autonomy, rendering us better equipped for the increasing prevalence of digital embodiment. Crucially, the theory of depth reveals unprecedented ways that BCI systems may matter in regards to bodily rights and interests, such as may be produced by their unique

9. Thanks to an anonymous reviewer for drawing my attention to this issue.

risk profiles. More ethical and legal attention should be given to these issues so that appropriate procedures are in place when conflict inevitably arises.

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