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ORIGINAL PAPER

Neurointerventions in Criminal Justice: On the Scope of the Moral Right to Bodily Integrity

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Abstract There is growing interest in the use of neurointerventions to reduce the risk that criminal offenders will reoffend. Commentators have raised several ethical concerns regarding this practice. One prominent concern is that, when imposed without the offender's valid consent, neurointerventions might infringe offenders' right to bodily integrity. While it is commonly held that we possess a moral right to bodily integrity, the extent to which this right would protect against such neurointerventions is as-yet unclear. In this paper, we will assess whether, why, and how severely three forms of neurointervention might infringe the right to bodily integrity. We show that the severity of the infringement of the right to bodily integrity differs across different forms of neurointervention. Moreover, we argue that mental and behavioral effects of neurointerventions could in some cases be relevant to determining the severity of infringements of the right to bodily integrity.

Keywords Neurointerventions · Bodily integrity · Criminal justice · Mental integrity

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Introduction

In recent years, there has been a growing interest in the idea of using neurointerventions to prevent reoffending in criminal offenders. Neurointerventions in criminal justice contexts can be defined as "interventions that exert a physical, chemical or biological effect on the brain in order to diminish the likelihood … of criminal offending" [1]. Some forms of neurointervention are already used in Europe and the United States. One example is so-called 'chemical castration' through the administration of psychoactive drugs. This intervention involves lowering testosterone activity in adult men to pre-pubescent levels, and has been used in sex offenders to reduce their risk of reoffending [2] (for ethical and legal discussion, see [3]). Given the likelihood of further advances in neuroscience, new neurointerventions that can reduce recidivism risk in a wider range of offenders might become available in the near future. For example, it has already been reported that in a forensic population aggression can

be reduced using transcranial direct current stimulation (tDCS) [4, 5].

There are, however, ethical objections to the use of neurointerventions to reduce recidivism risk [1, 6–8]. These objections advert, among other considerations, to autonomy, dignity and freedom of thought. Another important ethical objection is that, when a neurointervention is imposed without the offender's valid consent, this imposition may infringe an offender's right to bodily integrity. It is commonly held that we possess a moral right to bodily integrity (RBI) [9, 10], and that nonconsensually interfering with a person's body can infringe that right, and thereby wrong the rightholder [11, 12]. While the RBI is often appealed to in cases of clear intrusions into the body, such as organ removal [10], it is as-yet unclear to what extent the right would protect against the use of neurointerventions in criminal justice.

In recent years, several scholars have begun to examine the RBI in the context of neurointerventions [11, 13], and some have already explored whether different forms of neurointerventions could infringe or violate the right [8]. While such analyses have provided valuable insights into potential RBI-infringements by neurointerventions, it remains unclear whether different forms of neurointervention will infringe the RBI, how serious or severe such infringements will be, and which factors might be relevant to answering these questions.

In this paper, we will attempt to resolve some of this unclarity. We will assess the scope and strength of the protection that the RBI provides against different types of neurointervention. To do so, we first provide an overview of the existing literature on the RBI and its protective scope—that is, the range of interventions, generically characterized, that are considered to infringe it. Second, we assess whether and how severely different forms of neurointervention might infringe the right. Third, we consider whether the mental and behavioral effects of neurointerventions are relevant to determining the severity of RBI-infringements and argue that, for some types of neurointerventions, they are.

The Scope of the Moral Right to Bodily Integrity

The RBI protects individuals against certain interferences with their bodies. When performed without the rightholder's valid consent, bodily interferences may infringe the right and so wrong the rightholder [14, 15].

The RBI is often appealed to in medical ethics, such as in discussions on abortion [16], organ selling [17] and genital mutilation [14]. In these medical contexts, the RBI is sometimes understood as an element of a right to bodily autonomy—a right to determine what will happen to one's body—one implication of which is that medical professionals may intervene in the patient's body only with that patient's consent [18].

A right to bodily integrity is also widely recognized in legal documents, for instance in article 3 of the European Charter of Fundamental Rights and Freedoms and article 17 of the Convention on Rights of Persons with Disabilities. The RBI recognized in these documents is generally understood as a right that protects against non-trivial and nonconsensual interferences with the body [9, 19].

Both the legal and medical-ethical literature on the RBI have mainly been preoccupied with what might be called a *legal* or *conventional* RBI—the RBI that is recognized in law and, in the case of medical ethics, in professional standards, such as are found in codes of ethics and professional guidelines. While it is often supposed that we also possess a more fundamental *moral* right to bodily integrity (e.g., [12, 15]), such a right has been less fully discussed and is not well-defined. Presumably, the moral RBI is a right that protects individuals against certain interferences with their body. However, what *kind* of interferences infringe the right remains unclear [15].

There has been *some* discussion—mainly within ethical and philosophical literature—of a moral RBI; the right has not been entirely neglected. In this literature, the right is sometimes defined as a right that protects against bodily *insertions*, understood as involving the opening of the skin and/or entering the body. For instance, Wilkinson [10] has proposed an account of the RBI as "a right to veto invasions of one's body" (p. 8). He examines the moral right in the context of organ transplantation, and the RBI as a right against bodily 'invasions' can here arguably be understood as a right that protects against forms of entering the body. In a similar vein, Earp [14]—exploring children's right to bodily integrity—has suggested that an infringement of bodily integrity would be "any intentional … penetration into a bodily orifice, breaking of the skin, or alteration of a person's physical form" (p. 2), where especially "penetration into a bodily orifice" or "breaking of the skin" seem to imply some form

of insertion into the body in terms of (quite literally) entering the body.

Other accounts have discussed the moral RBI in relation to the use of neurointerventions in criminal justice settings. These accounts appear to understand the right more broadly, so as to protect not only against bodily *insertions* but also against forms of bodily *contact*. For instance, one of the present authors (Douglas) [11], in his examination of the RBI in the context of nonconsensual medical (neuro)interventions in criminal justice, defines the right as a "right that protects against intentional interference with one's body" (p. 106). He notes that the right "may protect its bearer against many different kinds of nonconsensual bodily interference ranging from relatively innocent forms of physical contact to major surgical procedures" (p. 109), thus allowing that the RBI might also be infringed by forms of mere contact. Shaw [13], in her critique of the use of mandatory neurointerventions in criminal justice, suggests that the RBI is a right that can "protect the individual from nonconsensual interference with their bodies" (p. 2). She illustrates some implications of the RBI by using an example of a person in a hurry physically moving someone out of the way, thereby putatively infringing the RBI. Using this example suggests that, on Shaw's account too, the RBI also protects against 'mere' bodily contact.

As the foregoing discussion suggests, there is a diverse range of views on the scope of the RBI. This has been recently acknowledged by Ryberg [8] in his attempt to establish whether neurointerventions pose a threat to bodily integrity. Ryberg explores multiple accounts of the right in his analysis,[1] including accounts on which the RBI protects against (A) interference with the outer physical boundary of the body, (B) entrance through the outer physical border of the body and (C) intrusion by unwanted alterations in the body. The RBI on account (B) only includes bodily insertion, and on account (A) it would also allow for other forms of bodily contact to infringe it. Account (C) introduces yet another form of bodily interference, where the RBI may also be infringed by inducing bodily *alterations* that need not involve any physical contact. An example of such bodily interference would be radiation-induced alterations in DNA.

Deciding which of the proposed accounts of the RBI is most compelling is not our objective, and we are open to the possibility that each can be understood as capturing a part of the right; as Ryberg notes, "it might well be the case that the right comprises several of the accounts and thereby provides moral protection against several of the outlined types of intrusion on the body" (p. 77).[2] In line with this, and in light of the lack of scholarly consensus on which bodily interferences infringe the RBI, our analysis of whether and how severely neurointerventions infringe the RBI will consider all three types of bodily interference—bodily insertion, bodily contact and bodily alterations—as potentially infringing the right. Including such a broad range of bodily interferences in our analysis will, we hope, allow us to detect all potential sources of RBI-infringements in the different neurointerventions, which we consider especially important given the relatively 'unfamiliar' way in which some of the neurointerventions affect the body.

An additional characteristic of bodily interferences is relevant to whether they fall within the scope of the RBI: the RBI is generally understood as protecting only against bodily interferences that are nonconsensual [10, 11, 13, 14]. Bodily interferences that are validly consented to—as with most medical procedures—are generally not considered to infringe the RBI, perhaps because the right has been waived, or partially waived, through the giving of consent.

A further important feature of the RBI that will be crucial for our later analysis, and to which we have already alluded, is that bodily interferences can seemingly infringe the RBI to different degrees or, as we will put it, with different severities; infringements of the right can be more or less severe. This is relevant for the moral evaluation of

[1] While Ryberg [8] entertains a total of six interpretations of the RBI, three of those interpretations treat the RBI as a positive right, where the right is not defined in terms what it protects *against* but in terms of *what* it protects. We will not take these positive accounts of the RBI into consideration, since such accounts are generally less common [10] and are less suited to establish which kinds of interferences the right would protect against, which is the purpose of this article.

[2] Since Ryberg [8] aims to determine the merit of the claim that neurointerventions are morally wrong because they infringe the RBI, he does go on to accept one of the accounts—account (B)—because he deems it most likely that neurointerventions would violate the RBI on such an account (although he concludes that *if* neurointerventions violate the RBI on this account, it will be to a very modest extent).

interferences, as the more severely an interference infringes the RBI, the more substantial the reasons must be to justify such an infringement. To illustrate, nonconsensually injecting a person with a needle is considered a less severe infringement of the RBI, and thus easier to justify, than nonconsensually performing surgery. Precisely what factors determine the severity of an infringement is not easily defined, and may vary for different forms of interference and across different contexts. Factors that could for instance play a role are the magnitude of interference (i.e., literal size of interference on a bodily scale), intensity of interference (i.e., strength or force) or centrality of the affected body part.

Apart from such bodily determinants, what might also be relevant to severity is how *functioning* is affected. The degree of functional disruption that an interference causes could be indicative of the severity of an infringement, and it might be that the three factors mentioned in the previous paragraph are relevant to the severity of an infringement because they are indicators of the likely degree of functional disruption. That is, it could be that interferences that are substantial in magnitude, have high intensity or affect a central body part (e.g., heart) constitute severe interferences because they cause, or are likely to cause, considerable functional disruption. Using the degree of functional disruption is an indicator of severity of infringement would also allow us to explain cases that are, for instance, similar in magnitude but intuitively different in infringement severity—such as unwanted touching of a fingertip versus an eye—or similar in affected body part but intuitively different in infringement severity—such as touching versus squeezing someone's throat—as these may differ in the extent of functional disruption they cause. We do not claim that the degree of functional disruption is the only determinant of infringement severity. Nor do we claim that magnitude, intensity and affected body part are relevant to infringement severity only insofar as they are relevant to functional disruption. However, we do think it plausible that degree of functional disruption is one determinant of infringement severity.

Thus, based on an analysis of the extant accounts, in the present article we will understand the RBI (henceforth referring to the moral RBI unless otherwise specified) as a right that protects against nonconsensual bodily interferences, where interferences can consist in bodily insertion, bodily contact or bodily alterations. We will entertain the different forms of bodily interference separately when applying the RBI to neurointerventions. In the next section, we aim to determine the extent to which neurointerventions employed in a criminal justice context may infringe the RBI.

Neurointerventions and the Right to Bodily Integrity

In exploring the protection provided by the RBI against nonconsensual neurointerventions employed in criminal justice, we will focus on three currently available forms of neurointerventions, namely (1) deep brain stimulation (DBS), (2) transcranial stimulation in the form of transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS) and (3) psychoactive drugs.

Before assessing the extent of the protection provided by the RBI against these three forms of neurointervention, we need to clarify a few further matters. First, it will be assumed that all neurointerventions are applied nonconsensually as is often, though not always, the case in criminal justice settings, where coercive measures may be employed.

Second, we will, however, limit our discussion to whether and how severely the neurointerventions *themselves* infringe the RBI, setting aside the ways in which measures that might be taken to apply such interventions nonconsensually—for instance, through the use of restraint or sedation—may infringe the RBI additionally.

Third, we assume throughout that these neurointerventions would be used *solely* to prevent re-offending by the recipient and not, for example, also for punitive purposes, such as the expression of blame or the infliction of deserved harsh treatment (see [8]). This allows us to set aside certain objections to the use of neurointerventions—for example, those that advert to an intention, on the part of the intervener, to harm the offender.

Fourth, for the sake of comparability between neurointerventions, we will assume that the neurointerventions all have as their sole aim the prevention of the same type of behavior—namely, unprovoked aggressive behavior. We further assume that all three types of intervention are equally effective at realizing this goal and have similar—and favorable—side-effect profiles. In making these assumptions, we do not mean to imply anything about the nature of neurointerventions that are actually available at present or likely to become so in the near future. Below, we consider whether different forms of neurointervention would, under these assumptions, infringe the RBI.

Deep Brain Stimulation

Deep brain stimulation (DBS) is the most invasive of the three types of neurointervention that we consider. It requires surgically implanting electrodes in the brain to serve as so-called 'neuro-stimulators,' through which electrical pulses are then sent into the targeted brain areas to effect changes in mental states or behavior. The amount of stimulation that the electrodes generate is regulated by a device placed under the skin of the patient—a pacemaker-like device called an implantable pulse generator, connected to the electrodes through a wire—that can be externally controlled by clinicians or the patient [20].

DBS requires brain surgery, including the opening of the skull, to implant electrodes into the brain. Moreover, the procedure involves the placing of the implantable pulse generator under the skin (often the upper chest). There is little doubt that these surgical procedures constitute bodily interference, since they involve considerable bodily insertion, bodily contact and bodily alterations, likely causing a high degree of functional disruption. This implies that the nonconsensual use of DBS severely infringes the RBI.

What is less clear is whether, once the electrodes have been implanted, the *electrical stimulation* of the brain via these electrodes constitutes a further infringement of the RBI. While it is not clear that the electrode stimulation would be considered bodily interference on the basis of insertion or contact, as these are commonly understood to involve penetration or touching by some kind of physical object, it plausibly interferes with the body because it causes bodily alterations. That is, one could argue that inducing neuronal alterations via an electrical current constitutes bodily interference and may therefore further infringe the RBI.

A potentially complicating factor here is that the ongoing nature of the electrical stimulation might—at least after a time—affect whether it constitutes interference. Bodily interference arguably signifies the process of being acted on by someone or something extrinsic. It might be thought that, after a time, the implanted electrodes would count as part of the person's body, in much the same way that, say, an implanted pacemaker might [21]. This might allow the stimulation to be construed as becoming part of the intrinsic brain dynamics of the individual [22], and thus no longer as bodily alteration induced by something extrinsic to the body [23]. This seems especially plausible in cases of closed-loop DBS, where the DBS device registers brain activity and stimulates neurons accordingly, thus intervening 'autonomously' in response to neuronal events [7, 24]. This may imply that even if the neurostimulation initially constitutes bodily interference, it may, after a time, no longer do so.[3]

If, however, we assume that the electrical stimulation *does* constitute bodily interference—perhaps if we consider the stimulation shortly after implantation—it is unclear how severely this would infringe the RBI. The electrodes stimulate neurons leading to their excitation or inhibition, eventually altering neuronal signaling locally at the site of the electrodes. This may involve only very minor neurochemical alterations on a cellular level. Some have doubted whether such alterations could count as RBI infringements [8], and even if they do, they might count as such mild infringements that they could very easily be justified.[4] In terms of literal magnitude on a bodily scale, we may compare such interventions to inducing minor chemical alterations in some cells in a person's skin by shining light on it, which is unlikely to be considered anything more than a very mild RBI-infringement. However, what might be a key difference is that, unlike the alterations in the skin, the alterations in neurons will likely cause some degree of functional disruption in terms of the mental and behavioral effects they bring about (in this case, reducing unprovoked aggressive behavior). If we take into account these functional consequences of the electrical stimulation-induced bodily alterations, it becomes more plausible that the alterations produced

[3] Important to note is that in cases where the state would be in indefinite control of the stimulation, and thus would continually determine where and how long the stimulation would occur, this may not apply. It only plausibly applies to cases where either the device would be self-controlled or the device acts autonomously (closed-loop).

[4] Naturally, the neurostimulation can have additional bodily effects caused by the neuronal alterations, such as effects on muscle movement [40]. However, such effects are highly dependent on stimulation location and thus vary considerably between cases [41]. Also, in our analysis we assume a context in which aggressive behaviors are targeted and side effect profiles are favorable, and thus potential additional bodily effects of DBS stimulation are currently not considered.

by the stimulation amount to a more severe, and no longer trivial, infringement of the RBI.

What we may conclude is that DBS constitutes a severe infringement of the RBI by virtue of the bodily insertion, bodily contact and bodily alterations involved in performing the required brain surgery. The electrical stimulation of the brain, once the electrodes have been introduced, may also infringe the right by virtue of the bodily alterations it produces, but the severity of this infringement will importantly depend on whether functional disruption is relevant to infringement severity. If it is not, this alteration may constitute at most a trivial infringement.

Transcranial Direct Current Stimulation and Transcranial Magnetic Stimulation

A different type of neurointervention that does not require any surgery or intensive physical contact is transcranial stimulation in the forms of tDCS and TMS. tDCS is a type of neuromodulation that delivers constant low-intensity currents to the brain through electrodes on the scalp to alter neuronal communication in brain regions involved in the target phenomena [25]. The electrical currents pass through the skull, typically without inflicting any pain or discomfort for the patient. TMS is a form of neuromodulation that uses magnetic fields to alter neural function. It uses an electromagnetic coil placed near the scalp that delivers magnetic pulses to generate electrical currents in the brain and thereby alter neuron signaling [26]. Similar to tDCS, the magnetic currents pass painlessly through the skull. A relevant difference between tDCS and TMS is that tDCS involves objects (the electrodes) being placed on the scalp, whereas TMS need not; the magnets can be placed a small distance away from the scalp, involving no bodily touching whatsoever.

Do tDCS and TMS infringe the RBI? Intuitively, one might say that they do, but it is uncertain that they infringe the right through bodily insertion. Bodily insertion, as we have understood it, arguably involves the insertion of a physical object into the body, which seemingly requires some form of 'opening' of the outer layer of the body to get inside. While with tDCS and TMS there is something entering the body—the electric current and magnetic field respectively—they involve no insertion of an *object*, and the entering does not require any opening of the skin; the external body stays entirely intact while the currents/fields pass through the body, with seemingly minimal to no functional disruption. Whereas some have argued that even such forms of entering the body could be considered 'invasive' [27], it seems that at least in terms of bodily *insertion*, tDCS and TMS do not constitute obvious bodily interferences [28].

It might be more plausible that tDCS and TMS infringe the RBI by virtue of the physical contact that they involve. tDCS involves placing electrodes on the scalp, which comprises physical contact, and TMS may also—though need not—involve similar contact. When nonconsensual, such contact may amount to an infringement of the RBI, however the severity of the infringement will, it might be thought, be rather limited.

If tDCS and TMS would more severely infringe the RBI, this would most plausibly be because of the bodily alterations they induce. The stimulation of tDCS and TMS instigates changes in neuronal signaling by either exciting or inhibiting neurons. Similar to the case of DBS just discussed, the severity of the RBI-infringement involved in such alterations is debatable. If we consider the extent of bodily changes, we can compare it to magnetic resonance imaging (MRI) of the brain, which also exerts well-described effects on neurons caused by magnetic fields. It is not at all clear though that MRI would involve any more than a trivial infringement of the RBI, even if done without consent, as it causes only very minor neuronal alterations. Taking into account the degree of functional disruption, however, electrical brain stimulation and MRI can no longer be treated as equivalent, since, contrary to MRI, the electrical stimulation of tDCS and TMS likely causes functional changes in the person on the mental and behavioral level. Accordingly, if we take these functional effects into account, it will be plausible that a more severe infringement of the RBI will be present.

Thus, it appears that tDCS and TMS do not infringe the RBI by virtue of constituting bodily insertion, and involve at most very mild infringements by virtue of involving bodily contact. However, they might infringe the right more severely by virtue of altering bodily states, provided that the functional consequences of the alterations contribute to infringement severity.

Psychoactive Drugs

A third type of neurointervention consists in the administration of psychoactive drugs. Psychoactive drugs alter neurochemical signaling in the brain to effect changes in mental states and behavior. One route of administration of psychoactive agents is injection. Administering agents in this way could clearly infringe the RBI; the penetration of the skin with a syringe is an evident insertion into a person's body, and involves evident bodily contact and bodily alterations. That injection of substances into the body is generally considered to infringe bodily integrity can for instance be seen in the literature on mandatory vaccination (e.g., [29–31]).

Psychoactive drugs can also be administered orally. The nonconsensual oral administration of a drug by someone other than the recipient might infringe the RBI on the basis of both bodily insertion and bodily contact. While it does not require any 'breaking of the skin,' the body is still nonconsensually entered by an object controlled by someone else, so there can be said to be an insertion of the body and bodily contact, involving a certain degree of functional disruption, and thus a likely infringement of the RBI [32]. If the act of administration, though not validly consented to, is performed by the recipient himself, however, it is less clear that it constitutes bodily interference on the basis of bodily insertion or bodily contact, as in that case the administration does not involve insertion by or contact with someone else. Still, even if the mode of administration does not clearly infringe the RBI, the alterations that it produces in the body might.

We may therefore consider to what extent psychoactive drugs, injected or orally administered, also infringe the RBI based on the bodily alterations they produce. Psychoactive drugs generally reduce aggressive behavior by modulating neurochemical signaling in the brain by increasing or decreasing the availability of a certain neurotransmitter [33]. Such neuronal alterations are limited in magnitude on a bodily scale, but they may be more substantial than in the cases of DBS and tDCS/TMS. Psychoactive drugs act more diffusely throughout the brain to achieve their effects while the effects of other neurointerventions are more localized [34], which may imply that the alterations produced by psychoactive drugs more severely infringe the RBI than those produced by DBS and tDCS/TMS.[5] If we also take into account the degree of functional disruption that such alterations may cause on the mental and behavioral level, this will further increase the severity of the RBI-infringement.

So, injecting psychoactive drugs invades the body and constitutes bodily interference that infringes the RBI. Psychoactive drugs that are nonconsensually orally administered by someone other than the offender would arguably also constitute bodily insertion and thereby also infringe the RBI. Self-administered psychoactive drugs, on the other hand, might only infringe the RBI on the basis of the bodily alterations it causes, with the severity of the infringement again depending importantly on whether functional disruption is relevant to infringement-severity.

Mental and Behavioral Effects of Neurointerventions

From our analysis thus far, we may conclude that the nonconsensual administration of DBS, which involves serious bodily insertion and bodily contact in the form of brain surgery, severely infringes the RBI. Psychoactive drugs injected or orally administered by someone other than the recipient of the drug—both involving bodily insertion and bodily contact—also seem to involve somewhat severe infringements of the right. As for tDCS, TMS and self-administered oral psychoactive drugs, it is less clear to what extent they infringe the RBI. These interventions involve no obvious bodily insertion and only transient (tDCS) or no (TMS and self-administered oral psychoactive drugs) bodily contact. They do, however, induce bodily alterations in the form of neuronal changes, and may therefore infringe the RBI. However, the severity of the infringement will depend on whether the degree of functional disruption caused by a bodily alteration affects the severity of any infringement of the RBI.

[5] Similar to DBS and tDCS/TMS, psychoactive drugs may also have additional bodily effects, but in contrast to DBS and tDCS/TMS, they generally have a more consistent side effect profile. For instance, psychoactive drugs for the treatment of aggression may often lead to nausea and weight gain [42]. However, as mentioned before, we focus our analysis on the brain and will not take these side effects into account for the sake of comparability between neurointerventions.

If the severity of the infringement depends solely on the magnitude of the immediate neuronal changes that it produces, these neurointerventions would seem to involve only minor—and indeed perhaps trivial—infringements of the right. However, such alterations are often accompanied by changes on the mental and behavioral level [35], especially in cases of using neurointerventions that we are considering here. The main objective of neurointerventions in criminal justice is to change the way an offender thinks, feels and behaves, and interfering with the body and its neurons is merely a means to effect such changes. Such mental and behavioral effects can be seen as the functional consequences of the neuronal alterations, and accordingly, they crucially add to the degree of functional disruption caused by such an interference. If the degree of functional disruption is a determinant of infringement severity, the neural alterations involved in these neurointerventions may amount to rather severe infringements of the RBI.

The question thus arises: do the functional consequences of a bodily alteration contribute to the severity of the associated RBI-infringement? Reflection on the manner in which we generally assess more 'traditional' interferences in other parts of the body suggest that they are. To illustrate, suppose someone induces some minor alterations to a person's heart valve that ultimately prevents the blood from flowing through the body. When we aim to determine the severity of the RBI-infringement involved in such an alteration of the body, we would surely take into account the functional consequences of the alteration—the disruption of the blood flow, possible failure of organs and perhaps ultimately death. If the blood flow is heavily disrupted and key organs are failing, the functional consequences are vast and the RBI would be considered more severely infringed than if, say, the blood flow is only disrupted transiently, even if we hold fixed the degree to which the heart valve itself is altered. The sum of such functional consequences seems to indicate the degree of functional disruption, and a more severe disruption would plausibly translate to a more severe infringement of the RBI. We suggest that the same holds true for interventions in the brain, where the most important functional consequences of induced alterations consist in a large part of mental and behavioral effects.

An ensuing question one may ask is whether other functional consequences of neurointerventions besides mental and behavioral ones should not also play a role in estimating RBI infringement severity. Think for instance of social effects, such as the loss of friends due to neurointervention-induced changes in behavior, which could also add to the degree of functional disruption. We think, however, that mental and behavioral effects are most relevant here due to their causal proximity to the bodily interference. In the cases we are considering, neuronal alterations directly cause the mental and behavioral effects—or may even be said to constitute them. For functional effects that arise later in the causal chain, whether they should contribute to infringement severity is less clear. Consider the earlier example of altering a person's heart valve. Say the person recovers from the procedure and at a later time starts to experience painful symptoms in her body, which in turn may lead to depressive thoughts. Such symptoms would likely not be relevant to determining the severity of the infringement.

This also means that mental and behavioral effects are not by definition relevant for infringement severity; such effects can also arise later in the causal chain. For instance, in cases of interferences in the form of bodily insertion or bodily contact that do not directly alter neurons, potential mental and behavioral effects that may arise are less causally proximate to the actual interference, and might not be relevant to infringement severity. But, if we focus on bodily interferences in the form of alterations in the brain, the causally proximate functional effects are (often) mental and behavioral ones. This also demonstrates that the brain is unique this way, as alterations in other bodily parts would not have a similar causal relation to mental and behavioral effects.

In response to our proposal for including mental and behavioral effects in the assessment of the severity of an RBI infringement, one may wonder whether we should not instead take into account such effects by recognizing specific rights for the mental domain, as some scholars have suggested [36–38]. These might include a right to *mental* integrity. Craig [37], for instance, has argued that we need mental rights because "there are strong reasons to believe that the most compelling arguments against nonconsensual DBIs [direct brain interventions] do not rest on the right to bodily integrity, but on the more fundamental right to 'mental integrity'" (p. 111). While we think that a right to protect the mental domain specifically may be warranted, this does not preclude the possibility that the mind also receives some protection from the RBI. Even if we were to recognize a right to mental

integrity, the question would remain whether and to what degree the RBI also protects against neurointerventions, and, as we have argued, this question can in some cases not be adequately answered without considering the mental and behavioral effects of the intervention.

The inclusion of mental and behavioral effects in assessments of the severity of RBI-infringements has varying implications for the moral evaluation of different types of nonconsensual neurointervention. For DBS the implications appear limited: brain surgery already constitutes a severe infringement on the basis of the bodily insertion and bodily contact it involves. For interventions such as tDCS and TMS, however, there are more significant implications. Neither involve anything more than a minor infringement of the RBI on the basis of bodily insertion or contact; if they would infringe the RBI more severely, it must be on the basis of bodily alterations. If the severity of such alterations were to be assessed on a bodily—neuronal—scale alone, they would likely not constitute severe infringements, which would imply that their nonconsensual use would be relatively easy to morally justify (at least in terms of bodily rights). This conclusion, however, seems somewhat unintuitive, as most would feel that nonconsensually intervening in the body with tDCS or TMS would require a rather strong moral justification. If, on the other hand, we assess infringement severity partly in terms of the degree of functional disruption—and thus take into account the mental and behavioral effects they cause—tDCS and TMS seem to more severely infringe the RBI, and their nonconsensual use will thus be more difficult to morally justify.[6] Including the functional consequences of neuronal alterations as determinants of the severity of RBI-infringement may thus allow the RBI to provide more extensive moral protection against neurointerventions.

[6] Importantly, in the context of criminal justice we are considering, it can be reasonably assumed that the neurointervention-induced mental and behavioral effects will be considerable, seeing that they are aimed at modifying persistent thought and behavioral patterns in offenders. But, of course, mental and behavioral effects can also be more modest, in which case they might be less relevant for the RBI. Also, there might be some differences in which *kind* of mental and behavioral effects would be relevant. We will not attempt to resolve such unclarities here, as we merely aim to show that mental and behavioral effects *could* in some cases be relevant to determining the severity of RBI infringements.

Concluding Remarks

The moral right to bodily integrity is relevant to neurointerventions, but the scope and strength of the protection that it provides against such interventions remains unclear. Many conceptions of the RBI found in the literature focus on 'traditional' bodily interferences involving direct physical intrusions such as organ transplantation and other surgical procedures. Some neurointerventions, however, constitute a relatively novel way of intervening in the body, and do not fit within this traditional view of bodily interference. Interventions such as tDCS and TMS do not involve any physical insertion and, in the case of TMS, may not even involve touching, yet they do induce bodily alterations in the form of changes in neural activity. The severity of the RBI-infringement involved in employing these interventions without valid consent can depend, we have argued, on the functional effects of these neural alterations, which include their mental and behavioral effects.

We believe that clarifying the protection provided by the RBI against neurointerventions, as we have begun to do, will better equip us to determine the moral permissibility of different types of neurointerventions that are, or may be, used in criminal justice. But the significance of our discussion may extend beyond the criminal justice context, as clarifying the protection provided by the RBI could also have direct implications for the broader debate on how different rights should protect against all kinds of neurotechnologies that not only affect the body, but also intend to influence mental states and behavior [37–39]. By more precisely defining the protection provided by existing rights, we get a clearer picture of the extent to which existing protection is adequate and where any gaps in protection might lie. For example, examining the scope of the protection offered by the RBI might give us a better idea regarding whether a right to 'mental integrity' is needed. Our suggested interpretation of the RBI for application to the brain—one that also takes into consideration its functions—might well encompass much of what a new right to 'mental integrity' would protect. Thus, our analysis may help in determining the permissibility of various forms of mental and bodily interference within—and beyond—the criminal justice context, and it may provide a foundation for further specifying the protection provided by the moral RBI.

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Declarations

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