Handbook of Clinical Neurology, Vol. 197 (3rd series)
Brain and Crime
H. Swaab and G. Meynen, Editors
https://doi.org/10.1016/B978-0-12-821375-9.00006-2

Chapter 18

Neurotechnology to reduce recidivism: Ethical and legal challenges

GERBEN MEYNEN[1,2]*, NAOMI VAN DE POL[1], VERA TESINK[2], AND SJORS LIGTHART[1,3]

[1]*Willem Pompe Institute for Criminal Law and Criminology, Faculty of Law, Economics and Governance, Utrecht University, Utrecht, The Netherlands*

[2]*Department of Philosophy, Faculty of Humanities, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands*

[3]*Department of Criminal Law, Tilburg Law School, Tilburg University, Tilburg, The Netherlands*

Abstract

Crime comes with enormous costs, not only financial but also in terms of loss of mental and physical health and, in some cases, even loss of life. Recidivism is responsible for a considerable percentage of the crimes, and therefore, society deems reducing recidivism a priority. To reduce recidivism, several types of interventions can be used, such as education and employment-focused rehabilitation programs which are intended to improve psychological and social factors. Another way to prevent reoffending is to influence the offender's brain functions. For example, medication can be offered to treat delusions or to diminish sexual drive. In the near future, innovative neurotechnologies are expected to improve prediction and prevention of reoffending. Potential positive effects of such neurotechniques include a safer society and earlier release of prisoners who are no longer "at high risk" to relapse into criminal behavior. Meanwhile, employing these neurotechniques in the criminal justice system raises fundamental concerns, for example, about autonomy, privacy and mental integrity. This chapter aims to identify some of the ethical and legal challenges of using neurotechnologies to reduce recidivism.

INTRODUCTION

Crime comes with enormous costs, not only financial but also in terms of loss of mental and physical health and, in some cases, even loss of life (Cohen, 2005; Yeh, 2010; Chalfin, 2015). Recidivism is responsible for a considerable part of the crimes. In the Netherlands, for instance, two-thirds of former prisoners have been reconvicted within 4 years after release (Wartna et al., 2005). In the United States, 68% of released prisoners is rearrested within 3 years and 83% within 9 years (Alper et al., 2018). Worldwide, reconviction rates 2 years after prison release range from 20% to 63% (Yukhnenko et al., 2019). Society therefore deems reducing recidivism essential.

To reduce recidivism, several types of interventions can be used, such as education and employment-focused rehabilitation programs which are intended to improve psychological and social factors (Wilson and Petersilia, 2011). Another way to prevent reoffending is to influence the offender's brain functions—which will be the focus of this chapter. For example, medication can be offered to treat delusions or to diminish sexual drive (Knack et al., 2020). In addition, brain scans have been used to predict recidivism, in research settings as well as in legal practice, albeit incidentally (De Kogel and Westgeest, 2015; Delfin et al., 2019; Kiehl et al., 2018—see Neurotechniques for the prediction and prevention of crime section). In the near future, neurotechnologies, such as neuroimaging and neuromodulation (changing brain activity through electrical stimulation of specific brain regions), are expected to

*Correspondence to: Gerben Meynen. Utrecht University, Achter Sint Pieter 200, 3512 HT Utrecht, The Netherlands. Tel: +31-30-253-7125, E-mail: g.meynen@uu.nl

improve prediction and prevention of reoffending (Glenn and Raine, 2013; Umbach et al., 2015; Chew et al., 2018; Meynen, 2019b; Tortora et al., 2020).

Consider a futuristic scenario: a sex offender receives deep brain stimulation (DBS) via electrodes implanted in his brain. The DBS-device monitors brain activity and becomes active when the offender is sexually aroused; using an algorithm, the DBS-device selectively stimulates the brain, thus reducing sexual arousal, to prevent reoffending. When it no longer detects the sexual arousal, the device will stop the stimulation (Ligthart et al., 2021a). The positive effects of neurotechniques to reduce recidivism could be the earlier release for prisoners who are no longer "at risk" to relapse into criminal behavior and a safer and more resilient society. At the same time, however, employment of neurotechniques in criminal justice entails serious risks. It raises *fundamental ethical and legal concerns*, for example about autonomy, privacy, mental and physical integrity (Hübner and White, 2016; Meynen and Widdershoven, 2017; Ryberg, 2017; Douglas, 2019; Meynen, 2019a). For instance, would it be morally and legally permissible to offer parole to offenders in exchange for accepting deep brain stimulation to reduce aggression? (Ligthart et al., 2021a).

How neurotechniques could be used in criminal justice in a responsible way has to be carefully considered. This is recognized as an urgent challenge in ethical and legal literature. (Chew et al., 2018; Ryberg, 2020; Vincent et al., 2020; Ligthart et al., 2021c; Ligthart, 2022). Often, this question of responsible use of neurotechnologies in criminal justice is approached from either legal or ethical perspectives. But, as it includes the ethics of criminal justice, it is necessary to combine legal and ethical perspectives. Moreover, as fundamental rights are concerned, similar values—such as autonomy and privacy—are central to both ethics and law. On this fundamental rights level, there is an important overlap where ethics and law can inform each other: the analysis of moral rights can benefit from analyzing human rights law that protects these rights, while the analysis of fundamental legal rights can benefit from analyzing its ethical underpinnings (Ienca and Andorno, 2017; Ligthart et al., 2019a; Ligthart et al., 2021b). Accordingly, in this chapter we will consider both ethical and legal perspectives.

On the one hand, we aim to identify why neurotechnology deserves serious consideration as a tool in criminal justice (at least in some of its many forms of manifestation). On the other hand, this chapter identifies important normative challenges regarding the (future) application of neurotechnologies in the context of criminal justice. In doing so, we make a case for thorough normative attention for the possible introduction and use of neurotechnologies in criminal justice.

The outline of this chapter is as follows. In the next section, we consider the current state of affairs regarding the prediction and prevention of recidivism. In the Neurotechniques for the prediction and prevention of crime section, we discuss some types of neurotechnology that could potentially contribute to the prediction and prevention of reoffending. The idea is to provide a generic account without any detailed descriptions of individual techniques. The Normative issues regarding employing neurotechnology to reduce recidivism section discusses central ethical and legal issues regarding the use of neurotechnology to predict and prevent recidivism: autonomy, mental privacy, and mental integrity. The Further ethical and legal issues section briefly considers four additional ethical issues, while the final section draws conclusions.

PREDICTING AND PREVENTING RECIDIVISM: THE CURRENT STATE OF AFFAIRS

High rates of recidivism show that there is ample room for improvement in the criminal justice system. Basically, there are two types of problems regarding recidivism: prediction and prevention.

First, it is difficult to accurately *predict* recidivism: current risk assessment tools often have only poor to moderate predictive performance (Fazel et al., 2012; Douglas et al., 2017). Individuals with dangerous behavior are not always adequately identified as such and may be released into society and cause further harm by reoffending (in this chapter, "dangerousness" refers to danger to other persons or property). Conversely, offenders who are not at risk for dangerous behavior (anymore) may be incorrectly identified as a threat to society and could therefore serve a much longer time in prison than necessary. This is actually a well-recognized problem of current risk assessment tools: they identify too many people as "high risk," which may well lead to unnecessary deprivation of liberty by the criminal justice system (Fazel et al., 2012; Douglas et al., 2017). This is clearly harmful to these offenders and their relatives.

Second, even if we correctly identify those offenders who are at risk for dangerous behavior, the interventions that are currently used to *prevent* recidivism are clearly not very successful. From various perspectives, the urgency of this problem has been recognized. For example, Yukhnenko et al. write that "with the increasing recognition of the health burden of violence and crime, reducing recidivism can make a large contribution to public safety and public health" (Yukhnenko et al., 2019). They refer to a World Health Organisation (2014) report that identifies a variety of negative health consequences of violence, both physical (e.g., thoracic, brain injuries, pregnancy complications) and mental

(e.g., depression, anxiety, posttraumatic stress disorder, suicidal thoughts, and behavior). In other words, reducing recidivism will not only have impact on social safety but is a health concern in its own right.

Furthermore, imprisonment has many adverse effects, for instance, on the prisoner's health. Currently, 10 million people are incarcerated worldwide, which is probably an underestimation (Walmsley, 2018), and the number of prisoners is increasing (Yukhnenko et al., 2019). According to the World Health Organization, "prisons are bad for mental health. There are various factors in prisons that have negative effects on mental health, including: overcrowding, various forms of violence, enforced solitude or conversely, lack of privacy, lack of meaningful activity, isolation from social networks, insecurity about future prospects (work, relationships, etc.), and inadequate health services, especially mental health services. The increased risk of suicide in prisons (often related to depression) is, unfortunately, a common manifestation of the cumulative effects of these factors." (WHO, 2005; Enggist et al., 2014). Importantly, it has been reported that better mental health relates to lower rates of recidivism (Wallace and Wang, 2020).

In addition to these negative effects of imprisonment, recent studies found that neurocognitive functioning in prisoners declined after 3–4 months in prison (Meijers et al., 2018; Umbach et al., 2018). It has been hypothesized that the impoverished nature of the prison environment could (partially) explain this negative change (see Chapter 4). Animal studies, and some experiments in humans, have reported on the impact of environmental stimuli on brain and behavior. The effects of prison on neurocognitive functioning have already been discussed in legal literature (Ligthart et al., 2019b), for instance, to argue against solitary confinement in the United States (Coppola, 2019). If the neuropsychological findings are correct, it appears that prison could have *unintended, diffuse adverse* effects on a prisoner's mental life and brain function, while future neurotechnology may have *intended, focused positive* effects on the quality of brain function, mental states, and, ultimately, behavior. This raises the question to what extent neurotechniques that change offenders' brains would be ethically and legally different from changing the brain as an (unintended) result of a prison environment.

Negative or even harmful effects of imprisonment on detainees provide an important reason to look at alternative ways for a society to respond to crime. Clearly, prison sentences are meant to punish (in general, retribution is one of the main goals of imprisonment), but they come with substantial negative unintended side-effects that may not only harm the detained person, but also society. Not only may prison sentences have adverse consequences for the individual offender, it is often argued that prison sentences, while in the short-term effective at keeping offenders behind bars, may in the long-term result in increased risks of recidivism (Gendreau et al., 1999; Cullen et al., 2011). We emphasize this because it makes clear that the current state of affairs—both the imperfect attempts to predict recidivism and the way we currently treat offenders—is in need of improvement.

In conclusion, if we are to evaluate the option of using neurotechnologies to reduce recidivism, we also have to take the current situation of prediction and prevention of crime into account. This means that we should not only consider potential disadvantages of these novel neurotechnologies, but also take account of negative effects of the existing practice of incarceration on society, victims, and offenders. Even though detention is meant to punish, generally it is also intended to prevent people from committing crimes—a goal that is often not satisfied by prison sentences. Neurotechnologies may possibly contribute to improvement.

NEUROTECHNIQUES FOR THE PREDICTION AND PREVENTION OF CRIME

Prediction

In an often-cited study, Kent Kiehl's group showed that it was possible to predict rearrest of offenders using fMRI (Aharoni et al., 2013; Allen et al., 2022). The offenders performed a go/no-go impulse control task while their brain was being scanned with fMRI. Based on the results, the researchers predicted who would be rearrested in a follow-up period of 4 years. As it turned out, the odds that offenders with low activity in a particular brain region, the anterior cingulate cortex, would be rearrested were about double that of offenders with high activity in this region. In 2019, Swedish researchers tried to predict recidivism in a forensic psychiatric population. Interestingly, they not only used brain scans (single-photon emission computed tomography, SPECT), but they combined information from these scans with typically used risk factors, such as criminal history. Using an algorithm, these researchers found that adding the data from the brain scans to more traditional risk factors significantly improved the prediction (Delfin et al., 2019). Zijlmans et al. (2021) recently studied prediction of recidivism in delinquent young adults using, among other factors, EEG and fMRI and they reported that the neurobiological data contributed to the accuracy of the prediction. These latter studies show that brain scans can be of particular value when *combined* with other data/techniques, such as standard risk factors we use today. Such a combination of techniques—which requires the analysis of data from different sources—is facilitated by recent developments in artificial intelligence (Tortora et al., 2020). Incidentally,

as reported by De Kogel and Westgeest, neurobiological data have already been used to answer questions about the risk of recidivism in legal practice (De Kogel and Westgeest, 2015).

Prevention

A common example of a brain-targeting intervention to prevent recidivism is the use of medication to treat a mental condition that is associated with an increased risk of future criminal behavior. For instance, antipsychotic drugs may be offered to offenders with a psychotic disorder. Occasionally, medication that reduces sexual drive is offered to sex offenders (Douglas et al., 2013).

Some have argued for using neuromodulation as an intervention for psychopaths and repeat offenders (Canavero, 2014). Recently, transcranial direct current stimulation (tDCS) has been used in a research setting to reduce aggression in a forensic psychiatric population (Sergiou et al., 2021; for a review, see Knehans et al., 2022). As far as we know, DBS has not (yet) been used in offenders to reduce criminal behavior, but such potential future use has been discussed by Fuss et al. (2015). They write that "patients with paraphilic disorders (sexual sadism and pedophilia) who have uncontrollable sexual urges and a concomitant high risk for sexual offense could eventually be eligible candidates" (Fuss et al., 2015). These authors have even identified the ventromedial hypothalamus as a potential target for DBS in these patients.

Technological developments suggest that, in the future, prediction and prevention could possibly be combined in a single neurotool that "reads" the brain *and* directly intervenes. Such devices, which combine the monitoring and modification of brain activity, are referred to as "*closed loop*" brain devices (Kellmeyer et al., 2016; Ligthart et al., 2021a). "Closed loop" refers to the fact that the activity of the device is not regulated by a person, but by the device itself—since there is no outside interference, the loop is "closed." The example in the introduction about the sex offender who received DBS concerned a closed loop scenario. This type of "intelligent" devices may have fewer side-effects compared with traditional DBS as they need not always be active, but rather respond only to certain stimuli (Meynen and Widdershoven, 2017). They may also be more effective as they can tailor brain stimulation to what is actually "needed" at a certain moment in time. Stimulation is provided *if and as far as* required, similar to a pacemaker for your heart: it detects problems with the heart rate and then, only when necessary, it intervenes. In a hypothetical situation, a closed loop brain device will only intervene to prevent an offender from committing a crime, protecting the interests of both the offender (fewer side-effects) and society (crime prevention).

Emerging technologies

A justified question is whether we are not too early in considering the normative intricacies of neurotechnologies in criminal justice, as they are basically *emerging* technologies, at best. Let us provide some responses.

First, as Wajnerman Paz reminds us, there is a recent example where normative considerations concerning technological developments came too late: Facebook-Cambridge Analytica. He writes: "If we wait for this [neuro]technology to be fully developed before deciding how to regulate it, by the time it is already developed, the technical features and social practices associated with it may become too culturally entrenched to be easily modified" (Wajnerman Paz, 2022). In other words, we should ensure that ethical and legal thinking *are ahead* of new neurotechnological advances (Nadelhoffer et al., 2012; Nadelhoffer and Sinnott-Armstrong, 2012; Meynen, 2019b). At the same time, we need to realize that neuroscientific developments are sometimes hyped (Mackor, 2010; Morse, 2018), with the risk of creating unrealistic expectations. So, there is the continued challenge to be realistic and to recognize the limitations of current and upcoming neurotechnologies.

Second, by being ahead of technological developments, both law and ethics could contribute to the design and development of neurotechnology (see also Yuste et al., 2017; Ienca, 2021a). Here, paragraph 15 of the *Strategic Action Plan on Human Rights and Technologies in Biomedicine 2020–2025*, adopted by the Committee of Bioethics (2019, Council of Europe), is highly relevant. It states that "there is a pressing need to embed human rights in technologies which have an application in the field of biomedicine. This implies that technological developments are *from the outset oriented towards protecting human rights*" (Emphasis added). Thinking ahead may ensure that human rights are embedded in the development of neurotechniques used in criminal justice.

In fact, it may be that certain applications will only be developed if the normative boundaries are sufficiently clear. Suppose that a company or research institute intends to develop a neurotechnology for use within an offender population. Approval by an ethical review board is required, and review boards are likely to take the special—in fact vulnerable (Kellmeyer et al., 2019)—position of offenders/detainees into account. Therefore, permission to study certain technologies in this population will probably only be obtained if the ethical and legal boundaries are clear, and more specifically, if it is clear that such boundaries will not be violated. Accordingly, clarifying the normative boundaries is important for developing potentially beneficial neurotechnologies in the criminal justice domain.

NORMATIVE ISSUES REGARDING EMPLOYING NEUROTECHNOLOGY TO REDUCE RECIDIVISM

The use of neurotechnology for behavioral prediction or intervention in an offender population raises profound normative concerns. These include (1) the offender's autonomy (Vincent et al., 2020), (2) mental privacy (Ligthart et al., 2020), and (3) mental integrity (Craig, 2016). In what follows, we focus on these three concerns. The discussion is not meant to be exhaustive; it aims to highlight some central normative issues regarding the use of neurotechnologies in criminal justice. The legal analysis is mainly based on the European Convention on Human Rights (ECHR).

Autonomy

Basically, there are three issues concerning the offender's autonomy that deserve attention. First, to what extent is the offender's autonomous choice compromised by the fact that an "offer" to apply a neurotechnique is made in an involuntary context, such as a prison or a parole situation? In healthcare, the patient's autonomy is normally respected, which means that, in principle, it is crucial that a patient gives *informed consent* before a medical treatment can start. In order to give valid consent, the patient has to be well-informed, competent and *free* to make a decision (Beauchamp and Childress, 2019). Meanwhile, in the context of criminal justice, the voluntariness of consent may not always be clear (Ryberg, 2020). As Douglas et al. (2013) write: "Some have argued that the state should not offer sexual offenders the choice between chemical castration and further incarceration because valid consent cannot be obtained in these circumstances." The very context of criminal justice casts doubts on the voluntariness of such a choice. More precisely, even a "free" choice can be coerced, and coercion, it has been argued, is not a matter of black and white, but rather a spectrum (Szmukler and Appelbaum, 2008). Therefore, it is essential to identify the normative relevance of this spectrum as related to various types of neurotechniques and criminal justice contexts. Suppose that an offender who is serving a long prison sentence is offered the option of DBS in exchange for parole (and refusal implies continuation of imprisonment). Would this really be a free choice, or rather an offer "one cannot refuse" (Pugh, 2018; Meynen, 2019b; Ryberg, 2020)? Some theorists have referred to these offers as "coercive offers" (Feinberg, 1986).

A second concern about autonomy is that the neurotechnological intervention itself may *affect* a person's autonomy by influencing the brain and mental functioning (Birks and Douglas, 2018). Neurotechniques could, for instance, have an impact on a person's decision-making, as exemplified by a case where DBS led to a manic state in which the person was no longer competent to make decisions (Leentjens et al., 2004). Even though the effects of neurotechnologies in offenders could be more subtle than inducing a manic state, they could still, and perhaps decisively, influence the choices offenders make, undermining their autonomy.

Third, neurotechnologies may also have positive effects on an offender's future autonomy. As Ligthart et al. (2021a) write: "For example, suppose the rehabilitation of an offender has failed several times because of behavioural patterns that he apparently cannot shake off—much to the offender's own regret. In this way, he will never be able to build the life in the community he desires. If a correctional CBD [closed loop brain device] targets those mental/brain states that undermine the offender's rehabilitation, the CBD might be considered to empower the offender, increasing his autonomy, at least in the sense of having control over one's life." In the same vein, Douglas et al. (2013) have argued that considerations about autonomy may support offering the option of chemical castration to a convicted offender: "castration may increase the offender's future autonomy by removing internal, psychological barriers to autonomy, such as irresistible sexual urges, and by allowing the offender to be released from prison, thus reducing restrictions on freedom of movement, association, and expression."

Whether one views neurotechnologies as harming or increasing autonomy depends, at least in part, on one's understanding of "autonomy." In fact, the first and second points mentioned above (regarding potentially "coercive" offers and impact on mental functioning) are primarily related to understanding autonomy as a right to "noninterference," while the third issue of increasing autonomy understands this concept as "having control over one's own life" (Ligthart et al., 2021a). In conclusion, there could be different ways—at least three—in which autonomy is relevant for evaluating the impact of these technologies, not just threatening autonomy, but, possibly, also fostering it.

Mental privacy

A second normative concern about employing neurotechnologies in criminal offenders regards the offender's mental privacy. Traditionally, criminal law regulates behavior and competences that physically take place in the visible, outside world. For example, the European Court of Human Rights (ECtHR) has established a clear legal doctrine on how telephone tapping by the police can harm private life (De Hert and Malgieri, 2020). Less attention is paid to legal norms that protect the *mental* domain. The reason is that until recently it was assumed

that thoughts, emotions and other mental processes are inaccessible to third parties (Bublitz and Merkel, 2014). The potential use of "brain reading" and neurointerventions in criminal law, however, prompts us to reflect on the degree and manner of legal protection that we want to offer to the brain and the mental domain regarding privacy (Ligthart, 2022).

Different fundamental rights are relevant to the protection of mental privacy. Below, we discuss the right to respect for private life, the right to freedom of thought, and the right to freedom of expression.

First, mental privacy could be protected by the right to *respect for private life* under Article 8 of the European Convention on Human Rights (ECHR). "Private life" is a broad concept and its meaning and scope are continuously evolving, inter alia because of technological and social developments (Ligthart, 2019). It is clear that the protection of personal data is covered by this right. The compulsory taking, retaining and/or using of someone's personal data therefore infringes the right to respect for private life. Brain scans retrieve personal data, as the data they generate relate to an identified individual (Rainey et al., 2020b). As a consequence, (coercively) obtaining, retaining, and/or using neuroimaging data in criminal law is likely to constitute an infringement of the right to private life (Ligthart, 2022). Indeed, sometimes these interferences may well be justified for the prevention and prosecution of (severe) crime. Still, Article 8 ECHR sets fundamental legal boundaries to the use of nonconsensual "brain-reading" in criminal law. At the same time, neurotechnologies that enable to discover what people think or feel, raise profound questions regarding the scope and degree of legal protection we would like to offer to our brains and our mental states (Goering et al., 2021).

Second, the right to *freedom of thought*, laid down in Article 9 of the ECHR, may safeguard mental privacy as well (Ligthart et al., 2022). The freedom of thought includes the freedom not to disclose thoughts (Vermeulen and Roosmalen, 2018). The "internal aspect" of this freedom is absolute: interferences can never be justified. However, the precise meaning and scope of the notion of "thought" are yet unclear (Bublitz, 2021). The ECtHR has decided that the freedom of thought, conscience and religion denotes only those views that attain a certain level of cogency, seriousness, cohesion and importance (Ligthart, 2022). This view is endorsed in literature (Rainey et al., 2020a), although broader interpretations have been advocated as well.

For example, Bublitz suggests that thoughts should be understood as mental states that have content and/or meaning (Bublitz, 2021). McCarthy-Jones proposes placing core mental processes that enable mental autonomy, such as cognitive agency, at the center of the right to freedom of thought. Additionally, he suggests that the freedom of thought should also cover external actions that are constitutive of thought, for example, reading and writing (McCarthy-Jones, 2019). Alegre (2017) furthermore interprets the notion of "thought" as including political opinions, emotional states and trivial thought processes. Apart from these broader interpretations of "thought," a debate has emerged on whether the freedom of thought should remain unconditional (absolute), or whether some exceptions should be allowed (Ligthart et al., 2022).

The mental states and characteristics that will typically be identified by neurotechnology to predict crime—such as aggressiveness and sexual drives—are unlikely to qualify as thoughts in the narrow understanding of the ECtHR (Ligthart, 2020). However, based on broader interpretations, such as of McCarthy-Jones, the right to freedom of thought may well protect mental privacy in a broad sense, covering all kind of techniques that disclose mental data and undermine mental autonomy (cf. UN Special Rapporteur on Freedom of Religion or Belief, Report on the Freedom of Thought, 5 October 2021, A/76/380).

Third, the *freedom of expression*, laid down in Article 10 ECHR, may offer protection to mental privacy as well. This freedom differs from the freedom of thought because unlike Article 9 ECHR, Article 10 ECHR comprises a right to *manifest* or *express* thoughts. Moreover, the scope of Article 10 ECHR is broader: the freedom of expression extends to the transmission of *almost any* type of information, regardless of the content or method of communication (Ligthart, 2022). Article 10 ECHR protects mental privacy by including a right not to be compelled to express oneself (Harris et al., 2018, p. 595). Every individual is thus free *not to* disclose information. Some neuroimaging assessments depend upon the subject's participation, for example, a subject could be required to perform an inhibition task in an fMRI scanner in order to determine brain activity in areas that correlate with antisocial behavior (Aharoni et al., 2013). Whenever such an assessment would take place involuntarily, the offender may well be conceived as to be forced to express herself. The question thus arises whether the obligation to "express" information through coercive "brain-reading" elicits protection under Article 10 ECHR (Ligthart, 2022).

Mental integrity

A third normative concern regarding the use of neurotechnologies in criminal justice is whether they interfere with the mental integrity of convicted offenders (for definitions of mental integrity, see below). Up until now, one of the most widely used punishments for criminal

offenders is incarceration, a punishment consisting of physical restrictions to the offender that may yield ethical concerns regarding autonomy and bodily integrity, but that does not typically prompt us to consider mental integrity. The introduction of neurotechnologies, however, presents a new "layer" of ethical and legal concerns that pertain to the mental, inner sphere of human beings that is targeted with these techniques (Bublitz and Merkel, 2014).

Mental integrity is protected by law. For example, Article 3(1) of the Charter of Fundamental Rights of the European Union (CFR) guarantees that "Everyone has the right to respect for his or her physical and mental integrity." A similar right has been recognized by the ECtHR, as part of the right to respect for private life (ECtHR 12 October 2006, § 83 (*Mayeka and Kaniki Mitunga v. Belgium),* see also Article 1 of the Convention on Human Rights and Biomedicine). Furthermore, Article 9 ECHR and Article 18 International Convention on Civil and Political Rights (ICCPR) guarantee the right to freedom of thought. Depending on the exact understanding of this right, it could protect against certain interferences with mental integrity as well (Bublitz, 2021; Lavazza, 2018; UN Special Rapporteur on Freedom of Religion or Belief, *Report on the Freedom of Thought*, 5 October 2021, A/76/380).

As such, mental integrity receives protection from various fundamental legal rights. However, inherent to this notion is some ambiguity regarding its exact meaning and scope (Bublitz, 2020). Some define a right to mental integrity as an individual's "mastery of his mental states and brain data" (Lavazza, 2018), characterizing it as a mental "capacity," while others define the right as a right "against nonconsensual mental interference" (Bublitz and Merkel, 2014; Mendlow, 2021), emphasizing the absence of external influences (see also Douglas and Forsberg, 2021). The notion of mental integrity is also closely associated with other, more well-known, fundamental concepts such as autonomy, agency, and bodily integrity. For example, Craig (2016) contends that the right to mental integrity "defends an individual's right to liberty of the inner-sphere that embodies features necessary for autonomous human agency," similar to how Lavazza (2018) claims that mental integrity "guarantees (among other things) freedom and autonomy." While the definitions may vary in their exact wordings, the essence appears to be that the right to mental integrity protects the mind from significant interferences by others.

Regardless of the ambiguity surrounding its exact meaning and scope, it is easy to imagine that the use of neurotechnologies on criminal offenders may pose a threat to this right. Neurotechnologies target the brain, and by extension, the mind. The primary aim of using intervention-techniques on offenders is to alter their mental states—their beliefs, desires and preferences—with the ultimate intention of altering their behavior so as to prevent reoffending. Hence, neurotechnologies appear to target that what a right to mental integrity would protect (Craig, 2016).

Consider an example of an offender who has reoffended on multiple occasions due to his aggressive tendencies. To prevent him from reoffending, a neurotechnique aimed at changing his aggressive tendencies may be offered—for instance tDCS, where small electrical currents are administered to the offender's brain via electrodes on the scalp to alter the electrochemical processing in his brain, which influence his mental states. In this case, the offender's pre-existing tendencies are replaced by "modified" tendencies using tDCS, and the offender will act differently from how he would have acted were his impulses not altered by the technique. Since the tDCS directly intervenes on the offender's mental states—in this case his aggressive tendencies—the use of such techniques in criminal justice raises concerns with respect to the right to mental integrity of offenders. Potential infringements of the right to mental integrity such as in this example may cause some to regard the use of neurotechnologies in criminal justice settings as morally problematic.

It may also be argued that the above example is morally problematic because tDCS infringes the right to *bodily* integrity of the offender. Such an infringement, however, may not fully account for the potential moral impermissibility of the example, because it is not the electrical currents entering the brain *per se* that signify the potential moral and legal wrongness. Rather, it is the alteration of the offender's *mental states*—his tendencies—that raises moral concerns. This illustrates that a right to bodily integrity may not be sufficient to account for potential moral worries about applying neurotechnologies in criminal justice settings—which underlines the need for clarity regarding moral and legal protection of the mental sphere (Bublitz and Merkel, 2014; Ienca and Andorno, 2017; Douglas and Forsberg, 2021).

The adequacy of a right to mental integrity will depend on how the right will be understood. Should it protect against *any* mental influence that may affect one's mental states? This might be too broad, as it would label everyday mental influences that may alter one's mental states—such as convincing someone to buy something—as a breach of the right, while this intuitively does not appear morally or legally problematic. Should it only protect against harmful mental interferences (Ienca and Andorno, 2017)? This, on the other hand, may be too narrow, as there are mental interferences that are not necessarily harmful but still should be considered to infringe a right to mental integrity, such as nonconsensually altering someone's mental states with a psychoactive

substance to make a person happier. In sum, the extent to which an offender's mental integrity will be protected by the law will be determined by how the right will be explicated.

FURTHER ETHICAL AND LEGAL ISSUES

In addition to the concerns about autonomy, mental privacy and mental integrity, there are several other ethical and legal issues that deserve attention too, some of which we will discuss briefly.

First, an important issue concerns the role of *physicians* in the application of neurotechniques in criminal justice (Ryberg, 2020). Ryberg (2020) argues that for medical procedures such as psychosurgery, medical doctors will be essential. These physicians, however, have their own medical ethical codes. Therefore, even if the criminal justice system could legally allow neurotechnological interventions, medical ethics may prohibit such procedures and, to the extent that physicians are essential, may make it *practically impossible* to apply such a technique. Even though Ryberg focuses on physicians, a similar line of reasoning may well apply to other health care professionals. In other words, medical ethics could prevent criminal justice systems from using certain neurotechniques. Of note, medical ethics is closely related to health law—so ethical boundaries may also constitute legal boundaries for health care professionals.

A central question here is: to which extent is it true that medical doctors are necessary for the application of neurotechniques? Clearly, where surgery is required, medical doctors have to be involved. And true, their medical codes might restrict the use of certain technologies. There are also noninvasive neurotechnologies, however, that can already be bought by consumers on the internet, such as EEG headsets. Several variants of these EEG headsets are for sale on *Amazon.com*, for instance "*Muse 2: The Brain Sensing Headband—Guided Meditation Multi Sensor Headset Tracker—Feedback Device Monitors Brain Wave, Heart, Breath & Body Activity.*" Such a device (we do not know if it works) is available without the involvement of any medical professional. So, the question arises of whether medical doctors or other relevant health care professionals will always be needed to apply neurotechnologies, such as a "brain reading" device during parole. Or could such devises be applied just like the current tracking ankle bracelet for offenders, which does not require any involvement of medical professionals at all? The answer to this question may be very relevant from an ethical perspective: to what extent could medical ethics put limitations on the use of neurotechniques in criminal justice?

The second, partially related issue concerns the *invasiveness* of neurotechniques. Some brain-targeting interventions may be considered highly invasive such as DBS, while others, like transcranial magnetic stimulation (TMS), may seem less invasive as no surgery is required; the skull and skin remain intact. However, is it justified to determine the "invasiveness" of these techniques merely based on the question whether surgery is involved (Bluhm et al., 2021)? Clearly, surgery may lead to serious side-effects, and it is physically the most invasive procedure. But the question that is relevant here is foremost: What kind of techniques are *ethically* and *legally* the most "invasive?" It may be that the brain-targeting effects of something that is simply ingested are more profound than a brain surgery procedure because what has been eaten may lead to *irreversible* effects, while the brain surgery's effect may be (largely) reversible. For instance, DBS requires surgery, but the effects of DBS can, to a considerable extent, be stopped/reversed if the stimulation is terminated. In other words, "invasiveness" must be considered through the lens of ethics and law in order to really determine the impact of these technologies (Ligthart et al., 2023).

Third, (future) neurotechnologies are likely to involve *artificial intelligence* (AI). AI is able to assemble a lot of neuroscience data and discover hidden links in these data, for example, between brain activity and behavior. On the basis of these links, AI can deduce general theoretical principles (Potter, 2007). AI could in the future, for example, be employed to extract more (detailed) information from brain scans. One profound concern regarding the use of AI is *bias*, which can lead to systematic errors in the output (Tortora et al., 2020). AI is trained on data—such as criminal files—and if these data reflect biases, the outcome can be biased as well. As a result, certain groups of individuals can be unfairly discriminated against. For example, COMPAS has been used in the United States to predict offenders' recidivism risk. It uses algorithms to convert certain offender characteristics into a risk score. However, the tool contained a bias that made it more likely for black offenders to be incorrectly labeled as "high risk" compared to white offenders (Washington, 2018). When developing neurotechnologies, it is important to be aware of bias and prevent it as much as possible, as bias may cause the neurotechnology not to work equally effective for different groups of persons.

Finally, Ienca and Andorno have argued that the (near future) possibilities offered by neurotechnology will require *new human rights* (Ienca and Andorno, 2017; Ienca, 2021b). They write that existing human rights may not be sufficient to protect citizens' mental dimension, and they suggest establishing four so-called neurorights: the right to cognitive liberty, the right to mental

privacy, the right to mental integrity, and the right to psychological continuity (also referred to as personal identity). Clearly, each of these is relevant to the application of neurotechniques in criminal justice. Meanwhile, the necessity of novel neurorights is a matter of ongoing debate (Bublitz, 2022; Ligthart, 2022). In brief, it has been argued that existing human rights are likely to provide sufficient protection against emerging neurotechnologies. It is only a matter of specifying the already existing rights with respect to novel technologies rather than developing new rights in response to technological developments. In any case, there is some unclarity about the protection offered by established human rights—also with respect to the application of neurotechnologies in criminal justice. Such unclarity is, at least in part, due to the fact that the courts and legislators have not yet considered cases concerning the use of neurotechnologies in criminal justice. In order to determine the need for new human rights, it is crucial to clarify the scope of the current human rights framework.

CONCLUSION

Prediction and prevention of recidivism are in need of improvement. Emerging neurotechnologies could contribute to such improvement in the near future. First, because they may more precisely predict reoffending by using brain data. Second, neurotechnologies may prevent reoffending by influencing the offender's brain functioning. Neuromodulation could be used to alter offenders' mental functioning, for instance, by inhibiting their aggressive impulses or sexual desires, to prevent them from committing crimes. In this way, neurotechnology could lead to earlier release of prisoners and to a safer and more resilient society.

However, there are considerable ethical and legal concerns regarding the use of neurotechnologies in criminal justice settings, pertaining to autonomy, mental privacy and mental integrity. Additionally, from a normative perspective, the role of health care professionals such as medical doctors in the application of neurotechniques should be considered, as well as the invasiveness of the techniques and the possibility of bias in the algorithms used to analyze brain data.

In conclusion, there are profound ethical and legal concerns that arise when neurotechnologies would be introduced into criminal justice systems. It is crucial to address these concerns before the neurotechnologies are fully developed and incorporated in our systems. Otherwise, we run the risk that the technologies become too ingrained in our societal structures for them to be subjected to any "moral modifications." Ideally, ethical and legal values should already inform the design of neurotechnologies, so they can be used to foster and protect fundamental rights.

ACKNOWLEDGMENT

This publication is part of the project Law and Ethics of Neurotechnology in Criminal Justice (LENC) (with project number VI.C.201.067) of the research program Vici which is financed by the Dutch Research Council (NWO).

References

Aharoni E, Vincent GM, Harenski CL et al. (2013). Neuroprediction of future rearrest. Proc Natl Acad Sci U S A 110: 6223–6228. https://doi.org/10.1073/pnas.1219302110.

Alegre S (2017). Rethinking freedom of thought for the 21st century. Eur Hum Rights Law Rev 3: 221–233.

Allen CH, Aharoni E, Gullapalli AR et al. (2022). Hemodynamic activity in the limbic system predicts reoffending in women. NeuroImage: Clin 36.

Alper M, Durose MR, Markman J (2018). Update on prisoner recidivism: a 9-year follow-up period (2005-2014), US Department of Justice, Office of Justice Programs, Bureau of Justice Statistics, Washington, DC.

Beauchamp TL, Childress JF (2019). Principles of biomedical ethics, eighth edn. Oxford University Press.

Birks D, Douglas T (Eds.), (2018). Treatment for crime. Philosophical essays on neurointerventions in criminal justice. Oxford University Press.

Bluhm R, Cortright M, Achtyes ED et al. (2021). "They are invasive in different ways.": Stakeholders' perceptions of the invasiveness of psychiatric electroceutical interventions. AJOB Neurosci 1–12. https://doi.org/10.1080/21507740.2021.1958098.

Bublitz JC (2020). The nascent right to psychological integrity and mental self-determination. In: A Von Arnauld, K Von der Decken, M Susi (Eds.), The Cambridge handbook of new human rights: recognition, novelty, rhetoric. Cambridge University Press, pp. 387–403.

Bublitz JC (2021). Freedom of thought as an international human right: elements of a theory of a living right. In: MJ Blitz, JC Bublitz (Eds.), The law and ethics of freedom of thought. Palgrave Macmillan, pp. 49–101.

Bublitz JC (2022). Novel Neurorights: from nonsense to substance. Neuroethics 15: 7.

Bublitz JC, Merkel R (2014). Crimes against minds: on mental manipulations, harms and a human right to mental self-determination. Crim Law Philos 8: 51–77.

Canavero S (2014). Criminal minds: neuromodulation of the psychopathic brain. Front Hum Neurosci 8: 124https://doi.org/10.3389/fnhum.2014.00124.

Chalfin A (2015). Economic costs of crime. In: The encyclopedia of crime & punishment, Wiley (online library).

Chew C, Douglas T, Faber NS (2018). Biological interventions for crime prevention. In: D Birks, T Douglas (Eds.), Treatment for crime: philosophical essays on neurointerventions in criminal justice. Oxford University Press.

Cohen MA (2005). The costs of crime and justice, Routledge.

Coppola F (2019). The brain in solitude: an (other) eighth amendment challenge to solitary confinement. J Law Biosci 6: 184–225. https://doi.org/10.1093/jlb/lsz014.

Craig JN (2016). Incarceration, direct brain intervention, and the right to mental integrity–a reply to Thomas Douglas. Neuroethics 9: 107–118.

Cullen FT, Jonson CL, Nagin DS (2011). Prisons do not reduce recidivism: the high cost of ignoring science. Prison J 91: 48S–65S.

De Hert P, Malgieri G (2020). Article 8 ECHR compliant and foreseeable surveillance: the ECTHR's expanded legality requirement copied by the CJEU. A discussion of European surveillance case law, 6: Working Paper *Brussels Privacy Hub*.

De Kogel CH, Westgeest EJ (2015). Neuroscientific and behavioral genetic information in criminal cases in the Netherlands. J Law Biosci 2: 580–605. https://doi.org/10.1093/jlb/lsv024.

Delfin C, Krona H, Andiné P et al. (2019). Prediction of recidivism in a long-term follow-up of forensic psychiatric patients: incremental effects of neuroimaging data. PLoS One 14: e0217127. https://doi.org/10.1371/journal.pone.0217127.

Douglas T (2019). Nonconsensual neurocorrectives and bodily integrity: a reply to Shaw and Barn. Neuroethics 12: 107–118https://doi.org/10.1007/s12152-016-9275-6.

Douglas T, Forsberg L (2021). Three rationales for a legal right to mental integrity. In: S Ligthart, D Van Toor, T Kooijmans, T Douglas, G Meynen (Eds.), Neurolaw: advances in neuroscience, Justice & Security. Palgrave Macmillan.

Douglas T, Bonte P, Focquaert F et al. (2013). Coercion, incarceration, and chemical castration: an argument from autonomy. J Bioeth Inq 10: 393–405. https://doi.org/10.1007/s11673-013-9465-4.

Douglas T, Pugh J, Singh I et al. (2017). Risk assessment tools in criminal justice and forensic psychiatry: the need for better data. Eur Psychiatry 42: 134–137. https://doi.org/10.1016/j.eurpsy.2016.12.009.

Enggist S, Møller L, Galea G et al. (Eds.), (2014). Prisons and health. World Health Organization, Regional Office for Europe, Copenhagen.

Fazel S, Singh JP, Doll H et al. (2012). Use of risk assessment instruments to predict violence and antisocial behaviour in 73 samples involving 24 827 people: systematic review and meta-analysis. BMJ 345: e4692.

Feinberg J (1986). The moral limits of the criminal law. *Volume 3,* Harm to self, Oxford University Press.

Fuss J, Auer MK, Biedermann SV et al. (2015). Deep brain stimulation to reduce sexual drive. J Psychiatry Neurosci 40: 150003.

Gendreau P, Coggin C, Cullen FT (1999). The effects of prison sentences on recidivism, Public Safety Canada; Government of Canada.

Glenn AL, Raine A (2013). Neurocriminology: implications for the punishment, prediction and prevention of criminal behaviour. Nat Rev Neurosci. https://doi.org/10.1038/nrn3640.

Goering S, Klein E, Specker Sullivan L et al. (2021). Recommendations for responsible development and application of neurotechnologies. Neuroethics 14: 365–386. https://doi.org/10.1007/s12152-021-09468-6.

Harris D, O'Boyle M, Bates E et al. (2018). Harris, O'Boyle, and Warbrick: law of the European convention on human rights, Oxford University Press.

Hübner D, White L (2016). Neurosurgery for psychopaths? An ethical analysis. AJOB Neurosci 7: 14–149.

Ienca M (2021a). Common human rights challenges raised by different applications of neurotechnologies in the biomedical fields. Report commissioned by the committee on bioethics (DH-BIO) of the Council of Europe, Council of Europe.

Ienca M (2021b). On neurorights. Front Hum Neurosci 15: 701258. https://doi.org/10.3389/fnhum.2021.701258.

Ienca M, Andorno R (2017). Towards new human rights in the age of neuroscience and neurotechnology. Life Sci Soc Policy 13.

Kellmeyer P, Cochrane T, Müller O et al. (2016). The effects of closed-loop medical devices on the autonomy and accountability of persons and systems. Camb Q Healthc Ethics 25: 623–633. https://doi.org/10.1017/S0963180116000359.

Kellmeyer P, Biller-Andorno N, Meynen G (2019). Ethical tensions of virtual reality treatment in vulnerable patients. Nat Med. https://doi.org/10.1038/s41591-019-0543-y.

Kiehl KA, Anderson NE, Aharoni E et al. (2018). Age of gray matters: neuroprediction of recidivism. Neuroimage Clin 19: 813–823. https://doi.org/10.1016/j.nicl.2018.05.036.

Knack N, Chandler JA, Fedoroff JP (2020). A qualitative study of forensic patients' perceptions of quasi-coercive offers of biological treatment. Behav Sci Law. https://doi.org/10.1002/bsl.2449.

Knehans R, Schuhmann T, Roef D et al. (2022). Modulating behavioural and self-reported aggression with non-invasive brain stimulation: a literature review. Brain Sci 12. https://doi.org/10.3390/brainsci12020200.

Lavazza A (2018). Freedom of thought and mental integrity: the moral requirements for any neural prosthesis. Front Neurosci 12: 82. https://doi.org/10.3389/fnins.2018.00082.

Leentjens AF, Visser-Vandewalle V, Temel Y et al. (2004). Manipulation of mental competence: an ethical problem in case of electrical stimulation of the subthalamic nucleus for severe Parkinson's disease. Ned Tijdschr Geneeskd 148: 1394–1398.

Ligthart SLTJ (2019). Coercive neuroimaging, criminal law, and privacy: a European perspective. J Law Biosci 6: 289–309. https://doi.org/10.1093/jlb/lsz015.

Ligthart S (2020). Freedom of thought in Europe: do advances in 'brain-reading' technology call for revision? J Law Biosci 7. https://doi.org/10.1093/jlb/lsaa048.

Ligthart S (2022). Coercive brain-reading in criminal justice: an analysis of European human rights law, Cambridge University Press.

Ligthart S, Douglas T, Bublitz C et al. (2019a). The future of neuroethics and the relevance of the law. AJOB Neurosci 10: 120–121. https://doi.org/10.1080/21507740.2019.1632961.

Ligthart S, Van Oploo L, Meijers J et al. (2019b). Prison and the brain: neuropsychological research in the light of the European convention on human rights. New J Eur Crim Law 10: 287–300.

Ligthart S, Douglas T, Bublitz C et al. (2020). Forensic brain-reading and mental privacy in European human rights law: foundations and challenges. Neuroethics. 14: 191–203.

Ligthart S, Kooijmans T, Douglas T et al. (2021a). Closed-loop brain devices in offender rehabilitation: autonomy, human rights, and accountability. Camb Q Healthc Ethics 30: 669–680. https://doi.org/10.1017/S0963180121000141.

Ligthart S, Kooijmans T, Meynen G (2021b). 'Brain-reading' in criminal justice and forensic psychiatry: towards an integrative legal-ethical approach. In: S Ligthart, D Van Toor, T Kooijmans, T Douglas, G Meynen (Eds.), Neurolaw: advances in neuroscience, justice, and security. Palgrave Macmillan.

Ligthart S, Van Toor D, Kooijmans T, Douglas T, Meynen G (Eds.), (2021c). Neurolaw: advances in neuroscience, Justice & Security. Palgrave Macmillan.

Ligthart S, Bublitz C, Douglas T et al. (2022). Rethinking the right to freedom of thought: a multidisciplinary analysis. Hum Rights Law Rev 22: 1–14.

Ligthart S, Tesink V, Douglas T et al. (2023). The normative evaluation of neurointerventions in criminal justice: from invasiveness to human rights. AJOB Neurosci 14: 23–25.

Mackor AR (2010). Strafrecht en neurowetenschappen. Hoop, huiver of hype? Rechtsfilosofie & Rechtstheorie 39: 3–8.

McCarthy-Jones S (2019). The autonomous mind: the right to freedom of thought in the twenty-first century. Front Artif Intell 2.

Meijers J, Harte JM, Meynen G et al. (2018). Reduced self-control after 3 months of imprisonment; A pilot study. Front Psychol 9: 69. https://doi.org/10.3389/fpsyg.2018.00069.

Mendlow GS (2021). Why is it wrong to punish thought? In: MJ Blitz, JC Bublitz (Eds.), The law and ethics of freedom of thought, Volume 1. Palgrave Macmillan153–181.

Meynen G (2019a). Ethical issues to consider before introducing neurotechnological thought apprehension in psychiatry. AJOB Neurosci 10: 5–14. https://doi.org/10.1080/21507740.2019.1595772.

Meynen G (2019b). Forensic psychiatry and neurolaw: description, developments, and debates. Int J Law Psychiatry 65. https://doi.org/10.1016/j.ijlp.2018.04.005.

Meynen G, Widdershoven GAM (2017). The impact of closed loop DBS on agency: an open question. Am J Bioeth Neurosci 8: 79–80.

Morse SJ (2018). The promise of neuroscience for law: hope or hype? In: D Boonin (Ed.), The Palgrave handbook of philosophy and public policy. 77–96.

Nadelhoffer T, Sinnott-Armstrong W (2012). Neurolaw and neuroprediction: potential promises and perils. Philos Compass 7: 631–642.

Nadelhoffer T, Bibas S, Grafton S et al. (2012). Neuroprediction, violence, and the law: setting the stage. Neuroethics 5: 67–99.

Potter SM (2007). What can AI get from neuroscience? In: M Lungarella, F Iida, J Bongard, R Pfeifer (Eds.), 50 years of AI, festschrift, LNAI 4850. Springer, pp. 174–185.

Pugh J (2018). Coercion and the neurocorrective offer. In: D Birks, T Douglas (Eds.), Treatment for crime. Philosophical essays on neurointerventions in criminal justice. Oxford University Press.

Rainey B, McCormick P, Ovey C (2020a). Jacobs, White, and Ovey: the European convention on human rights, eighth edn. Oxford University Press.

Rainey S, McGillivray K, Akintoye S et al. (2020b). Is the European data protection regulation sufficient to deal with emerging data concerns relating to neurotechnology? J Law Biosci 7. https://doi.org/10.1093/jlb/lsaa051.

Ryberg J (2017). Neuroscience, mind reading and mental privacy. Res Publica 23: 197–211.

Ryberg J (2020). Neurointerventions, crime, and punishment: ethical considerations, Oxford University Press, New York.

Sergiou CS, Santarnecchi E, Romanella SM et al. (2021). Transcranial direct current stimulation targeting the ventromedial prefrontal cortex reduces reactive aggression and modulates electrophysiological responses in a forensic population. Biol Psychiatry Cogn Neurosci Neuroimaging. https://doi.org/10.1016/j.bpsc.2021.05.007.

Szmukler G, Appelbaum PS (2008). Treatment pressures, leverage, coercion, and compulsion in mental health care. J Ment Health 17: 233–244.

Tortora L, Meynen G, Bijlsma J et al. (2020). Neuroprediction and A.I. in forensic psychiatry and criminal justice: a Neurolaw perspective. Front Psychol 11: 220. https://doi.org/10.3389/fpsyg.2020.00220.

Umbach R, Berryessa C, Raine A (2015). Brain imaging research on psychopathy: implications for punishment, prediction, and treatment in youth and adults. J Crim Just 43: 295–306.

Umbach R, Raine A, Leonard NR (2018). Cognitive decline as a result of incarceration and the effects of a CBT/MT intervention: a cluster-randomized controlled trial. Crim Justice Behav 45: 31–55. https://doi.org/10.1177/0093854817736345.

Vermeulen B, Roosmalen M (2018). Freedom of thought, conscience and religion. In: P Van Dijk, F Van Hoof, A Van Rijn, L Zwaak (Eds.), Theory and practice of the European convention on human rights. Intersentia.

Vincent NA, Nadelhoffer T, McCay A (2020). Neurointerventions and the law: regulating human mental capacity, Oxford University Press.

Wajnerman Paz A (2022). Is your neural data part of your mind? Exploring the conceptual basis of mental privacy. Minds Mach 32: 395–415.

Wallace D, Wang X (2020). Does in-prison physical and mental health impact recidivism? SSM Popul Health 11: 100569. https://doi.org/10.1016/j.ssmph.2020.100569.

Walmsley R (2018). World prison population list, 12th edn. World Prison Brief, Institute for Criminal Policy Research, London.

Wartna BSJ, Tollenaar N, Essers AAM (2005). Door na de gevangenis. Een cijfermatig overzicht van de strafrechtelijke recidive onder ex-gedetineerden, Boom Juridische uitgevers.

Washington AL (2018). How to argue with an algorithm: lessons from the COMPAS-ProPublica debate. Colo Tech Law J 17: 131–160.

WHO (2005). Mental health and prisons (Information Sheet), World Health Organization and International Red Cross, Geneva.

Wilson JQ, Petersilia J (2011). Crime and public policy, second edn. Oxford University Press, Oxford.

World Health Organisation (2014). Global status report on violence prevention 2014, WHO Press, Geneva, Switzerland 2014.

Yeh SS (2010). Cost-benefit analysis of reducing crime through electronic monitoring of parolees and probationers. J Crim Just 38: 1090–1096.

Yukhnenko D, Sridhar S, Fazel S (2019). A systematic review of criminal recidivism rates worldwide: 3-year update. Wellcome Open Res 4: 28. https://doi.org/10.12688/wellcomeopenres.14970.2.

Yuste R, Goering S, Arcas BAY et al. (2017). Four ethical priorities for neurotechnologies and AI. Nature 551: 159–163. https://doi.org/10.1038/551159a.

Zijlmans J, Marhe R, Bevaart F et al. (2021). The predictive value of neurobiological measures for recidivism in delinquent male young adults. J Psychiatry Neurosci 46: E271–E280. https://doi.org/10.1503/jpn.200103.