

October 2021

## Neurolaw: Brain-Computer Interfaces

Nadine Liv

Follow this and additional works at: <https://ir.stthomas.edu/ustjlpp>



Part of the [Health Law and Policy Commons](#), [Human Rights Law Commons](#), [Law and Philosophy Commons](#), [Law and Psychology Commons](#), [Law and Society Commons](#), [Medical Jurisprudence Commons](#), [Other Law Commons](#), and the [Science and Technology Law Commons](#)

---

### Recommended Citation

Nadine Liv, *Neurolaw: Brain-Computer Interfaces*, 15 U. ST. THOMAS J.L. & PUB. POL'Y 328 (2021).  
Available at: <https://ir.stthomas.edu/ustjlpp/vol15/iss1/9>

This Article is brought to you for free and open access by UST Research Online and the University of St. Thomas Journal of Law and Public Policy. For more information, please contact the Editor-in-Chief at [jlpp@stthomas.edu](mailto:jlpp@stthomas.edu).

# NEUROLAW: BRAIN-COMPUTER INTERFACES

NADINE LIV

## Table of Contents

|  |            |
|--|------------|
| <b>I. INTRODUCTION</b> .....                             | <b>328</b> |
| A. <i>What Are Brain-Computer Interfaces?</i> .....      | 329        |
| B. <i>Categorization of BCIs</i> .....                   | 331        |
| C. <i>What the Future Holds</i> .....                    | 333        |
| <b>II. LEGAL IMPLICATIONS</b> .....                      | <b>335</b> |
| A. <i>BCI-Mediated Action</i> .....                      | 335        |
| D. <i>Brain-Hacking</i> .....                            | 339        |
| E. <i>The Privilege Against Self-Incrimination</i> ..... | 340        |
| F. <i>Evidence</i> .....                                 | 341        |
| G. <i>Privacy</i> .....                                  | 344        |
| H. <i>Private Law</i> .....                              | 347        |
| <b>III. PROPOSED SOLUTIONS</b> .....                     | <b>349</b> |
| A. <i>New Human Rights</i> .....                         | 349        |
| I. <i>Chile</i> .....                                    | 352        |
| J. <i>Technocratic Oath</i> .....                        | 353        |
| <b>IV. CONCLUSION</b> .....                              | <b>354</b> |

## I. INTRODUCTION

Brain-Computer Interfaces (BCIs) are currently being developed for therapeutic and recreational purposes and are expected to be widely used in the next two decades. Legal scholars have recently begun considering the ethical and legal implications of future use of BCIs. Some point out the peculiarities BCIs entail. Most notable is the fact that BCI-technology enables its users to affect the world using devices such as robotic arms, prosthesis, or other machines, while the execution of commands in such devices runs through computers directed by brain signals which, in contrast to usual forms of actions, does not involve bodily movement at all.<sup>1</sup> Others call for recognizing new human rights in the age of neurotechnology to protect the mind, the last refuge of individual freedom and self-

---

<sup>1</sup> Steffen Steinert et al., *Doing Things with Thoughts: Brain-Computer Interfaces and Disembodied Agency*, 32 PHIL. & TECH. 457–82 (2019).

determination, from governments and companies gaining unprecedented access to components of mental information and abusing BCI-technology to influence individuals' capacity to govern their behavior freely.<sup>2</sup> However, given the early stage of these emerging technologies' development, the legal literature on this matter remains sparse. Scholars have yet to propose a concrete regulatory model that ensures the integrity of BCI-technology and protects users from unknown external manipulations. Without adequate safeguards, access to the neural processes that underlie conscious thought risks profound violation of individual privacy with the potential to subvert free will; personal identity, agency, and moral responsibility may be diminished. Such outcomes could change the nature of human societies and humanity.

This conference paper will cover the legal implications of BCIs and present examples of normative inconsistencies concerning the use of BCIs. This paper will explore the change BCI-technology can bring to human society's nature, address BCIs from the perspective of law, policy, and public interest, and advocate for a comprehensive reform of neuro-rights.

#### A. What Are Brain-Computer Interfaces?

BCIs are systems that translate the brain's electrical activity into signals controlling external displays and devices, such as cursors on computer screens, Internet browsers, robotic arms, switches, or prosthetic limbs.

BCIs are devices that can read brain signals and convert them into control and communication signals. These are artificial systems that bypass the body's efferent pathways (normal neuromuscular output channels); instead of using peripheral nerves and muscles, BCIs directly measure brain activity then translate and record it into matching control signals for BCI applications in a translation procedure that includes signal processing and pattern recognition done by a computer.<sup>3</sup>

---

<sup>2</sup> Marcello Ienca & Roberto Andorno, *Towards New Human Rights in the Age of Neuroscience and Neurotechnology*, 13 LIFE SCI., SOC'Y & POL'Y (2017); Rafael Yuste & Sara Goering, *Four ethical priorities for neurotechnologies and AI*, 551 NATURE 159 (2017).

<sup>3</sup> BERNHARD GRAIMANN, BRENDAN ALLISON & GERT PFURTSCHELLER, *Brain-Computer Interfaces: A Gentle Introduction*, in BRAIN-COMPUTER INTERFACES: REVOLUTIONIZING HUMAN-COMPUTER INTERACTION 1–28, 1–4 (Bernhard Graimann, Brendan Allison, & Gert Pfurtscheller eds., 2010).

The first BCI was introduced in 1964 when Dr. Grey Walter surgically implanted electrodes in the motor areas of a patient's brain and connected them to a slide projector. Dr. Grey asked the patient to press a button to move forward slides at his own free decision (boredom, curiosity, or otherwise), but what advanced the slides was the amplified signal from the electrodes implanted in the patient's motor cortex.<sup>4</sup> That was the first time that control of an external device without movement was achieved. Since then, BCI research has focused on therapeutic purposes - developing control and communication systems for people suffering from severe medical conditions such as complete paralysis or locked-in syndrome - to provide users with essential assistive devices. With the advances in BCI technology, it has become appealing to users with less severe disabilities and offers new means of treating stroke, autism, and other disorders.

What is more, BCIs have become appealing to healthy individuals as well for enhancement purposes. At Neuralink's launch event, Elon Musk stated his venture's objectives are to understand and treat brain disorders, preserve and enhance healthy brains, and create a well-aligned future.<sup>5</sup> The Royal Society assesses that by 2040 neural interfaces for therapeutic purposes will evolve and expand.<sup>6</sup>

The current medical research has shown that you can read neurons in human brains, which is an essential proof of concept that this could be done. But, current BCIs are attached to big wires and boxes that come out of the patient's head, which may cause a risk of infection, and they are not comfortable.

Tech companies are working against the clock to develop this technology for both therapeutic and recreational purposes. Facebook has invested about 500 million dollars in a company that connects the brain to computers using non-invasive technology.<sup>7</sup> Elon Musk invested 100 million dollars from his personal capital in the Neuralink venture that develops

---

<sup>4</sup> DANIEL C. DENNETT, *CONSCIOUSNESS EXPLAINED* 167 (1991).

<sup>5</sup> Neuralink, *Neuralink Launch Event*, YOUTUBE (July 16, 2019), <https://www.youtube.com/watch?v=r-vbh3t7WVI>.

<sup>6</sup> ROYAL SOCIETY, *iHUMAN: BLURRING LINES BETWEEN MIND AND MACHINE* 58-61 (2019), <https://royalsociety.org/-/media/policy/projects/ihuman/report-neural-interfaces.pdf>.

<sup>7</sup> Charlotte Jee, *Facebook Is Buying a Startup That Makes a Wristband To Control Computers With A Twitch*, MIT TECHNOLOGY REVIEW (Sept. 24, 2019), <https://www.technologyreview.com/2019/09/24/132908/facebook-is-buying-a-brain-machine-interface-startup-to-further-its-ambitions-in-the-field/>.

invasive BCIs aimed at helping patients with paralysis or amputated limbs regain the ability to communicate with their environment. He has not hidden that the ultimate goal is to connect us directly to machines to improve ourselves with artificial intelligence.<sup>8</sup> Twenty years from now, the estimates are that the use of BCIs for therapeutic purposes will evolve and expand and that BCIs for enhancement purposes will become widely used for gaming, fitness, and well-being. When put into practice, this technology is expected to bring about some inconsistencies to the legal system as we know it.

#### B. Categorization of BCIs

There are three categories for operating BCIs: active, reactive, and passive BCIs.<sup>9</sup>

Active BCIs – Active BCIs derive outputs from consciously controlled brain activity independent of external events.<sup>10</sup> In active BCIs, the user intentionally performs mental tasks that create a particular brain activity pattern, which the BCI system detects.<sup>11</sup> One common mental strategy is motor imagery. In this technique, the user imagines moving parts of her body – typically a hand, foot, and the tongue, for their comparatively large and topographically different motor and somatosensory cortex areas – without actually moving them. The patterns produced by the motor imagery are similar to the patterns elicited by actual movements and are directly connected to the normal neuromuscular output pathways. For example, some BCIs can detect if the user is imagining moving her left hand, right hand, or feet, allowing three signals to be mapped as commands for the BCI to perform, such as to move left, right, and select.<sup>12</sup> Moreover, Aflalo et al. implanted two microelectrodes in the posterior parietal cortex of a tetraplegic patient and asked them to perform motor imagery. The researchers were able to read out the intentions of action planning from the posterior parietal cortex, where the motor intentions are formed before their transmission to the motor

---

<sup>8</sup> Catherine Clifford, *Elon Musk's Brain-Computer Interface Company Neuralink Has Money And Buzz, But Hurdles Too*, CNBC (Dec. 5, 2020), <https://www.cnbc.com/2020/12/05/elon-musks-neuralink-bold-ideas-hurdles.html>.

<sup>9</sup> Thorsten O. Zander et al., *Enhancing Human-Computer Interaction with Input from Active and Passive Brain-Computer Interfaces*, in *BRAIN-COMPUTER INTERFACES* 181–99 (Desney S. Tan & Anton Nijholt eds., 2010).

<sup>10</sup> *Id.*

<sup>11</sup> Steinert et al., *supra* note 1.

<sup>12</sup> GRAIMANN, ALLISON & PFURTSCHELLER, *supra* note 3, at 11–13.

cortex. The reading was used to control external devices, including a robotic limb and a cursor.<sup>13</sup>

Reactive BCIs – Reactive BCIs derive outputs from brain activity arising in reaction to external stimuli, which is indirectly modulated by the user for controlling an application.<sup>14</sup> A commonly used paradigm is P300-based selection. A P300 wave is an event-related potential (ERP) component produced when the brain detects stimuli that deserve a person's attention. It is a neural signature of the form of positive (P) deflection in the EEG about 300 milliseconds after the onset of the stimuli (hence P300).<sup>15</sup> In P300-based selection BCIs, a sequence of stimuli, *e.g.*, letters, are presented before a user, and she has to focus her attention on the letter she wishes to choose. The BCI system detects a P300 signal in response to her selection, indicating her selected letter.<sup>16</sup> This brain signal is used for different BCI applications: P300-based BCI systems are optimal for spelling characters with high speed and accuracy (compared to other BCI strategies such as motor imagery);<sup>17</sup> they have shown success in operating environmental control systems;<sup>18</sup> they have been implemented for controlling Internet browsing;<sup>19</sup> they enable creative expression by facilitating brain-painting.<sup>20</sup>

Passive BCIs – Passive BCIs are systems that derive their output from arbitrary brain activity without the purpose of voluntary control for enriching human-computer interaction with implicit information.<sup>21</sup> Passive

---

<sup>13</sup> Tyson Aflalo et al., *Decoding Motor Imagery from the Posterior Parietal Cortex of a Tetraplegic Human*, 348 SCI. 906–10 (2015).

<sup>14</sup> Swartz Center for Computational Neuroscience, UCSD, *Thorsten Zander: Passive and Reactive BCI*, YOUTUBE (Mar. 27, 2013), <https://www.youtube.com/watch?v=6LeiWshbaNM>.

<sup>15</sup> John Polich, *Updating P300: An Integrative Theory of P3a and P3b*, 118 CLINICAL NEUROPHYSIOLOGY 2128–48 (2007).

<sup>16</sup> Steinert et al., *supra* note 1.

<sup>17</sup> Christoph Guger et al., *How Many People are Able to Control a P300-Based Brain-Computer Interface (BCI)?*, 462 NEUROSCIENCE LETTERS 94–8 (2009).

<sup>18</sup> Yoji Okahara et al., *Operation of a P300-Based Brain-Computer Interface by Patients with Spinocerebellar Ataxia*, 2 CLINICAL NEUROPHYSIOLOGY PRACTICE 147–53 (2017).

<sup>19</sup> José L. Sirvent et al., *P300-Based Brain-Computer Interface for Internet Browsing*, in 71 TRENDS IN PRACTICAL APPLICATIONS OF AGENTS AND MULTIAGENT SYSTEMS 615–22 (Yves Demazeau et al. eds., 2010).

<sup>20</sup> Jana I. Münßinger et al., *Brain Painting: First Evaluation of a New Brain-Computer Interface Application with ALS-Patients and Healthy Volunteers*, 4 FRONTIERS IN NEUROSCIENCE (2010).

<sup>21</sup> Zander et al., *supra* note 9.

BCIs monitor a user's brain activity without needing her to carry out mental tasks,<sup>22</sup> allowing real-time analysis of bio-signals aimed at quantifying insights such as mental and emotional states.<sup>23</sup> Predating passive BCIs have been proposed for detecting forms of mental workload,<sup>24</sup> and perception of self-induced errors.<sup>25</sup> Current trends include applying passive BCI for driving, aviation, training, and expertise assessment in operative environments such as hospitals and public transport, team resources evaluation where the success of the task is based on the ability to do effective teamwork, a commercial application like gaming and neuromarketing.<sup>26</sup>

### C. What the Future Holds

In healthcare, BCIs demonstrate remarkable potential to help people replace or restore functions that have been compromised by illness or injury. The most immediate target for clinical BCI research is the locked-in syndrome and advanced ALS patients to whom BCIs are expected to restore basic communication. Other diseases and injuries interfere with mobility. Some conditions — such as cervical spinal-cord injury, brain-stem stroke, ALS, and other motor neuron diseases: Guillain-Barrè syndrome, neurofibromatosis, multiple sclerosis, spastic tetraplegia, and “watershed” distribution bilateral strokes — can even result in tetraplegia, which makes restoration of mobility another primary goal of BCI research, even in small amounts such as hand grasp. Mobility is also a priority for people with paraplegia, most commonly caused by injury to the spinal cord. However, it could also result from thoracic/lumbar/sacral spinal-cord injuries, post-polio syndrome, multiple sclerosis, neurofibromatosis, artery of Adamkiewicz ischemia, spastic diplegia, some types of muscular dystrophy, and bilateral anterior cerebral artery vasospasm. Also, amputation of one or more limbs due to trauma, vascular disease, or for therapeutic purposes in cases of cancers or infections is another cause of decreased ability to move where BCIs might help restore mobility by providing control of powered

---

<sup>22</sup> Steinert et al., *supra* note 1.

<sup>23</sup> P. Aricò et al., *Passive BCI Beyond the Lab: Current Trends and Future Directions*, 39 *PHYSIOLOGICAL MEASUREMENT* 08TR02 (2018).

<sup>24</sup> Guido Dornhege et al., *Improving Human Performance through Real-Time Mental Workload Detection*, in *TOWARD BRAIN-COMPUTER INTERFACING* 409-22 (2007).

<sup>25</sup> Benjamin Blankertz et al., *Single Trial Detection of EEG Error Potentials: A Tool for Increasing BCI Transmission Rates*, in 2415 *ARTIFICIAL NEURAL NETWORKS — ICANN 2002* 1137-43 (José R. Dorronsoro ed., 2002).

<sup>26</sup> Aricò et al., *supra* note 23.

wheelchairs, hand orthoses, robotic arms, or powered exoskeletons. Loss of autonomic functions (*e.g.*, bladder and bowel control, sexual function, regulation of heart rate, blood pressure, and body temperature) can significantly impact an individual's health, potentially mediated by BCIs. Because autonomic functions are in large part neurally based, BCI technology can contribute to their restoration. Also, BCIs can help supplement standard therapies to improve functional outcomes in stroke rehabilitation and help manage other neurological or psychiatric illnesses, *e.g.*, epilepsy and other cognitive and mood disorders.

BCIs have a range of other possible uses in addition to serving as assistive technology for rehabilitation and other therapeutic purposes. For the general population, non-medical BCI uses fall into three categories. First, BCI systems might be used to optimize performance in conventional neuromuscular tasks. Meaning, the devices might intervene when attention reduces or modify workload when it gets to a level that is likely to result in diminished performance and errors. Second, BCI systems might be used to enhance neuromuscular performance beyond that possible conventionally. For example, BCI detection of EEG features specific to target stimuli might increase speed and accuracy in a detection task, BCI recognition of EEG premovement potentials might enable shorter reaction time, or BCI error detection might allow the canceling or correction of mistake. Third, BCIs will enable the creation of systems that broaden or enrich life experience through media-related activities (*e.g.*, internet access), new methods of artistic expression, or appealing new computer games that engage the interest of numerous people regardless of disability.

It is commonly known that technology advances faster than the law – the “pacing problem” – and that today's legal practice may prove futile when applied to tomorrow's legal challenges. For example, the internet was initially designed as a research project when security and privacy issues were not a critical concern. However, with the expansion of the internet, we now face legal cases dealing with these matters daily without having prepared solid groundwork, and we adapt regulations “on-the-go.” The most prominent current example that illustrates the “pacing problem” is tech-giants now facing antitrust hearings in front of the American Congress concerning their market dominance, as well as the movie *The Social Dilemma*<sup>27</sup> that reveals the dangerous impact of social media networks on

---

<sup>27</sup> THE SOCIAL DILEMMA (Netflix release, Sept. 9, 2020).



human society. Hence, it is crucial to get ahead of the use of BCIs and design legal doctrines to accommodate the legal implications of these innovations.

## II. LEGAL IMPLICATIONS

### A. BCI-Mediated Action

In the field of criminal law, a BCI-mediated action performed by a brain-controlled prosthetic limb does not satisfy the criminal law's fundamental requirements of *actus reus* and *mens rea*. The principle of conduct – the *actus reus* – requires that a criminal act, or an unlawful omission of an act, must have occurred; a person cannot be held liable for just thinking criminal thoughts. It is customary to understand the 'act' as a person's bodily movement contributing to the offense's occurrence. However, the use of BCIs is problematic for criminal law as the traditional doctrine of understanding the act requirement as a bodily movement is not compatible with BCI-mediated actions.

A conventional action differs from BCI-mediated action. In conventional action, the bodily and muscle movements constitute the action, whereas, in BCI-mediated action, it is a mental act that triggers and controls a device by realizing neural correlates of thought activity. The outcomes in the world are results of devices such as robotic arms, prostheses, or other machines, operated through a computer and directed by brain signals. Thus, a BCI-mediated action does not satisfy the law's 'action' requirement, which includes willed bodily movement; this creates a gap and serves as a basis for updating legal definitions.<sup>28</sup>

BCIs allow users to control devices without moving their bodies. The users imagine certain things, and the BCIs read the neural activity and operate the output device accordingly. Users who affect the world using BCIs do not perform any conduct, so when they commit crimes using BCIs, it is unclear how they have satisfied the *actus reus*. But imposing differential criminal liability on people based on how they committed the violation – whether by a bodily movement or by a BCI-mediated action – would be unfair. So, it seems that BCI-mediated actions should be qualified to satisfy the 'act' requirement – the question is: how?

The most intuitive and plausible way of remedying this gap would be to qualify a BCI-mediated action as a bodily movement. We can do that

---

<sup>28</sup> Stephen Rainey, Hannah Maslen & Julian Savulescu, *When Thinking is Doing: Responsibility for BCI-Mediated Action*, 11 *AJOB NEUROSCIENCE* 46–58 (2020); Steinert et al., *supra* note 1.

by recognizing neural activity as an indicator of movements. The factual basis of the offense is perceived as an objective dimension that comprises all physical components of the offense in the tangible world. The core of the 'act' is a bodily movement that is currently understood as muscle activation. However, the physiological system allows motion – the musculoskeletal system – to move on commands from the brain in the form of neurons firing electrical pulses. Until now, muscles have been the sole executors of brain commands and the only observable and measurable markers for their occurrence. With BCIs bypassing the body's biological muscular output channels, they may allow a new array of outputs to affect the world. However, they still rely on electrical pulses to initiate intentional movement. One way of solving this problem would be to shift focus from where the action ends to where it begins.

Recognizing neural activity as an indicator of movements will satisfy the factual basis of the offense. The core of the 'act' is a bodily movement currently understood as muscle activation. Until now, muscles have been both the sole executors of brain commands as well as the sole observable and measurable markers for the occurrence of such executions of brain commands. With BCIs bypassing the body's biological muscular output channels, they allow a new array of outputs to affect the world. Nevertheless, they still rely on electrical pulses to initiate movement. These electrical pulses are objective and physical measures indicating the initiation of the brain commands' execution process that could be measured by objective external means in accordance with the factual basis of the offense.

Two things are important to emphasize with this regard: First, as Kramer Thompson notes, not every brain *activity* is an *act*, similar to not every bodily activity being an act/action. For example, neural activity responsible for maintaining the body's homeostasis is not an act rather an activity.<sup>29, 30</sup> Second, qualifying brain acts to satisfy the 'act' requirement does not entail criminalizing thoughts. For a consequential offense to occur, there *must* be a causal relationship between the act and the outcome in the world stipulated in the offense. Causation has a two-prong test: factual and legal. Factual causation means that the offender's act constitutes an essential

---

<sup>29</sup> Kramer Thompson, *Committing Crimes with BCIs: How Brain-Computer Interface Users Can Satisfy Actus Reus and be Criminally Responsible*, NEUROETHICS (2019)

<sup>30</sup> Rainey, Maslen, & Savulescu, *supra* note 29.

link in the chain of events that produced the end result and is determined by the NESS (Necessary Element of a Sufficient Set) and the “but-for” tests.

Scholars have expressed concerns that if the act is satisfiable by neural activity, a user’s action may satisfy the act requirement before she is aware of performing it or even having the intention to perform it.<sup>31</sup> While a valid argument, this criticism is not different from the criticism of the Libet experiment on free will, which had previously established that decisions are unconsciously made in the brain and only later made it into consciousness once the decision signal had become strong enough.<sup>32</sup> The question of whether we have free will is a profound question at the very heart of the foundations of the criminal system. The author of this paper strongly believes that these foundations are in need of a reconsideration in light of recent discoveries in neuroscience and epigenetics; however, this reconsideration is beyond the scope of this conference paper as it will only focus on BCIs.

Having said that, some scholars have expressed concerns that if the act is satisfiable by neural activity, a user’s action may satisfy the act requirement before she is aware of performing it or even having the intention to perform it. While this is a valid argument, the criticism is not different from the criticism that the Libet experiment raised on the notion of free will.<sup>33</sup> These experiments had previously established that even with conventional acts, decisions are unconsciously made in the brain and only later make it into consciousness once the decision signal had become strong enough. The question of whether we have free will is not unique to BCIs. Rather, it’s a profound question at the very heart of criminal law. This topic is beyond the scope of this short conference; however, it is covered extensively in Professor Sapolsky’s book *Behave*.<sup>34</sup>

BCI-mediated action involves a lesser degree of control over the actions they mediate. Recalling that BCIs are classified into three types: *active* BCIs that derive outputs from consciously controlled brain activity independent of external events; *passive* BCIs that derive their outputs from random brain activity without voluntary control activation; and *reactive* BCIs that derive outputs from brain activity arising in reaction to external stimuli.<sup>35</sup>

---

<sup>31</sup> Thompson, *supra* note 31.

<sup>32</sup> Benjamin Libet, *Unconscious Cerebral Initiative and the Role of Conscious Will in Voluntary Action*, 8 BEHAV. & BRAIN SCI. 529–39 (1985).

<sup>33</sup> *Id.*

<sup>34</sup> ROBERT M. SAPOLSKY, BEHAVE (2017).

<sup>35</sup> Zander et al., *supra* note 9.

Another problem in criminal law arises from the voluntary act requirement. This legal principle requires all criminal acts to be voluntary and entail an alternative to act differently, by way of action or abstention.<sup>36</sup> Imposition of liability under circumstances where the person had no possibility to act otherwise undermines criminal justice's purposes such as deterrence and directing behavior, and the principles of conduct and guilt.

Another problem that arises from BCI-mediated action is with the *mens rea*. BCIs can affect a user's sense of agency, particularly unique cases that arise in the combination of BCIs and Intelligent Devices (IDs). Providing devices with artificial intelligence can significantly enhance the performance of BCIs and is valuable for the rehabilitation and daily life support of disabled people. However, confusion may arise when the behavioral control shifts from the user to the ID, which can affect the experience of the person as generating the action and may either decrease or increase a user's sense of agency and thus her responsibility for the actions.<sup>37</sup> To emphasize the separation of action from the experience of will, Wegner distinguishes between *doing without feeling* and *feeling without doing*.<sup>38</sup> However, free will entails an ability to act in a different manner.<sup>39</sup> Since with BCIs, we have to think in terms of "go-commands" for specific movements – they lack a veto control.<sup>40</sup> A human agent embedded with a BCI-ID system can, by merely thinking about a specific action, cause the robot to carry it out without being able to block the consequences. This principle, to which Metzinger refers to as the principle of veto-autonomy, causes the distinction between volition and action to become blurred, and it raises questions regarding when should we hold a human agent legally culpable?<sup>41</sup> The extent to which one has free will to control her actions determines criminal responsibility, and if one's ability to control her actions is diminished – so should her culpability be.

---

<sup>36</sup> Gideon Yaffe, *The Voluntary Act Requirement*, in THE ROUTLEDGE COMPANION TO PHILOSOPHY OF LAW 174 (Andrei Marmor ed., 1st ed., 2012).

<sup>37</sup> Pim Haselager, *Did I Do That? Brain-Computer Interfacing and the Sense of Agency*, 23 MINDS & MACHINES 405–18 (2013).

<sup>38</sup> DANIEL M. WEGNER, THE ILLUSION OF CONSCIOUS WILL 8–9 (2002).

<sup>39</sup> Joshua Greene & Jonathan Cohen, *For the Law, Neuroscience Changes Nothing and Everything*, 359 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON. SERIES B: BIOLOGICAL SCIENCES 1775–85 (2004).

<sup>40</sup> Rainey, Maslen & Savulescu, *supra* note 29.

<sup>41</sup> Thomas Metzinger, *Two Principles for Robot Ethics*, in ROBOTIK UND GESETZGEBUNG 40, 40 (2013).

## B. Brain-Hacking

The term brain hacking describes the emerging possibility of malicious actors accessing BCIs and other neural devices to compromise the operations of these devices, similar to how computers are hacked. In computer science, the model designed to guide information security policies is the CIA triad – Confidentiality, Integrity, and Availability. A hacker should not be able to penetrate a device to obtain private information (confidentiality); a hacker should not be able to interfere with the device’s settings (integrity); a hacker should not be able to deny access to the device from its authorized users (availability). In particular, Denning et al. define the term “neurosecurity” as the protection of the confidentiality, integrity, and availability of neural devices from malicious parties, and they give examples for attacks against BCIs that might compromise the three tenets of cybersecurity. These include the wireless hijacking of a prosthetic limb, the malicious programming of neurostimulation therapy, and the eavesdropping of a brain implant’s signals to reveal private information.<sup>42</sup> Li et al. survey possible security scenarios and potential attacks against BCIs and classify them into four categories based on their usage: (i) neuro medical applications – where they reiterate the example of hijacking a prosthetic limb; (ii) user authentication – in authentication systems that verify individuals by their EEG signals, in which scenario a hacker can attack the authentication system using a synthetic EEG signal; (iii) gaming and entertainment – rely on standard Application Programming Interfaces (API) to access BCIs that provide unrestricted access to raw EEG signals for BCI games; (iv) smartphone-based applications – that are prone to attacks that originate in the mobile device itself.<sup>43</sup> What is more, in addition to the direct harm that results from the attack against the information technology system in its conventional form (the CIA triad), attacks against the human brain (and mind) can lead to indirect harm with profound ethical and legal implications. Ienca and Haselager emphasize that misusing neural devices for malicious purposes may not only threaten users’ physical security, but it can influence their behavior and alter their sense of identity and personhood. This violates moral

---

<sup>42</sup> Tamara Denning, Yoky Matsuoka & Tadayoshi Kohno, *Neurosecurity: security and privacy for neural devices*, 27 NEUROSURGICAL FOCUS E7 (2009).

<sup>43</sup> QianQian Li, Ding Ding & Mauro Conti, *Brain-Computer Interface Applications: Security and Privacy Challenges*, in 2015 IEEE CONFERENCE ON COMMUNICATIONS AND NETWORK SECURITY 663-66 (2015).

values of autonomy, free will, and self-determination. They call for further suggestions as to the appropriate legal safeguards ought to be established.<sup>44</sup>

Now, as seen, there are a few peculiarities that BCIs bring to the legal arena. But all in all, these peculiarities can be addressed by employing suitable mechanisms that would enable us to apply the law equally. This is almost a technical matter. Then, what is the central problem that arises from BCIs? It is the fact that we are facing a new era that will bring about new threats to fundamental freedoms.

### C. The Privilege Against Self-Incrimination

The privilege against self-incrimination is a legal principle that prohibits governments from compelling individuals to witness against themselves involuntarily or to furnish evidence that implicates their involvement in a crime. The privilege against self-incrimination protects suspects from the 'cruel trilemma' of having to choose between self-accusation, contempt of court, and perjury. In the United States, the privilege is outlined in the Fifth Amendment to the U.S. Constitution, stating that no person "*shall be compelled in any criminal case to be a witness against himself.*"<sup>45</sup> In *Schmerber v. California*, the Supreme Court held that the Fifth Amendment does prevent the government from compelling a suspect to provide *testimonial* evidence such as communicative and verbal statements; however, it does not prevent the government from compelling a suspect to provide *physical* evidence such as blood.<sup>46</sup> The rationale to the distinction between physical and testimonial evidence *Schmerber* created was that the Fifth Amendment prohibits the use of physical or moral compulsion to extort communication from suspects, not an exclusion of their body as evidence because the former puts a person in 'the cruel trilemma' whereas the latter does not.<sup>47</sup> Interestingly, as Stoller and Wolpe have recognized, emerging neuro-technologies make a *hybrid* form of evidence. On the one hand, they extract information directly from the brain that indicates, *e.g.*, whether a person is lying or recognizing an object concerning a crime, which is

---

<sup>44</sup> Marcello Ienca & Pim Haselager, *Hacking the Brain: Brain-Computer Interfacing Technology and the Ethics of Neurosecurity*, 18 ETHICS & INFO. TECH. 117–29 (2016).

<sup>45</sup> U.S. CONST. amend. V.

<sup>46</sup> *Schmerber v. California*, 384 U.S. 757 (1966).

<sup>47</sup> Matthew Baptiste Holloway, *One Image, One Thousand Incriminating Words: Images of Brain Activity and the Privilege against Self-Incrimination Comment*, 27 TEMP. J. SCI. TECH. & ENVTL. L. 141–76 (2008).

testimonial in nature; but on the other hand, they are available in the form of a physical object, *e.g.*, a brainwave or a flow of blood, without requiring a verbal response.<sup>48</sup> Thus, neuroscientific evidence does not fit the existing dichotomic framework of testimonial/physical evidence about the privilege against self-incrimination.<sup>49</sup>

The complimentary Fourth Amendment, which protects “*the right of people to secure in their persons, houses, papers, and effects, against unreasonable searches and seizures,*”<sup>50</sup> also raises issues of privacy and criminal procedures in varying degrees to different categories of individuals – suspects, key eyewitnesses, and general members of the population.<sup>51</sup> As for suspects, some argue that there is a high expectation of privacy for brain activity.<sup>52</sup> In contrast, others maintain that the low intrusiveness of non-invasive BCIs might overcome this expectation.<sup>53</sup> As for critical eyewitnesses, Laura Klaming & Anton Vedder discuss the possibility of improving eyewitness memory using neuro-technologies. However, using such methods entails a risk of planting misinformation.<sup>54</sup> In particular, Haushalter refers to eyewitnesses who suffered traumatic brain injury either due to the crime being investigated or otherwise, and allowing them to participate in criminal investigation and “testify” in a trial using BCIs.<sup>55</sup>

#### D. Evidence

Brain-based lie detection could potentially be relevant for a wide variety of issues, *e.g.*, to substantiate if one was at the scene of a crime, evaluate subjective pain, support eyewitness testimony, predict future

---

<sup>48</sup> Sarah E. Stoller & Paul Root Wolpe, *Emerging Neurotechnologies for Lie Detection and the Fifth Amendment*, 33 AM. J. L. & MED. 359–75 (2007).

<sup>49</sup> Nita A. Farahany, *Incriminating Thoughts*, 64 STAN. L. REV. 351–408 (2012).

<sup>50</sup> U.S. CONST. amend. IV.

<sup>51</sup> Amanda C. Pustilnik, *Neurotechnologies at the Intersection of Criminal Procedure and Constitutional Law*, in THE CONSTITUTION AND THE FUTURE OF CRIMINAL JUSTICE IN AMERICA 109–34 (John T. Parry & L. Song Richardson eds., 2013).

<sup>52</sup> Francis X. Shen, *Neuroscience, Mental Privacy, and the Law Privacy, Security, and Human Dignity in the Digital Age*, 36 HARV. J. L. & PUB. POL’Y 653–714 (2013).

<sup>53</sup> Pustilnik, *supra* note 53.

<sup>54</sup> Elizabeth F. Loftus, *Planting misinformation in the human mind: A 30-year investigation of the malleability of memory*, 12 LEARNING & MEMORY 361–66 (2005).

<sup>55</sup> Jessica L. Haushalter, *Neuronal Testimonial: Brain-Computer Interfaces and the Law*, 71 VAND. L. REV. 1365 (2018).

behavior at parole hearings, and to consider mental states at sentencing. There are two prominent techniques for brain-based evidence: EEG measures electrical activity in the brain, and fMRI detects changes in hemodynamic; both depend on various factors, including the experimental design, proper implementation of the design, and proper interpretation of the results.<sup>56</sup> In using brain scans as evidence, a few issues arise.

**BRAIN SCANS.** As non-invasive brain imaging techniques have been rapidly improving in detecting brain activity, attorneys proffer brain scans as evidence to civil and criminal courts. The legal system is not only interested in how people act (*actus reus*) but also in what they were thinking or capable of thinking when they acted (*mens rea*).

Owen D. Jones et al. outline concerns relating to neuroscientific testimony, including varying scientific certainty standards, the use of jargon, problems in the translation of neuroscientific evidence, and the use of group averaged data applied to an individual.<sup>57</sup> Teneille Brown and Emily Murphy provide a comprehensive analysis of fMRI use in legal contexts, arguing that given the status, capabilities, and constraints of currently used fMRI technologies and techniques, such images should not be admitted into evidence to prove or rebut criminal *mens rea* charges.<sup>58</sup> Emily Baron and Jacqueline Sullivan approach the topic from the perspective of the philosophy of the social, cognitive, and behavioral sciences. They explain that current criteria for evaluating brain evidence to determine its admissibility in legal contexts are inadequate, contending that a more detailed evaluation of the research studies on which such evidence is based is needed to ensure its effectiveness in legal contexts.<sup>59</sup> Shats, Brindles & Giordano contend that neuroscientific evidence must first be scrutinized more heavily for its relevance, to ensure that the right question is asked of neuroscientists, to enable expert interpretation of neuroscientific evidence

---

<sup>56</sup> Francis X. Shen & Owen D. Jones, *Brain Scans as Evidence: Truths, Proofs, Lies, and Lessons The Brain Sciences in the Courtroom*, 62 MERCER L. REV. 861–84 (2011).

<sup>57</sup> Owen D. Jones et al., *Neuroscientists in court*, 14 NATURE REVIEWS NEUROSCIENCE 730–36 (2013).

<sup>58</sup> Teneille Brown & Emily Murphy, *Through a Scanner Darkly: Functional Neuroimaging as Evidence of a Criminal Defendant's Past Mental States*, 62 STAN. L. REV. 1119–208 (2010).

<sup>59</sup> Emily Baron & Jacqueline Sullivan, *Judging Mechanistic Neuroscience: A Preliminary Conceptual-Analytic Framework for Evaluating Scientific Evidence in the Courtroom*, 24 PSYCH., CRIME & L. 334–51 (2018).



within the limits of their field of expertise that allows the judge or jury to determine the facts in the case.<sup>60</sup>

**LIE DETECTION.** Shen and Owens explore a particular context of law and neuroscience, the use of brain scans as evidence of lying or truth-telling, and illustrate the use of those scans by the landmark 2010 federal criminal trial *United States v. Semrau*.<sup>61</sup> That case involved the first federal hearing regarding the admissibility of testimony about brain scans submitted as evidence of a person lying or telling the truth. They identify five topics pertinent to future encounters between courts and brain scanning evidence: experimental design, ecological and external validity, ensuring subject compliance with researcher instructions, false memories, and making individual inferences from group data. If scientific progress is sufficient, someday brain scan evidence will be admissible in new legal contexts. But, in the case of lie detection — not yet.<sup>62</sup>

**ERP AND BEOS.** An Event-Related Potential (ERP) is a measured brain response that directly results from a specific sensory, cognitive, or motor event. Electroencephalography (EEG) measures ERP.<sup>63</sup> Scholars have suggested using ERPs in a forensic investigation as part of the various techniques used to solve crimes such as fingerprints and DNA. The concept of using a BCI as a forensic tool requires that a suspect take a guilty knowledge test (GKT) that contains information related to the crime while a specialist is recording an EEG signal. Then signal analysis is applied to the recorded electric signal to determine if the crime-related information was of significance to the suspect or not. If the information is proven significant, then the suspect is classified as guilty.<sup>64</sup> A variant of ERP is the Brain Electrical Oscillation Signature Profiling (BEOS), which individuals experience participating in a crime. The technique was developed in 2003 in India. Currently, investigators use BEOS as a forensic tool in investigation,

---

<sup>60</sup> Katherine Shats, Timothy Brindley & James Giordano, *Don't Ask a Neuroscientist about Phases of the Moon: Applying Appropriate Evidence Law to the Use of Neuroscience in the Courtroom*, 25 CAMBRIDGE Q. HEALTHCARE ETHICS 712–25 (2016).

<sup>61</sup> *United States v. Semrau*, No. 07-10074, 2010 U.S. Dist. WL 6845092, (W.D. Tenn. Jun. 1, 2010).

<sup>62</sup> Shen & Jones, *supra* note 58.

<sup>63</sup> STEVEN J. LUCK, AN INTRODUCTION TO THE EVENT-RELATED POTENTIAL TECHNIQUE (2005).

<sup>64</sup> Mariam Al-Sagban et al., *Brain computer interface as a forensic tool*, in 2008 5TH INTERNATIONAL SYMPOSIUM ON MECHATRONICS AND ITS APPLICATIONS 1–5 (2008).

and attorneys use BEOS as corroborative evidence in criminal trials.<sup>65</sup> This technology raises disturbing questions concerning criminal procedure, evidence, and the rights of criminal suspects.

#### E. Privacy

While BCI-applications are developed to improve the quality of life, providing access to a user's brain signals, and the features extracted from them, they can seriously violate the user's privacy.<sup>66</sup>

Article 12 of the Universal Declaration of Human Rights (UDHR) protects the right to privacy. It states, "no one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honor and reputation."<sup>67</sup> Similarly, Article 8 of the 1950 European Convention on Human Rights (ECHR) stipulates that "everyone has the right to respect for his private and family life, his home and correspondence."<sup>68</sup> The right to privacy was first defined in 1890 by Samuel D. Warren and Louis D. Brandeis as "the right to be alone."<sup>69</sup> Judge Posner perceives privacy as composed of two different interests. One is the interest in being left alone, and the other is the right of an individual "to conceal discreditable facts about himself."<sup>70</sup> In Europe, the right to privacy recently gained recognition with the new General Data Protection Regulation (GDPR), primarily aimed at giving individuals control over their data considering multinational corporations' common practice — especially in media and communication — to collect and process users' data for monetary profit.<sup>71</sup> The question is: does the current privacy protection regime apply to mental data as well?

When the UDHR was adopted in 1948, the future challenges of BCIs and artificial intelligence could not even be imagined. And so, there are no

---

<sup>65</sup> Puranik, *Brain Signature Profiling in India: Its Status as an Aid in Investigation and as Corroborative Evidence -As Seen from Judgments*, in ALL INDIA FORENSIC SCIENCE CONFERENCE 815-22 (2010).

<sup>66</sup> A. Agarwal et al., *Protecting Privacy of Users in Brain-Computer Interface Applications*, 27 IEEE TRANSACTIONS ON NEURAL SYS. AND REHAB. ENG'G 1546–55 (2019).

<sup>67</sup> G.A. Res. 217 A, Universal Declaration of Human Rights, (Dec. 10, 1948).

<sup>68</sup> Convention for the Protection of Human Rights and Fundamental Freedoms art.8, Sept. 3, 1953, E.T.S. 5

<sup>69</sup> Samuel D. Warren & Louis D. Brandeis, *The Right to Privacy*, 4 HARV. L. REV. 193–220 (1890).

<sup>70</sup> DANIEL J. SOLOVE, UNDERSTANDING PRIVACY 21 (2008).

<sup>71</sup> *Complete guide to GDPR compliance*, GDPR.EU, <https://gdpr.eu/> (last visited Apr. 17, 2020).

provisions in the UDHR to tackle new threats created by technological advances. Rights that were once taken for granted are now exposed to possible violations.

One of the most worrisome dystopian scenarios about BCIs relates to their use by the state (and other asymmetric powerful entities like the military and employers). In China, government-backed surveillance projects deploy brain-reading technology to detect emotional state changes in employees on the production line and drivers of high-speed trains.<sup>72, 73</sup> In the U.S., legal scholars analyzed and debated whether the Fourth and Fifth Amendments provide sufficient protection of mental privacy.<sup>74</sup> *E.g.*, Farahany argued that “mental privacy is not sacrosanct under either the Fourth or Fifth Amendment, which provides procedural safeguards but not substantive ones to protect mental privacy adequately.”<sup>75</sup> In a *Nature Review Neuroscience* article, the authors maintained that it should be possible to decode mental states from brain activity — at least in principle — as accuracy and efficiency remain unclear due to such a decoding process’ *inferential* character.<sup>76</sup> Indeed, with the use of artificial intelligence algorithms, science has progressed exponentially in decoding mental states from brain activity. However, it might exacerbate the problem of biases in forensics when applied to criminal justice.<sup>77</sup>

Since Warren and Brandeis declared a “right to privacy,” U.S. court rulings have established privacy rights by referring to precedent in the Bill of Rights, such as the Fourth Amendment right to privacy from *Katz v. United States*.<sup>78</sup> However, these kinds of interpretations do not apply in the

---

<sup>72</sup> Stephen Chen, *Forget the Facebook leak: China is mining data directly from workers’ brains on an industrial scale*, S. CHINA MORNING POST (March 30, 2020), <https://www.scmp.com/news/china/society/article/2143899/forget-facebook-leak-china-mining-data-directly-workers-brains>.

<sup>73</sup> Xiaoliang Zhang et al., *Design of a Fatigue Detection System for High-Speed Trains Based on Driver Vigilance Using a Wireless Wearable EEG*, 17 SENSORS 486 (2017).

<sup>74</sup> Jesper Ryberg, *Neuroscience, Mind Reading and Mental Privacy*, 23 RES PUBLICA 197–211 (2017).

<sup>75</sup> Farahany, *supra* note 51.

<sup>76</sup> John-Dylan Haynes & Geraint Rees, *Decoding Mental States from Brain Activity in Humans*, 7 NATURE REVIEWS NEUROSCIENCE 523–34 (2006).

<sup>77</sup> Saul M. Kassin, Itiel E. Dror & Jeff Kukucka, *The Forensic Confirmation Bias: Problems, Perspectives, and Proposed Solutions*, 2 J. APPLIED RSCH IN MEMORY & COGNITION 42–52 (2013).

<sup>78</sup> *Katz v. United States*, 389 U.S. 47 (1967).

commercial realm.<sup>79</sup> Facebook is currently developing wearable EEG-based BCIs that read and interpret users' thoughts, emotions, and intentions to provide hands-free communication without saying a word to its platform. This information could enable us to make inferences regarding a user's memory, emotional reactions, and conscious and unconscious interests. When putting this technology into practice, Facebook will gain access to read the neural and mental activity of millions of users and will be able to detect brain signals whenever a user's brain responds to something worth noting. Thus, Facebook will study user's preferences and identify political views, religious views, and sexual orientations—even before the user herself is conscious about it (in addition to the company's already enormous databases on users). It would still be able to sell the user's data to third parties. However, neural data differs from mental data, or in the words of neuroscientist Read Montague, “[y]our mind is not equal to your brain and the interaction of its parts, but your mind is equivalent to the information processing, the computations, supported by your brain.”<sup>80</sup> Concerning this data, Bublitz suggests a brain-mind distinction for normative purposes that subjects different properties to different regulatory regimes. Through the lens of data protection, both brain data and mental data can link to individual persons; hence, it constitutes personal data protected by the EU's GDPR. Both can be regarded as ‘personally identifiable information’ and receive protection in the US because there is a reasonable expectation of brain activity privacy. However, in the words of Nita Farahany, “there are no legal protections from having your mind involuntarily read.” This means that at present, no specific legal or technical safeguards protect brain data from being subject to datamining and privacy-intruding measures similar to other types of information.

Some may argue that there is not much of a difference between the data that social media companies are now obtaining from their user, and analyzing for profit, and between the additional data BCIs will provide them. They would say that Facebook analyzes our every online move and makes inferences about our conscious and unconscious online behavior.<sup>81</sup> But, there is a particular concern about neural signals. Each person has control over

---

<sup>79</sup> Katherine Pratt, *Brain Computer Interfaces: Privacy, Ethics, and Policy* (Aug. 2019) (Ph.D. dissertation, University of Washington).

<sup>80</sup> READ MONTAGUE, *YOUR BRAIN IS (ALMOST) PERFECT: HOW WE MAKE DECISIONS* 8 (2007).

<sup>81</sup> Personal talk with Doron Friedman, Professor, Tel Aviv University (Date).

their ability to overtly share information of mental states and voluntarily choose to either express or suppress information. These choices are variants of expressing or concealing neural information, and a BCI device should not violate this control. BCIs can violate a person's agency and bypass her control over what she shares with the outside world. There is a privacy violation when the signals are obtained or analyzed for purposes not intended by the individual because they no longer maintain the ability to mediate their own information.<sup>82</sup>

We have to live with the undesirable results of social media, and it is too late to go back. We do not want the same thing to happen with BCIs; they are so much more important because they are related to manipulating brain activity, which is the physical basis of the human mind.

#### F. Private Law

The most clear, significant, and immediate implications are related to criminal law issues and privacy issues, but they are not the only ones, such as intellectual property (IP) law. The academic literature paid little to no attention to IP from the perspective of neuro-technologies, even more so BCIs. The Copyright Clause of the U.S. Constitution enables Congress to secure "to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."<sup>83</sup> Copyright law protects original works of authorship expressed in any tangible medium such as literary, musical, graphic, architectural works, etc.<sup>84</sup> It protects *expression in works of authorship* against copying, and it entails three basic requirements: (i) work of authorship, (ii) original, and (iii) fixed in a tangible medium of expression.<sup>85</sup> The novelty of BCIs in the context of proprietary rights stems from our recently acquired ability to express brain waves via tangible mediums. NeuroSky is a manufacturer of BCI technologies for commercial and recreational use. One of the applications the company offers is *Braintone Art*, an EEG-based algorithm (Braintone Art Imagery Generation Engine) that enables to projection of users' emotions as abstract art on a digital canvas using nothing but brainwaves. The company markets this app (and its supplementary EEG headset) as "EEG art" and a new visual way to express

---

<sup>82</sup> Pratt, *supra* note 81.

<sup>83</sup> U.S. CONST. art. I, § 8, cl. 8.

<sup>84</sup> 17 USCS § 102.

<sup>85</sup> *Id.*

creativity.<sup>86</sup> Lisa Park is an interdisciplinary artist who attempts to display human emotion and physiological changes in auditory presentations. She is using a commercial brainwave sensor (Emotiv EPOC) to musicalize brainwaves.<sup>87</sup> Both visual and auditory examples satisfy the law's three requirements: both works of authorship, both original, and both fixed in a tangible medium of expression. Nevertheless, they can be a topic for legal debate. A preliminary question is who owns and controls the raw neural data (EEG scans) obtained from using a consumer device? The relationship between neural data and BCI users and their control over their neural data is neither regulated nor standardized.<sup>88</sup> Even if the user retains ownership of the raw neural data, it is still unclear who retains ownership over the finished artwork, which realization could not occur without the joint effort of both the artist's brainwaves and the company's (probably patent protected) algorithm.

Another law field is tort. Tort law is the legal regime governing when entities or persons are civilly liable for harm befalling others and compensate the injured parties for damages. With the expansion of use in BCI devices for therapeutic, professional, and recreational purposes, users probably cause property damage and personal injuries due to limits in both controllability of BCIs using mental states and foreseeability of outcomes inherent in these devices, which the law will soon need to address.<sup>89</sup> Contrary to the gap described in Section BCI-Mediated Action referring to the establishment of responsibility, in tort law, there is no requirement for a voluntary bodily movement, as the law defines an 'act' as "an external manifestation of the actor's will."<sup>90</sup> Establishing civil liability deals with causation, duties of care, and negligence – inferred by evaluating the actions at hand compared with a hypothetical reasonable person's actions in the same situation. However, cases that involve BCI-mediated action will encompass unique scenarios and circumstances.<sup>91</sup> For example, exoskeleton or prosthetics that harm their

---

<sup>86</sup> *Beautiful Brainwaves: Creating EEG Art*, NEUROSKY (Nov. 2011), <http://neurosky.com/2015/11/beautiful-brainwaves-creating-eeg-art>.

<sup>87</sup> *Eunoia II*, LISA PARK, (2014) <https://www.thelisapark.com/work/eunoia2>.

<sup>88</sup> Stephanie Naufel & Eran Klein, *Brain-computer interface (BCI) researcher perspectives on neural data ownership and privacy*, 17 J. NEURAL ENG'G. (2020).

<sup>89</sup> Rainey, Maslen, & Savulescu, *supra* note 29.

<sup>90</sup> Andreas Kuersten, *Legal Ramifications of Brain-Computer-Interface Technology*, *AJOB NEUROSCIENCE* (2020), <https://www.tandfonline.com/doi/abs/10.1080/21507740.2019.1704931> (last visited Apr. 8, 2020).

<sup>91</sup> *Id.*

users, others, or property result from *unanticipated subconscious thought*.<sup>92</sup> In one experiment, to mitigate delay in a prosthetic limb's movement, researchers implanted a (non-AI) BCI into users' posterior parietal cortex (PPC), an area associated with movement mapping and planning, and sub- or pre-conscious thought. The technology predicts and triggers actions before the user is consciously aware that she will make them.<sup>93</sup> Another example is actions occurring in the convergence of *artificial intelligence* and BCI, where free will, autonomy, and agency arise. As a result, it may seem that no one bears liability.

In trying to resolve the gaps, Rainey et al. propose distinguishing between “necessary” and “recreational” use of BCIs. Disabled people causing harm as a result of the necessary use of BCI should not be liable. After all, they could not act otherwise. In contrast, commercial users causing harm due to recreational use of BCI should be held liable because they had an alternative to acting otherwise when they decided to create the risk.<sup>94</sup> Bublitz et al. suggest that BCI users bear a specific duty to prevent harm to others that arise from operating the BCI and thus should be held by *liability for omissions* even if not initiated or controlled by them, or by way of imposing a *strict liability* regime.<sup>95</sup> What seems to be agreed upon by all of the abovementioned scholars is that tort law cases relating to BCI would increase, and the legal framework should be updated to accommodate them.

### III. PROPOSED SOLUTIONS

#### A. New Human Rights

The rapid advancement in human neuroscience and neurotechnology open unparalleled possibilities for accessing, collecting, sharing, and manipulating information from the human brain. Such applications challenge human rights principles that need to be addressed to prevent unintended consequences. Ienca and Andorno analyzed the relationship between neuroscience and human rights and identified four new human rights that will become of great relevance in the coming years: (i) the right to cognitive

---

<sup>92</sup> Sharon Nakar, Sara Weinberger & Dov Greenbaum, *Legal and Social Implications of Predictive Brain Machine Interfaces: Duty of Care, Negligence, and Criminal Responsibility*, 6 *AJOB NEUROSCIENCE* 40-42 (2015).

<sup>93</sup> Sara Weinberger & Dov Greenbaum, *Are BMI Prosthetics Uncontrollable Frankensteinian Monsters?*, 3 *BRAIN-COMPUTER INTERFACES* 149-55 (2016).

<sup>94</sup> Rainey, Maslen & Savulescu, *supra* note 29.

<sup>95</sup> Christoph Bublitz et al., *Legal liabilities of BCI-users: Responsibility gaps at the intersection of mind and machine?*, 65 *INT'L J. L. & PSYCHIATRY* (2019).

liberty; (ii) the right to mental privacy; (iii) the right to mental integrity; (iv) and the right to psychological continuity.<sup>96</sup>

**THE RIGHT TO COGNITIVE LIBERTY.** While thoughts had been considered inherently private in the past, neuro-technologies have changed the situation and may – in the future – lead users to develop meta-cognition.<sup>97</sup> Having their brains monitored, prospective BCI users might change their inner-life and limit the scope of their thoughts out of fear of exposure, which in turn would impact their personality and sense of identity, including cognitive capabilities, intelligence, and fantasies.<sup>98</sup> In the age of technological intrusion into our minds, legal scholars resurrect the concept of freedom of thought by promoting the idea of “cognitive liberty,” defined by Sententia as a twenty-first century updated term for “freedom of thought,” which takes into account the power we now have — and increasingly will have — to monitor and manipulate cognitive function.<sup>99</sup> The right to cognitive liberty aims at protecting our mental capacities from undesired influence. It comprises a negative dimension that protects freedom *from* interferences by the state and third parties, and a positive dimension that grants the freedom *to* self-determine one’s inner sphere, *e.g.*, the content of a person’s thoughts, consciousness or any other mental phenomena.<sup>100</sup> As Bublitz concisely put it, it is the legal principle that guarantees “the right to alter one’s mental states with the help of neuro tools as well as to refuse to do so.”<sup>101</sup>

**THE RIGHT TO MENTAL PRIVACY.** The typology of Finn et al. acknowledges seven different types of privacy concerning protection of individuals against new and emerging technologies: privacy of the person; the privacy of behavior and action; privacy of personal communication; the

---

<sup>96</sup> Marcello Ienca & Roberto Andorno, *Towards New Human Rights In The Age of Neuroscience and Neurotechnology*, 13 LIFE SCI. SOC’Y. & POLICY (2017).

<sup>97</sup> Steinert et al., *supra* note 1.

<sup>98</sup> Alžběta Krausová, *Legal Aspects of Brain-Computer Interfaces*, 8 MASARYK UNIVERSITY J. L. & TECH. 199-208 (2014).

<sup>99</sup> Wrye Sententia, *Neuroethical Considerations: Cognitive Liberty and Converging Technologies for Improving Human Cognition*, 1013 ANNALS N.Y. ACAD. SCI. 221-28 (2006).

<sup>100</sup> Jan Christoph Bublitz & Reinhard Merkel, *Crimes Against Minds: On Mental Manipulations, Harms and a Human Right to Mental Self-Determination*, 8 CRIM. L. & PHIL. 51-77 (2014).

<sup>101</sup> Jan Christoph Bublitz, *My Mind Is Mine!? Cognitive Liberty as a Legal Concept*, in COGNITIVE ENHANCEMENT: AN INTERDISCIPLINARY PERSPECTIVE 233-64 (Elisabeth Hildt & Andreas G. Franke eds., 2013).



privacy of data and image; privacy of thoughts and feelings; privacy of location and space; privacy of association. Frank Tong and Michael Pratte have argued mental privacy could face enormous new challenges, in both legal settings and beyond, as there has been no precedent for having the ability to look into the mind of another human being.<sup>102</sup> Recent years have seen growing attention to the discussion on whether mental privacy should receive legal protection and in what context. There are many different ways in which acts may violate a person's mental privacy:

**THE RIGHT TO MENTAL INTEGRITY.** The right to personal physical and mental integrity is protected by Article Three of the EU's Charter of Fundamental Rights, stating that "everyone has the right to respect for his or her physical and mental integrity."<sup>103</sup> The separation between physical and mental health delineated in Article Three stems from Descartes' philosophy of body-mind dualism that views the body and the mind as distinct and separable. Moreover, almost every legal system has embedded this dualism, which led the law to systematically afford protection to bodies and brains, not minds and mental states. For instance, the E.U. Charter of Fundamental Rights considers mental integrity as the right to mental health from a psychiatric/psychological perspective.<sup>104</sup> With the emergence of neuro-technologies legal scholars are advocating for the law to protect the inner sphere of persons by broadening the scope of the right to mental integrity so that it would guarantee not only the right of individuals with cognitive conditions to access psychiatric treatment instead of additionally ensuring the right of individuals to protect their mental sphere from harm. Bublitz has recognized two types of potential damage to the mental sphere: the infliction of mental injury — *i.e.*, pain, disorder, impairment of mental health, and mental manipulation — *i.e.*, influences on preferences and choices.<sup>105</sup> Indeed, BCIs can bring about alterations of a person's neural computation and perception of their identity.

**THE RIGHT TO PSYCHOLOGICAL CONTINUITY.** BCIs and other neuro-technologies may also cause unintended alterations in mental states that are crucial to personality and can affect an individual's identity. This right should provide specific normative protection from potential

---

<sup>102</sup> See Frank Tong & Michael S. Pratte, *Decoding Patterns of Human Brain Activity*, 63 ANN. REV. PSYCHOL. 483 (2012).

<sup>103</sup> Charter of Fundamental Rights of the European Union art. 3, July 6, 2016, (O.J. C 202)

<sup>104</sup> *Id.*

<sup>105</sup> Bublitz & Merkel, *supra* note 102.

neurotechnology-enabled interventions involving the unauthorized modification of a person's neural computation and harming the victim. Accordingly, a violation of this right is comprised of three elements: (i) direct access and manipulation of neural signaling; (ii) unauthorized; and (iii) result in physical or psychological harm.

Combined, these novel human rights that have been put together, and suggested by Ienca and Andorno, aimed at assuring anyone could protect her identity from external influence and reject changes in her brain functions. Their purpose is to protect us from the possibility of abusing technology to manipulate our neural activity.<sup>106</sup> While the guideline they propose is essential to the era of neuro-technologies, the law should further define what kinds of mental phenomena are worthy of protection by their mental properties and introduce provisions penalizing interferences with mental integrity rather than expanding the protection of bodily integrity to mental integrity.<sup>107</sup>

#### B. Chile

In Chile, a commission designated to address the challenges of the future presented, last month, in front of the senate, two law projects that aim to protect people's brain data and mental privacy in the face of BCI and artificial intelligence. The first is an amendment to the constitution that defines mental identity for the first time in history as a right that cannot be manipulated. It states that any intervention, even for health reasons, must be legally regulated.<sup>108</sup> The second is a bill that includes fundamental revolutionary principles,<sup>109</sup> that are based on the five principles defined by Columbia University's NeuroRights Initiative:<sup>110</sup>

---

<sup>106</sup> Ienca & Andorno, *supra* note 98.

<sup>107</sup> Bublitz & Merkel, *supra* note 102.

<sup>108</sup> Elena Blanco-Suarez, "Neurorights" and Why We Need Them, PSYCHOLOGY TODAY (June 25, 2020), <https://www.psychologytoday.com/us/blog/brain-chemistry/202006/neurorights-and-why-we-need-them> (last visited Jan. 19, 2021).

<sup>109</sup> *Chile could turn into the first country that has a law that protects neurorights (Originally in Spanish)*, COLUMBIA | NEURORIGHTS INITIATIVE (Oct. 16, 2020) <https://nri.ntc.columbia.edu/news/chile-could-turn-first-country-has-law-protects-neurorights-originally-spanish> (last visited Jan. 19, 2021).

<sup>110</sup> NeuroRights Initiative, *The Five NeuroRights*, [https://neurorights-initiative.site.drupaldisttest.cc.columbia.edu/sites/default/files/content/The%20Five%20Ethical%20NeuroRights%20updated%20pdf\\_0.pdf](https://neurorights-initiative.site.drupaldisttest.cc.columbia.edu/sites/default/files/content/The%20Five%20Ethical%20NeuroRights%20updated%20pdf_0.pdf).

1. The first principle is the Right to Personal Identity. This principle states that boundaries must be developed to prohibit technology from disrupting the sense of self. When BCIs connect individuals with digital networks, it could blur the line between a person's consciousness and external technological inputs.
2. The second principle is the Right to Free-Will. This principle states that individuals should have ultimate control over their own decision making without unknown influence from external technologies.
3. The third principle is the Right to Mental Privacy. This principle states that any data obtained from measuring neural activity (NeuroData) should be kept private. Moreover, the sale, commercial transfer, and use of neural data should be strictly regulated.
4. The fourth principle is the Right to Equal Access to Mental Augmentation. This principle states that there should be established guidelines at both international and national levels regulating the development and applications of mental-enhancement neuro-technologies. These guidelines should be based on the principle of justice and guarantee equality of access to all citizens.
5. The fifth principle is the Right to Protection from Algorithmic Bias. This principle states that countermeasures to combat bias should be the norm for machine learning. Algorithm design should include input from user groups to address bias foundationally.

If passed, Chile could turn into the first country that has a law that protects neurorights!

### C. Technocratic Oath

But, if we genuinely want to protect our NeuroData, we must do so by dint of design. And to that end, the most current project is Professor Rafael Yuste's "Technocratic Oath." Professor Yuste is drafting an ethical framework for entrepreneurs, physicians, and researchers developing BCIs and artificial intelligence.<sup>111</sup> Just like as doctors follow the Hippocratic Oath,

---

<sup>111</sup> Yuste & Goering, *supra* note 2.

those who design and administer neurotechnology would follow the “technocratic oath.”

#### IV. CONCLUSION

The discussion shows that BCIs – uniquely integrated with artificial intelligence – entail complex legal matters. Naturally, the field of law that received the most attention thus far is constitutional law and human rights; it is central to the understating of legal theory and from which all other rights and privileges stem. The following field relative to the number of publications is criminal and procedural law and for a good reason. Both of these public law fields deal with providing individuals protections against the asymmetric and disproportional power of governments, which are of direct concern to the society.

Access to the neural processes that underlie conscious thought entails access to a level of the self that cannot be consciously filtered.<sup>112</sup> This risks violation of individual privacy and dignity, with the potential to suppress free will and breach the ultimate sanctuary of human freedom – the human mind. Personal identity, agency, and moral responsibility may be diminished by merging neurological and digital experiences. Such could change the nature of humanity and human societies unless we reform – not only our laws – but also our perspective on NeuroData and the protections it should receive.

In a globalized world, where tech companies influence our lives unhindered, both at the individual and the societal level, linking the brain directly to digital networks could fundamentally change human societies and humanity. On October 22, 2020, the Council of Europe adopted resolution 2344 (2020), where it called on its member states to develop specific legal frameworks that guarantee adequate respect and protection of individual rights and ensure appropriate bodies exist for the oversight of BCI-technology to ensure effective implementation of the application frameworks.<sup>113</sup> The Council of Europe stated there is an urgent need for

---

<sup>112</sup> *The brain-computer interface: new rights or new threats to fundamental freedoms*, COUNCIL OF EUROPE (Sept. 24, 2020), <https://pace.coe.int/pdf/7b76df74999e4c6c3eb0b0d022c9bfbe52e0d4e83326667a8259ffe25682ae848428feba12/doc.%2015147.pdf>.

<sup>113</sup> *Id.*

precautionary regulation now, and the legal community should respond to this call to action.