Autonomy Under Control:
Ethical Challenges of Brain-Machine Interfaces

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Abstract

This article explores the intersection of science fiction, philosophy, and ethics in the context of emerging technologies, with a specific focus on Brain–Machine Interfaces (BMIs). It asks how the development and potential normalization of BMIs may transform our understanding of autonomy, agency, identity, and justice, and whether speculative fiction can illuminate the ethical and socio-political implications of these transformations. Science fiction, with its imaginative exploration of alternative futures, offers a unique platform for anticipating the ethical challenges posed by technological advancement. Speculative narratives invite critical reflection on issues such as autonomy, identity manipulation, justice, and the concentration of power in the hands of corporations and governments. Through an examination of works such as John Scalzi's *Lock In*, Mary Robinette Kowal's *The Spare Man*, and S. B. Divya's *Machinehood*, this article highlights emerging ethical dilemmas and the far-reaching societal changes that the widespread adoption of BMIs could give rise to. Ultimately, these narratives provide a philosophical lens through which to examine the relationship between technology and human values, offering ethical insights that may help anticipate future challenges.

Keywords:

Brain-Machine Interfaces; Science Fiction; Philosophy; Neuroethics.

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1. Introduction

For many years, the literary genre of science fiction has presented its readers with worlds of possibilities, marking this genre as one turned towards the future while incorporating elements of plausibility (Csicsery-Ronay 2003, 119), as promoted by Hugo Gernsback during the pulp era of science fiction (Attebery 2003, 34). As the world of technology expands, so does science fiction present more challenges in this field, sourcing its material from the many scientific and technological inventions that would potentially change the world and humankind. In this sense, science fiction is a genre that envisions a future (whether utopian, eutopian, or dystopian) often through the lens of technological development (Jones 2003, 169).

But speculative fiction, with its capacity to visualize alternative realities, also plays an essential role as a meaningful tool for philosophical inquiry and critique, especially when it comes to understanding and debating the profound changes technology may bring to humanity. It serves, as Hava Tirosh-Samuelson said, "as social criticism and popular philosophy" (2011, 29). By imagining the consequences of biomedical interventions such as mind-altering devices, cybernetic implants, or genetic enhancements, science fiction acts as a conceptual testing ground for deep philosophical and ethical questions that remain too speculative for real-world experimentation. Narratives exploring the erosion of personal agency, the undermining of autonomy, the manipulation of identity, the exacerbation of social injustices, or the consolidation of power by corporations and governments are of particular interest to ethicists and philosophers, as they shed light on the intersection between speculative storytelling and philosophical and ethical inquiry.

This article aims at exploring the intersection between philosophy and science fiction by questioning how Brain-Machine Interfaces (BMIs) may transform our understanding of autonomy, identity, social justice, and power relations, and by examining how science fiction illustrates these challenges, pointing to the role of this literary genre in anticipating the future of emerging neurotechnologies and addressing some of their ethical challenges in advance.

While speculative fiction may not provide definitive answers, it helps us frame the moral dilemmas that could arise as these technologies become more prevalent and widespread through free and democratic societies. In doing so, we examine how these fictional narratives can influence our ethical approaches to new biomedical technologies, ensuring that their development aligns with the values we hold dear, such as autonomy, agency, identity, dignity, and justice.

Methodologically, this article positions science fiction as an anticipatory heuristic method, a framework that recognizes the genre as a legitimate and uniquely useful resource for conjecturing future technological applications and their complex societal implications. Hence, through works like John Scalzi's *Lock In*, S. B. Divya's *Machinehood*, and Mary Robinette Kowal's *The Spare Man*, we will explore possible futures shaped by emerging neurotechnologies, offering a critical philosophical lens to evaluate and address the ethical challenges they might present.

Therefore, this article will be divided into three parts. In the first, we will provide some background on the emergence of BMIs in recent years as well as a contextualization of the intersection of technological progress and science fiction literature. We also explore the narratives developed by Scalzi, Divya, and Kowal, and address the potential challenges and threats that the technologies in each story may pose for society at large.

The second part will consist of an analysis of the ethical concerns that the emergence of certain technologies raises in the three novels, focusing on how the narratives may portray challenges to autonomy and identity.

The third part will examine their extrinsic ethical dimension, exploring how biomedical and neurocognitive tools may deepen existing inequalities and create new forms of social stratification. In this section, we argue that BMI adoption will not be a simple matter of individual choice but, above all, that it will be shaped by and will actively reinforce a recursive socio-technological loop. This loop, where technology reshapes the society that adopts it, creates conditions of "coercive convenience," transforming potential enhancements into engines of permanent social division and eroding the possibility of meaningful, autonomous choice.

Ultimately, this article aims to center the debate on the challenges that technologies like BMIs bring to society, highlighting the philosophical and ethical barriers that make this such a sensitive field; and by bringing science fiction into the fray, we intend to explore the intersection of two major fields, literature and philosophy.

2. Brain-Machine Interfaces in Contemporary Speculative Fiction: Three Case Studies

Over the last decades, science fiction has demonstrated that the relationship between humans and machines is growing closer. While great works of fiction from the late nineteenth century and early twentieth century explored the usefulness of certain technologies in the life of humans, more recently, what used to be external devices manually operated by a human have transformed into machines integrated *into* the human body, often connected directly to the brain and operated through thought alone. There has been an increasing interest in the relationship between biology and machines, an interest that has led to "depictions of human-machine hybrids" (Slonczewski & Levy 2003, 175). The theme of biology is explored in multiple ways in the genre, such as the relationship between brain function and intelligence, but also genetic engineering, which "alters the physiology or behavior of individuals, populations or the entire human race" (175). In the field of genetic engineering, many science fiction novels emerged throughout the twentieth century and after, that engaged with biotechnology for various purposes: the cloning of humans, in such novels such as Kate Wilhelm's *Where Late the Sweet Birds Sang* (1976), Michael Marshall Smith's *Spares* (1997), and Kazuo Ishiguro's *Never Let Me Go* (2005); or genetic engineering for reproductive purposes, in novels like John Varley's *The Ophiuchi Hotline* (1977) or Marge Piercy's *Woman on the Edge of Time* (1976), where "artificial wombs are used to free women for other work" (182). After the Second World War, the space race, the fear of warfare, and environmental concerns shaped the genre for many

years to come, giving rise also to what Priscilla Wald argued was a "set of concerns about the changing nature of humanity as a result of both geopolitical transformation and biological metamorphosis" (2015, 184).

The emergence of Brain-Machine Interfaces (BMIs) in recent years echoes a development that science fiction brought to the literary debate several decades ago. BMIs are an emerging technology aimed at creating a direct communication pathway between the human brain and external devices. By interpreting neural signals, these systems can generate commands that enable users to operate prosthetic limbs, control cursors on a screen, or interact with other devices through thought alone (Maiseli *et al*. 2023). With significant applications in medicine and rehabilitation, BMIs offer promising solutions for individuals with severe neurological impairments, such as paralysis or spinal cord injuries, with the potential to restore functionality and improve quality of life. Furthermore, researchers are exploring their ability to augment cognitive functions and push human capabilities beyond *natural* limitations (Mudgal *et al*. 2020, 2).

A particularly challenging aspect of advanced BMIs is their bidirectional nature. This functionality allows them to not only extract information from the brain but also to input data back into it. For instance, a bidirectional BMI could control a prosthetic arm while simultaneously delivering sensory feedback to simulate the feeling of touch. This possibility of altering neural activity raises deep philosophical and ethical questions, as it has the potential to induce lasting changes in brain function and modulate a user's cognitive processes, emotions, and even sense of self (Gigante & Goodman 2011, 478-479).

While a more detailed examination of these concerns will follow in Section 3, this initial understanding of BMIs allows us to appreciate how speculative fiction engages with their potential. Science fiction has long served as a critical arena for exploring the converging paths of human and machine, and BMIs represent a central frontier in this ongoing exploration. Moving beyond simple depiction, the genre functions as an anticipatory heuristic method. This aligns quite well with what Philip Brey terms "anticipatory technology ethics." Pivotal to Brey's (2012) anticipatory framework is the recognition that "the conjecturing of future artifacts and applications is an imaginative activity" (10). It is precisely this recognition that leads him to validate the use of "science fiction stories for ideas about possible future artifacts and applications" (10) as a legitimate scholarly resource. This methodological approach is also present in a more recent study by Rania Elshabassy (2022), who similarly examines BMI representations in science fiction to deconstruct their challenges to "traditional notions of identity, consciousness, agency and freedom" (2022).

Hence, science fiction provides a rich repository of such scenarios, allowing us to model possible futures, serving as a critical tool to identify, critically analyze, and encourage debates about the societal challenges that technologies like BMIs present. In doing so, science fiction also promotes the debate about the boundaries of what it means to be human and to live a good, meaningful life. Moreover, it takes the discussion to adjacent technologies that purport to improve human life and the enhancement of our abilities to feel, move, and lead not only good, but *better* lives.

In the following sections, we examine noteworthy examples of science fiction novels that explore these technologies, particularly BMIs, analyzing their potential benefits, but also highlighting the various dangers and threats they could pose both for our health and for our independence as members of society. We will analyze three key works: John Scalzi's *Lock In* (2014), which explores a world after a pandemic where BMIs restore agency to the disabled; S. B. Divya's *Machinehood* (2021), which depicts a gig economy where human enhancement is necessary to compete with AI; and Mary Robinette Kowal's *The Spare Man* (2022), which presents a more personal story of a BMI used for chronic pain management.

2.1. John Scalzi's *Lock In*

John Scalzi's *Lock In*, published in 2014, depicts American society in the aftermath of a global pandemic known as "the Great Flu." In the prologue, the author describes the progression of the flu that became known subsequently as "Haden's syndrome," a condition characterized by three stages, the second of which "caused deep and persistent changes to the brain structure of some of its victims" (Scalzi 2014, 10). For many survivors, this second stage resulted in locked-in syndrome, a condition that causes quadriplegia and sensory loss but doesn't affect cognition (Das *et al*. 2023). The prologue reports that more than four million U. S. citizens were affected by locked-in, which resulted in the creation of a fund to study brain function associated with Haden's, and the development of "the first embedded neural nets, Personal Transports, and the Haden-only online space known as 'the Agora'" (Scalzi 2014, 11). The neural nets consist of implants that allow the locked-in victims to connect to humanoid artificial bodies called Personal Transports, or "threeps," which permit them to move, feel, speak, and participate in society. However, this participation is neither simple nor *normal*; it is structurally conditioned by social stigma, social and political discrimination, and significant economic inequality, as access to this technology is far from universal. One other side of Haden's syndrome is that a very small percentage of the people affected did not suffer from lock-in despite the changes in their brain structures. These became known as Integrators, humans whose bodies can be rented by Hadens to perform the same functions as a threep (40).

Through an implant in the brain, the neural network, Hadens are able to make use of threeps and lead apparently normal lives. The narrative of Scalzi's novel points to the impact of this particular brain-machine interface and its exclusive use only on Hadens:

> Right now, neural networks and threeps and all the innovations that came out of the Haden Research Initiative Act have been kept to the benefit of Hadens. So far the FDA has only approved them for Hadens. But paraplegics and quadriplegics can benefit from threeps. So can other Americans with mobility issues. So can older Americans whose bodies are failing them in one way or another. (Scalzi 2014, 99)

Here is reflected one of the social disparities caused by the technologies derived from the Haden context, raising several questions: who should have access to neural networks, and therefore to the Personal Transports? Should they be exclusive for people suffering from Haden's? Should non-Hadens who suffer from paralysis be allowed to access these technologies? The difficulty in answering these questions lies in the dangerous process of

implanting neural networks in someone's brain, which may constitute a health problem. The novel also presents a regulation – named Abrams-Kettering Bill – as a solution in this regard, by "[setting] a pathway to getting these technologies out to more people. More Americans will be using these technologies in the future" (99).

Ultimately, the novel discusses the advantages and disadvantages of the relationship between humans and machines, presenting a positive solution to a world problem, but always alerting society to the potential dangers that the rapid advancement of technology may bring, dangers that can be associated with health, economy, or the freedom of individuals. This is concurrent with the "new kinds of humans-machine mergers," referred to by Andy Clark (2016, 134), about which he states that one should reflect on the "complex and transformative nature of animal-machine relationships that may or may not ensue" (135) with the advent of such technologies as the BMIs.

In addition to these systemic and distributional concerns, *Lock In* also implicitly raises deeper, intrinsic questions about the nature of agency and embodiment (as well as identity) in the context of BMI use. The neural networks in the novel enable Hadens to operate robotic bodies or even inhabit other people's bodies, challenging the limits of bodily autonomy and the continuity of subjective experience, which intimately relates to selfhood.

This exploration of fragmented identity and mediated agency in *Lock In* provides a concrete case study for the kind of critical work identified by scholars like Elshabassy (2022). As previously noted, Elshabassy's research into BMI representations in science fiction concludes that these interfaces challenge values as important as autonomy, agency, identity, and consciousness. Scalzi's novel dramatizes this theoretical challenge through the lived, often precarious, experience of his Haden characters, moving the philosophical problem from abstraction into narrative reality. When a Haden temporarily inhabits another person's biological body, the continuity of subjective experience and bodily ownership is called into question. While the use of a threep extends the body into a tool, riding an Integrator represents a more profound and worrying form of embodiment because it is one that blurs the line between two distinct identities, thus raising questions about personal boundaries and the integrity of the self.

Hence, while the restoring of participation to those otherwise excluded from society is portrayed largely as a social good, it also redefines what it means to be physically present, to inhabit and experience one's body as "the vehicle of being in the world" (Merleau-Ponty 2012, 84), and to exercise free will when actions are mediated through external devices. These are not mere technical or external transformations but imply substantive alterations of subjectivity itself. Through this mechanism, the novel raises a more subtle, intrinsic implication of BMI adoption: how cognitive, emotional, bodily, and moral agency can become intertwined with systems of mediation that shape and reshape not only what users can do, but also who they understand themselves to be (*i.e.*, their identity). In this sense, *Lock In* exemplifies how speculative fiction can reveal the ontological stakes of technological dependency, even in narratives that foreground access and empowerment, thus illustrating that the challenge isn't simply about access to a body, but about the stability of identity when the body itself becomes a shared or rented platform.

The novel relates these issues from the perspective of FBI agent Chris Shane, a Haden who is socially and politically vulnerable due to increasing discrimination against the Haden population. Furthermore, he is permanently dependent on his paralyzed body, which he still needs to inhabit to sleep, for instance, and without which he cannot survive. His position in the FBI, specifically in the Haden-related division, puts him at further risk, as he must protect the integrity of his threep but also that of his human body.

The narrative also highlights the socioeconomic burden on Hadens, who must fund their costly threeps and allocate resources to maintain their biological bodies, which require permanent care. Being wealthy himself, Chris doesn't feel this strain; he has a nurse who provides medical care to prevent complications such as sores and infections. However, he is aware of and reflects on the financial challenges of maintaining threeps, which may cost as much as cars (Scalzi 2014, 94).

While Chris maintains a sensory connection to his body, some Hadens choose not to, transferring all sensory input to their threeps and abandoning awareness of their physical selves. The BMI that allows people to connect to the personal transports carries a significant risk, as some users may choose complete disembodiment, potentially ignoring critical physical symptoms. Chris's nurse recounts that a previous client died of a heart attack after failing to notice the signs, having routed all sensory perception onto her threep (79-80).

Seen through this lens, *Lock In* confronts the reader with difficult questions about what it means to be a person when one's mind operates separately from the physical body. However, from Chris's point of view, we can see that the benefits can outweigh the risks, since the interface in his brain allows him to lead a full life and realize his potential as a human being.

These reflections on bodily intentionality and corporeal subjectivity underscore how Scalzi's novel affirms science fiction's capacity, as Sheryl Vint suggests, to "think differently about ability, disability, and normative embodiment" (2021, 94).

2.2. S. B. Divya's *Machinehood*

In this wave of science fiction novels that explore the growing proximity between humans and technology, author S. B. Divya has published multiple works that deal with this relationship, particularly in her debut novel, *Machinehood*. Published in 2021, *Machinehood* takes place in America and India in 2095, in a world that is dominated by artificial intelligence, with which humans must compete in order to keep up in the context of the world's gig economy.

Welga Ramirez is a former member of special forces, who had to go through an "Advanced Technology and Intelligence" training, in which she "received cutting-edge implants for audio, visual, and network interfaces. She had more electronics in her body than most people in the world," (Divya 2021, 8) including better and faster sensors to regulate the aftereffects of medication. While the novel focuses more on the impact of artificial intelligence, which is embedded in every aspect of human life, the narrative also refers to the technologies like Welga's brain implants as being important in specific fields like the military.

In the wake of all these technological marvels, a group calling itself the Machinehood has published a manifesto, denouncing the way in which humans have blended with machines. For instance, concerned with the technological progress of recent years, the Machinehood Manifesto questions the very essence of humanity: "We have now reached the breaking point of the Biotechnology Age. Humanity is engineering itself to where the definition of 'human' may not go forward as it has been" (91). Even more important is another principle that relates to humanity's role in the aftermath of the technological revolution, and which states that:

> The Biotech Age has saved humanity up to now, allowing us to maintain our worth (to ourselves and the oligarchy) and, therefore, to survive the gig lifestyle. Mech-suits integrated with human bodies let us carry or run or endure like a machine. Pills let us outthink them. But the cost of these so-called enhancements is twofold. One, they destroy our biological bodies (no matter how safe the oligarchy says they are). And two, they propel the machine designers to build even faster, stronger, smarter machines. We are trapped in a vicious cycle of self-destructive progress. (Divya 2021, 114)

In the novel, the challenges of a hyper-technologized society are experienced firsthand through the protagonist, Welga. Having to maintain a competitive edge against artificial intelligence, Welga relies on "zips," pills that "speed up the communication between peripheral neurons and the brain" (48). But these enhancements give her involuntary tremors, a side effect that worsens over time. Welga's sister-in-law, Nythia, identifies a direct link between the zips and the tremors, which are triggered as the effects wear off. As Welga's condition deteriorates, she faces a difficult choice: taking the pills maintains her performance but risks seizures or death, while stopping them is not viable. She is dependent both physically, experiencing withdrawal symptoms if she stops, and functionally, as she could no longer compete with AI or perform her job. This illustrates the heavy physical, psychological, and functional toll of technological augmentation.

Welga reflects on the potential side effects from these pills that people describe as "tiny machines tinkering with [people's] bodies" (320). The narrative draws attention to how economic instability among parts of the population may suggest higher health risks, as cheaper versions of these pills carry greater dangers. Welga's personal history reinforces these dangers; she has witnessed her mother die from an early design of "flow," the pills that enhance focus and processing of information. This particular flow design has killed millions of people globally. Despite the tragic outcome, both protagonists in Divya's novel recognize the need for these enhancements, without which humans are useless compared to AI.

Welga also observes the speed at which new technologies appear in the world. Younger generations are equipped with better "sensors to monitor their body's responses, faster feedback mechanisms to control the effects of pills" (8). Ultimately, Welga realizes that she's "obsolete in every way" (8).

Divya's novel raises, thus, multiple issues relating to technological advancements, particularly those like the Brain-Machine Interfaces, which combine humans and machines to improve quality of life. While the novel focuses on the advantages of this fusion, a group

like the Machinehood works as a warning to society of the potential dangers of an unfettered use of technology, that may cause dependence and endanger human health. Consequently, throughout *Machinehood* we find a critically ambivalent tone. While the technology is indispensable for survival in a competitive gig economy, its benefits are consistently undercut by the narrative's stark depiction of physical precariousness, addictive dependency, and the systemic exploitation that these very enhancements perpetuate.

This narrative of ambivalence and precarious dependency offers an interesting framework for analyzing the specific challenges posed by invasive BMI technology, which the novel's pill-based enhancements metaphorically prefigure. Welga's physical deterioration and the addictive cycle of zips point directly to core ethical dilemmas of neural implants. A particularly interesting example of this risk is found not in fiction but in clinical reality. Frederic Gilbert, Marcello Ienca, and Mark Cook (2023) detail the case of "Patient R," who surgically received an invasive BMI to treat severe epilepsy. When the providing company (Neurovista) discontinued the trial for financial reasons, the device had to be explanted, abruptly ending the therapeutic benefit and subjecting the patient to the risks of another neurosurgical procedure. This case illustrates how this person's health and autonomy became critically dependent on the commercial viability and long-term support of a corporate entity.

It is obvious that, contrary to a smartphone that can be easily replaced, an embedded neural interface requires risky surgical procedures for hardware updates, repairs, or explantation, posing persistent health threats but also raising questions about neurorights. In the case of "Patient R," just mentioned, explantation due to corporate discontinuation did not merely end a treatment; it violated the patient's psychological continuity and mental integrity. According to Patient R, the BMI "was like an alien at first, you grow gradually into it and get used to it, so it then becomes a part of everyday, […] it becomes part of you. Because that's what it did, it was me, it became me" (Gilbert *et al.*, 2023, 785). The implanted BMI had become constitutive of the patient's cognitive structure and agential capacities because it allowed her to predict and manage seizures, something that fundamentally reshaped her sense of self and autonomy. But the removal of the BMI caused a profound psychological distress and drastically diminished her quality of life, effectively robbing her of "*de novo* agential capacities" (2023, 787).

As one can see, the vulnerability of Patient R's neurorights is intrinsically related to corporate or economic priorities (here, the providing company discontinued the trial, but one can consider scenarios of bankruptcy, or the obsolescence of hardware, the unilateral alteration of important software functionality, or a mandatory and possibly costly subscription model for essential updates). This mirrors and intensifies the precariousness depicted in *Machinehood*, where Welga's dependence on pills for competitive agency places her health at the mercy of market forces and upgrade cycles. This dependency becomes a matter of *neurorights*: the right to continuous access to a technology that has become integral to one's cognitive functioning, the right to non-disruptive maintenance, and the right to protection from exploitative or coercive upgrade cycles.

Moreover, Welga's declaration of feeling "obsolete in every way" as newer, better-integrated technologies emerge finds a real-life parallel in Patient R's experience of being rendered *functionally* and psychologically obsolete by the explantation of her device. It's not just about a violation of neurorights, but about losing a symbiotic agency and identity: "To finally switch off my device was the beginning of a mourning period for me. A loss, a feeling like I'd lost something precious and dear to me, that could never be replaced: It was a part of me" (Gilbert *et al.*, 2023, 786). Her statement that she is not "the happy, outgoing, confident woman [she] was" (785) also mirrors the diminishment Welga faces without her enhancements. Interestingly, Patient R's testimony that the device "became me" and that its removal triggered a period of intense "grief and mourning" (785) demonstrates that the BMI had transcended its role as a tool to become a constitutive part of her identity. This blurs the line between *becoming* obsolete (Welga's fear) and *being made* obsolete (Patient R's reality).

In both cases, it is possible to see that when a technology like a BMI is deeply integrated into one's cognitive and social functioning, its disruption or removal isn't a simple inconvenience, but it dismantles a vital component of the self, inflicting psychological harm that aligns with the violation of important rights to mental integrity and psychological continuity.

2.3. Mary Robinette Kowal's *The Spare Man*

Over the course of its history, science fiction literature has made ample use of technologies based on brain implants for multiple purposes. Andy Clark points to cybernetics and computer science as important areas that have found common ground in this literary genre, stating that "implanted electronic devices use bodily feedback signals to automatically regulate wakefulness, metabolism, respiration, heart rate and other physiological functions" (131). More importantly, however, is that these technological alterations carry the type of intrinsic consequences mentioned before, particularly that they participate in a deeper co-constitutive or symbiotic relationship between humans and technology. As bodies become sites of intervention and optimization, identity is no longer just self-fashioned but symbiotic, co-constructed through technological mediation (Verbeek & Crease 2005). The integration of external enhancements into the human form inevitably shapes and reshapes subjective experience, which inevitably affects agency and authenticity, impacting every possible notion of what it means to be human—as we just saw with the illustrative case of Patient R.

A science fiction novel that makes use of a similar implant is *The Spare Man*, by Mary Robinette Kowal, published in 2022. The novel follows protagonist Tesla Crane, a robotics engineer who has suffered an accident that left her severely incapacitated. As a result, she has had installed a Deep Brain Pain Suppressor (DBPS) to manage the pain. At the end of the novel, Kowal wrote a note about the science in *The Spare Man* and addressed the DBPS, stating that she had been inspired by a Deep Brain Stimulator (DBS) implanted in her mother's brain to help with symptoms of Parkinson's. Here, Kowal remarks that the process took five surgeries, "two of which were brain surgeries" (2022, 420).

This case also finds an interesting parallel in the real-life experience of Victoria Gray, who underwent groundbreaking CRISPR gene therapy to cure her sickle cell disease, which made her feel imprisoned in a body that threatened her with "sudden, excruciating bouts of pain" and the constant risk of stroke or heart attack (Stein 2019; The Royal Society 2023). Though the treatment was successful and eliminated the disease, Gray reported that she could not entirely escape the emotional trauma of her past; the memory of being trapped in a failing body continued to shape her self-perception and identity. Of course, technically, this doesn't involve neural implants nor BMIs, but the comparison is justified because of one's lived experience: in both scenarios (genetic edition and neural interfacing) we see a radical technological alteration of the body to manage a chronic, life-defining condition. And in both scenarios, the parallel lies in the resulting psychological and existential reality: on the one hand, the technology succeeds in its primary function of eliminating disease and suppressing pain, but on the other hand, it cannot erase the feelings of trauma that manifest in the body that was a source of suffering and vulnerability.

This same linking of identity and technological intervention was evident in the case of Patient R and her discontinued BMI. For her, the device "became me," a dependable component of her very agency. Its explantation was experienced not as a simple hardware removal, but as the theft of "a part of me" (Gilbert *et al.*, 2023, 787) leading to the profound mourning for her lost symbiotic self. The biomedical technology, whether a BMI or gene editing, becomes a permanent part of the constitution of the user's identity, for better and for worse.

It is precisely this enduring psychological mark that mirrors the condition of Tesla Crane in *The Spare Man*. Tesla's DBPS manages her physical pain, but it does not erase the memory of the accident or the existential vulnerability it instilled. Both cases reveal a key limit of technological intervention: while biomedical tools can repair or regulate the body, they cannot automatically reconstitute a seamless, pre-trauma identity. The technology becomes part of a new narrative of the self. Tesla's implant does not return her to a state of "wholeness" but instead integrates into her identity as a permanent mediator between her past trauma and her present agency. This illustrates precisely the kind of co-constitutive relationship between humans and technology, that transforms identity from something we see as a given into something far more precarious and unstable.

In the novel, we also encounter multiple references to Tesla's DBPS and its effects on her routine, which has been largely affected by her accident. So, the simplest movements are potential triggers for pain, which the implant identifies and manages: "Tesla slipped out, twisting to stand, and her back spasmed. Her deep brain pain suppressor compensated automatically, slamming into its built-in safeties so the red cords of pain were present but muted" (21).

In addition, the narrative describes the benefits of the DBPS, stating that, like a "switch […] in her brain," it allowed Tesla "to go whole hours without pain. It let her sleep through the night. It let her function without having to measure every single goddamned step she would have to take in a day" (395).

While the narrative of *The Spare Man* looks positively on this technology, referencing the beneficial impact this had on the life of the protagonist, who would otherwise be in constant pain and probably unable to lead a normal life, Kowal's testimony at the end of the novel may raise some concerns about the potential dangers of having such a machine implanted in one's brain. While the focus is on the advantages, the invasiveness of the process that required two brain surgeries in the case of the author's mother is a testament to the risks that BMIs may have on one's health, something that is referred as well in Scalzi's *Lock In*, where the brain implant that allows people to use threeps is exclusive for Haden's because, as stated in the narrative, "jamming a second brain into your head is inherently dangerous" (99). Hence, to intrinsic risks such as the alteration of subjectivity through the external mediation of thought and (self-) perception, we must add the extrinsic risks involved in their material implementation, including invasive surgeries for implantation or explantation, and the physical vulnerabilities of hardware components like threads protruding from the brain.

To further illustrate this problem, consider the recent case of Noland Arbaugh, who was implanted with a Neuralink BMI (Mullin 2024). Paralyzed below the shoulders, Arbaugh represents a case for whom the potential benefits of a BMI (*i.e.*, restored communication and agency) are deemed worth every existential risk. His reported sentiment, that the danger of the invasive procedure was a risk he was willing to take given his condition, mirrors the calculus of characters like Tesla Crane and the real-world patients discussed. This highlights a basic ethical tension: when life without the technology is experienced as a form of imprisonment or radical limitation, the "choice" to undergo a dangerous, identity-altering intervention is made under conditions of profound constraint (which are exactly the cases of Patient R, of Victoria Gray, and of Noland Arbaugh). This reality underscores that the adoption of BMIs is rarely a free choice between convenience and risk, but that it might be (or become) a necessary gamble under certain conditions, as in more extreme medical cases. Arbaugh's case serves as a real-world example to the speculative narratives, demonstrating that the ethical problems they explore are not as distant as they might sound.

Many similar issues are explored in science fiction, but the three novels analyzed in this section provide three more recent examples of how humanity has progressed regarding BMIs, either in the face of a crisis like the global pandemic that resulted in Haden's syndrome or in the enhancements that improve the lifestyle of human beings. Nonetheless, more than portraying the wonders of the future, these novels delve into the ethical problems that our relationship with technology poses. Ultimately, these science fiction novels demonstrate "how biotechnology is changing what it means to be human and challenging the premises of humanism" (Vint 2021, 115).

3. Ethical and Philosophical Concerns

Having established how science fiction functions as an anticipatory heuristic method, allowing us to model the societal integration of BMIs through the three novels analyzed, we now focus more closely on the philosophical and ethical analysis of the challenges they reveal. That the speculative scenarios found in these texts are not merely imaginative

exercises is something we've already ascertained; they illuminate a coherent set of ethical concerns that cluster around fundamental philosophical concepts. In this section, we will therefore look at four critical domains in which the relation between science fiction as an anticipatory tool, philosophical problematization, and ethical dilemmas conflates: the erosion of agency and autonomy, the fragmentation of identity, the amplification of power asymmetries and injustice, and, finally, the contested future of the human itself.

3.1. The Erosion of Agency and Autonomy

A primary philosophical concern regarding advanced BMIs is their potential to undermine human agency and autonomy. Agency refers to the capacity of an individual to initiate and guide actions based on intentions or reasons that one consciously endorses (Schlosser 2019). It involves being the source of one's actions, such that what one does is attributable to one's own deliberation or motivational states. Autonomy, on the other hand, is the capacity of an individual to govern one's actions based on reasons, motives, or values that one can authentically endorse as one's own, rather than being determined by external processes beyond one's awareness or control (Christman 2019). Thus, for an agent to act autonomously, one must both originate the action through consciously endorsed intentions and be able to deliberate over the decisions affecting one's own states.

This understanding aligns with influential hierarchical models of autonomy, such as that developed by Harry Frankfurt (1971). Frankfurt distinguishes between first-order desires (the desire to do or not do something) and second-order desires (the desire to have, or not to have, a particular first-order desire). On this account, what is essential for personhood and free will is the capacity for "second-order volitions," which are a specific kind of second-order desire where we want a particular first-order desire *to be our will*, that is, to be the desire that effectively moves us to act. Autonomy, in this framework, depends on this capacity for reflective self-endorsement: our actions are truly our own when they flow from desires we have volitionally embraced. Frankfurt is laconic on this respect: "[i]t is in securing the conformity of his will to his second-order volitions, then, that a person exercises freedom of the will" (1971, 15).

It is the distinctively human process of formation of second-order reflection and endorsement that closed-loop BMIs threaten. Predictive closed-loop BMIs have the particularity of intervening pre-emptively to modulate or suppress first-order desires and emotions, thus bypassing the possibility of second-order reflection and endorsement. The individual is, with respect to those modulated states, rendered a passive patient of the technology rather than an active author of his will. Such an image might be familiar to the readers of C. S. Lewis's well-known book *The Abolition of Man* (2009), where he claims that the "conditioned" are precisely those whose desires, beliefs, and moral reactions are engineered by the "conditioners." Because they are externally programmed by the technological influence of the conditioners, the conditioned are not really the authors of their lives, nor can they be autonomous agents. True autonomy depends not just on the capacity for reflective self-endorsement, but on the *preservation* of the conscious, deliberative space in which that endorsement can occur.

This capacity for self-determination is most directly threatened by the development of closed-loop BMIs that integrate predictive algorithms. AI-powered bidirectional BMIs go beyond traditional user assistance by interpreting neural signals and *autonomously* responding to the user's *needs*, thus bypassing or overriding human decision-making. Closed-loop predictive systems that intervene pre-emptively without the subject's awareness may jeopardize autonomy by excluding the agent from the decisional process concerning one's own mental states. For instance, if programmed to prevent an epileptic seizure, the device intervenes and stabilizes neural activity before the individual realizes a seizure was imminent; if designed to suppress excessive anger or impulsive behavior, the device can pre-emptively modulate emotional states, keeping the user calm without him ever experiencing the emotional escalation (Gilbert *et al*. 2018). By contrast, Patient R, whom we met above, received alerts of an impending crisis, preserving her decision-making control and keeping her in the decisional loop (*e.g.*, she could take the medicine to prevent the crisis or not). Hence, when closed-loop predictive BMIs intervene by triggering actions or mental-state changes pre-emptively (*i.e.*, before the individual can form or affirm intentions), agency becomes diminished, as the individual is no longer the initiator or guiding force behind the action and loses his role as a purposive agent (Mateus 2025).

If this is the case, it is not only our autonomy and agency that are threatened, but also our freedom. It is not just that we are excluded from the decisional loop, as Gilbert and colleagues argue (2018), but also that there is the possibility that essential aspects of our identity could be radically and permanently altered by the technology without our awareness or consent. In the end, this is much more insidious than what happened with Patient R's explantation: in this case, we become byproducts of the advanced AI algorithms that constantly read, interpret, and modulate our brains through stimulation to keep us as functional agents without us being aware of that process.

This dynamic constitutes a direct challenge to what John Harris terms the "freedom to fall": the freedom to err or to act in morally questionable ways (2016, 60-76). This freedom is essential because, even in extreme situations, we must retain the capacity to make voluntary, autonomous moral choices, including those that might involve violence or rebellion. Imagine a scenario where a person, faced with a moral conflict, chooses to use force to prevent a robbery or stop a terrorist attack. A BMI might intervene to suppress neural patterns associated with impulsive or aggressive dispositions, classifying them as *undesirable* or *pathological*. Such intervention could occur even in circumstances where actions motivated by these dispositions are necessary to preserve one's own life or protect others. The risk, therefore, is not just the suppression of particular actions deemed "immoral" by an external standard, but the erosion of the agent's capacity to knowingly, voluntarily, purposefully, and autonomously determine his own course of action. By removing this capacity, the technology undermines our moral agency, understood as the ability to deliberate, self-reflect, and develop our understanding of good and evil based on subjective valuation. In doing so, it not only bypasses our autonomy, but it obstructs moral growth and self-determination, and this directly threatens the grounds of what it means to be an autonomous moral agent and, consequently, of what it means to be a free, purposeful individual.

Mary Robinette Kowal's *The Spare Man* illustrates this dynamic of technological control for beneficial purposes quite well. The protagonist's Deep Brain Pain Suppressor (DBPS) automatically manages her chronic pain, which is a largely therapeutic function. As can be observed in the narrative, the DBPS allows Tesla Crane to experience hours without pain, or to engage in day-to-day activities without having to control every step. This technology works like an on and off switch embedded in Tesla's brain that can regulate the amount of pain in certain scenarios. However, this represents a direct technological mediation of a fundamental human experience. While the DBPS grants her functionality, it also operates autonomously, as when Tesla has to perform sudden movements that, for example, make her back spasm (Kowal 2022, 21). In such situations, the deep brain suppressor would act accordingly to mute any pain. This showcases a softer and more intimate form of agency being bypassed, which once more raises the question of where we draw the line between assistance and overreach, even when the outcomes are desired. Consequently, technological interventions that bypass the agent's deliberation, even if previously accepted and agreed on by the agent, still risk undermining autonomy by removing the individual from the decisional loop of action.

A similar threat to agency is depicted in *Lock In*. As explained earlier, a group within Haden society known as the Integrators consists of individuals who were infected by the virus but did not become locked in. Although they retain physical mobility, their brains have nonetheless been altered, enabling them to connect to Hadens through an implanted neural network. When an Integrator permits a locked-in Haden to use their body, control is almost entirely transferred, resulting in a significant loss of the Integrator's agency and autonomy. Despite assurances that Integrators may take over and end the connection at any time (Scalzi 2014, 58), the narrative centers on a murder involving Integrators and the possibility of hacking their neural networks to unwillingly make them perform illegal tasks, robbing them entirely of their free will and wiping their memory in the process (227). Scalzi's novel illustrates a more severe form of agency displacement than that we find in Kowal's novel, where the impact is confined to a single individual. In *Lock In*, it is the autonomy of an entire social group that is put at risk, which illustrates how BMIs can reshape the conditions under which decisions are made and authority is exercised, thus drawing our attention to how BMIs can interfere with decision-making at multiple levels.

3.2. The Fragmentation of Identity

Beyond the erosion of agency and autonomy, BMIs also challenge the stability and continuity of personal identity. We can understand the notion of identity as referring to the sense of psychological continuity and self-attribution through which one understands one's thoughts, actions, and experiences as one's own across time. It concerns the way a person maintains coherence between past, present, and anticipated future states as part of an *authentic* self (Noonan & Curtis 2022).

Recall the experience of Patient R discussed above. Her testimony that the BMI device "became me" indicates the point where the technological object was no longer an external tool but was incorporated into her own sense of self. This symbiotic fusion meant that the subsequent explantation was not merely a medical procedure but an act that

disrupted her psychological continuity, leading to what she described as a loss of "a part of me" and a period of intense mourning and grief (Gilbert *et al*., 2023). It is precisely this violation of her personal identity that makes the case paradigmatic of an infringement of neurorights. When a BMI becomes constitutive of a person's cognitive and agential capacities, its presence or its removal directly affects the integrity of that person's identity.

This concern echoes a much older philosophical problem. The ancient thought experiment of the *Ship of Theseus* famously probes the concept of identity, questioning how identity and continuity persist as an object's components are gradually replaced. BMIs bring this philosophical dilemma into the neurotechnological debate by pressing a critical question: as our thoughts, emotions, and sensory experiences are increasingly mediated or generated by integrated technology, at what point do we cease to be the original "ship"? Does the integrated system become a new, hybrid entity, and what are the implications for our sense of self?

The bidirectional nature of BMIs is central to this existential concern because of the complex interactions between the brain and external devices or software. A key concern with this feature is the potential to alter neural activity through brain stimulation techniques and thus to modulate brain activity (Gigante & Goodman 2011, 478-479). This opens the possibility for inducing lasting changes in brain function, given the brain's significant plasticity. For instance, Pieter Roelfsema and colleagues (2018) demonstrated that BMIs can associate specific emotions with particular concepts, making it possible to enforce positive feelings towards certain ideas or to suppress negative emotions entirely. When external interventions alter mental states without the agent's awareness or endorsement, this continuity may be disrupted, thereby undermining the agent's sense of identity and self-authorship.

It is easy to see the implications this can have on our own identity, on how we perceive ourselves, on our values, and our sense of moral responsibility. If BMIs intervene and bypass our decision-making, if they artificially engineer our emotions from the outside, this might alter the way we think, feel, and act, possibly undermining our ability to define ourselves based on our own *authentic* experiences and choices. Gradually, we will become technologically determined beings.

While it is true that external influences (*e.g.*, traumatic life events, reading a book, or watching a film) can be impactful and transformative in shaping our identity, BMIs present a more profound challenge. In this case, our agency and ability to choose how we engage in (self-) transformative processes are overridden. We do not actively participate in shaping our own selves; instead, we become passive objects, exposed to continuous monitoring, interpretation, modification, and optimization by technology. Rather than being the active agents of our own development, we are reduced to passive subjects. This uniformization of society, where individual identity is erased to eliminate disruptive emotion and reaction, is at the core of, for example, Lois Lowry's *The Giver* (1993).

However, it is in William Gibson's *The Peripheral* (2014) that this specific speculative dimension is better explored. Here, characters control "peripherals," which are synthetic bodies, through neural interfaces that transmit sensory information such as vision, sound, and touch. The novel highlights the limitations and dangers of these systems:

users often cannot feel pain or detect malfunctions in the synthetic body, leading to severe injuries going unnoticed. More critically, frequent use of peripherals induces a growing sense of disconnection from the users' biological bodies, introducing some of the questions raised earlier about embodiment and selfhood. Gibson's depiction emphasizes real-world worries about users feeling detached from their own bodies, experiencing altered sensory perceptions and facing challenges to their sense of self. Once again, this perfectly matches the case of Patient R.

This exploration of fragmented identity and mediated agency is also central to John Scalzi's *Lock In*. The neural networks in the novel enable Hadens to operate robotic bodies or inhabit other people's bodies, challenging the limits of bodily autonomy and the continuity of subjective experience, which intimately relates to selfhood. This aligns with a key concern in the critical literature on neurotechnologies in SF. As Elshabassy (2022) argues in her analysis of BMIs, these interfaces "challenge traditional notions of identity, consciousness, [and] agency" (275), a challenge that *Lock In* dramatizes through the lived, often precarious, experience of its Haden characters. The novel demonstrates that identity is not simply transferred intact into a new vessel but becomes a contested, mediated, and socially negotiated state, fragmented across biological and artificial forms.

3.3. Power Asymmetries, Control, and Justice;

The threats to agency, autonomy, and identity are not distributed equally. Instead, they are intensified and weaponized within existing structures of power, which raises important concerns about justice and control. The potential of neurotechnologies like BMIs to directly manipulate brain activity and alter our identity makes it conceivable for corporations, governments, or other actors to subtly shape a person's preferences and behaviors without their explicit awareness. One might believe one retains autonomy and control because one continues to make everyday decisions, but if one's deeper cognitive processes are being influenced or controlled (*i.e.*, neuro-engineered), this sense of autonomy is illusory.

We find this dynamism of technological control and dependency in *Lock In*, where Hadens rely entirely on threeps that are produced and controlled by a limited number of corporations. The varying quality and accessibility of these threeps create a marketplace that shapes users' everyday experiences and freedoms, reinforcing existing social and economic inequalities. This corporate control creates a form of technological dependency that can be exploited for profit and power. Additionally, the risk of the hacking and hijacking of the neural networks installed in Hadens highlights in the narrative a form of control that can be exercised over other beings to possibly devastating consequences.

The potential for misuse extends beyond the corporate sphere to the highest levels of political control. In the hands of a totalitarian regime or any other malicious entity, this technology could be weaponized to cultivate loyalty and affection towards selected ideologies, organizations, or leaders, while instilling hatred or aversion to others. Likewise, such systems could detect dissenting thoughts in real time and respond with punitive measures, such as inducing pain or distress to silence opposition (Rafferty 2021, 57). This scenario represents the ultimate vision of control for an authoritarian regime: the power to govern not just external actions, but internal thoughts and emotions.

The reason why this may sound alarming is that, according to the Democracy Index of *The Economist* Intelligence Unit, in 2023 only about 8% of the world's population resided in a "full democracy," while nearly 40% lived under authoritarian regimes (*The Economist* Intelligence Unit 2023). And while it is true that we commonly associate these dangers with authoritarian or totalitarian regimes, it is critical to recognize that such risks are not exclusive to them and could emerge in any context where unchecked power and advanced technologies converge.

If we consider S. B. Divya's *Machinehood*, we can argue that the narrative perfectly illustrates the risks that control over certain technologies may bring, and the negative repercussions it could have in society. Not only is the terrorist group calling itself the Machinehood taking over several technologies via hacking, but they are also threatening to stop pill production in the name of an ideology. From reading Divya's novel, we can reflect on how society becomes powerless as it is at the mercy of those who hold the technological advantage.

Consider the hypothetical example of a democratic government facing a severe health pandemic. To control the spread of the disease, the government, working alongside health experts and international organizations, implements a wide-reaching vaccination program. However, some citizens are skeptical. In a society where BMIs are widely used, the government could employ BMIs in situations of emergency to automatically identify individuals who are hesitant or refuse vaccination and thus severely threaten public health. Those flagged as non-compliant might face serious consequences, such as restrictions on travel, denial of access to public spaces and services, or public shaming. Even more disturbingly, brain stimulation could be employed by governments to directly punish individuals who do not comply, inflicting pain as a deterrent (Rafferty 2021). In an even more troubling scenario, individuals' thought processes could be manipulated to the extent that their desire to remain unvaccinated is entirely erased.

If we look again at C.S. Lewis's *The Abolition of Man*, we see how this resonates with his arguments. What seems like power over our own minds can quickly become the power of some individuals over others. Those who own and control the technology wield influence not just over actions but over thoughts and identity itself. This dynamic reduces many to subjects or victims, shaped and controlled by forces beyond their own agency, stripping them of autonomy and self-determination (Lewis 2009, 54-56). This power imbalance can make governments, corporations, or tech developers the "Conditioners" that Lewis described (2009, 72-73), the ones that hold control over the very processes that define the human identity and agency of the "conditioned."

We can think of further concerns that include the possibility of misuse by insurance companies and corporations. Access to neural data could enable them to pursue targeted marketing campaigns or invasive surveillance programs (Rafferty 2021). The danger of unauthorized access is real; experiments have shown that it is possible with this technology to extract sensitive and private information from users, such as PIN codes, bank details, and the identities of familiar individuals (Martinovic *et al*. 2012). In a different study, researchers demonstrated that unconscious facial recognition can be accurately detected using EEG, revealing that "unaware recognition" can occur even when the person

does not consciously recall the faces they saw (Bellman *et al*. 2018). Considering that neurohacking is already a reality, the consequences of malicious actors gaining access to such sensitive information could be severe (Ienca & Haselager 2016).

M. T. Anderson's novel *Feed* (2002) vividly depicts this possibility, portraying a society that relies heavily on brain-implanted chips. With information being stored in the chip, one of the dangers explored is that of hacking, which endangers the users' personal information. The chips also allow the government and corporations to monitor people closely and target them with personalized content, conditioning their desires and behaviors.

Finally, these power asymmetries are also starkly visible in non-therapeutic uses, such as enhancing soldiers' capacities. A key application is the enhancement of cognitive functions like focus, alertness, and emotional regulation (*e.g.*, stress, anxiety, fear) to improve combat effectiveness (Munyon 2018, 2). A RAND Corporation report highlighted emotional modulation as a central goal of military BMI technologies (Binnendijk *et al*. 2020, 17). In science fiction literature, Welga's Advanced Technology and Intelligence training in *Machinehood* is a perfect demonstration of such cases, as is Richard K. Morgan's *Altered Carbon*, with its "neurachem conditioning" and augmentation to create super-soldiers. This demonstrates how the tools that can erode individual agency are often first developed and valorized within structures of institutional power, potentially creating a new kind of technologically-enhanced soldier whose very emotions are a tool of the state.

3.4. The Human Future: Transhumanism and Existential Questions

Finally, the convergence of challenges directly threatening agency, autonomy, identity, and power relations forces us to confront questions about human nature and our human future, for the simple reason that the debate around the development and applications of neurotechnologies sits at the heart of a larger philosophical debate about the very definition of what it means to be human and to live a good life. As we see from the *Lock In* technology, it is the nature of humanity and embodiment that is at stake. For example, what implications does transferring one's consciousness to a machine have for our understanding of what it means to be human and to exist as an embodied entity?

This debate is central to the transhumanist and posthumanist movements. Transhumanists argue that the messy design of our organic and biological bodies makes us fragile and disabled, and thus in need of enhancements (More 2020; Bostrom 2008). This perspective often relies on a dualist ontology, viewing minds and bodies as distinct, separate, and separable entities. In contrast, many posthumanists have contended the opposite, namely that the mind and body are deeply interconnected (Sorgner 2014). If this non-dualist view is correct, what viability can the entire project of mind uploading have, and how disruptive could its effects be on our identity and agency? The very attempt to separate consciousness from its biological substrate might not be a transition but a destruction of the self.

As Michael Hauskeller argued, it is a mistake to think that our human limitations are *per se* bad (2019, 65). These limitations are often constitutive of our experience and values. But we must ask existential questions like, how would such transformations affect the way we relate to one another and express our emotions? Wouldn't our digital, *in silica* existence as avatars greatly compromise human intersubjectivity (*i.e.*, the way we emotionally relate, express empathy, and share experiences), potentially leading to a fundamental redefinition of human dignity? These speculative questions help us articulate the main philosophical and ethical concerns regarding values like autonomy, agency, identity, dignity, freedom, love, justice, and others.

Some of these values are at the core of some of the science fiction narratives analyzed here, particularly *The Spare Man*. A close reading of the novel makes clear that Tesla Crane's life would have been very different without her DBPS. Tesla's autonomy and agency would have decreased because her motor function would have been impaired; the constant pain would also affect her dignity, her relationships, and her freedom. Tesla's life has been severely changed by her accident, and the Deep Brain Pain Suppressor has allowed her to reframe her life, regain her autonomy, and redefine her identity. This is the exact same thing we saw happen with Victoria Gray and Noland Arbaugh.

The widespread and uncritical adoption of such technologies could lead to the archetype of what Neil Postman defined as a **"**technopoly**"**: a society in which technology is the dominant and omnicompetent force that dictates and reshapes all other aspects of life. The idea is that technology is not just a set of tools or systems, but it becomes the central organizing principle of culture, politics, economy, and even personal identity (Postman 1993). Wouldn't this be even more true once neurotechnologies powered by advanced AI algorithms begin to condition our minds towards goals that are not our own, goals we can neither rationally scrutinize nor evaluate for their moral value, because they are the product of minds that have already been artificially engineered? Along the way, our autonomy is bypassed by technology.

Divya's *Machinehood* seems to illustrate Postman's scenario effectively by portraying a society ruled by technology, and in which someone's identity is based on their performance, itself dictated by the quality of the enhancement pills each person takes. Through the Machinehood Manifesto, the narrative demonstrates that political power and technology go hand in hand: "In the aftermath of every major technological advance, we observe a consolidation of wealth and then a political correction, some more bloody than others, but all leading to a redistribution of power across society" (Divya, 55). Once more, this narrative, alongside Scalzi's and Kowal's, focuses on the idea of power, control, and autonomy, stressing the relationship between humans and technology.

In any case, ensuing questions arise: who controls the data flowing through these devices? Who defines the limits of their use? How do we ensure that they empower rather than subjugate? Is there a risk that AI could reduce us to mere *standing reserves* (Heidegger 2013, 10), keeping us alive only to harvest our data? In a technopoly, will we be free, or will we, like the body in an experience machine, live trapped in an artificial illusion of existence?

Ultimately, the philosophical and ethical insights sparked by speculative thought, often inspired by science fiction literature, might have the potential to influence technology designers and contribute to the creation of responsible BMIs. If philosophers and ethicists can help shape the ethical foundations of these technologies, our speculations will prove their worth.

4. Inequality, Dependency, and Control: Political and Social Dynamics

To conclude our analysis, we will focus on the extrinsic ethical dimension, exploring how biomedical and neurocognitive tools may deepen existing inequalities and create new forms of social stratification. In this section, we argue that BMI adoption will not be a simple matter of individual choice but, above all, that it will be shaped by and will actively reinforce a recursive socio-technological loop. This loop, where technology reshapes the society that adopts it, creates conditions of "coercive convenience," transforming potential (cognitive, physical, emotional, moral) enhancements into motors of persistent social division and eroding the possibility of meaningful, autonomous choice.

In his 2010 book *The Artificial Ape*, Timothy Taylor gives us a compelling framework that we can use to shed light and understand the potential long-term societal impacts of BMIs. Taylor argues that human evolution has always been co-determined by our relationship with tools and material culture. He contends that the boundary between human biology and external technology has never been fixed. For example, early technologies, like slings, fire, and clothing have restructured our cognitive and social development in very substantive ways. What is crucial about Taylor's thesis is that technology is not just a product of intelligence, but one of its causes (2010, 77). This framework is especially relevant when considering the long-term societal impact of BMIs: these are not neutral and inert instruments, but recursive systems that will likely restructure behavioral norms and institutional structures, along with a deep alteration of all the economic and political structures of our societies, as older technologies have done up to this day (Taylor 2010, 202). Science fiction narratives, such as those in *Lock In* and *Machinehood*, depict precisely this; they present us with worlds where the introduction of BMIs has enacted profound societal changes that brought with them specific social, economic, and health disparities tied to access to technologies like "threeps" or enhancement pills. And while Kowal's *The Spare Man* presents an individual case of a BMI with no apparent effects on society, affecting only the protagonist, its mere existence may suggest that others could have access to a DBPS, implying, therefore, a structural change among certain social groups. On the other hand, access to this technology may be conditioned by economic barriers, which is not Tesla's case.

Therefore, unequal access to these technologies risks transforming existing social hierarchies into a hard-wired split between enhanced and unenhanced groups, reminiscent of the "GenRich" versus "Naturals" divide that Lee M. Silver (1999, 4-8) describes. Silver argues that a laissez-faire, free-market approach to genetic enhancement would increase genetic diversity within the human species to such an extent that a "species splitting" could become an inevitable consequence (1999). While Silver was speaking specifically about genetic enhancements, a similar dynamic can emerge from our progressive integration

with technologies like BMIs: those with the resources to acquire and use advanced BMIs may not constitute a genetically distinct species, but they could form a socio-technological elite that is functionally separate from the rest of the population and whose cognitive advantages translate into disproportionate access to institutional power and privilege. As certain groups gain privileged access to cognitive and physical enhancements, the gap between enhanced and unenhanced individuals solidifies into systemic divisions, affecting employment, education, healthcare, and political representation (Wolbring 2006). This dynamic reflects broader historical patterns where access to key infrastructures has shaped privilege and marginalization, but with higher stakes, as these tools alter the very capabilities that enable social mobility and participation.

Moreover, this stratification would be driven not only by cost, but by a more insidious mechanism: the normalization of technology through market forces and institutional expectations, which creates conditions of coercive convenience. Here, access to and mastery of a technological apparatus and symbolic language become a *de facto* requirement for social participation, rendering the choice to opt out socially or personally punitive. A simple, practical, and perhaps too familiar example might illustrate this quite well. In some fitness centers, members are now required to download a smartphone application to schedule sessions, enter and leave the gym via QR code scan, track attendance, pay fees, and other services. Many will see this as a seemingly (positive) minor change in their daily routines, but it entails a cascade of demands: one must own a compatible and updated smartphone, invest time in learning the interface, remain constantly connected to the internet to book sessions in advance, accept the app's intrusion into one's daily routines, and always carry the phone ready to grant access to gym facilities. While presented as convenience or optimization, this imposes a hidden tax on time, attention, consumption, and privacy, affecting at a significantly intrusive level those with limited technological access and digital literacy.

Hence, a regime in which opting out is no longer a meaningful choice ensues, in ways that even those prone to resist this interference cannot avoid, under the risk of being excluded from social life (the gym example is the tip of the iceberg, but think of other services like public transportation systems requiring digital tickets, government services moving to online-only platforms, healthcare appointment scheduling apps, school systems relying on digital portals for attendance and communication, etc.). Although it is framed as *voluntary* and *autonomous*, this dynamic of coercive convenience leaves little real autonomous choice, as opting out also carries the risk of social exclusion and non-participation.

This logic applies with even greater force to therapeutic BMIs. In *The Spare Man*, the protagonist's Deep Brain Pain Suppressor (DBPS) is indispensable for managing chronic pain, with benefits that range from being able to move painlessly to sleeping soundly at night (395). The device redefined the protagonist's entire life, allowing her to lead a full life that includes, for example, travelling with ease, getting married, and enjoying activities that would otherwise be impossible without the DBPS. However, this restorative technology could create a dependency where "opting out" means a return to debilitating suffering. The DBPS transitions from a voluntary aid to a necessary condition for a functional life, showing

how even beneficial, therapeutic BMIs can foreclose meaningful choice, embedding a form of technologically mediated necessity.

Science fiction depicts the social exclusion that follows from being on the wrong side of this coercive convenience. In M.T. Anderson's *Feed*, characters without the brain-implanted "feed" are progressively left behind and ostracized. Violet reflects on the difficulties her father faced attending university without a feed in a society where "three quarters of the American population" have them (Anderson 2002, 112). The feed, like today's smartphone, evolves from a discretionary tool to an infrastructural necessity without which full social participation is impossible.

This speculative dynamic finds a direct parallel in the marketing of contemporary consumer BMIs. Devices like the Muse headband, for example, are promoted not merely as tools for relaxation, but as essential cognitive coaches. A closer look at their website proves this; it is all about you taking action: "train your brain," "sharpen your attention," "push your cognitive limits," follow the guidance of an "AI brain coach" (Muse n.d.). This actively constructs a narrative where neurotechnological self-optimization is framed as a prerequisite for professional success and personal well-being. The implication is clear: to remain competitive, focused, productive, and mentally fit, one must engage with the technology. This pre-emptively structures the conditions of social participation where, much like in *Feed*, opting out is framed not as a choice, but as a deficit.

Again, Taylor's thesis helps explain how this external requirement becomes an internalized norm. The smartphone has evolved from a communication tool into a ubiquitous device of behavioral conditioning, employing tactics like rewards, habit-forming cues, and targeted content to guide attention, create routines, and keep users engaged (Anbumalar & Sahayam 2024, 1-2). It recursively shapes our cognitive processes and social expectations. This recursive loop blurs the boundary between external social pressures and internalized behavioral norms. In such a case, dependency is both engineered by our own design and embedded in our own lived experiences. What initially seems like a response to institutional or market demands gradually turns into a self-reinforcing dynamic because technologies begin to shape our actions, and this gradually extends to how we think and relate to others (High *et al*. 2024).

For BMIs, this entanglement will intensify. Consumer-grade devices like the already-mentioned Muse are being advertised as tools for increased focus, productivity, stress management, and sleep, normalizing neurotechnological self-optimization as both a prudential responsibility and a competitive requirement. In this context, opting out can signal neglect, inefficiency, or social nonconformity (Norquist 2024). In Divya's *Machinehood*, renouncing enhancement pills means not being able to stay competitive with AI and suffering debilitating withdrawal symptoms, rendering a person "obsolete." The technology shapes the rules of the game, then defines the penalties for not playing.

This dynamic also echoes a classic dystopian trope: the individual who refuses the mandated enhancement. In Aldous Huxley's *Brave New World*, the rejection of the conformity-inducing drug Soma by characters like John the Savage represents the ultimate rebellion against a system that equates technological compliance with social stability and personal happiness.

Here, we see how the individual-level threats to agency and autonomy and the societal-level threats of stratification intersect. The structural imposition of coercive convenience meets the internal, pre-emptive modulation of advanced closed-loop systems discussed in Section 3. This convergence directly attacks what John Harris terms the "freedom to fall," understood as the essential capacity to make voluntary, even errant, moral choices, which is fundamental to moral agency (Harris 2016, 60-76). This attack operates on the structure of the will described by Frankfurt. Freedom to fall presupposes the possibility of second-order volition: the space to reflect on an impulse (a first-order desire) and choose, for better or worse, whether to endorse it as one's will. As we saw, a closed-loop BMI that pre-emptively modulates these impulses destroys that deliberative space, acting as an external source of first-order desires that the agent cannot reflectively engage with or reject. The individual is thus rendered, in Frankfurt's terms, a "wanton," meaning an agent who has first-order desires but does not have any second-order volitions. In other words, the agent does not care about which of his desires becomes his will; he does not reflect on or identify with some desires over others (1971, 10-11). Hence, what is going on is this: the societal pressure of coercive convenience externally compels the adoption of technologies like BMIs, while the BMI itself is internally pre-empting volition, thus eroding agency and autonomy from the outside and from the inside, and thereby collapsing the very possibility of "Frankfurtian" freedom. In this way, when societal structures make non-adoption punitive, and the technology itself can bypass our conscious deliberation, the space for authentic, purposeful choice is eroded at both the social and the cognitive level.

John Scalzi's *Lock In* engages with this matter by exposing the fault with the Integrators, who are subjected to possible viruses in their neural implants that allow Hadens to use and abuse Integrator bodies, removing their freedom. But since society is structured in a way that makes it difficult for both Hadens and Integrators not to be active participants, there is little choice but to submit to these principles and agree to the risks.

All in all, what begins as unequal access to emerging neurotechnologies potentially evolves into forms of stratification that were unintended at first, where social inclusion depends not only on material access but on profound behavioral and cognitive alignment with technologically mediated rules. Hauskeller's concept of the "transhumanisation of culture" (2015) is visible in this pervasiveness, where external structures of coercive convenience (*i.e.*, market logics, institutional adoption, infrastructural dependency) converge with internal processes of neuromodulation and self-regulation. This makes extrinsic and intrinsic dimensions of technological control inseparable, blurring the line between autonomous adoption and pervasive structural imposition.

Again, Frankfurt's work on free will is useful to shed light on this problem. According to Frankfurt, moral responsibility does not require the ability to do otherwise, but only that one's action was not caused by the constraint that removed those alternatives. As Frankfurt states, "the principle of alternate possibilities is false. A person may well be morally responsible for what he has done even though she could not have done otherwise. The principle's plausibility is an illusion, which can be made to vanish by bringing the

relevant moral phenomena into sharper focus" (1969, 829). The recursive socio-technological loop described in this section, however, creates a more totalizing threat: the external constraint (coercive convenience) and the internal bypass (pre-emptive neuromodulation) do not merely remove choices. Instead, they become the causal drivers of thought and behavior. Thus, the individual likely acts only because the system has engineered his compliance. In this scenario, the system is no longer a simple constraint but the primary cause of the action. Consequently, Frankfurt's criterion for moral responsibility cannot be met, as the conditions for authentic, reasons-responsive agency are systematically dismantled.

Therefore, this analysis, grounded in the anticipatory heuristic of science fiction, demonstrates that the foremost ethical-political challenge of BMIs lies in their potential to become catalysts within a recursive socio-technological loop. This loop threatens to transform cognitive enhancement from a matter of personal autonomy into a mandatory, stratifying force. It challenges established conceptions of justice and autonomy by revealing how technologies can engineer dependencies that operate simultaneously through external structures and internalized norms. The task for neuroethics and the philosophy of technology is thus expanded: it must develop frameworks not only for the ethical design of devices, but for resisting the emergence of these totalizing socio-technological systems that, more than foreclosing the very possibility of the "freedom to fall," exclude us from the decisional loop altogether.

5. Conclusion

In this article, we explored the deep ethical challenges posed by emerging technologies, namely Brain-Machine Interfaces (BMIs). Our analysis highlighted the potential risks these technologies pose to personal autonomy, agency, identity, and justice. Through the analysis of works by Scalzi, Divya, and Kowal, juxtaposed with real-world cases like those of Patient R, Victoria Gray, and Noland Arbaugh, we have traced a continuum of philosophical and ethical concerns that allowed us to reframe speculative fiction as a vital form of anticipatory philosophical inquiry into the nature of the self and the social contract.

BMIs, while offering therapeutic benefits, raise concerns about the erosion of individual autonomy and agency, the potential for manipulation by corporations or governments, and the loss of self-determination and the sense of selfhood. The speculative scenarios analyzed suggest that while technological advancements hold great promise, they also demand careful ethical scrutiny to ensure that progress does not come at the cost of human dignity and civil and political liberties. In fact, the real-world case scenarios analyzed are already punctual examples of these challenges.

Speculative fiction serves as a crucial lens for ethical reflection on all these pressing challenges. By presenting imagined worlds shaped by biomedical interventions, these narratives compel us to confront the ethical dilemmas, societal transformations, and philosophical puzzles that these technologies already pose, challenges that will only increase over time. Works like *Lock In*, *Machinehood*, and *The Spare Man* allow us to critically evaluate the potential trajectories of technological progress, offering a platform to consider not only the benefits but also the identified risks of these innovations. Moreover,

with its ability to envision alternative futures, science fiction serves as a vast field of untapped possibilities, filled with the potential of *what could be*. Philosophy, much like the man with the lamp, walks through this field, searching for the ethical dilemmas and challenges that might arise within these imagined futures. Engaging with these narratives allows ethicists, technologists, and other parties to examine the implications of technological advancements, particularly as they relate to values as important as autonomy, agency, identity, privacy, justice, and human dignity more broadly. The continuous integration of technologies into our lives (*e.g.*, Internet of Things, Internet of Bodies) will make the dialogue between philosophy and speculative fiction increasingly essential.

Ultimately, this dialogue reveals that the paramount challenge posed by BMIs is one of integration: not just of machine with brain, but of technological progress with a coherent, defensible vision of human flourishing. By bringing science fiction into sustained conversation with philosophy, this article argues that safeguarding our future requires us to look ahead with both imaginative foresight and rigorous ethical scrutiny, ensuring that as we re-engineer our capacities, we do not unmake our values.

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