Neuralink and BCIs: Addressing Policy Gaps and Societal Concerns

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

A month after Neuralink, Elon Musk's pioneering brain-computer interface (BCI) company, successfully implanted its first device, known as the "Link," into a human subject, the wires came loose. As a result, the device malfunctioned, leading to a decrease in data transmission (Gibson, 2024). Reports soon revealed that Neuralink knew about these potential issues for years but proceeded with human trials regardless (Levy, 2024). This incident highlights the complex relationship between corporate decision-making, trust in private companies, and the policies governing life-altering technology.

Neuralink, founded by Musk in 2016, is at the forefront of developing BCIs. As the Government Accountability Office (GAO) stated, these devices "allow people to control machines using their thoughts," which can ultimately "help people with disabilities as well as enhance human-computer interactions" (GAO, 2022, p.11). With bold promises, such as restoring motor function, enabling thought-based control of devices, and even enhancing humans cognitively, Neuralink has captured the attention of scientists and the public at large (Neuralink, n.d.). While its therapeutic applications align with societal values like improving quality of life, their hints at enhancement applications raise concerns about ethics and potential inequities.

These concerns open the floor for questions about the regulatory frameworks that govern BCIs. Specifically, the research question guiding my research is as follows: Does the current policy landscape surrounding BCIs reflect societal values, and if not, what gaps need to be addressed? In this paper, I explore the intersection between BCI technology, corporate priorities, societal values, and policy— ultimately leading to policy proposals which will allow for Neuralink and other BCI companies to be more aligned with the values of society.

In order to do so, I focus on the policy analysis framework and methodology, in which I examine existing regulations, identify their strengths and weaknesses, and assess their effectiveness in addressing ethical, social, and technical concerns. In my research, I analyze existing regulatory frameworks, such as HIPAA, the GDPR, and FDA guidelines through both ethical and technical lenses. This approach evaluates how well current policies align with core societal values such as privacy, autonomy, equity, and transparency, and it lays the groundwork for proposing reforms. By the end, I argue that there are indeed gaps that need to be addressed, as we must create policies which are better suited for life-changing technologies, such as mandatory transparency, ethical oversight, dynamic consent frameworks, and establishing different guidelines for enhancement and therapeutic applications.

Background

Neuralink was founded in 2016 by Elon Musk, with "the intention of creating another 'layer' to the brain to complement the functions of existing layers like the limbic system and the cortex" (Konapur & Zou, n.d.). In other words, its goal was to create BCI technology that could integrate seamlessly with human brains, enabling direct communication between the brain and external devices. Musk first publicly mentioned Neuralink in 2017, explaining that the importance of such technology is that it would allow humans to stay competitive with AI, hinting at it primarily being used in an enhancement fashion (Baxter, 2025).

In 2021, Neuralink released footage of a monkey playing 'Mind Pong,' successfully controlling the paddles on the screen using only its thoughts. This demonstration helped bolster confidence in the Link's efficacy, and Neuralink used this to pivot their sentiment. Musk stated that the first Neuralink product would "enable someone with paralysis to use a smartphone with their mind faster than someone using their thumbs," and that "later versions will be able to shunt

signals from Neuralinks in brain to Neuralinks in body motor/sensory neuron clusters, thus enabling, for example, paraplegics to walk again" (Reuters, 2021). This signaled the start of Neuralink's shift to therapeutic endeavors, potentially trying to garner more public trust and acceptance. This can also be seen in Musk's tweets from around the same time, as he posted on X, formerly Twitter, "The device is implanted flush with skull & charges wirelessly, so you look & feel totally normal" (Musk, 2021).

Axios reported that in May of 2023, Neuralink received FDA approval to begin human trials with the Link. They also outlined the general process that a company must go through for a medical device, such as the Link, to become marketable. This includes defining the Link as a medical device, classifying the risks associated with it, beginning human trials, and undergoing the premarket approval process (Knutson, 2024). As of now, Neuralink is in the human trial stage, so they are well on their way to going to market. Neuralink and the FDA, however, have not disclosed any additional information about their regulatory interactions. Privately held companies such as Neuralink are not obligated to provide details about these proceedings, leaving a lot of details out of view from the public and potentially leaving room for some skepticism, especially in the face of recent issues (Dickey, 2023).

In January 2024, the Link was implanted into its first human patient, Noland Arbaugh, who was able to control a computer and play video games like Mario Kart using only his mind. While his condition has remained stable, about 85% of the device's wires slipped loose from his brain, temporarily reducing the Link's functionality (Jewett 2024). It later came out that Neuralink was aware of this potential for years, but they somehow received approval from the FDA and proceeded with human trials (Levy, 2024). Also, this seemed far from the therapeutic

benefits Neuralink had promised, stirring skepticism among the public, as progress seemed slow and long-term reliability seemed uncertain.

This brings us to today. In August 2024, Neuralink announced a second trial with a patient named Alex. The device has become quicker to use out-of-the-box, it has gained more use cases such as more complex first-person-shooter video games and computer aided design (CAD), and there have been measures in place to reduce the potential for the thread retraction seen in the first patient. Neuralink stated that Alex has not experienced any thread retraction to this point (Neuralink, 2024).

While Neuralink has made notable progress, significant challenges remain. It is yet to be seen how the device can be used in a purely therapeutic manner, and Neuralink has not yet let go of the potential for the Link to be used in enhancement applications. Their mission statement clearly states a goal to "eventually expand how we experience the world" (Neuralink, n.d.). This may make people question their true motives, begging the question of whether their shift to therapeutic purposes may just be a temporary stepping stone toward the approval and acceptance necessary to achieve broader, more dramatic goals.

Societal Values

The integration of BCIs like the Link must reflect the societal values of the communities they serve, and the procedures and policies surrounding this integration must do the same. Failure to do so could exacerbate inequalities, destroy public trust, and limit innovation. Conversely, aligning with societal values can foster public acceptance, ensure ethical development, and create regulations which encourage responsible innovation. Understanding what society values will lay the groundwork for later discussions surrounding policy analysis and

identifying gaps. In all, across the U.S. and Europe, these values emphasize ethical responsibility, equity, privacy, and transparency.

One set of values in both the U.S. and Europe which relates to Neuralink and BCIs is equity and accessibility. In both of these regions, there have been talks around the risk of neuro-technological divides, where the benefits of BCIs could disproportionately favor wealthier individuals or nations (Mykhalchuk, 2022). As the Royal Society from the United Kingdom stated, "If cognitive enhancement confers a long-term advantage to users who can afford it, this increases inequity within generations; if those users are then better able to afford enhancement for their children, disadvantage is multiplied across generations" (The Royal Society, 2019, p. 70). People are clearly scared of the prospect of using BCIs purely for enhancement purposes, instead favoring the idea of equitable and universal access for therapeutic BCIs.

Relating to this concern surrounding inequity, another core societal value in the development of BCIs is the prioritization of therapeutic benefits over cognitive enhancements. Both Europe and the U.S. share a strong preference for using BCIs to improve quality of life for individuals with disabilities or medical conditions. Studies in Europe advocate for BCIs to restore autonomy to individuals with severe impairments, emphasizing their role as tools for inclusion rather than a means for people to exercise their privilege (Glannon, 2014). U.S. perspectives on bioethics also reflect a cautious approach to enhancement, with people often pushing back against enhancement applications due to how they may deepen existing inequalities or create new forms of social division (Grubler & Hildt, 2014).

It is also clear that transparency and corporate trust are relevant societal values. In order for large corporations like Neuralink to gain trust from the public and other scientists, they need to be transparent, particularly in addressing societal concerns about safety, regulatory

compliance, and ethical use of neural data. Both U.S. and European perspectives, according to Bernd Carsten Stahl and coauthors, emphasize the importance of public engagement and oversight to ensure that technological advancements reflect societal priorities (Stahl et al., 2017). However, as Shoshana Zuboff outlined in *The Age of Surveillance Capitalism*, there is growing apprehension about the power of technology companies to exploit data for profit, particularly personal data (Zuboff, 2019). Neural data, being inherently tied to thoughts and emotions, make these concerns even bigger. This leads into the final societal value which I will discuss.

Autonomy and privacy is another critical societal value. Since BCIs inherently interact with users' neural data, privacy concerns become paramount. This value is already clear in some laws and regulations that I will examine in more detail soon, as they aim to protect individuals' sensitive data by establishing guidelines for data handling, processing, and consent. Additionally, Sedat Sonko and coauthors emphasize the importance of developing robust regulatory frameworks to protect users' cognitive freedom and privacy in the face of rapidly advancing technology (Sonko et al., 2024).

In all, these values — therapeutic prioritization, equity, transparency, autonomy, and privacy — are central to evaluating whether current BCI policies reflect societal expectations. While this list isn't exhaustive, it provides a useful lens for identifying policy strengths and gaps. As BCIs continue to evolve, aligning their development and regulation with societal values will be crucial for building public trust and minimizing risk.

Neuralink Concerns

As already touched on in the discussion of societal values, there are concerns with Neuralink, and I have categorized them into four main areas: corporate power/prioritization, equity, trust and transparency, and surveillance.

In terms of corporate prioritization and equity concerns, Neuralink's focus on both therapeutic and enhancement applications raises concerns that profitability may outweigh societal benefit. While the company's goals currently state that they want to help people with disabilities regain motor control, they have also consistently hinted at enhancement applications, such as "merging our intelligence with artificial intelligence" to compete with AI (Gurtner, 2021, p. 1). These applications may target wealthier markets, overshadowing the development of therapeutic applications for those in need. This also comes with future risks, as "many researchers highlighted the high potential for such a scenario to 'exacerbate class divisions,'" as "the reproduction of social inequalities would be even more amplified than already exists in society'" (Kostik-Quenet et al., 2022, p. 5). Clearly, balancing innovation and accountability will remain an important challenge for Neuralink's long-term plans.

Along the lines of trust, Neuralink's past actions have been marked by a lack of transparency, leading to skepticism about their intentions and the safety of their technologies. As mentioned, reports of thread retraction in the Link device highlight the risks of going forward with trials without fully fixing known issues (Levy, 2024). Also mentioned was how private companies like Neuralink are not required to disclose details of their interactions with regulatory agencies, leaving the public with little insight into their ethical considerations and compliance with regulations (Dickey, 2023). Making all of these trust issues even more serious is how Neuralink has been able to proceed with trials despite known issues, as well as how Neuralink deals with neural data, which is uniquely personal and sensitive.

One additional concern is the potential for broader surveillance and behavioral control, as highlighted in Brian Brock's discussion of surveillance capitalism. While Neuralink presents itself as therapeutic, history has shown that technologies claiming to be for therapy often become

tools used for other purposes, such as exoskeletons for people with mobility impairments later being repurposed for military applications to enhance soldiers' strength and endurance (Enterprise Wired, 2024). Brock claims that the collection of neural data could be leveraged for economic and political gain, ultimately undermining individual autonomy. In fact, he highlighted that this data can become even more powerful when combined with existing forms of data, stating "By combining different forms of data—the sort of information your phone collects, for example, and cortex activity—both sets become more meaningful" (Brock, 2023, p. 162). If not regulated, BCIs could create a future where people are subjected to new levels of surveillance and data-driven manipulation.

Addressing these risks is crucial for the future of Neuralink and the entire BCI industry, and creating strong policies and regulations is the best step to take. The following sections examine existing policies and identify key gaps to secure a safer and more ethical future for BCIs.

Current Laws and Regulations

Several existing policies, including HIPAA, GDPR, and FDA regulations, play a role in governing BCIs and their development, each with distinct approaches to data privacy, medical safety, and more. Most were created before BCIs came about and then retroactively applied to these technologies.

One such policy is the Health Insurance Portability and Accountability Act (HIPAA), enacted in 1996 to regulate how Protected Health Information (PHI) is handled by healthcare providers, insurers, and their associates (GAO, 2024). However, HIPAA has both applicable and non-applicable aspects in the context of Neuralink and other BCI companies. Since BCIs record data surrounding brain activity and response to stimuli, it is considered biometric in nature, and

HIPAA protects this information (McDonald, 2016). However, these protections are limited to medical contexts, such as if the data is transferred to insurance providers or doctors (Li, 2018). This means that if Neuralink works with healthcare providers or sends them any neural data during clinical trials or rehabilitation programs, they would have to comply with HIPAA, as it would become a business associate of those entities who are already bound by HIPAA's rules. This includes implementing safeguards for data, ensuring patient consent, and restricting unauthorized access.

The General Data Protection Regulation (GDPR) is a European Union regulation offering broader protections by giving individuals control over their personal data and setting strict guidelines for companies handling it (GDPR, n.d.). Often seen as the gold standard for data protection, the European Union clearly stated that "the protection of natural persons in the relation to the processing of personal data is a fundamental right." These rules also apply to organizations outside the EU that "offer goods or services" or "monitor the behavior" of individuals within the EU (GDPR, Article 3), meaning that if Neuralink expands to global markets, it would be bound by the GDPR (Office Journal, 2016). Under the GDPR, Neuralink's processing of neural data falls under special category data, which requires "explicit consent" unless an exception, such as medical necessity, applies (GDPR, Article 9). As a company handling biometric and health-related data, Neuralink must establish a lawful basis for processing, as outlined in Article 6, which states that data processing is lawful only when it is "necessary for the performance of a contract," "complies with a legal obligation," or has been granted "explicit consent" from the data subject (GDPR, Article 6). Additionally, users in the EU have several rights over their neural data, including "the right to access" (GDPR, Article 15), "the right to erasure" (GDPR, Article 17), and "the right to data portability" (GDPR, Article 20).

Users can also object to automated decision-making that produces "legal effects concerning him or her" or "similarly significantly affects him or her" (GDPR, Article 22). Compliance with these regulations is essential for Neuralink's potential expansion into the EU, ensuring transparency, user control, and ethical data usage.

The U.S. Food and Drug Administration (FDA) is responsible for regulating BCIs like the Link under its Center for Devices and Radiological Health (CDRH) (Health, 2025). As touched on earlier, the risks associated with the device under consideration must be classified, and since BCIs involve implantation into the brain, they are classified as Class III medical devices. This means they are subject to the FDA's most stringent approval process due to their severe potential risks. Before conducting human trials, Neuralink was required to obtain an Investigational Device Exemption (IDE), demonstrating sufficient safety data from preclinical studies before progressing further—a step it successfully completed. However, before the Link can be marketed to the public, it must still receive premarket approval (PMA), which requires extensive testing to assess long-term safety, reliability, and effectiveness (Knutson, 2024). Additionally, the FDA enforces "good manufacturing practices" and mandates post-market surveillance, requiring Neuralink to monitor patients and report adverse events (Chan, 2024). However, questions remain about how well existing FDA regulations address the unique challenges of adaptive BCIs, particularly regarding long-term effects, device updates, and ethical concerns surrounding the value-laden nature of the Link's abilities.

Policy Gaps

HIPAA, established in 1996, clearly has gaps that stem from it being enacted well before these new technologies. Although HIPAA broadly covers biometric data, it falls short in specifically addressing neural information, a highly sensitive form of data. This lack of detailed

guidelines has the potential to become especially problematic when companies like Neuralink shift towards realms that are closer to consumer electronics than medical devices. HIPAA's protections apply only when neural data is processed within the context of traditional healthcare systems. As the Office of Civil Rights (OCR) highlights, HIPAA's role remains dependent on whether Neuralink operates within a healthcare framework, as its protections only extend to entities covered under the law (OCR, 2015). If Neuralink were to take more of a direct-to-consumer (DTC) approach instead of going through conventional healthcare frameworks, Dylan Sekuterski stated, "Neuralink and similar DTC neurotechnology companies may not fall under the 'covered entities' classification" of HIPAA (Sekuterski, 2023). This means that the collection, storage, and sharing of neural data would not be subject to HIPAA's safeguards, allowing Neuralink to do essentially anything with patients' sensitive data.

Regulatory gaps like this raise significant concerns in the context of the societal values mentioned earlier, such as privacy, transparency, and equity. Without sufficient oversight, individuals could have their neural data exploited or misused, undermining public trust in these new and innovative technologies. Ambiguity in HIPAA's language not only leaves sensitive neural data vulnerable but also makes us think of a bigger issue, which is the need for modern policies which explicitly address emerging technologies. Revising existing policies to cover these direct-to-consumer models is very important in a time where BCIs and other technologies are rapidly evolving,

While the GDPR provides more expansive protections than HIPAA directly does, it still has some gaps in the context of neural data. One major challenge is the issue of true anonymity. Although the GDPR allows the use of anonymized data, Alyson Tseng stated that even anonymized data that is stripped of direct personal identifiers can often be used to "re-identify

specific individuals" due to the unique patterns present in neural data (Tseng, 2020, p. 7). This means that even if Neuralink anonymizes data that is studied and sent to partners, a clear gap exists which can get around the GDPR's promise of privacy and directly go against society's value of keeping their sensitive data private. Also, as Tseng further highlighted, the topic of consent within the GDPR is a bit more complicated in the neural data context. According to the definitions listed in Article 4 of the GDPR, "consent of the data subject means any freely given, specific, informed and unambiguous indication of … agreement to the processing of personal data relating to him or her" (GDPR, Article 4). However, neural interfaces often generate data that is both unforeseen and unrelated to the initial purpose for which consent was obtained. As Tseng argued, "consent cannot be meaningful or legally valid if it is collected once at the beginning of data collection when the data's future research uses are largely undetermined" (Tseng, 2020, p. 9). This approach to consent which fails to account for the dynamic and evolving nature of neural data makes it unclear if people are truly able to exhibit control over such personal information.

Specifically, the GDPR's protections fall short in the areas of autonomy and transparency. Autonomy is essentially taken away when people can not exercise continuous and ongoing control over how their sensitive information is used or if they can't make a truly informed decision about all the things their data may be used for. This lack of dynamic consent also reduces transparency in data storage/processing practices, as again, people can be left uninformed about potential future uses of their data. Altogether, these gaps compromise individual rights, and they also make it harder for people to trust new technologies and the policies that govern them, as society's values such as privacy, autonomy, and transparency are directly threatened by the lack of comprehensive protections.

The FDA's evaluation framework also has gaps which mostly stem from the value-laden nature of technologies such as the Link. While the FDA is competent at assessing safety and efficacy through specific processes and metrics, it struggles more with subjective questions about what is truly beneficial. In a peer-reviewed article in the AMA Journal of Ethics, Charles Binkley and coauthors noted, "Because what is good or beneficial to an individual is subjective and value laden, it is not justifiable for the FDA to base its approval of a device on any one specific notion of what is good or beneficial" (Binkley et al., 2021, p. 746). This statement highlights a fundamental limitation: the FDA's risk-benefit analysis cannot fully capture the complex ethical, social, and personal considerations that come with the use of BCIs. These value judgements are implicit in the FDA's safety and efficacy evaluations, but they, just like the GDPR, rely on a static and fixed notion of what individuals see as beneficial, which is less suitable for an evolving technology which walks the line between therapy and enhancement

This static and inflexible approach conflicts with societal values such as autonomy, equity, and transparency. For example, when users are promised improvements in quality of life, they also likely expect that these promises are rooted in ethical bases that respect their personal values and circumstances. If the FDA's framework does not allow for these considerations, then these users may be subjected to devices whose approved benefits do not align with their own beliefs of what truly constitutes a benefit. It treats the idea of benefits as the same for everyone, hurting autonomy and equity in the process. This gap also hurts transparency, as the FDA's approval process which is based mostly on quantifiable safety and efficacy data can overshadow the underlying value judgments that must be made in regards to making products such as the Link and other BCIs available for the public. This lack of clarity in terms of the FDA's scope of

responsibility makes it difficult for the public to fully understand or trust that the benefits of BCIs truly outweigh the risks in a way that aligns with their values.

Policy Suggestions

Taking the identified policy and regulatory gaps into consideration, it is clear that new policy frameworks must be developed to address the unique challenges posed by BCIs like Neuralink's Link device. Given the dynamic nature of these technologies and the inherent connection they have with individual privacy, autonomy, and social equality, policymakers must design regulations that consider the future, explicitly acknowledge the sensitive nature of neural data, balance therapeutic and enhancement uses, and maintain public trust.

One policy recommendation is to modernize existing regulations like HIPAA by specifically incorporating neural data under its protections and also applying strict data use guidelines even for direct-to-consumer models. This could start by expanding the definition of biometric data to explicitly include neural data, and also holding companies operating outside of conventional healthcare frameworks to high standards. Patrick Magee and coauthors backed up this neural data distinction, stating, "Adopting a…term like cognitive biometrics would allow regulators to treat similar data alike based on inferences they enable and the risks they pose to mental privacy" (Magee et al., 2024). Policymakers should also distinguish between enhancement applications and therapeutic uses. By creating separate regulatory criteria for these two categories, policymakers can ensure that devices intended for cognitive enhancement, which tend to be more value-laden and prone to inequities, are not lumped into the same category as technologies designed solely for therapeutic purposes. This sort of distinction would uphold the societal value of prioritizing therapeutic benefits, ensuring that further advancements in BCIs do not worsen existing disparities in access and quality of care.

In regards to the gaps identified in the GDPR, additional changes may be needed despite those who think of it as the gold standard. For example, there could be policies which require periodic audits and risk assessments for anonymization techniques in order to ensure that even when direct identifiers are removed from data, it is not susceptible to being tracked back to specific individuals. Along with these concerns were concerns about consent. To combat this, a new consent framework should be established which takes into account the dynamic and ongoing changes in data collection and usage that comes with these devices. As stated in an article published on the Future of Privacy Forum, "Developers and regulators should… identify measures facilitating a level of transparency that both gives users meaningful control over personal neurodata and reflects a particular BCI application's privacy risks" (Berrick, 2022). This would give individuals prolonged and ongoing control over how their data is used, aligning with the societal values of autonomy and transparency.

To further this transparency, companies like Neuralink must also be required to disclose more details regarding their research, development, regulatory interactions, and clinical trials, with the hopes of avoiding the repetition of previous issues involving the knowledge of potential problems before they inevitably arose. By publicly disclosing information about their data handling practices, trial outcomes, and regulatory interactions, this would not only open the door for external oversight, but it would also create a system of accountability. As a result, the policies surrounding Neuralink and BCIs would better align with transparency, equitable access to information, and corporate trust.

Lastly, the FDA's evaluation framework should evolve to better integrate ethical oversight alongside its safety and efficacy assessments. To allow them to focus more on their strengths, this could be through independent advisory committees consisting of a wide range of

relevant stakeholders, such as bioethicists, patients, advocates, and industry experts. These groups could assess whether the benefits of BCIs align with societal values such as equity, therapeutic prioritization, and fairness, rather than relying solely on quantitative measures of safety and efficacy. A model for this already exists in NYU Langone's Compassionate Use Advisory Committees (CompAC), which include bioethicists, medical experts, and patient representatives who provide guidance on the allocation of investigational drugs. This structure has ensured a transparent and fair evaluation process, and it has been deemed a success by third party evaluators (Division of Medical Ethics, n.d.). Implementing a similar structure for BCI regulation would allow for a more nuanced risk-benefit analysis and ensure that the approval process does not naturally favor a single notion of what constitutes a benefit.

In all, updating policies to explicitly cover neural data in both healthcare and direct-to-consumer contexts, establishing guidelines to distinguish between therapeutic and enhancement uses, implementing dynamic consent processes, requiring transparency at all steps, and integrating ethical oversight into development and regulations are all potential avenues for reform. These policy suggestions aim to ensure that the transformative potential of BCIs is not just encouraged, but encouraged in a way that protects individual rights and aligns with broader societal values.

Conclusion

In conclusion, I have explored the array of challenges posed by BCIs like Neuralink's Link device, and I have examined how current regulatory frameworks align or fail to align with core societal values. We have seen that while BCIs offer promising therapeutic benefits, they also cause complex issues related to privacy, autonomy, equity, and transparency. Current policies such as HIPAA, the GDPR, and the FDA's evaluation framework provide some protections, but

they ultimately fall short in addressing the unique characteristics of neural data and the inherent value-laden considerations that come along with such new and transformative technologies.

Beyond addressing the immediate concerns surrounding Neuralink, the provided policy recommendations have broader implications for the governance and regulation of emerging technologies. As society begins, and continues, to face the ability for technology to be a means for both empowerment and division, it is crucial that policy frameworks evolve at the same rate. This dynamic and iterative approach will help protect individual rights and also allow for responsible technological innovation.

Ultimately, while I provided a foundational analysis and a set of preliminary policy ideas, it is only the beginning of an ongoing conversation. Further research by subject matter experts and policy specialists is necessary to refine specific clauses, stipulations, and metrics of the broader suggestions which I provided. While I presented these ideas, they must become more specific and actionable in order to be put into effect, which is beyond the scope of my research. Also, as the future of Neuralink continues to unfold, continuous monitoring and new policymaking will be critical. By taking these ideas into the future, we can ensure that we unlock the potential of these truly groundbreaking technologies while still ensuring that they align with and promote the societal values of therapeutic benefit, equity, transparency, autonomy, and privacy.

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