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Review Article

Recent Progress on Neuralink's Brain-Computer Interfaces

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ABSTRACT

Brain-Computer Interfaces (BCIs) represent a rapidly evolving frontier in neuroscience and engineering, establishing direct communication pathways between the brain and external devices. Neuralink, founded in 2016, has emerged as a leading and ambitious entity in this domain, driven by a vision that encompasses both near-term therapeutic applications for severe neurological disorders and a long-term objective of achieving a symbiotic relationship between human and artificial intelligence. This comprehensive review synthesizes the latest available information on Neuralink's core technology, its significant developmental milestones from preclinical animal studies to pioneering human trials, and its expansive future roadmap. We critically examine the innovative technologies underpinning the Neuralink platform, including the N1 implant (The Link), high-density flexible electrode "threads," and the precision robotic surgical implanter (R1 Robot). Furthermore, we analyze the substantial technical, regulatory, and ethical challenges inherent in this transformative technology, such as issues of biocompatibility, long-term device stability, data security, and the profound societal implications of human enhancement. By consolidating and evaluating Neuralink's progress and ambitious vision, this paper provides an in-depth overview of its potential to revolutionize medicine, redefine the boundaries of human capability, and contribute to the broader discourse on human-AI integration.

INTRODUCTION

The direct interfacing of the human brain with computational devices, once a staple of science fiction, has transitioned into a tangible and rapidly advancing objective within biomedical engineering [1]. Brain-Computer Interfaces (BCIs) are sophisticated systems designed to acquire, analyze, and translate neural signals into commands for external output, thereby establishing a non-muscular channel for communication and control [2]. Historically, BCI research primarily focused on restoring lost function for individuals suffering from severe

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motor or sensory disabilities. However, recent exponential advancements in neurotechnology, microfabrication, and artificial intelligence have significantly accelerated progress, bringing the prospect of high- bandwidth, bi-directional brain interfaces closer to widespread reality.

Neuralink Corporation, established in 2016 by Elon Musk and a distinguished team of neuroscientists and engineers, has positioned itself at the forefront of this technological revolution. The company's stated mission is dual-pronged: to develop ultra-high-bandwidth BCIs for addressing a spectrum of neurological conditions in the short term, while simultaneously pursuing a long-term vision of creating a symbiotic link between human cognition and artificial intelligence (AI) [3]. This ambitious dual objective distinguishes Neuralink from many conventional BCI research endeavors, framing its work not only as a medical imperative but also as a potential trajectory for the future of human evolution and the mitigation of existential risks posed by advanced AI.

This review provides a comprehensive and updated examination of the Neuralink platform, incorporating the latest developments as of mid-2025. We will delve into the foundational vision that propels the company, meticulously dissect its core technological innovations, and chart its remarkable progress through key preclinical and clinical milestones, including the recent human trials. Furthermore, we will critically analyze the ambitious future outlook proposed by the company, contrasting it with the significant technical, safety, regulatory, and profound ethical challenges that Neuralink must navigate to realize its transformative potential. This paper aims to serve as an authoritative resource for understanding the current state and future implications of Neuralink's pioneering work in the BCI landscape.

ORIGINS AND FOUNDATIONAL VISION

Inspiration and Early Goals

The conceptual genesis of Neuralink’s ambitious vision is frequently attributed to the science fiction concept of a "neural lace," a sophisticated, brain-interfacing mesh described in Iain M. Banks seminal Culture series [4]. This fictional construct, enabling seamless mind-machine interaction, was adapted by Elon Musk into a more concrete and immediate objective: the creation of a "digital tertiary layer" that would augment the human brains limbic system and cortex. Musk's primary articulated motivation for this endeavor is existential. He posits that in order to mitigate the potential long-term risks posed by advanced general artificial intelligence, humanity must dramatically increase the bandwidth of its own cognitive connection to the digital world. This, he argues, is crucial for achieving a "symbiosis with artificial intelligence" and ensuring humanity's continued relevance and control in an increasingly AI-dominated future [5].

While this overarching, long-term vision undeniably centers on human enhancement and the potential for a new stage of human evolution, the company’s initial and more pragmatic mission has been strategically focused on developing medical devices. Specifically, Neuralink aims to create technologies for treating severe neurological conditions, including brain and spinal cord injuries, and a range of debilitating diseases. This medical-first approach provides a clear, well-defined regulatory and ethical pathway for the technology’s initial development, clinical validation, and eventual deployment, allowing for a phased introduction of increasingly advanced capabilities.

Company Evolution and Funding

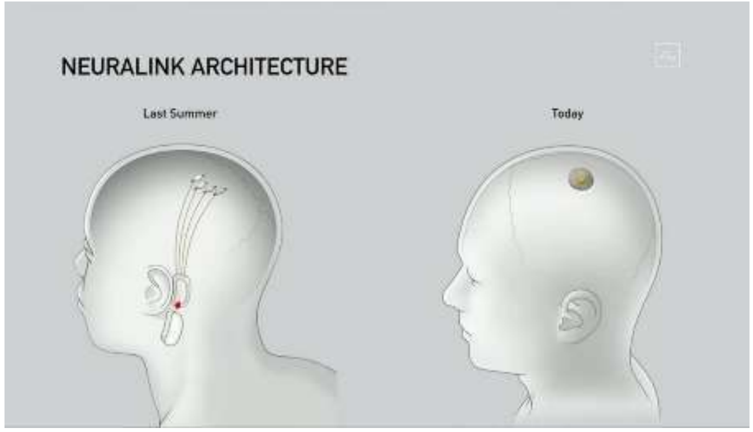
Neuralink operated in a highly secretive "stealth mode" during its formative years, quietly assembling a multidisciplinary team of top-tier talent drawn from diverse fields such as neuroscience, robotics, microfabrication, and electrical engineering. Headquartered in Fremont, California, with announced plans for significant expansion in Austin, Texas, the company has successfully secured substantial funding to fuel its capital-intensive research and development efforts. By 2019, Neuralink had alreadyraised 158million, with a significant portion—100 million—contributed by Elon Musk himself [6]. More recently, a major funding round announced in June 2025 reportedly secured an additional 650million, bringing the total raised to over 1 billion. This substantial influx of capital underscores robust investor confidence in Neuralink's rapid progress, its technological advancements, and its ambitious future potential [7]. The consistent ability to attract significant investment highlights the perceived viability and transformative impact of Neuralink's endeavors within the neurotechnology landscape.

Core Technology and Innovations

Neuralink's distinctive approach to Brain-Computer Interfaces is characterized by the synergistic integration of three primary technological innovations. These advancements are meticulously engineered to surmount the inherent limitations of conventional BCI systems, which have historically struggled with issues such as low channel count, potential for tissue damage, and the practical constraints imposed by percutaneous (tethered) connections.

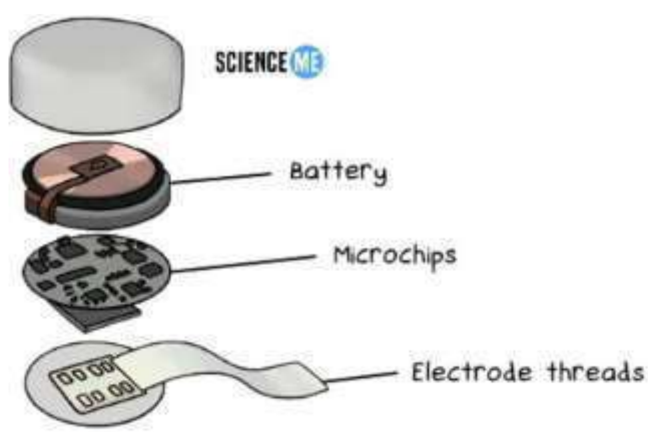
Technology	Description	Key Features	Advantages	Future Goals
N1 Implant ("The Link")	Hermetically sealed, coin- sized device surgically embedded in the skull.	23mm x 8mm, wireless (inductive charging), 1024 electrode channels, custom ASICs, Bluetooth transmission.	Eliminates percutaneous wires (infection risk), cosmetically invisible, high channel count.	All-day battery life, enhanced processing capabilities.
Flexible Electrode "Threads"	Ultra-thin, flexible polymer threads with electrodes.	4-6 µm width, biocompatible (polyimide), 64 threads per implant, 16 electrodes per thread (1024 total).	Minimizes tissue damage, inflammation, glial scarring; moves with brain.	Thousands to millions of channels for higher resolution.
Surgical Robot ("R1 Robot")	Custom- designed robot for precise thread insertion.	High-resolution optics, autonomous trajectory planning, avoids blood vessels, 1.5 sec/thread insertion.	Unparalleled precision, automates complex surgery, reduces human error.	10-minute procedure, comparable to LASIK, mass scalability.

A. N1 Implant ("The Link")



The N1 implant, colloquially known as "The Link," serves as the central processing unit of Neuralink's BCI system. This device is a hermetically sealed, coin-sized disc, measuring approximately 23mm in diameter and 8mm in thickness, designed for seamless surgical embedding within the skull. The implantation procedure involves a craniectomy, where a small circular section of the skull is precisely removed and subsequently replaced by the N1 implant, allowing it to sit flush with the surrounding cranial bone. A pivotal innovation of the N1 is its completely wireless operation, which eliminates the need for external wires that traditionally penetrate the skin. Such percutaneous connections are a significant source of infection risk and limit patient mobility and comfort. The N1 implant is inductively charged via a wearable external charger, conceptually similar to a modern smartwatch, providing a convenient and hygienic power solution [8]. Initial reports from human trials indicate a battery life capable of sustaining operation for the majority of a day, with ongoing development aimed at achieving all-day usage. Internally, the N1 houses custom-designed Application-Specific Integrated Circuits (ASICs) that are responsible for the amplification, digitization, and preliminary processing of neural signals. These ASICs manage data from an impressive 1,024 electrode channels before wirelessly transmitting the processed information via a high-bandwidth Bluetooth connection to an external device, such as a smartphone or computer, for further decoding and interpretation [9].

B. Flexible Electrode "Threads"



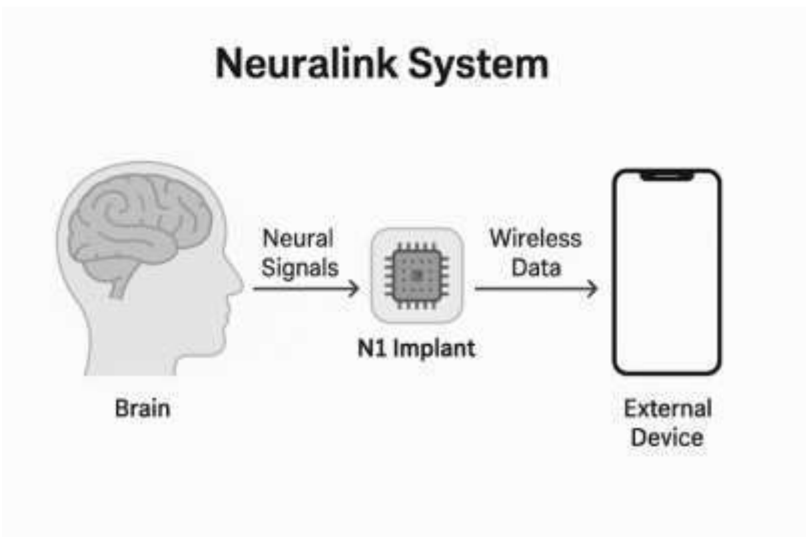
Neuralink's departure from the conventional rigid silicon-based electrode arrays, such as the widely used "Utah Array," marks a significant paradigm shift in intracortical BCI design. Instead, Neuralink developed ultra-thin, highly flexible "threads" [10]. These threads, fabricated from biocompatible polymers like polyimide, are remarkably slender, with a width ranging from approximately 4 to 6 micrometers—substantially thinner than a human hair. This inherent flexibility is a critical design feature, enabling the threads to move synchronously with the brains natural micromotions within the cranial cavity. This dynamic compliance is theorized to significantly minimize tissue damage, reduce inflammatory responses, and mitigate the formation of glial scarring, a common biological reaction that can progressively degrade signal quality and device performance over extended periods [11]. Each N1 implant is intricately connected to 64 of these flexible threads, with each thread housing 16 individual electrodes. This configuration collectively provides 1,024 distinct recording and stimulation channels per implant. These electrodes are dual-functional, capable of both "reading" (recording the electrical activity, or action potentials, from individual neurons) and "writing" (delivering precise electrical stimulation to specific neural populations). This bi-directional communication capability is fundamental for both decoding neural intent and potentially modulating brain activity. Future iterations of the Neuralink system are projected to scale this channel count dramatically, aiming for thousands and eventually millions of electrodes to achieve an unprecedented level of neural interface resolution [12].

C. Surgical Robot ("R1 Robot")

The precise and safe insertion of Neuralink's delicate threads into specific cortical layers, such as Layer 5 of the motor cortex, without causing damage to the surrounding neural tissue or the dense vascular network on the brain's surface, presents an extraordinary surgical challenge. To overcome this, Neuralink engineered a highly specialized, custom surgical robot, designated the R1 Robot. Often described as operating with the precision of a "sewing machine," the R1 robot integrates advanced high-resolution optical systems to meticulously map the intricate vasculature of the cerebral cortex. This detailed mapping allows the robot to autonomously plan a safe and optimized insertion trajectory for each individual thread, meticulously avoiding blood vessels as minute as a few microns in diameter [13]. This unparalleled level of precision is far beyond the capabilities of even the most skilled human neurosurgeon. The R1 robot employs a sophisticated needle-like tool that delicately grasps and inserts each thread individually. Neuralink's ongoing development aims to further enhance the robot's capabilities; next-generation models are reportedly capable of inserting a single thread in as little as 1.5 seconds and are designed to be compatible with over 99% of adult skull anatomies. The ultimate strategic objective is to fully automate the implantation procedure to such an extent that it can be completed in approximately 10 minutes, thereby achieving an efficiency and accessibility comparable to that of LASIK eye surgery [14]. This automation is crucial for the scalability required to achieve Neuralink's long-term vision of widespread adoption.

D. Data Acquisition and Processing

Once the N1 implant is successfully positioned, the system initiates the continuous recording of neural activity, specifically focusing on action potentials or "spikes," from thousands of individual neurons simultaneously. This raw, high-volume neural data is then wirelessly transmitted to an external computational device, where sophisticated machine learning algorithms are employed to decode the users intended actions or thoughts. For applications such as motor control, these algorithms are rigorously trained to recognize and interpret the complex patterns of neuronal activation that correlate with a desired movement, such as manipulating a cursor on a digital display. The current demonstrated bandwidth of the Neuralink system, as evidenced by the performance of its first human participant, is approximately 10 bits per second (BPS) for cursor control, a rate that has enabled record-breaking performance in digital interaction [15].



However, Neuralink's long-term objective is to achieve significantly higher data rates, targeting megabit and eventually gigabit-level throughput. This massive increase in bandwidth is considered an essential prerequisite for realizing the ambitious vision of a whole-brain interface and ultimately enabling a true symbiosis with artificial intelligence, where complex thoughts and concepts could be directly communicated [16]. The continuous refinement of these decoding algorithms and the underlying data processing infrastructure is a complex thoughts and concepts could be directly communicated [16]. The continuous refinement of these decoding algorithms and the underlying data processing infrastructure is a critical area of ongoing research and development for Neuralink.

CLINICAL DEVELOPMENT AND MILESTONES

Neuralink's journey from conceptualization to clinical application has been marked by a series of significant developmental milestones, progressing from extensive preclinical animal studies to groundbreaking human trials, all under rigorous regulatory oversight.

A. Early Animal Work (Proof-of-Concept)

Prior to human implantation, Neuralink extensively utilized animal models to validate its technology and demonstrate proof-of-concept. Early work with rats successfully showcased the system's capability to record neural activity from over 1,500 electrodes simultaneously. A notable public demonstration in 2020, dubbed the "Three Little Pigs" event, featured a pig named Gertrude, who had a Link implant. This demonstration provided real-time transmission of neural data corresponding to her snout's interaction with various objects, illustrating the device's ability to capture meaningful brain signals in a living subject[17]. The most compelling preclinical demonstration, however, came in 2021 with Pager, a macaque monkey. Pager, equipped with a Neuralink implant, was able to proficiently play the video game "MindPong" using only his thoughts to control the paddle, providing a vivid illustration of the BCI's potential for intuitive control of external devices [18]. These animal studies were crucial for refining the implant design, surgical procedures, and decoding algorithms before advancing to human subjects.

B. FDA Approvals and Designations

Securing regulatory approval from the U.S. Food and Drug Administration (FDA) has been a critical step in Neuralink's progression towards human application. In May 2023, Neuralink announced a landmark achievement: receiving FDA approval to initiate its first-in-human clinical trial, officially known as the PRIME (Precise Robotically Implanted Brain-Computer Interface) Study [19]. This approval was a significant validation of the company's safety protocols and technological readiness. Following this, Neuralink has continued to receive additional FDA Breakthrough Device Designations, which are granted to devices that provide more effective treatment or diagnosis for life-threatening or irreversibly debilitating diseases or conditions. In September 2024, Neuralink received such a designation for its ""Blindsight vision restoration device, and in May 2025, for a speech restoration device [20]. These designations are crucial as they expedite the regulatory review pathways for these promising technologies, potentially accelerating their availability to patients.

C. Human Trials (PRIME and CONVOY Studies)

The first human implantation of a Neuralink device occurred in January 2024, marking a pivotal moment in BCI history. The recipient was Noland Arbaugh, a 29-year-old man with quadriplegia resulting from a diving accident. As part of the PRIME study, Arbaugh received the N1 implant, and the initial product enabled by this implant was named "Telepathy." Since his implantation, Arbaugh has demonstrated remarkable capabilities, showcasing the practical utility and transformative potential of the device. He has been able to play online chess, engage in complex strategy games like Civilization VI, and even control characters in Mario Kart, all solely through his thoughts. Notably, Arbaugh reportedly achieved and subsequently doubled the previous world record for brain-to-computer cursor control speed, and has utilized the device for up to 70 hours per week, indicating a high degree of practical utility and a positive user experience [21].

Building on this initial success, Neuralink has expanded its human trials, implanting several more participants, including Alex Toddling (P2) and individuals diagnosed with Amyotrophic Lateral Sclerosis (ALS). Demonstrations from these participants have further highlighted the versatility of the Neuralink system, including controlling a robotic arm for writing and playing rock-paper-scissors, operating a television, and performing tasks within 3D design software [22]. The CONVOY study, launched in November 2024, is specifically focused on exploring the use of the N1 Implant to control an investigational assistive robotic arm, aiming to restore greater independence for individuals with motor impairments [23]. In parallel with its domestic efforts, Neuralink has also secured regulatory approvals to launch trials internationally, including the CAN-PRIME study in Canada (November 2024), and additional trials in the United Kingdom and the United Arab Emirates, signifying a significant global expansion of its clinical research [24].

D. Addressing Early Challenges

The initial human trial, while largely successful, was not without its technical challenges. It was publicly reported that a number of the implanted threads in Noland Arbaugh's brain had retracted from the cortical tissue, leading to a reduction in the number of active electrodes and a subsequent degradation in performance [25]. Neuralink promptly addressed this issue by implementing a more sensitive decoding algorithm. This algorithmic refinement not only compensated for the loss of active electrodes but ultimately enabled Arbaugh to surpass his initial performance levels. For future surgical procedures, Neuralink has outlined specific plans to refine its implantation technique. These refinements include strategies for managing brain fluid levels to control brain size during surgery, optimizing the precise insertion locations of the threads, and implanting the threads to a slightly greater depth to mitigate the risk of future retraction. While the fundamental challenge of long-term biocompatibility— how biological tissue reacts to implanted materials over extended periods—is considered by the company to be "pretty well solved" due to its careful material choices, it remains a critical area of ongoing research and meticulous observation to ensure the sustained safety and efficacy of the implants [26].

FUTURE OUTLOOK AND VISION

Neuralink's strategic roadmap extends significantly beyond the immediate goal of restoring motor function and communication. The company envisions a future where its BCI technology not only addresses profound medical needs but also fundamentally reshapes human capabilities and the interaction between human and artificial intelligence.

A. Product Pipeline and Enhancement

Neuralink's product development is characterized by a clear progression from foundational restorative applications to advanced enhancement capabilities:

- **Telepathy:** The immediate and ongoing focus for Neuralink is to continuously improve the bandwidth, precision, and functionality of its initial product, Telepathy. The ultimate aim is to enable direct text decoding from neural activity, allowing users to type and operate complex software with speeds that rival or even exceed conventional manual input methods. This involves refining the decoding algorithms and expanding the range of multi-dimensional control capabilities [27].
- **Blindsight:** Neuralink's next major product, Blindsight, is designed to restore vision for

individuals who are blind, including those who have lost their eyes but retain an intact visual cortex. This ambitious endeavor will involve implanting devices directly into the visual cortex and utilizing an external camera to translate visual information into patterns of neural stimulation While initial versions are anticipated to provide a low-resolution, "bionic" form of vision, the long-term objective is to enable superhuman visual capabilities, such such as the ability to perceive infrared or ultraviolet spectra.Human implantation for Blindsight is tentatively anticipated . for late 2025 or 2026, following its FDA Breakthrough Device Designation [28].

- **Speech Restoration:** For patients suffering from severe speech impairments, such as aphasia or anarthria due to conditions like Amyotrophic Lateral Sclerosis (ALS) or stroke, Neuralink is developing a device capable of decoding intended speech directly from the brain's language centers. This technology holds immense promise for restoring effective communication and significantly improving the quality of life for non-verbal individuals, building upon the recent FDA Breakthrough Device Designation for this application [29].

B. Beyond Restoration – Cybernetic Enhancements and Superpowers

The long-term vision of Neuralink extends into the realm of cybernetic enhancement. A compelling future application involves the seamless integration of Neuralink devices with advanced robotics, such as the Tesla Optimus humanoid robot. This integration could potentially allow individuals with limb loss to control "cybernetic" Optimus arms and legs with the same intuitive neural commands as biological limbs, potentially even achieving faster response times and greater dexterity. A more profound and speculative application involves the ability to "mentally remote" into an Optimus robot, effectively inhabiting it and experiencing the world through its diverse array of sensors. This concept represents a clear and significant shift in Neuralink's trajectory, moving beyond mere restoration of lost function towards the augmentation and enhancement of human capabilities [30].

C. AI Symbiosis and Civilization Risk Mitigation

The ultimate, foundational goal that underpins Neuralink's entire enterprise is the establishment of a high-bandwidth connection between the human brain and artificial intelligence. Elon Musk articulates a future where complex, abstract thoughts and even "uncompressed concepts" can be directly communicated between human minds and AI systems, effectively enabling a form of conceptual telepathy. He argues that this unprecedented level of integration is not merely an advancement but an existential necessity for humanity to maintain pace with and remain relevant in a world increasingly shaped by superintelligent AI. This symbiosis is presented as a critical strategy for mitigating the potential long-term risks associated with advanced AI, ensuring that humanity retains agency and influence [31].

D. Scalability and Mass Adoption

To achieve its expansive vision, particularly the goal of AI symbiosis and widespread human enhancement, Neuralink recognizes that its technology must transition from a specialized medical intervention to a safe, affordable, and widely accessible platform. A cornerstone of this scalability strategy is the automation of the surgical implantation procedure using the R1 robot. The objective is to make the procedure as routine, efficient, and accessible as common corrective eye surgeries like LASIK. This ambitious goal necessitates massive investment in manufacturing infrastructure to facilitate the production and deployment of millions of Neuralink devices annually, transforming BCI technology from a niche medical solution into a pervasive human augmentation [32].

CHALLENGES AND CRITICISMS

Despite its rapid technological advancements and ambitious vision, Neuralink faces a multitude of significant challenges and has attracted considerable criticism from various stakeholders, ranging from animal welfare advocates to bioethicists and the broader scientific community.

A. Animal Welfare Concerns

Neuralink has been subjected to intense scrutiny regarding its treatment of animal test subjects during preclinical research. Organizations such as the Physicians Committee for Responsible Medicine have publicly alleged that early primate trials resulted in significant complications, undue suffering, and premature euthanasia, prompting federal investigations into the company's animal research practices [33]. These allegations have raised serious questions about the ethical conduct of Neuralink's animal studies. In response, Neuralink has consistently defended its practices, asserting its unwavering commitment to humane animal care and emphasizing the indispensable necessity of animal models for the safe and effective development of novel medical devices, particularly those involving invasive brain surgery. The company maintains that its animal research adheres to all applicable regulations and ethical guidelines, and that it actively works to refine, reduce, and replace animal use where feasible [34].

B. Human Safety Challenges

The long-term safety and reliability of any permanent brain implant remain a paramount concern. The potential risks associated with Neuralink's technology are multifaceted and include: infection at the implant site, tissue damage and scarring during the surgical implantation or subsequent removal procedures, potential device malfunction, and the critical issue of long-term biocompatibility of the implanted materials. The reported thread retraction issue observed in Neuralink's first human participant, Noland Arbaugh, while successfully managed through algorithmic adjustments, underscores the inherent and complex challenges of maintaining a stable and functional interface between delicate biological neural tissue and electronic components over extended periods [35]. Rigorous, long-term clinical data, extending over many years, will be absolutely essential to fully assess and mitigate these potential risks, ensuring the sustained safety and efficacy of the Neuralink device in human subjects.

C. Ethical and Societal Implications

Beyond the technical and safety considerations, the development and potential widespread adoption of high-bandwidth BCIs like Neuralink's raise profound and complex ethical and societal questions that demand careful consideration and public discourse.

- **Security and Privacy:** The prospect of direct neural interfaces introduces unprecedented vulnerabilities related to data security and privacy. The potential for a BCI to be hacked, or for highly sensitive neural data—including thoughts, intentions, and emotional states—to be accessed without explicit consent, represents a major concern. The manipulation of thoughts or emotions, once confined to the realm of science fiction, becomes a plausible threat in a world with advanced, interconnected BCIs [36]. Safeguarding neural data and ensuring robust cybersecurity measures will be critical.

- **Societal Impact and Inequality:** If Neuralink successfully achieves its human enhancement goals, it could inadvertently lead to the creation of a "two-tiered" society. In such a scenario, access to advanced cognitive or physical enhancements might be limited to a privileged few, exacerbating existing socioeconomic inequalities and creating a new form of digital divide between the cognitively enhanced and the unenhanced This raises fundamental. questions about equitable access, social justice, and the potential for a widening gap in human capabilities [37].
- **Identity and Consciousness:** The integration of advanced BCI technology directly into the human brain challenges our fundamental understanding of human identity, autonomy, and consciousness. As the line between human biological capabilities and machine augmentation blurs, questions arise about what it means to be human, the nature of personal identity, and the extent to which an individual's thoughts and actions remain truly their own when mediated or influenced by technology. The potential for a profound shift in self- perception and the very definition of humanity necessitates deep philosophical and ethical deliberation [38].

CONCLUSION

Neuralink has demonstrated remarkable and rapid progress, transitioning from an ambitious research and development endeavor to achieving tangible clinical impact in less than a decade. Through its innovative integration of flexible electrodes, wireless technology, and precision robotic surgery, the company has introduced a new paradigm for brain-computer interfaces, achieving unprecedented success in its initial human trials. The technology offers profound potential to restore function and significantly improve the quality of life for individuals grappling with severe neurological conditions, as evidenced by the groundbreaking achievements of its first human participants. However, the path to realizing Neuralink's full, expansive vision—ranging from widespread medical application to the ambitious goal of human-AI symbiosis—is fraught with immense hurdles. Overcoming the persistent technical challenges of long-term device stability, ensuring robust safety profiles, navigating the stringent and evolving regulatory landscape, and, crucially, addressing the complex ethical and profound societal questions raised by brain enhancement technologies will be as critical as the scientific innovation itself. Neuralink is not merely developing a medical device; it is engineering a technology that possesses the potential to fundamentally alter the human experience and redefine the very essence of human capability. Its continued development therefore warrants careful, critical, and sustained public discourse, ensuring that technological progress is aligned with societal values and human well-being.

This review is based on publicly available information, including company presentations, press releases, official blog updates, and peer-reviewed publications available as of mid-2025. Comprehensive peer-reviewed publications from Neuralink detailing the full scope of their technology and extensive clinical trial data are eagerly anticipated by the scientific community

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