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Neuralink Technology and Superego Functions: The case of China's Social Credit System

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Abstract

This paper explores theoretical dimensions of Neuralink technology and how superego-type ethical and moral compasses can be embedded in its functionalities. A case study of the Social Credit System applied in China serves as context for developing the arguments made. We consider how specific elements of Neuralink can directly affect users' behaviour, The analysis contextualises Neuralink technology as being at the most advanced stage of the spectrum of commercial digital technologies, and considers the economics of the servitisation elements that can be implemented through Neuralink. The superego-type configurations in the technology, identified as Superego+ in the paper, is suggested as a tool that can be built in its default mode through an amalgamation of Immanuel Kant's philosophical ideas. In the case study, we propose that China's Social Credit System can be implemented through Neuralink technology, customised

for the state-determined norms and standards, adding an explicit servitisation element to this technology. Ethical dimensions of this application are considered, covering both human aspects and societal perspectives. We aim to contribute to the new emerging literature on applications of Neuralink and other similar technologies, which are anticipated to be disruptive technologies at the forefront of Industry 5.0 and Society 5.0.

Keywords: Neuralink, Disruptive Technologies, Service Economy, Superego, China's Social Credit System

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1. Introduction

Artificial Intelligence is a disruptive technology that has the capability to potentially lead to significant paradigm shifts in the way that several sectors of economies operate. This technology seems to be at its infancy, and we are yet to experience the full extent to which it can influence international and domestic trade (Żukrowska, 2021), economic performance (Gonzales, 2023) , labour productivity (Moniz et al., 2022), labour markets and the way in which people live their lives. Technological advances in hardware have made it possible for computer hardware to extend beyond traditional options (i.e. computer mouse and keyboard), and to reach the stage in which computer hardware and peripherals are directly placed inside the human skull. Such options are available through Neuralink and Neucyber, which manufacture Brain Chip Implants (BCI) to be used in humans (Reuters, 2024).

Intervention directly in the human skull to connect a device would have only been considered in the context of science fiction up until recently, with several well-known movies being built around this idea, such as "Total Recall" (released in 1990), "The Matrix" (released in 1999) and "Kingsman: The Secret Service" (released in 2015). However, this concept has recently transcended to the real world, with Neuralink installing a BCI in the skull of a human volunteer (a quadriplegic patient), which allowed this person to control a computer system with functionalities similar to those of a traditional computer mouse (Gimenez et al., 2024).

In this paper, we conceptualise on the way in which BCIs can facilitate transition to the 5th Industrial Revolution, considering potential applications and capabilities that such chips can deliver, beyond the current implementation at human-testing level. We propose a 3-tier model, in which we consider the way in which technology, interconnectedness and artificial intelligence can help humanity through: prosthetics and life facilitator approaches; enhanced human capabilities; and applications that support humans in controlling their behaviours and creating beneficial outcomes for themselves, as well as positive economic externalities.

We recognise the several types of intelligence that psychological literature assumes (Lozano-Blasco et al., 2022). We suggest that performance in some of these areas can be improved through assistance from a BCI, if the technology is developed to deliver such services to its users. Based on this premise, and through the fundamental economic principle that states that "People respond to incentives" (Mankiw, 2018), we expect that there will be significant market demand for the use of BCIs. This can be the case if future regulation and legislation adjust to the existence of the BCIs, and they introduce frameworks which reward practices that can be

supported by this technology.

We contextualise this application through a case study of China's Social Credit System, through a theoretical approach on how BCIs can help people in the system achieve higher compliance. We assume that users can benefit from an AI-powered superego, in the absence of strong personal attributes that amount to a strong natural superego. We also explore the option for interconnected BCIs to curb human behaviour. This is based on the aforementioned economic principle "People respond to incentives", and has been examined empirically by Farmer et al. (2010) in another context.

2. Purpose of this paper

This paper focuses on Brain Chip Implant (BCI) technologies, focusing on Neuralink's projects. In the paper, we specifically conceptualize on the way in which BCIs can deliver value to their users, and how this technology has the potential to gradually transform industries and can lead to servitisation through paradigm shift in the operation of several markets and sectors of the economy. This study identified a gap in the literature om BCIs and their potential incorporation in society and the economy, and proceeded to examine this potential and implications. This study proposes one theoretical framework, with three explicitly different tiers – separated by extend of involvement of technology as well as by time horizon – for the understanding of the ways in which BCIs can be used, introducing novel services for users. This paper explores a state-of-the-art technology, and its practical implementations which can become large-scale in a relatively short time horizon. Considering this, one can see the value and the profound need for this study.

3. Literature review

3.1 Sigmund Freud's theory of the superego

Sigmund Freud, the founding father of psychoanalysis, introduced the concept of the superego as a crucial component of his structural model of the psyche (Schafer, 1960). Developed in the early 20th century, Freud's model divides the human psyche into three distinct elements: the id, the ego, and the superego. The id represents the primal, unconscious desires governed by the pleasure principle, seeking immediate gratification of basic drives. In contrast, the ego operates according to the reality principle, mediating between the id's demands and the external world (Freud, 1989). The superego, which emerges later in childhood through the internalization of parental and societal norms, functions as the moral conscience of the individual. The superego is further divided into two subsystems: the conscience and the ideal self (or ego-ideal) (Weigert, 1962). The conscience punishes the ego with feelings of guilt when societal rules are violated, while the ideal self-rewards the ego with feelings of pride when moral standards are upheld (Josephs, 2001; Milrod, 1972). These internalized ideals and prohibitions guide behavior by imposing moral judgments, striving to inhibit the impulses of the id, and persuading the ego to act ethically. Thus, the superego serves as an internalized representation of societal and parental norms, exerting a significant influence on behavior and decision-making.

In Freudian theory, the superego plays a pivotal role in regulating behavior and maintaining societal order by enforcing internalized moral standards. One of its primary functions is moral judgment, where the superego evaluates actions based on these internalized standards, resulting in feelings of pride or guilt. Additionally, the superego seeks to inhibit the id's base desires, ensuring that behaviors conform to societal norms and values (Parsons, 1952). By shaping the individual's aspirations through the formation of ideals, the superego motivates the pursuit of goals aligned with these standards. Furthermore, it mediates conflicts between the id and the ego, promoting actions that are socially acceptable and ethically sound. In essence, the superego functions as the moral compass of the psyche, guiding individuals toward ethical behavior and societal conformity.

Modern interpretations of Freud's concept of the superego have evolved, incorporating insights from various psychological disciplines. Contemporary psychoanalysts and psychologists have expanded upon Freud's initial concepts, considering the superego within the broader context of personality development and socialization (King & Noerr, 2020). These contemporary views

often critique Freud's deterministic perspective on human behavior and the overemphasis on early childhood experiences. Critics argue that the superego is not solely shaped by parental and societal norms but is also influenced by peer interactions, cultural shifts, and individual experiences throughout life (Garcia, 2003). In contemporary society, the concept of the superego can be applied to understand the psychological impact of various social and technological phenomena (Balick, 2018). The rise of digital surveillance and social media platforms, for instance, has introduced new dimensions to the internalization of societal norms (Fuchs & Trottier, 2015; Westin, 2003). Constant exposure to curated online personas and pervasive monitoring can amplify the superego's functions, leading to heightened feelings of guilt or inadequacy (Anusnigdha, 2024). This suggests that modern technology can intensify the internal pressures exerted by the superego, affecting individual behavior and self-perception.

In the context of China's Social Credit System, the superego concept is particularly relevant. This system, which monitors and evaluates citizens' behaviors to enforce conformity to social and legal norms, can be seen as an externalized superego. By rewarding or punishing individuals based on their actions, the Social Credit System mirrors the internal processes of moral judgment and inhibition of undesirable impulses. Similarly, emerging technologies like Neuralink, which aim to integrate human cognition with artificial intelligence, could potentially influence the superego's functions by altering how individuals internalize and respond to societal norms. By understanding these applications, we aim to highlight the ongoing relevance of Freud's superego in analyzing the interplay between individual psychology, societal expectations, and technological advancements.

3.2 Neuralink Technology

Neuralink Corp., is an American neurotechnology company founded by Elon Musk and launched in 2016, aiming to create brain-computer interfaces that enable direct communication between the human brain and external devices. Brain-computer interfaces represent a paradigm shift in the field of neurotechnology, promising to revolutionize the way humans interact with machines (Konrad & Shanks, 2010). Neuralink stands at the forefront of this revolution, developing sophisticated devices that bridge the gap between neural activity and digital interfaces. The company's flagship products, Telepathy and Blindsight, represent this technological leap, offering profound implications for individuals with disabilities and,

potentially, for the broader human-machine symbiosis.

Neuralink's primary products are designed to restore and enhance human capabilities through direct brain-machine communication. Telepathy is Neuralink's first product, which enables individuals to control a computer or a phone solely through thought. This product is particularly significant for people with paralysis, providing them with digital independence. By decoding brain signals related to movement and translating them into digital commands, Telepathy allows users to interact with their devices without physical movement (Khan et al., 2024). The implications for individuals with severe motor impairments are substantial, offering a new level of autonomy and engagement with the digital world. Blindside is another groundbreaking product under development by Neuralink, aimed at restoring vision to individuals who have lost their eyesight or optic nerve function. By stimulating the visual cortex directly, Blindside could enable blind individuals to perceive visual information, thus significantly enhancing their quality of life (Waisberg et al., 2024). This technology has been demonstrated in animal models, showing the potential to replicate naturalistic hand and leg movements and, in the future, restore vision.

The functionality of Neuralink's devices is rooted in sophisticated technology that combines miniaturized hardware, advanced software, and surgical precision. The key characteristics of these devices include miniaturized hardware, wireless communication, high bandwidth and low latency, and biocompatibility and stability. Neuralink's devices are comparable in size to a coin and are designed to replace a small portion of the skull. This miniaturized hardware contains tiny wires or electrodes, which are surgically implanted into the brain. These electrodes read and write electrical signals from and to the neurons, enabling direct brain-machine communication. The tiny size of the electrodes, which are a fraction of a human hair's diameter, minimizes brain damage and allows for more precise interfacing with neural circuits (Neuralink Corp., 2024).

The devices are entirely wireless, relying on inductive charging similar to that of an Apple Watch. This wireless capability ensures that users can interact with their devices seamlessly and without the need for external connectors, enhancing usability and comfort. The wireless communication also extends to the interfacing with external devices like computers and smartphones, typically using Bluetooth protocols. The current generation of devices already demonstrates significant control capabilities, with users able to perform complex tasks such as

playing video games and controlling computer cursors with their brain. The company envisions future devices achieving even higher bandwidths, potentially reaching megabit levels, which would enable more complex and rapid interactions.

The electrodes used in Neuralink's devices are designed to be biocompatible and stable over long periods. Once implanted, the electrodes interface with neurons by reading the electrical signals they produce and writing signals back to them. This bidirectional communication enables the decoding of brain signals related to movement, vision, and potentially other functions, translating them into digital commands that can control external devices (Drew, 2024). The software developed by Neuralink plays a crucial role in interpreting these signals and ensuring that the interactions are smooth and intuitive for the user. Neuralink's advancements in brain-computer interfaces represent a significant leap forward in neurotechnology.

Through its primary products, Telepathy and Blindsight, the company aims to restore and enhance human capabilities, offering profound benefits for individuals with disabilities. The combination of miniaturized hardware, wireless communication, high bandwidth, biocompatibility, and advanced surgical techniques underpins the functionality and potential of these devices. As Neuralink continues to refine its technology, the prospect of achieving seamless human-machine symbiosis becomes increasingly feasible, promising a future where the boundaries between biological and digital realms are profoundly redefined.

3.3 Transformative Service Research (TSR)

Transformative Service Research (TSR) is a relatively young research paradigm, a subfield within service research that focuses on the design, delivery, and impact of services aimed at improving individual and collective well-being (Rosenbaum, 2015). This research agenda extends beyond the traditional metrics of service efficiency and customer satisfaction to include broader societal outcomes such as health, happiness, and social equity (Anderson & Ostrom, 2015). TSR emphasizes the role of services in facilitating positive transformations in users' lives, advocating for the development and implementation of services that can bring about meaningful, long-term improvements. This perspective aligns closely with interdisciplinary approaches, integrating insights from psychology, sociology, and public policy to understand and enhance the ways services contribute to societal well-being (Russell-Bennett et al., 2019).

In examining Neuralink technology through the lens of Transformative Service Research (TSR), we see a unique opportunity to leverage advanced neurotechnology for substantial societal benefits. Neuralink's brain-computer interface, capable of influencing and enhancing human capabilities, presents a transformative service that can potentially elevate individual well-being and societal outcomes. By embedding ethical and moral compasses, akin to a Superego, into Neuralink's functionalities, we can create a service that not only augments cognitive and physical abilities but also guides users towards ethical behavior. This integration can drive positive behavioral changes, aligning with TSR's goal of enhancing life quality and social equity through innovative service designs.

Additionally, applying TSR principles to the case study of China's Social Credit System via Neuralink technology, we explore a service model where individual compliance and societal harmony are incentivized through digital means. Neuralink's potential to implement state-determined norms and ethical standards within its system exemplifies a transformative service with profound societal implications. By providing real-time prompts and cues, Neuralink can assist users in making decisions that align with social norms, thereby enhancing compliance and contributing to the common good. This approach not only aligns with TSR's focus on societal well-being but also demonstrates the practical application of integrating ethical frameworks within advanced technologies to foster a more compliant and harmonious society. Through this conceptual framework, we contribute to the emerging discourse on the ethical deployment of disruptive technologies in shaping the future of human behavior and societal interactions (Choi & Moon, 2023; Royakkers et al., 2018).

4. Conceptual Model

In considering current and future directions for BCIs, the model presented in this paper conceptualises three tiers. The model is illustrated in Figure 1. As we move across these, the intervention to humans becomes more complex and advanced, and the benefits and ethical dimensions for consideration become more significant. Also, the populations start from being very specific initially (i.e. patients needing support) and extend to applications for members of the general public who wish to receive/purchase the services that BCIs offer. By extension, the third tier of the moder can be considered as a potential avenue to addressing psychological conditions, working either in tandem with other mental health services providers, or independently as a separate support mechanism.

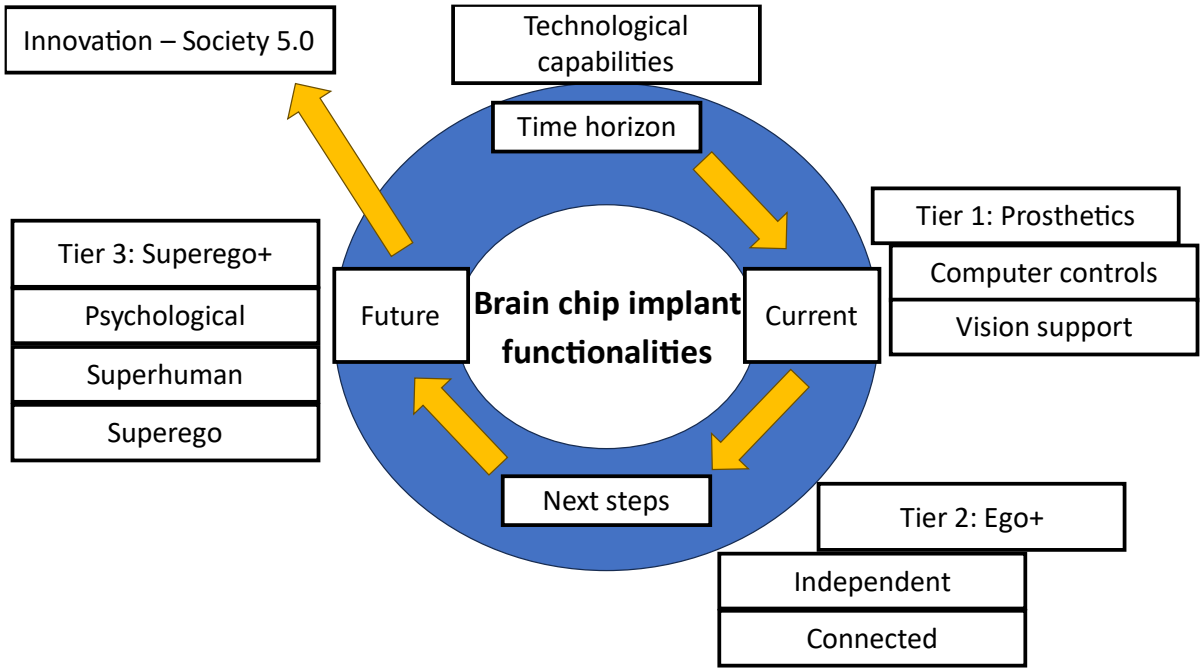

Figure 1: Main Model

4.1 Tier 1

Tier 1 of the model, titled "Prothetics", focuses on the use of BCIs as prosthetics. The details Tier 1 of the model are shown in Figure 2. This is very much associated with the current use of BCIs, which are in the human testing phase. This tier includes capabilities of using a computer cursor through the BCI. Equally, we could consider how the BCI can introduce keyboard capabilities, facilitating communication with the external world for patients who have limited ability to physically do so.

We assume that such controls can be extended to offer speaking capabilities, through software that creates spoken language and which can be controlled through a computer mouse and/or keyboard. Additional capabilities can be offered to future users of the technology through the control and use of exoskeletons. Additionally, it is possible that the technology can help patient gain the ability to see (Hart, 2024). This is something that Neuralink is exploring through the project Blindsight (Waisberg et al., 2024).

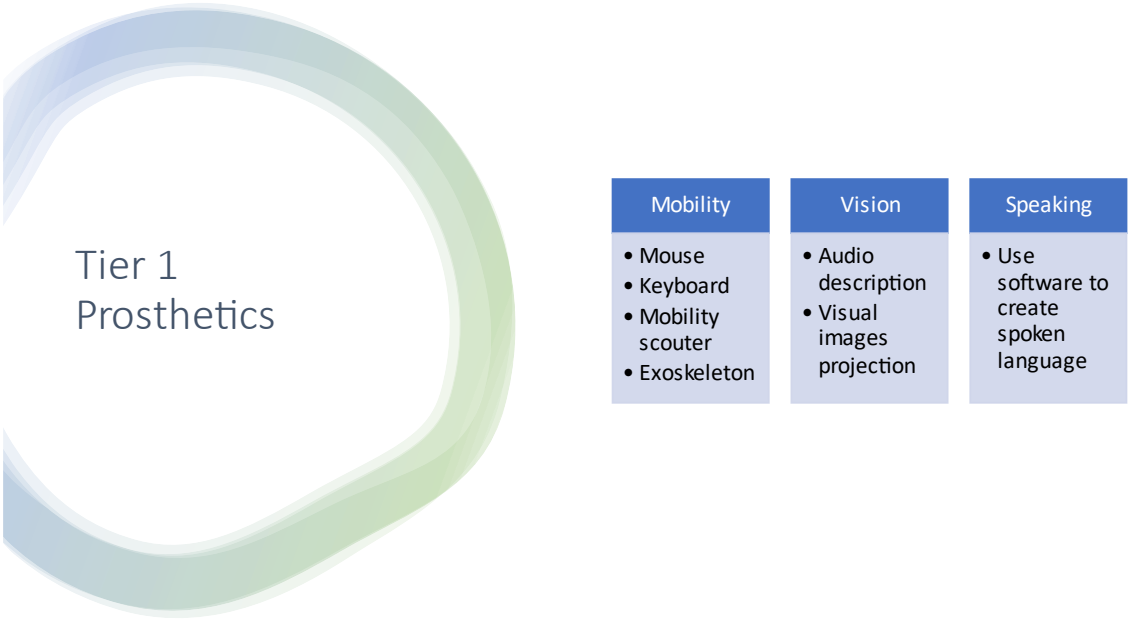

Figure 2: Tier 1 of the model

4.2 Tier 2

Tier 2 of the model, titled Ego+, suggests the use of the BCI to enhance the knowledge and information that users can access through this technology. This is anticipated as the next step in the implementation of BCI technology. This is conceptualised through two approaches: the Independent and the Connected.

The Independent approach relates to having the BCI acting separately from other devices. In this version, the technology acts as a source in which information can be stored and retrieved. The user can use the technology as a repository of knowledge and data.

The Connected approach goes beyond that, assuming continuous connectivity with the internet though other devices (e.g. mobile phone, laptop, Wi-Fi). The BCI acquires access to information and data on demand, and can facilitate the life of the user through this. This approach opens up the possibility of offering live support and suggestions to the user, covering a wide scope of possibilities which can include social skills, counselling, behavioural assistance and languages support. The suggestions in this list can expand and become more advanced and user-specific, as the application of the technology becomes more widely adopted.

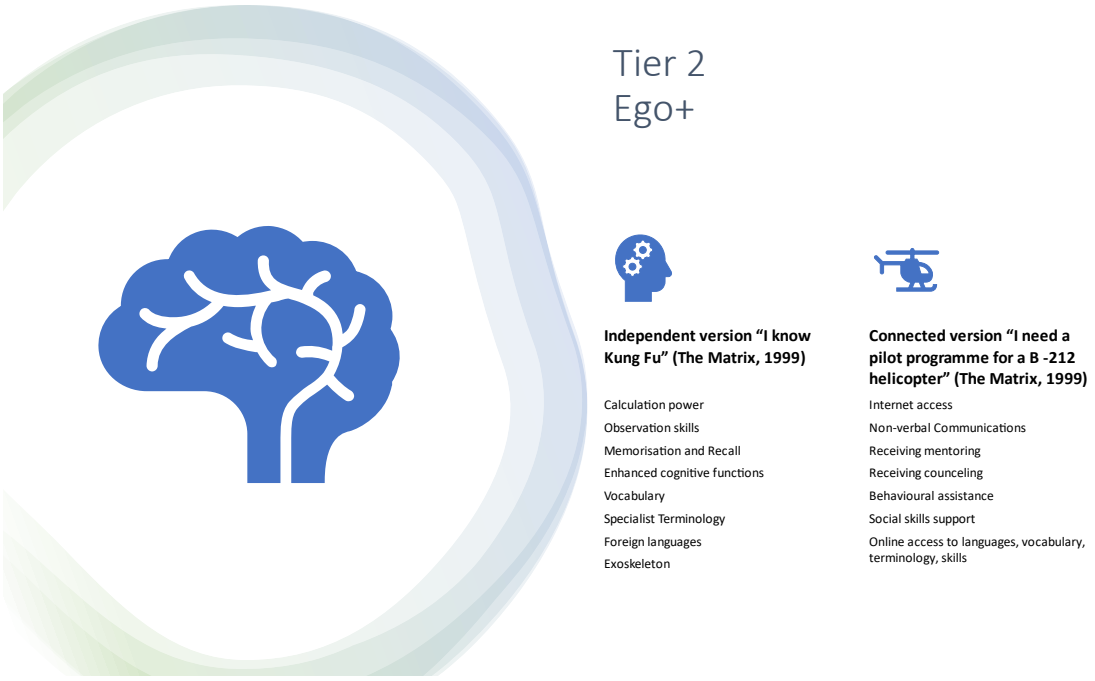

Figure 3: Tier 2 of the model

4.3 Tier 3

Tier 3 of the model, titled Superego+, suggests the use of BCI technology as a transformational agent in enhancing human functionality and performance. Tier 3 is illustrated in Figure 4. This is conceptualised as potential future application of BCIs, which can be implemented in the future, with the advance of connectivity of devices, 5G or beyond, and with Industry 5.0 and Society 5.0 or further coming into effect. We identify three approaches in this stage, and we remain open that many more applications can emerge in addition to or in parallel to these.

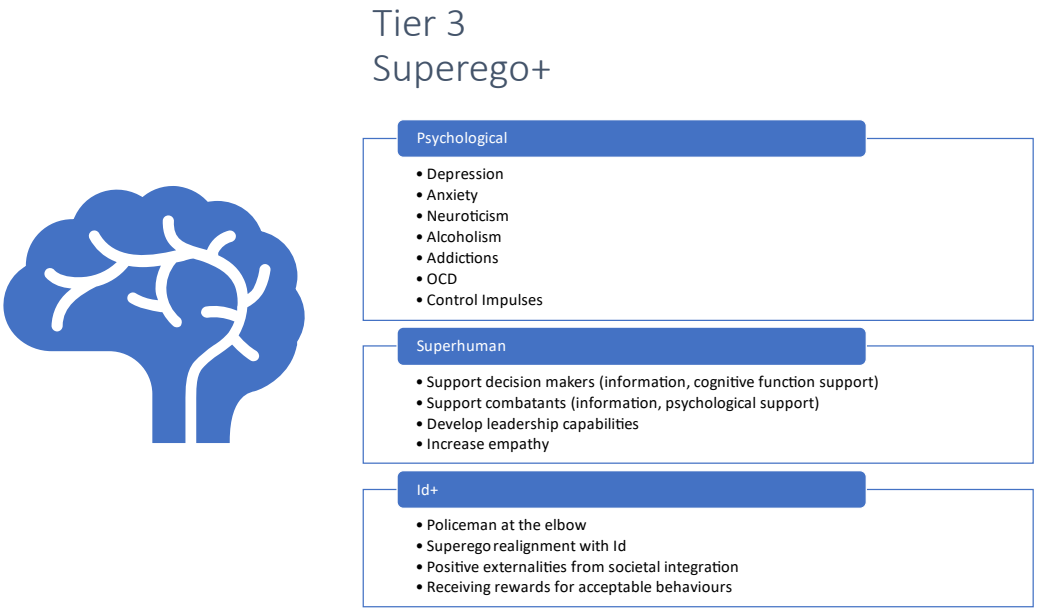

Figure 4: Tier 3 of the model

The Psychological approach focuses on offering support to users who need it. The BCI can offer psychological evaluation, mood stabilisation, counselling and support to users, helping them deal with low mood, issues in confidence, and perhaps also more severe conditions such as anxiety and depression. It might also help with addictions to substances (e.g. alcoholism) and Obsessive Compulsory Disorder control. The Superhuman approach suggests that decision making of users can be supported and enhanced through the BCI. The technology can provide guidance and rational decision-making support based on live information. This type of application of the technology can also be extended to allow users to drive vehicles, control drones, receive images and sound information from remote sources and sensors, and also to receive recommendations for optimal actions from Artificial Intelligence-driven platforms.

The Id+ approach is what the authors of this paper consider to be the most advanced application of the technology. Whilst the Psychological and the Superhuman approaches operate in a way similar to an external device, but delivered through the BCI (without the use of a hand-held device and a screen), the Id+ approach constitutes a technological leap. The BCI connects directly to the human and it enhances the human directly, rather than being a device that merely provides information to the user. In the Id+ approach, the BCI becomes part of the human system.

The way in which Superego+ applications of the technology are set up can potentially alter

significantly the outcomes of each application. In terms of decision-making support and superego configurations for the Superman and Id+ approaches of Tier 3, the paper's recommendation is that Kantian Ethics are used as the basis for morality in the default setup (Schmidt, 2024). This is expected to result in rational decisions and to adoption of moral laws and rules that are universal.

The conceptual model introduced in this paper assumes varying levels of incorporation of BCIs into the economy and into society. We theorize that the gradual implementation of BCIs will alter the way in which several sectors of the economy operate, leading to servitisation (Kowalkowski et al., 2017) of several industries which go through a digital transformation and transition to less hardware-heavy offerings.

4.4 China's Social Credit System – case study

China's Social Credit System is a system which scores the creditworthiness of an individual. There are practices and actions which increase the social credit score of an individual and practices and actions which decrease it (Mac Síthigh & Siems, 2019). As this system is merit-based and attempts to make citizens work towards hard-to-achieve outcomes, citizens could find it challenging to stay in the prescribed track, especially if they are not naturally inclined to do so. The BCI can act in enhancing their commitment and involvement with the process of earning points in this system. It is anticipated that monitoring in this system is highly technology-intensive, utilising face recognition cameras and large databases to implement scoring practices. Penalties in the system can be very significant for citizens, and they are expected to be interested in increasing their compliance levels and their social score. Introducing BCIs to this system can be conceptualised through the following 4 approaches.

1. As a measurement tool. This implies that BCIs become a part of the existing technological system for monitoring implementation of China's Social Credit System.
2. As a reforming tool. This implies that BCIs intervene to the user's brain, offering an artificial superego, which can be aligned with the Social Credit System's requirements and also can be customised to the needs and characteristics of the user.
3. As a measurement tool in an advanced Social Credit System. In this case, the BCI can be used to earn and deduce points to the user for their own thoughts.
4. As a judiciary and forensic tool. The BCI can help the legal system identify is a person has been reformed and whether they are likely to reoffend, based on the natural

superego function of each user and the willingness of the person to comply. In this case, the BCI can be a cyberpunk-type tool for the return of offenders to society.

5. Discussion

5.1 Brain Chip Implants and society

The major implication from the aforementioned implementation approaches for BCIs is that society and mankind might be altered in significant ways. People with access to this technology can use it to enhance their skills, substituting or supplementing self-acquired knowledge and experience. Generational wealth continuity and successful maintenance of assets and wealth can be facilitated through this process. Future generations being more likely to live up to the economic, managerial, leadership and overall entrepreneurial abilities of their ancestors. This can act in tandem with traditional approaches such as education, acquiring of experiences, mentoring support, professional support and social networks.

Social disruption that had traditionally been facilitated by education (Arnold, 2012) in previous paradigms of the ways in which economy works, especially in democratised capitalist-economy countries. Education allows members society that are considered to be of lower social class or of lower income to become successful professionals, disrupting societal structures. BCIs can make it possible that those who afford these will be more competent in a number of areas, making it more challenging for the aforementioned education-led transition to take place.

A new social class can emerge from this technology, with some members of society ending up being separated by others through possession of a large variety of strong skills and abilities, powered by BCIs. This can be a fascinating evolution, but it can also be alarming if we consider how it can lead to a more unequal society. Whilst Tier 1 applications in the model of Section 4 explicitly aim at building a more accessible society, attempting to facilitate users' lives, it is also the case that as we move to Tier 2 and then to Tier 3, there is the potential that BCIs will be used from people who do not need them to fulfill support needs, but instead wish to use this technology to acquire superior personal and professional capabilities that can give them an advantage in society and in business.

5.2 Challenges and Ethical considerations

Introducing BCIs does not only bring advantages and opportunities, but it also exposes users, industries and the economy to risks. The most profound of these risks is associated with cybersecurity. As with all other devices with connectivity characteristics, it is possible that BCIs can be a target of a cyberattack. Significance of such an event can range from the most unimpactful to the most severe.

Another consideration is the maintenance of the BCI, and what happens if there are any requirements for replacement of hardware in the future, as the device is installed surgically, and such surgeries as well as the removal of the previous device from the brain might have negative health consequences. Additionally, human health can be affected with a range of unidentified short-term, medium-term and long-term impacts that the BCI might create. These can be associated with the physical health as well as with the mental health of the user.

In terms of ethics, a very significant question is whether it is acceptable for a technology to be used in such a way, altering humans. For Tier 1 applications of the model that was presented in this paper, this can be straightforward. Projects like Neuralink's Telepathy and Blindsight have an obvious resemblance to prosthetics and to pharmaceutical products, helping users deal with health problems and issues. As we move to Tier 2 applications, this approach can also be adopted, but with more questions and doubts in place. For Tier 3 applications, one would have to wonder even more as to what is suggested is morally and ethically correct, as there is a possibility for changes that can be made to human decision-making, character, personality and conscience. The counterargument for this point is that such human characteristics can be altered throughout life and can be affected by the choices that each person makes and the life that they live. In line with being able to make other possible choices, people can also choose to have a BCI installed in their brain.

Another very significant aspect is the calibration of the BCI for Tier 3 applications. For these Superego+ applications which include decision-making support, and which also include the introduction of an artificial superego, working together with the natural superego of the user, setting the parameters of the framework is of critical importance. We suggest that the setup follows the philosophy of the Enlightenment philosopher Immanuel Kant. As per Kantian Ethics, the person should be prompted by the BCI in Superego+ mode to act rationally, and to uphold moral laws and duties. Such an approach can lead to consistent approaches in terms of

the nature of the support offered by the BCI, being consistent with the idea of categorical imperative.

6. Conclusions

This paper concludes that BCIs such as the ones from Neuralink can result in a paradigm shift for several industries, leading to Society 5.0 and Industry 5.0. The level of involvement of users with the BCI and the applications of it can vary very significantly, with the exact details not yet being known, as such applications have not reached the commercialization stage. Society, professional life and everyday life of users can be affected heavily, and society and regulatory authorities have to be vigilant to regulate and control the way in which this technology alters life as we know it. Valuable opportunities emerge for the use of BCIs, but we also identify that a number of challenges and risks are present.

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