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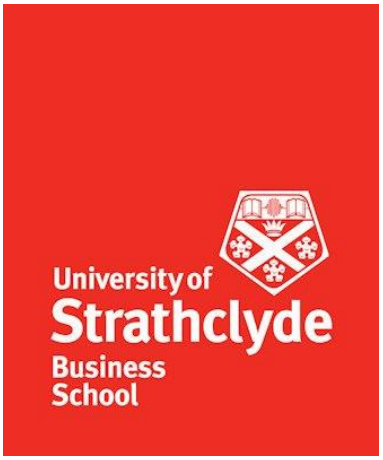

Brain Chip Implants and Superego Functions: The case of China's Social Credit System

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Brain Chip Implants and Superego Functions: The case of China's Social Credit System

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Abstract

This paper explores theoretical dimensions of Brain Chip Implant (BCI) 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 BCI applications, as implemented by Neuralink, can directly affect users' behaviours. The analysis contextualizes Neuralink's existing publicly known projects as the most advanced stage of the spectrum of commercial digital technologies, and considers the servitization elements that can be implemented through Neuralink's BCIs. In the case study, we propose that China's Social Credit System can be implemented through BCI technology, customized for the state-determined norms and standards, adding an explicit

servitization element to this technology. We note that having this technology drive parts of the paradigms in the economy suggest the study of relevant technological economics considerations. Ethical dimensions of such an application are also introduced in the paper, covering human aspects and societal perspectives. This paper contributes to the relatively new emerging literature on applications of BCI and other similar technologies, which are anticipated to be disruptive technologies at the forefront of Industry 5.0 and Society 5.0.

Keywords: Brain Chip Implant, Neuralink, Technological Economics, Disruptive Technologies, Servitization, Superego, China's Social Credit System

1. Introduction

Artificial Intelligence (AI) is a disruptive technology that has the potential to 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 (Koukopoulos et al., 2024) and the way in which people live their lives. Technological advances in hardware have made it possible for computers peripherals and controls to extend beyond traditional options (i.e. computer mouse and keyboard), and to reach the stage in which the computer hardware and peripherals are directly placed inside the human skull. Such options are currently available through private firms Neuralink and Neucyber, which manufacture Brain Chip Implants (BCI) for these 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. However, this concept has eventually emerged as a reality in the world of technological innovation, with Neuralink installing a BCI in the skull of two human volunteers (as of August 2024), which allowed these persons to control a computer system with functionalities similar to those of a traditional computer mouse (Gimenez et al., 2024).

In this paper, we conceptualize on how BCIs can facilitate the transition to the 5th Industrial Revolution, considering potential applications and capabilities that BCIs 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, AI and BCIs 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 recognize 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 BCIs, if the BCI technology becomes involved in development of relevant platforms to deliver such services to its users. Based on this premise and the intrinsic value from the increased human intelligence of users, and through the fundamental economic principle that states that “People respond to incentives” (Mankiw, 2018), we anticipate that

there will be significant market demand for the use of BCIs to enhance intelligence and performance in the measurement areas. Future regulation and legislation will need to adjust to the existence of the BCIs and Artificial Intelligence (Danias & Koukopoulos, 2023), to introduce frameworks which reward practices that can be supported by this technology.

We contextualize this application through a case study of China's Social Credit System. This case study offers a conceptual approach on how BCIs can help people in China's Social Credit System achieve higher compliance. We theorize 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, on a voluntary participation basis. 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 theorizes on the potential of Brain Chip Implant (BCI) technologies, employing publicly available information 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 transform industries and to result to servitization for BCI manufacturers and related AI platform leaders. This study identified a gap in the literature on BCIs and their upcoming incorporation in society and the economy, and proceeded to examine their potential uses and implications from these uses. This paper proposes a theoretical model which comprises 3 explicitly different tiers. These 3 Tiers are separated by the extend of involvement of technology as well as by the technology's time horizon for implementation and for acceptance by society and by the users. As per the Technology Acceptance Model (Legris et al., 2003), the implementation of BCIs and their associated services should be accepted by the users, before a widespread adoption of such services occurs. This paper offers a theoretical discussion on a state-of-the-art technology, and its practical implementations. It is understood by the authors that these implementations can potentially increase in scope and in impact in a relatively short time horizon. Considering these implications and the novel nature of the technology, one can argue for 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, whilst 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 behaviour by imposing moral judgments, by striving to inhibit the impulses of the id, and by persuading the ego to act ethically. The superego serves as an internalized representation of societal and parental norms, exerting a significant influence on behaviour and decision-making.

In Freudian theory, the superego plays a pivotal role in regulating behaviour 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 behaviours 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 behaviour 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 behaviour 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 behaviour 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' behaviours 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 Artificial Morality

The theoretical foundation of this paper's psychological perspective is closely linked to the concept of Artificial Morality (AM). As there is no widely accepted definition of Artificial Morality, we offer our own definition of Artificial Morality, arguing that it is the *"implementation of ethical decision-making principles and behaviour in Artificial Intelligence (AI) systems"*.

Artificial Morality refers to the concept of equipping AI with the ability to evaluate and act according to moral guidelines in complex situations, mimicking human-like moral reasoning

(Allen et al., 2005). AM aims to ensure that AI systems operate within socially acceptable and ethically responsible frameworks, making decisions that align with human values, laws, and norms. This concept is crucial for AI systems deployed in sensitive fields such as healthcare, law enforcement, autonomous driving, and decision-making that impacts human lives (Misselhorn, 2018). Empirical evidence from Söderlund (2023) shows that privacy violations committed by robots negatively affect their overall evaluation, mediated by perceptions of their morality and humanness, similar to reactions toward human behaviour.

Chen et al. (2024) developed a device inspired by human thought processes and ethical decision-making. This device incorporates one of the "three laws of robotics", as introduced by science fiction writer Isaac Asimov in his 1942 short story collection *I, Robot* (McCauley, 2007), enabling that robot to distinguish between good and bad actions when facing moral dilemmas. The device operates similarly to the human mind, involving different mental states such as the ego (practical self), id (instincts), and superego (moral conscience). The device also processes six key ethical principles, including instinctive behaviour, moral duty (deontology), and the balance between selfish and altruistic actions (egoism vs. utilitarianism). Chen et al. (2024) demonstrated that morality in robots can arise from an internal struggle between conscious and subconscious processes, much like in humans. This suggests that there is a potential path for AI to develop a form of consciousness and ethical understanding.

3.3 Neuralink Corp. and CBI

Neuralink Corp. is a neurotechnology company which aims to create Brain-Computer interfaces that enable direct communication between the human brain and external devices. Brain-Computer interfaces constitute state-of-the art technological innovations 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, implement 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, and it enables

individuals to control a computer device solely through the user's thought. This product has the potential to become a valuable tool 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 a requirement for physical movement (Khan et al., 2024). The implications for individuals with severe motor impairments are substantial, offering to users a higher level of autonomy in engaging with the digital world. Blindsight is another groundbreaking product under development by Neuralink, aimed at restoring vision to individuals who have lost their eyesight or who have impaired optic nerve function. By stimulating the visual cortex directly, Blindsight attempts to enable its users (who might be suffering from various degrees of blindness) to perceive visual information, significantly enhancing their quality of life (Waisberg et al., 2024). This technology has been tested 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 its sophisticated technology that combines miniaturized hardware, advanced software, wireless communication, high bandwidth and low latency, biocompatibility, stability, and surgical precision. 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 transmit 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 during installation and allows for more precise interfacing with neural circuits (Neuralink Corp., 2024).

These BCI devices are entirely wireless, relying on inductive charging similar to that available in other consumer electronic devices (i.e. mobile phones, smartwatches). 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 signal exchanges with external devices such as computers and smartphones, typically through Bluetooth protocols. The current generation of BCI devices already demonstrates significant control capabilities, with users able to perform complex tasks such as playing video games and controlling computer cursors with their thought. The company envisions future devices achieving even higher bandwidths, potentially reaching megabit levels, which would enable more complex and rapid interactions and exchange of more

complicated data and signals.

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 that they produce and by transmitting 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 products developed by Neuralink are able to interpret these signals and to ensure 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 Telepathy and Blindsight, the company aims to restore and enhance human capabilities, offering profound benefits for individuals with disabilities. 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 will be profoundly redefined.

3.4 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 in which services contribute to societal wellbeing (Russell-Bennett et al., 2019).

In examining BCI technology through the lens of Transformative Service Research (TSR), we see a unique opportunity to leverage advanced neurotechnology for substantial societal benefits. In the case of Neuralink, their brain-computer interface seems to be capable of influencing and enhancing human capabilities, and it presents a transformative service that can

potentially elevate individual wellbeing and societal outcomes. By embedding ethical and moral compasses, akin to a Superego, into Neuralink's functionalities, a service can be created which will not only augment cognitive and physical abilities but also will guide users towards ethical behaviour. Such an extension to the BCI services portfolio can drive positive behavioural 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 BCI technologies, we explore a service model where individual compliance and societal harmony are incentivized through digital means. The potential of BCI technology to support the implementation of state-determined norms and ethical standards exemplifies a transformative service with profound societal implications. By providing real-time prompts and cues, BCI technology 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 behaviour 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 conceptualizes three Tiers of technological capabilities and functionalities. The model is illustrated in Figure 1. As we move across the model from left to right, the intervention to humans increases in complexity and becomes deeper in the way that it supports and affects behaviours. As we move from Tier 1 to Tier 2 and then to Tier 3 of the model, the benefits and ethical issues for consideration progressively become more significant. At the same time, demographics of users start from being very specific for Tier 1 (i.e. patients needing support to increase their quality of life) and increase in demographical scope in Tiers 2 and 3, as applications extend to more generally applicable services. Tier 3 of the model can be considered as a potential platform for addressing psychological conditions, working either in tandem with other mental health services providers, or independently as a separate support mechanism. The potential for the use of Artificial Intelligence to support mental health patients is something that has been explored in the literature (Koukopoulos & Danias, 2024).

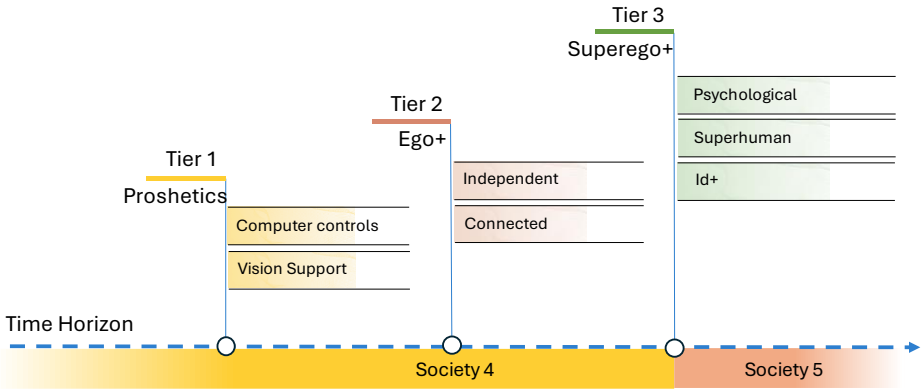

Figure 1: Main Model – Brain Chip Implant technological capabilities and functionalities

4.1 Tier 1

Tier 1 of the model, titled "Prosthetics", focuses on the use of BCIs as brain prosthetics. A detailed presentation of Tier 1 of the model is shown in Figure 2. This is very much associated and in line with the current use of BCIs, which are in the human testing phase. Tier 1 includes capabilities of using a computer cursor through the BCI. As an extension to this capability, this model considers how the BCI can introduce keyboard capabilities, facilitating communication with the external world for patients who have limited ability to physically do so.

We extend the assumption for the capabilities that can be built through the existing controls, suggesting that speaking capabilities can be developed. This can be through software that creates spoken language and which can be controlled through a computer cursor and/or keyboard. Future services for BCI users can involve the control and use of exoskeletons and/or mobility scouters. Tier 1 of the model includes the potential of the technology to help blind (fully or partially) patients gain the ability to see (Hart, 2024), which is something that Neuralink is already exploring through the project Blindsight (Waisberg et al., 2024).

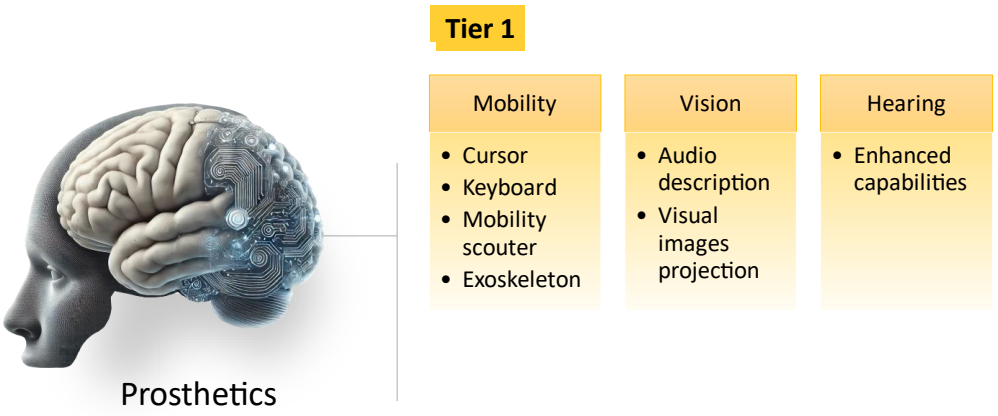

Figure 2: Tier 1 of the model

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, and is conceptualized through two approaches: the Independent and the Connected. The title of Ego+ is inspired by the element of ego that Sigmund Freud introduced, with the authors of this paper suggesting that services and applications of Tier 2 connect to the conscious self.

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 BCI user can receive services from this technology platform without need for connectivity, with the BCI acting 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 Bluetooth/hotspot, Wi-Fi). In this application, the BCI acquires access to information and data on demand, and uses these to support and facilitate the life of the user. This approach introduces the possibility of offering live AI-powered support and suggestions to the user, on a range areas. These areas can include: social skills, counselling, behavioural assistance, languages support, directional assistance when

moving, updates on crowd traffic and car traffic, etc. The areas covered by the BCI technology can expand and can become more advanced and more user-specific in the future, as the application of the technology becomes more widespread.

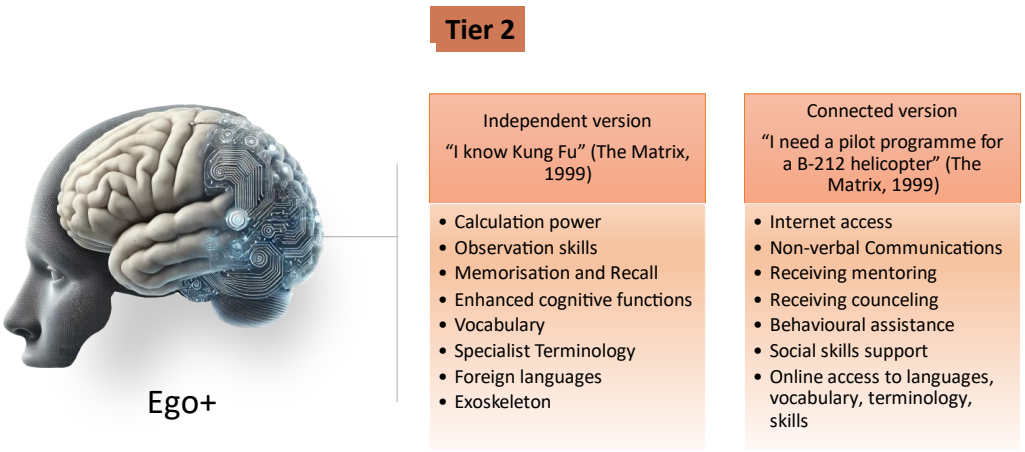

Figure 3: Tier 2 of the model

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, leading to symbiosis of human and BCI. Tier 3 is illustrated in Figure 4, and its title "Superego+" draws connections to Sigmund Freud's work, and to the deep mechanism of the superego. Tier 3 of the model proposes for the natural superego of a person to be supported and assisted by BCI applications. The symbiotic relationship between human and BCI and the external input from the BCI suggest that the human's nature will be altered through the interaction. Humans learn by their experiences, and the BCI has the potential to support and guide this learning, having a continuous and direct connection with the brain. The BCI might develop the potential to create a substitute for psychotherapy, mentoring, coaching and peer-support activities, and can also stand in as the AI-powered ethical educator and moral compass of the user.

Tier 3 is conceptualized as collection of potential future application of BCIs, which can be

implemented in conjunction with the advance of BCI and other devices' connectivity, and with the gradual advance towards Industry 5.0 and Society 5.0 (Ajali & Travieso, 2023). Tier 3 of our model includes three approaches. The authors of the paper remain open to the idea that many more applications can emerge in addition to those identified in the paper.

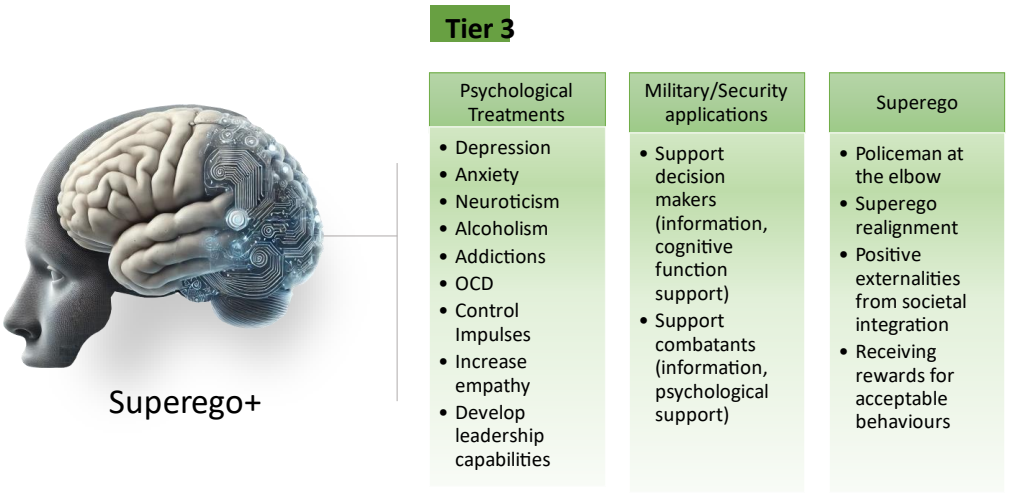

Figure 4: Tier 3 of the model

The Psychological approach focuses on offering support to users who need it. This approach theorizes on the services that BCI can offer in the areas of: psychological evaluation, mood stabilization, counselling and support to users. Such services can potentially help the BCI users deal with problems of: low mood, decreased confidence, anxiety and depression. The BCI might also be able to help users deal with addictions to substances (e.g. alcoholism) and with controlling undesirable manifestations of Obsessive Compulsory Disorder.

The Superhuman approach focuses on supporting and enhancing decision-making of users through the BCI, based on live information. This type of application of the technology might be extended to allow users to: operate machines, drive vehicles, control drones, receive images and audio information from remote sources, and also receive recommendations for optimal actions from AI-powered platforms.

The Id+ approach is what the authors of this paper consider to be the most advanced application

of the technology. The title for this approach has once again been inspired by the work of Sigmund Freud, similar to titles of other elements of the model. The reference to the Id by the title is driven by the idea that this approach can work deep into the psyche of the user. Whilst the Psychological and the Superhuman approaches of Tier 3 operate in a way similar to an external device, but delivered through the BCI (without need for using an external device), the Id+ approach constitutes a conceptual leap for the capabilities of the technology. The BCI connects directly to the user's brain and directly enhances the capabilities of the human, rather than acting as a device that merely provides information to the user. In the Id+ approach, the BCI becomes part of the natural human system and of the brain's function, aiming for human-machine symbiosis.

The conceptual model of this paper proposes applications that could lead to varying levels of incorporation of BCI technology into the economy and 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. These industries have the potential to move to less hardware-heavy offerings, through the BCI-technology-driven digital transformation.

4.4 China's Social Credit System – case study

China's Social Credit System is a system which scores the creditworthiness of an individual. In this system, certain practices and actions increase the social credit score of an individual, whereas other practices and actions decrease it (Mac Síthigh & Siems, 2019). This system is merit-based and attempts to make citizens work towards hard-to-achieve outcomes. As a result, some citizens could find it challenging to continuously follow the behaviours that are regarded positively by this system, especially if they are not naturally inclined to exhibit these behaviours. BCI technology can assist them in enhancing their commitment and involvement with the process of earning points in this system. It is understood that monitoring in this system is highly technology-intensive, utilising face recognition cameras and large databases to implement scoring practices. Penalties from the implementation of the system can be significant for citizens, and thus citizens are expected to be interested in increasing their compliance levels and their social score. Introducing BCI technology applications to this system can be conceptualized through the following 4 approaches.

1. As a measurement tool. This implies that BCIs can become part of the existing technological system for monitoring implementation of China's Social Credit System.

2. As a reforming tool. This implies that BCIs can 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 customized 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 become a cyberpunk-type tool, offering a technological platform through which citizens are able to earn points, or can have points deducted from them, for their own thoughts.
4. As a judiciary and forensic tool. The BCI can help the legal system identify if a person has been reformed and whether they are likely to reoffend, based on the natural superego function of the person 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 employ it to enhance their skills, substituting or supplementing their own self-acquired knowledge and experience. Such a process can be helpful for people to achieve generational wealth continuity and successful maintenance of wealth. Through BCI-supported services, future generations can be supported in increasing their chances to live up to the economic, managerial, leadership and overall entrepreneurial abilities of their ancestors. The use of BCIs can be in tandem with traditional approaches used to this end, such as high-quality formal education, exposure to valuable experiences, connections with professional networks, mentoring support, and support from social networks.

Social disruption is understood to be facilitated by education (Arnold, 2012) in previous paradigms of the operation of society and of the economy, especially in democratized capitalist-economy countries. Education, skills, professional expertise and specialist knowledge allows members society that could have had a lower social and economic background at birth to become successful professionals, disrupting societal structures and achieving social status and/or financial wealth, and potentially also finding themselves in significant leadership positions in the economic and/or societal system. This paper suggests that BCI technology could possibly help its users to be more competent in a number of areas,

complementing the education-led transition. Access to BCIs and to specific configurations of the BCIs might become the "royal road" to knowledge (Engelfriet, 1998), which has historically been sought by the powerful, but could not be achieved by any other means other than personal development through education (either formal or experience-based).

A new social class can emerge from the implementation of BCI technology, with some members of society ending up being in 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. Tier 1 applications in the model of Section 4 explicitly aim at building a more accessible society, attempting to facilitate users' lives. However, 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. Instead, these users could pursue the use of this technology in order to acquire superior personal and professional capabilities that can give them an advantage in society and in the economy.

5.2 Challenges and Ethical considerations

Introducing BCIs does not only bring advantages and opportunities, but it also exposes users, industries, the economy and society 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 cyberattacks. The significance of such an event can range from unimpactful to extremely severe. With evolutions in cyberthreats being very fast, this is a very challenging area, especially if one considers that hardware updates will be very disruptive for users. Hardware designs for BCIs and software platform integrity will be of critical importance in order to avoid negative impacts from the area of cybersecurity.

Another consideration is the maintenance of the BCI hardware after the installation, and the strategies that can be pursued if there are requirements for replacement of hardware in the future. With BCIs being introduced to the human skull surgically, one could argue for the benefits of having as few of these surgeries as possible. Requiring for the removal of an initially installed device from the brain in order to install a subsequent more advanced one, or because that initial BCI malfunctions, might have negative health consequences. Additionally, we have to make allowances for the idea that human health can be negatively affected with a range of unidentified short-term, medium-term and long-term impacts from the introduction and/or

from the use of BCIs. These impacts can be on the physical health as well as on the mental health of the user.

A significant ethical question that emerges is whether it is acceptable for a technology to be used in such a way, altering humans. For Tier 1 applications in this paper's model, this question can be addressed rather straightforwardly. 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. For Tier 2 applications, a similar approach to Tier 1 can also be adopted. However, skeptical thinkers might not be convinced in this case, as examining critical perspectives can lead to questions being asked and to doubts being raised. For Tier 3 applications, further questions and challenges on ethics emerge, and one might wonder whether Tier 3 applications are morally and ethically correct or not. The discourse might include, amongst other questions, the possibility for changes to human decision-making, to a person's character, to a person's personality and to their conscience. Counterarguments might include the notion that such human characteristics can be altered throughout life and can be affected by the choices that each person makes in their life, and by the experiences that they gain. A plausible extension of this idea is that, in line with having the option to make other choices, people can choose to have a BCI installed in their brain.

A very significant ethical consideration is the calibration of the BCI for Tier 3 applications. For the "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. These parameters can impact the decisions and their consequences for the life of the user, and can also lead to permanent changes in the personality of the user. This is an area in which further research will be required.

6. Conclusions and limitations

This paper concludes that BCIs can result in a paradigm shift or even full operations restructuring for several industries, leading to Industry 5.0 and Society 5.0. We theorize that the level of involvement of users with the BCI and the applications of the technology can vary very significantly. The exact details are not publicly known yet, as such BCI applications have not reached the commercialization stage. Society, the professions and the everyday life of BCI users and non-users can be affected heavily. Society and regulatory authorities need to be

vigilant and to regulate and control the applications of BCI technology, as these can potentially alter 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, one of which is in the area of Artificial Morality.

As in each and every conceptual paper, this paper comes with limitations. Firstly, this paper is primarily conceptual, relying on publicly available data, particularly from Neuralink, which may not fully capture the current state or potential of BCI technology. Secondly, the proposed applications and models are speculative, as BCIs have yet to reach widespread commercialization. Additionally, the study lacks empirical validation, relying instead on theoretical arguments and case-specific analysis, such as China's Social Credit System, which may not generalize to other contexts. Future research could address these gaps by expanding on ethical considerations, and by exploring broader societal and technological contexts.

7. Recommendations for future research

To encourage future research on brain chip implant applications and services, this study outlines several potential directions for further investigation. One recommended area is the exploration of how users of BCI devices could control commercial robots, such as Tesla’s robot Optimus, and the impact of such applications on perceived service characteristics, including ease of use, reliability, and adaptability.

In addition, researchers could explore the effectiveness of other approaches of Artificial Intelligence, like Neurosymbolic AI - a hybrid approach in Artificial Intelligence which combines the strengths of symbolic AI (knowledge-based systems) and neural networks (learning-based systems) (Garcez & Lamb, 2023). This line of inquiry could uncover innovative solutions for enhancing the functionality and interpretability of BCIs.

Finally, future studies could investigate the opportunities and challenges associated with implementing different ethical frameworks, such as Kantian ethics or utilitarianism, and their implications for individuals, governance structures, and broader societal contexts. This research could provide valuable insights into balancing individual autonomy with collective ethical standards in the integration of BCIs into society.

8. Impact on Society

The implementation of Brain Chip Implants (BCIs) with advanced functionalities, such as those explored in this paper, could significantly influence societal structures and individual lives. BCIs have the potential to enhance human capabilities, improve accessibility for individuals with disabilities, and reshape industries through servitization and efficiency gains. By integrating ethical frameworks and AI-powered superego functions, BCIs may promote ethical decision-making and societal harmony, especially in systems like China's Social Credit System.

However, this technology also poses challenges, including ethical concerns about autonomy, personality alterations, and inequality in outcomes, as access to such advancements could exacerbate societal divides. Additionally, the potential for cybersecurity risks and misuse highlights the need for stringent regulation and oversight. BCIs could redefine concepts of education, skill acquisition, and professional advancement, but their societal impact hinges on balanced governance, inclusive access, and continuous ethical evaluation to ensure their benefits are equitably distributed and aligned with collective well-being.

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