GENEVA ACADEMY
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Academy of International Humanitarian Law and Human Rights

THE UNIVERSITY OF SYDNEY

RESEARCH BRIEF

NEUROTECHNOLOGY - INTEGRATING HUMAN RIGHTS IN REGULATION

EXECUTIVE SUMMARY

The exponential advancement of neurotechnology[1] over the past decades has pushed it to the forefront of scientific, ethical and, in some countries, political debate. Such discourse has focused, not only on what neurotechnology can do, but also who is doing it – particularly how the corporate sector has penetrated and positioned itself in what was once a small and highly regulated medical space and research environment. This situation might be regarded as a double-edged sword. There is no doubt that the entry of private companies into the neurotechnology sector has accelerated the pace at which therapeutic devices have reached the market. However, as companies are now the lead designer, manufacturer and retailer of neurotechnologies this also raises concerns around the protection of human rights. This especially relates to neurotechnology's 'dual-use' potential, i.e. when innovations originally developed for medical application are repurposed to create spinoff commercial devices and applications. Concerns about devices whose origins are not closely related to therapy are also significant.

These issues have spurred debate around how human rights might be integrated into regulations governing neurotechnology. Scholars such as Professor Rafael Yuste advocate for the recognition of 'neurorights', either by 'upgrading' existing law or creating new multilateral instruments. The other side of the debate is the view that the existing international rights framework – which protects, for example, freedom of opinion, freedom of thought and the right to privacy – is adequate. Moreover, it might be argued that the existing architecture has proven itself to be sufficiently malleable to adjust to new technology. Examples of adaptations include resolutions issued by the UN Human Rights Council ('HRC') and General Assembly, General Comments of treaty bodies, and reports of human rights by Special Rapporteurs.

A further issue is that while the possible misuses of neurotechnology speak to the logic of strict regulation, where lines should be drawn is often unclear and very much determined by dynamic and contested societal norms. It would be deeply regrettable, for instance, if the possible therapeutic upside of neurotechnology was unnecessarily impeded by law. Other arguments levelled in support of neurotechnology include neuro-enhancement to tackle global challenges like climate change, cognitive manipulation to improve public safety, and brain 'hacking' to prevent terrorist attacks or other serious crimes. Regulation is also riddled with complication.

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With the means and resources to develop neurotechnology independently, companies can take advantage of digitalized technologies' ease of transfer and the integrated nature of the globalized economy to strategically locate in the regulatory environment that offers the most attractive conditions. This problem is not novel. As the business and human rights community of practice knows too well, despite a responsibility for companies to respect and uphold human rights, there is no enforcement or accountability framework at the international level. The most effective form of regulation continues to be domestic law and policy; however, this varies in robustness and application and can be evaded by creative constructs such as shell companies.
As debates about neurotechnology and regulation gain pace — including at UNESCO,[2] the OECD,[3] the Inter-American Commission of Human Rights[4] and, in the Asia-Pacific region, the Australian Human Rights Commission[5] — it is critical that human rights sit at the fore. Indeed, neurotechnology will have implications for human rights both directly (particularly freedom from discrimination, and the rights to privacy, freedom of thought, and property) and indirectly (by creating spillovers for social cohesion, identity, equality, inter-group tolerance and perhaps other areas that are harder to foresee). These areas need to be understood both as independent fields of inquiry, and also in terms of their mutually constituting and interconnected nature.

In response, the Geneva Academy of International Humanitarian Law and Human Rights ('Geneva Academy') has collaborated with the University of Sydney Law School ('USYD Law School') to support the HRC Advisory Council, which under Resolution A/HRC/51/3 will prepare a study examining the human rights implications of neurotechnology to be presented at its sixtieth session.[6] In anticipation of this, an event was held at the University of Sydney in April 2024, which was a joint event between the Geneva Academy and USYD Law School aimed at introducing some of the relevant technology to stimulate discussion among a group of invited experts in science, engineering, philosophy, commerce and law, and were selected for their expertise related to the subject of enquiry.

The current paper represents the views of the two co-authors (from the Geneva Academy and the USYD Law School), who also organized and participated in the event. These views were inspired by and respond to some of the main themes that emerged at the meeting (see appendix for the list of participants) but should not be thought to represent the views of the participants or their organizations.[7]

After first considering neural monitoring and decoding, this paper examines neurocognitive enhancement before presenting a case study on the possible use of neurotechnologies in criminal justice.

The paper makes the following recommendations to the HRC Advisory Council:

1. For just and effective regulation, a difficult balance is required – an anticipatory stance is needed that monitors plausible trajectories of neurotechnological development without straying too far into possible distant futures.
2. Any regulatory steps should also consider unintended consequences of regulation that might thwart beneficial technologies, especially those in the therapeutic domain.
3. Consideration of the privacy and data issues resulting from increased monitoring and decoding of neural data should be prioritized as those issues are the most immediate.
4. The extent to which states, employers and companies that gather data from consumers can legitimately surveil populations requires careful consideration along with the role of consent in such surveillance and the question of whether the relevant consent is genuine.
5. In relation to enhancement, consideration should be given to what it is to be 'enhanced' and the role of regulation and other policy in ensuring that any related benefits are widely distributed.
6. Consideration needs to be given to the competitive environment that neurotechnological enhancements may give rise to, whether in the case of individuals competing in their workplaces or other social environments as well as how to respond to the competitive pressures related to neurotechnology that are emerging in the international and military contexts.
7. In relation to criminal justice, the extent to which direct access to brain or nervous system data (that might allow inferences about the mental states of those caught up in the system) can legitimately be required by the state needs to be considered against how this might change the relationship between those governing and the governed, and the kind of society that might emerge from a world in which greater access is available to criminal justice authorities with respect to people's inner worlds.
8. Historical debates about rehabilitation and the purposes of punishment should be revisited in order to evaluate possible neurotechnological criminal justice interventions as a means of addressing crime. This consideration should evaluate how neurotechnological interventions are similar and different to existing and historical criminal justice interventions, and how novel interventions might have implications for the mental privacy, mental integrity ,freedom of thought, and dignity of those involved.
9. The trajectory of neurotechnological development should be monitored in terms of its impact on individuals and also its wider social impact.

SOME IMPORTANT DEFINITIONS

Neurocognitive enhancement involves techniques aimed at augmenting neuro-physical or cognitive functions that improve capabilities beyond the 'normal' human range.[8] Such techniques include the administration of psychotropic drugs, neuroimaging combined with neurofeedback, neurostimulation technologies, and brain-computer interfacing. These techniques, which may be invasive or non-invasive, alter the neurophysiological mechanisms that govern mental processes or brain function.[9]

Neurostimulation involves the application of electrical currents (invasively or non-invasively) or other means to specific areas of the brain to transiently alter brain function.[10]

Brain Computer Interface ('BCI') systems operate by detecting and translating patterns of brain activity into commands for devices or communication and movement tools. This technology allows individuals with paralysis, locked-in syndrome or who have lost communication ability, to produce text or speech (using an avatar or synthesizer[11]) or move (for example a cursor, wheelchair or robotic limb).[12] Some BCI systems currently work through electrodes implanted in the brain tissue and others through external devices such as EEG headsets. Other approaches include fMRI, inter-cranial EEG and high-density electrocorticography (ECoG).[13]

Neurolaw is an emerging scholarly discipline involving lawyers, philosophers and scientists that focusses on the implications of neuroscience for the law's practices. This might involve analysis of how the law is responding to neuroscience and/ or consideration of how it should respond.[14]

PART 1. NEURAL MONITORING AND DECODING

BACKGROUND

Advancements in neurotechnology mean that, in clinical and research settings, thoughts (i.e. inner speech) can be translated into text, spoken words or functional commands with a fairly high degree of speed and accuracy.[15] This should not imply that the same technology can be used in a non-clinical context to facilitate passive or surreptitious 'brain-reading'. First, it must be underscored that the decoding capability of even the most sophisticated neurotechnology is still nascent; it is unable to decode mental content in a rich or granular manner comparable to what could be envisioned or communicated orally/in writing.[16]

There are also technical reasons why passive 'brain reading' technology is unlikely to reach commercial application soon. Most BCI technology only works though user cooperation i.e. only when the patient chooses to make their intentions or commands 'heard' (e.g. by imagining a movement) can the system read and interpret them. Even then, effective use of a BCI requires lengthy training on the part of the user, and a process of synchronization between their brain activity and the machine. Indeed, it is unlikely that that a general 'cypher' to decode human speech from brain activity exists, mitigating the risk of broad-use surveillance. The other issue is that some of the most powerful relevant technologies such as fMRI are currently expensive and bulky. More affordable and non-invasive approaches, such as EEG have not yet been able to fully overcome the impediments posed by skull, hair, flesh and exterior 'noise' to produce resolution quality close to that needed for precise decoding.[17]

However, it is worth noting that accessible devices are improving in their capacities and if for therapeutic or non-therapeutic reasons people increasingly start to see benefit in portable neurotechnologies they may be motivated to train devices that are specific to them thereby increasing the possibilities for surveillance.

But while brain-reading may not be an extant concern, it is important to evaluate the risks that would present should technological barriers be overcome in the future. From a scientific perspective, a possible scenario is that the technology underpinning therapeutic thought-decoding could be repurposed to identify, make inferences about, or associate character traits/neural states with an individual. Four possible applications are set out below, each with varying levels of social utility and protection concerns.

THE USE CASE FOR DECODING AND MONITORING BRAIN ACTIVITY

Identifying individuals and understanding individual characteristics

The science suggests that an individual's electroencephalography (EEG) signal is a unique biometric identifier[18] that could, some day, replace passwords, fingerprints and iris scanning as authentication tools. If realizable at scale, other applications might include use in immigration/passport control, or to identify, for example, missing persons or individuals who pose a security threat.

Neuroimaging can also be used to reveal an individual's general preferences, traits or characteristics. One study was able to successfully discriminate between republican and democrat participants based on differences exhibited in their cognitive processing around risk, which was detectable on fMRI imaging.[19] This suggests that it may be possible to identify other traits such as gender,[20] religiosity or sexual orientation.[21] While it is easy to imagine how such technology could be misused to target or discriminate, less malign applications might be possible. For example, such technology may be able to identify an individual's proclivity to gambling, alcoholism or abusing illicit substances.[22] Neuro-marketing is a further application; a growing number of companies use non-invasive neurotechnologies to gain insight into how different consumer groups react (positively and negatively) to products, packaging, services and shopping environments.[23]

Brain monitoring in the workplace and learning facilities

The strongest utility argument for brain monitoring concerns tracking alertness in e.g. drivers, pilots, surgeons, and other professions where sustained high-level attention is required for reasons of safety.[24] Such monitoring may be complemented by interventions such as mandating a pause in activity or activating a signal, for example a sound, vibration or change in temperature.[25] From a public utility perspective, this could arguably result in heightened public safety, reduced workplace accidents and improvements to workplace conditions.

Iterations on such approaches could be employed more generally in workplaces to improve or monitor[26] productivity, for example by creating the conditions most conducive for innovation and problem solving, and/or to guard against employee burn out. Likewise in schools and other learning/training institutions, techniques could be used to create tailored learning environments and pedagogical tools. For example, neural monitoring could give insight into how students process and respond to information including according to type, volume, delivery platform, classroom environment etc. This could inform curricula development and teacher training with widespread benefits that could be realized at scale. At an individual level, neural monitoring could enable students to learn in a more personalized and self-paced manner, and facilitate the early detection of conditions such as ADHD and other learning differences.[27]

Brain scanning as a recruitment tool

A further application is the analysis of brain scanning data as a recruitment or human selection tool. Certainly, employers (government, non-government, military and corporate) use profiling methodologies to measure characteristics deemed important for professional performance, such as proficiency in desirable traits (e.g. intro/extroversion), proclivity to specific behaviors (e.g. risk taking) and cognitive performance (e.g. processing speed). Brain scanning — which might measure the same characteristics — could therefore be seen as a more sophisticated means of measuring employee suitability, potentially even removing some of the biases inherent in traditional recruitment, including in the areas of race, gender, age and privilege.

REGULATORY QUESTIONS

Few would question the value-added of therapeutic brain reading and decoding technology in terms of patient quality of life, dignity and wellbeing. However, when it comes to the repurposing of this technology outside the medical sector, the risks are many and complex, suggesting the need for a strict regulatory framework.

A first area of risk concerns the analysis of brain activity for the purposes of identification. While a social utility argument might be levelled for the use of such technology in law enforcement, border control, or forecasting dangers to public safety, it is not difficult to imagine scenarios where state authorities either (i) introduce identification technology for legitimate ends but then extend its use in ways that encroach upon human rights, or (ii) use identification technology as a tool for mass surveillance,[28] to enforce draconian policies such as around migration/movement, or to illegally target minority groups such as LGBTQI+.

In assessing such risks, it is important to consider both trends, particularly in terms of increased societal surveillance and monitoring, and alternate emerging technologies. Indeed, the past two decades has seen a steep increase in the (lawful and unlawful) monitoring of individual and groups' communications, associations, location and movements. This has been fast-tracked by innovations (5G-enabled services, edge computing, artificial intelligence and machine learning techniques) which have together widened the scope of data collection, speed of assessment, and complexity of analysis.[29] This again raises the question of whether there may be some technologies (or application of technologies) that should be completely banned.

However, it also must be taken into account that if the objective is to identify individuals, track their location and understand their preferences, current and sometimes better tools already exist. Analyzing someone's 'digital exhaust' is a cheap, efficient and fairly accurate means of assembling a complex and informative profile of an individual,[30] including their political beliefs, religion and/or sexual orientation.[31] Social graph analysis is a further extant example, albeit one that generally requires judicial/legislative authorization. Here, surveillance data is pooled and cross-analyzed with other open-source information such as observed behaviors, financial and commercial transactions, installed applications in a smartphone, social network profiles etc.

Most likely, neurotechnological approaches to identification will not replace, but instead augment existing systems of monitoring and surveillance, increasing their speed, accuracy and granularity. To the extent that this results in more accurate and timely law enforcement and crime control, benefits should accrue. However, this must be assessed against the likelihood of negative externalities, particularly 'mandate creep' as States move towards more ubiquitous and invasive forms of citizen surveillance.

The use of brain decoding technology in neuromarketing and recruitment is also questionable from an ethical perspective. Some might argue that employing EEG technology to understand consumer preferences and leverage these to expand sales, is interfering with individual decision-making in an obtrusive and coercive manner. Certainly, the use of EEG (or related technologies) without consent would endanger rights to privacy and raise additional concerns with respect to data protection. If this was coupled with techniques such as suggestive selling or content pushing (which aim to exploit heuristics such as the Baader–Meinhof phenomenon[32] and mere exposure effect[33] to provoke a purchase), then rights around freedom of and non-interference in thought would also likely be impacted. However, conducting EEG-based marketing experiments with consenting and informed adults, and applying the results to larger consumer groups, is unlikely to be rights violating so long as data is managed appropriately. Arguably, it is simply a more sophisticated iteration of what is currently taking place when companies conduct market surveys to inform advertising campaigns, product development and consumer engagement strategies.

Similar arguments might apply to the use of brain scanning and analysis in recruitment. Assuming that the neural device yields accurate results, it might be argued that there is little difference between approaches based on brain activity and the psychometric testing used by many companies and state agencies today. Such approaches might even contribute to a more equitable workforce and merit-based recruitment by controlling for biases around gender, race and privilege in staff selection. Guaranteeing accuracy, however, may be difficult. The scientific analysis of human behavioral and cognitive traits remains a highly contested area (although this concern also applies to psychometric testing). Biases in the data that inform the neurotechnological device is more problematic. To date, there is insufficient *representative* brain data available to the scientific community to ensure that devices can operate in a non-discriminatory manner. Further, the unequal bargaining power of the parties in a recruitment context might be thought to present issues of consent and employers would need to ensure that they did not use the data in a way that amounted to a prohibited form of discrimination, and moreover to ensure it was either deleted or, if there was a good reason to retain it, to keep it in a way that was secure.

A final question surrounds the use of brain activity monitoring in workplaces and educational facilities. If properly managed, benefits could conceivably extend to a range of stakeholders. Examples include improved productivity and innovation, heightened worker/student wellbeing, reduced scope for injury (mental and physical), accelerated learning through improved pedagogical techniques, and the early detection of neurological disease and learning differences. For countries in the Global South — where disability from workplace accidents is highest and improved productivity is needed most — outcomes may have broader development impact. Likewise, in countries with low quality education systems, such interventions could have a leavening approach to student capacity development with widespread implications for economic growth, development and equality.

The risk lies in the management of the technology, especially in contexts of power imbalance often found in workplaces and schools. Indeed, it is easy to envision how tools designed to empower could be misused to exploit, control and abuse. Tests involving the cognitive monitoring of students in China caused backlash, mainly due to concerns over consent, how the data would be shared, and whether it might be used in a punitive manner (either by teachers or parents).[34] The same risks apply to workplace monitoring, with perhaps added concerns around the technology being used in a coercive or exploitative manner to grow profit margins. In this regard, it is important to see neurotechnology-enabled tools as part of a trend towards heightened workplace surveillance. Such norms have existed in blue-collar professions for several decades, but extended to other sectors during the COVID-19 pandemic, when many companies introduced software that logged keystrokes and mouse movements, captured screenshots, tracked location, and even activated webcams and microphones.[35] Again, this suggests that neurotechnology is less likely to drive new types of violations as it is to make existing transgressions more potent.

PART 2. NEUROCOGNITIVE ENHANCEMENT

2.1 BACKGROUND

Any discussion of neurocognitive enhancement needs to be framed in the context of the medical innovations that preceded it. Heralded as the first widely implanted neurotechnological device, the cochlear hearing implant was first trialed in humans in 1977 with more than 1 million in use today. The device — a neuroprosthesis — comprises an external microphone that transmits radio signals to electrodes implanted in the auditory nerve to restore a sense of hearing in patients with severe auditory impairment.

A second key advancement is the development of brain-computer interfaces. These implantable or external systems receive specific patterns of brain activity, which are then translated into technical commands such as text, movement or a decision. Since around 2004, the implanted form of this technology has been used in clinical trials to allow individuals with different forms of paralysis — Amyotrophic Lateral Sclerosis (ALS), cerebral palsy, stroke or spinal cord injury etc. — to use their mind to perform basic functions such as operating smart devices, controlling a wheelchair/prosthetic or move a cursor. The technology is not yet approved for more general clinical use. Non-invasive EEG brain-computer interfaces are also available and have been used for pursuits such as brain-drone racing, but have not yet taken off in a substantial way in the commercial context.[36]

A third innovation underpinning enhancement technology is procedures that target specific areas of the brain for example with electrical currents or ultrasound, either to regularize neural activity, or stimulate or inhibit neural circuits. These treatments can be invasive; for example, Deep Brain Stimulation[37] uses implanted electrodes that give off electrical impulses in individuals suffering from tremors, epilepsy and Parkinson's disease. Others do not involve a surgically implanted device, but are medical procedures that need to take place under highly controlled conditions. Focused Ultrasound, for example,[38] facilitates a tailored manipulation of brain activity by stimulating or inhibiting specific neural circuits. There is ongoing research to ascertain whether these approaches might be administered to patients with forms of dementia, such as Alzheimer's disease, to boost memory function.[39]

Arguably the fastest growing area of medical research concerns least-invasive means of external brain interference. Examples include repetitive Transcranial Magnetic Stimulation ('rTMS'),[40] Transcranial Direct Current Stimulation ('TdCS') and Transcranial Electrical Stimulation ('tES').[41] These techniques seek to modify neural activity and/or brain plasticity using electrical currents. While treatment regulation varies between countries, they have been used to treat disorders including depression, Obsessive Compulsive Disorder, Post-Traumatic Stress Disorder, Attention Deficit Disorder, as well as addiction (e.g. smoking) and learning difficulties (e.g. dyslexia).[42]

There is no doubt that these neurotechnologies have had a transformative impact on beneficiary patients' quality of life, particularly in terms of their dignity, agency and independence. Such innovations also support the realization of specific human rights, including the right to health[43] and the right to benefit from scientific progress and its application.[44] From a State perspective, benefits accrue both in terms of reconstituting the contributions impacted individuals can make to society, and reducing the costs borne by care-givers, health infrastructure and the education system. If upwards trends in longevity[45] and mental health disorders[46] continue, such benefits will augment further.

For the most part, if concerns around privacy are properly managed, the application of these medical innovations is not socially or ethically contentious given the significant upside for patients. However, some important caveats should be noted. Disability rights advocates highlight that not all people with disabilities have a desire to be 'fixed'. Moreover, that such medical innovation consolidates the systemic 'ableism' present in modern society and diverts attention away from more important issues such as discrimination and multi-factor accessibility. It is also important to recognize that while the abovementioned neurotechnologies have been developed and are authorized to treat medical conditions, what is understood as a medical condition has changed over time. It is only in recent decades that conditions such as depression, Obsessive Compulsive Disorder and addiction have been understood to have a neuro-biological basis. Reciprocally, some traits that were previously understood to be medical disorders, such as same-sex preference, are now broadly accepted as variations in the normal human condition.

FROM TREATMENT TO ENHANCEMENT

Progress in the efficacy of neurotechnologies developed for clinical use has given rise to questions around whether the same approaches might be applied, not to replace or restore a lost sense or function, but to enhance or extend the range of functioning in healthy individuals. This raises important regulatory and policy questions; chiefly, in what circumstances should neurotechnology be applied to enable healthy individuals to breach natural cognitive limits? As discussed below, these questions are complex to answer, not only due to the ethical issues involved, but also from a perspective of societal utility.

BCIs that heighten situational awareness in individuals executing high stakes and complex operations

Human decision-making is enabled by inter-linked neural processes including perception, attention and working memory.[52] Situational awareness — the ability to understand and interpret complex informatics in dynamic settings — is particularly important in contexts where information load and flow is fast and errors can beget serious consequences. Examples include air traffic control, disaster/humanitarian response, emergency medical treatment, emergency law enforcement and military combat. Professionals in these areas generally need to sustain high levels of stimuli processing, while combining motor response and executive functions (such as choice discrimination and prioritization).[53]

NEURO-ENHANCEMENT AS A MILITARY TOOL

Most of the research on human augmentation has been undertaken by the military sector. Opacity in disclosure, however, prevents a complete understanding of how far the science has progressed. With this caveat, three areas of research can be mentioned. The first involves the administration of nootropics – psychotropic drugs – aimed at affecting the cognitive processes that control behavioral response, such as inhibition, recklessness and empathy.[47] A second innovation is neuroprotheses that increase the strength, reach and maneuverability of human limbs.[48] The final and newest area is the development of BCIs that enable the neural remote control of weapons,[49] robots[50] and 'collaborative' BCIs that facilitate communication between soldiers in remote locations.[51]

This raises important questions around whether neurotechnology might be leveraged to improve performance in situations where outcomes have a high impact on human wellbeing. Indeed, laboratory experiments suggest that human decision-making *can* be improved by systems that integrate real-time attention and situation awareness monitors within a closed-loop/passive-BCI system.[54] In 2014, for example, a team of scholars measured the theta and beta EEG rhythm ratio in air traffic controllers as a proxy for workload/situational awareness. This data readout was connected to the information system they were operating, and programed to adapt in real-time in a way that allowed the controller to more effectively perform the tasks required of them.[55]

While the evidence is less robust and results more muted, studies have also suggested that neuro-stimulation techniques can improve problem solving by honing neural functions such as working memory, processing speed and multiple object tracking.[56] Clark et al (2012) demonstrated that transcranial Electrical Stimulation ('tES') significantly and consistently improved performance in a simulated scenario of complex threat detection.[57] tDCS has likewise been evaluated for its potential to bolster cognitive performance, including perception, learning and memory, attention and decision making,[58] with studies identifying correlations with improved speed and/or accuracy of visual detection/tracking,[59] verbal problem-solving[60] and spatial-numeric problem solving.[61] Finally, there is experimental evidence supporting neuro-stimulation (principally TMS) as an intervention to improve attention,[62] including in the areas of visual spatial attention,[63] target detection, selective attention[64] and attention orientation.[65]

'Brain webs' and Collaborative BCIs that advance problem-solving

A second area where a case might be made for applying neurotechnology to healthy subjects is as a tool to improve problem-solving. Certainly, finding solutions to complex diseases such as cancer and global challenges such as climate change may require innovation and thinking beyond the capability of a single human. Moreover, vis-à-vis computers, individuals are capable of holding and processing only an extremely limited amount of information, and likewise for the management of knowledge. Human collaboration for problem-solving, however, is problematic and inefficient. This has given rise to the idea of 'joining up brains' — technically referred to as Brain Nets — where the combined brain power of the system exceeds the sum of the parts.

Scientists have simulated what this might look like through laboratory experiments involving both primates and humans. In one experiment, monkeys with electrode implants were able to move an avatar arm collaboratively.[66] In another, a group of humans connected through a non-invasive Brain Web were able to engage in rudimentary communication and task collaboration.[67]

Group decision-making is another area where neurotechnology might enable higher quality outcomes. In 2011, Wang et al tested a collaborative BCI (cBCI) which resulted in significant improvements (compared to individual performance) in a visual target detection task.[68] In 2014, Poli et al piloted a similar hybrid cBCI that integrated behavioral and neural data to achieve group decisions that were more accurate than both the average single observer and traditional BCI groups.[69]

In terms of building a use case, employing cBCIs to improve facial recognition[70] and target detection[71] has clear military and law enforcement utility. More broadly, although it cannot be assumed they will, cBCIs might overcome problems inherent in decision-making processes such as groupthink,[72] hierarchy, and the conformity and authority heuristics.[73] In such situations, rational or evidence-based decision-making is compromised because of group dynamics and/or social norms. Indeed, dysfunctional group decision-making has been a lead factor in disasters (such as the explosion of the Challenger space shuttle and sinking of the sea carrier Titanic), military failures (the invasion of Iraq on the grounds that its government held weapons of mass destruction) and mass persecution (the Salem Witch Trials).

Accelerated learning

A third area where neuroenhancement might have application is in improving the speed of learning and/or task acquisition. To date, most of this research has taken place in the law enforcement sector; for example, to understand whether neurostimulation techniques (such as tES) can accelerate learning in areas such as visual search,[74] threat detection and target acquisition.[75] Results, however, have lacked generally efficacy and replicability. Another approach has been to combine continuous brain-monitoring (such as EEG) with known physiological correlates of task learning (such as visual, auditory, or haptic feedback) in real time. This has achieved effective results i.e. accelerated learning, in sniper training and decision-making.[76]

REGULATORY QUESTIONS

It must be underscored that the enhancement technologies discussed above have only yielded results in laboratory settings, and even in the case of successful outcomes, these are generally meagre. Moreover, non-invasive neuro-stimulation techniques such as tES and TMS (which have the most scope for commercialization) have the least efficacy. The upshot is that neuroenhancement technology is far from 'market ready'. Moreover, even if challenges around efficacy and reliability could be overcome, these remain sensitive and expensive devices.[77] DBS, for example, is costly, can only be operated by highly trained medical professionals, and is only viable in settings where users can benefit from ongoing monitoring and support.

However, especially taking into account the exponential advancements being facilitated by AI and ML, the idea that neuro-enhancement devices will be achievable operationally and at scale must be entertained. As the above analysis demonstrates, there are several areas where neuro-enhancement could be seen as socially efficacious. Higher cognition, improved decision making, and superior problem-solving might all contribute to a range of aims such as more effective disaster/emergency response, public health and safety, and finding solutions to global challenges.

Neuro-enhancive technology could conceivably also be a tool to close inequality gaps, both between income groups and the Global North and South. Indeed, disability and morbidity stemming from mental health disorders, climate change impacts and infectious disease, disproportionately impact low-income countries in the Global South. Such challenges might be ameliorated by prioritizing access to neurotechnology, and purposing neurotechnology to craft new and innovative solutions to these development obstacles. Neuro-enhancement might even be regarded as a tool to level the playing field, for example by accelerating learning in contexts where schools are overcrowded, cannot afford equipment and/or lack quality teachers.

Other applications of neurotechnology are more ethically concerning. Chiefly, enhancing military capacity might be deemed in a nation's best interests, but not from a perspective of global peace and security, nor in the case of States that have a poor record of belligerency or human rights compliance. Employing neurotechnology to enhance the quality of problem solving and group decision-making is equally complex. While a public utility argument can be applied to areas of macro-policy such as healthcare, renewable energy, education, policing etc., the slope is slippery. All areas of governance — including the seemingly mundane — ultimately connect and contribute to the lives and wellbeing of citizens. This risks a situation where access to neuro-enhancement technology becomes, not the carefully-justified exception, but the norm, perhaps with an unwelcome competitive pressure to enhance. The slippery slope argument likewise extends to the corporate sector. Governments generally regard economic growth, enabling market competitiveness and promoting an environment receptive to investment as key objectives. Companies would likely argue that ready access to enhancive technology — for their R&D, decision-making and workforce productivity — would contribute to such goals, by aiding their competitiveness and promoting growth.

Another approach to questions of neuro-enhancement, is to view the creation and diffusion of the technology as inevitable and invoke a risk management approach. As noted, especially with the advent of AI and ML, extant technological blockages may be resolved in the coming decades. A further reality is the strong military incentives to develop neuro-enhancive technology. History instructs that such technology eventually spills over into the civilian domain, and that once scope for commercialization exists, market forces will drive access. Likewise for therapeutic neurotechnologies, the vast benefits they offer (especially for countries with aging populations) mean that governments have strong incentives to develop them and facilitate their use. The more prevalent, socially acceptable and efficacious neurotechnologies become, the harder it will be to prevent their dissemination, including to healthy individuals. Laws around the recreational use of marijuana provide a case in point.

A different argument that might be put forward — but one that may point towards the same conclusion — is that neuroenhancement is a normal (and indispensable) feature of the human development process. Society has always strived towards higher standards in cognition and mental productivity with a view to maximizing human potential. This is most clearly showcased in how education systems and tools have evolved, but nutrition, nootropics, communication and human networks can all be viewed as innovations contiguous to this goal. Most of these innovations were contested at their inception; vitamins, the Internet, advertising, computer games etc. all gave rise to polarizing debates around where the balance should be set between innovation and interfering with the human condition. But in most cases the arguments were overcome and the technologies normalized. A similar trajectory could conceivably take place with enhancive neurotechnology but of course it cannot be assumed that this will be the case.

If it is accepted that enhancive neurotechnology will — rightly or wrongly — make its way into society, the discussion should shift to risk mitigation and management. Among the most significant risks is worsened inequality. Indeed, while enhancive technologies *could* be utilised to close inequality gaps by targeting its use towards issues of relevance to the Global South, it may be more likely that if markets regulate the distribution of enhancive technology, gaps between social groups, wealth classes, countries and regions will widen. This supports the case for regulation that specifically makes provision for equality of access, preferential access, and development collaborations aimed at solving global challenges or issues specific to the Global South.

PART 3. NEUROTECHNOLOGY AND CRIMINAL JUSTICE

Building on the themes of monitoring, decoding and enhancement, a further area worthy of consideration is the use of neurotechnology in the criminal justice system. While approaches that derive information from the brain are not necessarily new to investigations and law enforcement, there are important normative and ethical considerations that warrant discussion, as well as practical challenges that need to be overcome for both human rights and fair trial principles to be observed.

BRAIN SCANS AS EVIDENCE

One way that neurotechnology has been employed in criminal justice is via hospital-grade brain imagery. Most commonly, expert witnesses, such as forensic psychiatrists, give evidence on brain abnormalities detectable from brain scans.[78] If an individual's offending is linked to dementia, for example, this may be significant to a sentencing judge from a perspective of gauging moral culpability or the risk of recidivism.[79]

Importantly, the brain data used in these scenarios is not contemporaneous with the commission of the crime. The information presented to a court via an expert witness will generally be gleaned from *static* images (such as an MRI image) taken before or after the criminal act (perhaps for a medical purpose or in preparation of the case). This may change if neural devices (invasive or non-invasive) become more prevalent in society and if they also record neural activity in real time. Indeed, information about what was happening inside a defendant's brain as they offended (and/or shortly before or after) may reveal important information that is legally relevant to a case. Some experts, however, contest the kinds of inferences that might be drawn from brain scans[80] and their reliability, especially given the rapidly evolving technologies these devices employ and their commercialization. These will be important questions to be answered by scholars of evidence law and courts.

Other questions relate to issues of an extant nature. Police in Dubai, Singapore and India have acquired, and in some cases are known to have made use of, neural devices in their investigations to determine whether a suspect has "guilty knowledge".[84] In the US, defendants have invoked the use of 'recognition brain scanning' in an attempt to provide exculpatory evidence in support of an alibi.[85] The relevant technology operates via EEG headsets that monitor involuntary neural activity related to various stimuli, such as a photograph. The technique can be used to infer whether a person recognises, for example, an object that was present at a crime scene, as the neural activity of someone familiar with the image will be different from a person who

> Within the neurolaw scholarship, some have suggested that neuroscience, and associated technology like brain scanners, might have a role in challenging ideas about free will leading to the demise of retributivism and leaving a criminal justice system that is more focussed on consequentialist aims such as deterrence or incapacitation.[81] Others are more sceptical,[82] with some concluding that there is no evidence that retributivism in the decisions of courts is on the demise.[83]

is encountering it for the first time.[86] Such approaches are neither definitive nor fail-safe. Chiefly, a witness to/victim of a crime, or someone who encountered the same object for an innocuous reason, might well exhibit a similar brain activity marker.[87] Moreover, the community of practice remains divided over the efficacy of such technology. The work of Larry Farwell, a pioneer of EEG-based 'brain fingerprinting', for example, has been extensively criticized on the basis that his research has not been subject to sufficient independent review, that accuracy was overstated, or that it could be subject to countermeasures.[88] Nonetheless, as the technology progresses — fuelled by an enthusiastic commercial environment — its "potential to be developed into a powerful new tool in forensic investigations and related applications" cannot be ignored.[89]

DECODING INTENTIONS AND THE BRAINS OF OTHERS IN THE CRIMINAL JUSTICE SYSTEM

Another use of brain monitoring and decoding technology is to give an agent a new means of acting in the world, as is the case with some BCI. For example, an individual fitted with an implanted or non-invasive BCI could use their brain to control a drone to kill another person.[90] If they are charged with murder, the prosecution needs to prove both mens rea (guilty mind) and actus reus (the criminal act) beyond reasonable doubt. While the mens rea may not be difficult to establish, the actus reus is unusual in that a traditional bodily action involving the muscular system is absent. If the individual controlled the drone by imagining a bodily act (such as moving a thruster or a directional aid) and the device 'understood' these mental acts to be controls, then the conduct constituting the criminal act becomes unclear. It might be argued that the mental act equates to or replaces the criminal act, however the distinction between the guilty mind and criminal act is no longer as bright as it was (i.e. the *act* of the defendant was arguably as much in the mind as the mens rea).[91]

It is also possible to envisage situations where a neural device malfunctions and wrongly infers an intention. In such a case, the defence might have little difficulty in raising a reasonable doubt that the defendant is guilty, however reflection on this raises complex questions with respect to responsibility for the wrongdoing. For example, should the device be regarded as part of the defendant, or an external tool that they were using? Would this question be answered differently depending on whether the device was invasive (implanted) or non-invasive (a headset)? From a human rights perspective where does the human (rights bearer) end and the technology they use begin?[92]

INFLUENCING THE BRAIN

Neurotechnology might alternatively be used as a means to address criminal behaviour and/or mitigate the risk of recidivism. Gilbert and Dodds, for example, have considered whether approaches used in neurostimulation treatments for some forms of epilepsy might be repurposed to treat impulsive aggression.[93] Such epilepsy treatments work by way of implanted devices that monitor brain activity to detect the precursors to a seizure and then apply stimulus to avert it.[94] Noting that electronic monitoring (albeit geographical rather than neural) is a sentencing option in some jurisdictions, McCay has considered whether someone charged with assault might leverage an implanted neural device to qualify for a non-custodial sentence (e.g. on the basis that the device could help to manage a mental health condition involving impulsivity and aggression).[95] Such an option might be attractive from both a cost and prison overcrowding perspective, as well as arguably in terms of rehabilitation. Again, however, the risks and legal questions are many. If a device malfunctioned (or was deliberately hacked) the result could be that aggressivity was magnified. Not only is this a public safety risk, but it also raises questions around whether the device is considered part of, or separate to, the individual. Another question is the possible influence and responsibilities of corporations if governments contract out the maintenance, monitoring and running of neural devices in the way they have done with private[96] prisons.[97]

Most concerning, however, is the scope for a slippery slope in judicial (or more seriously, extra-judicial) intervention, towards 'treating' offenders for their social deficiencies or to improve their capacity for moral agency. If such neurotechnological enhancement became possible,[98] might authorities in countries with poor human records start to treat characteristics they deem undesirable including around sexual identity, religion or political affiliation? It is noteworthy that there is a history of concern about such 'treatment' of offenders, such as in the 1950s when rehabilitation was more of a prominent aim in many western legal systems. CS Lewis famously worried that if he was to offend he might: "undergo all those assaults on my personality which modern psychotherapy knows how to deliver; to be re-made after some pattern of 'normality' hatched in a Viennese laboratory to which I never professed allegiance".[99] Whether a liberal state should engage in refashioning offenders rather than punishing them in a way that is proportionate, was likewise a theme in Anthony Burgess's famous book *A Clockwork Orange* (further popularized by a Stanley Kubrick film of the same name).

MIGHT NEUROTECH LEAD TO NEW OFFENCES AND CRIMINAL NEGLIGENCE STANDARDS?

Neuro-hacking: As neurotechnologies become more widespread, the risk of hacking will increase,[100] including from other citizens, the state or even third-party states. Hackers may seek to obtain neural data or manipulate a device, potentially to affect behavior or cause harm.[101]

Expanding drug laws: Laws may be argued to be needed to prevent misuse that could culminate in dangerous or destructive behavior. Indeed, neurotechnology may produce highs in a user[102] in much the same way that heroin or other synthetic drugs act.

Criminal negligence: Might a surgeon who chose not to cognitively enhance be prosecuted (e.g. for gross negligence manslaughter) for an error that would likely have been avoided through enhancive technology?[103]

A REQUIREMENT TO NEURO-ENHANCE

Defendants are not the only criminal justice actors that neurotechnology might be applicable to. Armed police, for example, need to make high-stakes decisions, raising questions around whether they should be monitored for cognitive impairment/degradation, or even surveilled so that data would be available should there be a criminal justice process relating to their conduct in the future. Such arguments might be extended to other actors within the criminal justice chain — prosecutors, judges etc. — and whether they should (or even be required to) neuroenhance to perform their jobs as effectively as possible.

Californian police chief, Brian Millar, has weighed in on this topic, noting the need to balance opportunities and risks.[104] He gives the example that while neurotechnology to enhance situational awareness may seem justifiable, it also touches on the possibility of modulating empathy. .However some might see this latter possibility as less clear cut. On the one hand, heightened empathy might decrease unnecessary resort to firearm use but might increase the officer's bond with suspects making prosecution less likely. Dulled empathy might lead to more frequent arrests and heavy-handedness in policing, with knock on effects for social cohesion.[105][106] Perhaps empathy modulation might even be tailored to the needs of specific officers with some dialed up and others dialed down, but this raises some of the concerns voiced by CS Lewis (albeit in relation to law enforcement personnel rather than offenders). A related consideration is the rights of individual actors in the justice system. Indeed, enhancement — at least looking at the trajectory of current technology — might not be something that can easily be removed when an employer finishes work. To the extent that enhancement might have impacts that penetrate the private sphere, decisions on whether the costs outweigh the benefits would need to be made, as well as clear protections for those who chose not to enhance. However, as neurotechnology becomes more sophisticated and accessible, these questions may become moot. Specifically, if large networks of criminals begin to make use of cognitive enhancement tools (as they have started with AI tools) pressure to 'level the playing field' might demand that criminal justice professionals adopt a similar approach and follow suit.

REGULATORY QUESTIONS

While many of the technologies discussed in this section remain experimental or theoretical, the fast pace of innovation in decoding mental images[107] and words[108] suggests that it is only a matter of time before neural data begins to play a role in criminal justice systems.[109] This raises important and complex questions, many of which merge with issues of human rights, ethics and the purpose of criminal justice in modern society.[110]

A first issue the law will need to deal with is how to balance mental privacy and the right to not self-incriminate, with the probative value that neural evidence may offer a criminal process.[111] On the one hand, freedom of thought is a non-derogable human right, and a world where neural data might be harvested to implicate or exonerate individuals in criminal trials may have cascading spillovers. For example, a 'chilling effect' on thought might, in turn, incentivize controlling one's mental world and neural activity so that any inculpating inner life is less accessible (a "poker brain"[112]), with further impacts on personal interactions, relationships and innovation. On the other, individuals have the right to a remedy and a fair trial, something that may in the future be contingent on the invocation of neural data. A related issue is consent, especially since those caught up in criminal justice processes may find themselves in somewhat coercive environments. The volume and granularity of personal information that can be derived from neural data will likely to increase over time as technologies become more sophisticated. The upshot is that there may be a disconnect to what information individuals consent to provide, and what can be gleaned from that information in the future.

Other issues are more doctrinal, for example what constitutes a neurobionic actus reus, and the human rights and responsibilities that attach to a neurally-cyborgised individual.[113] Another question cuts to the purpose of criminal justice in society and whether — given what neurotechnology can offer — judges should move beyond punishing and preventing harm, towards using brain-modulation devices to reform individuals with a view to mitigating future harm? But while it might be the case that some offenders would prefer a brain-implant to prison (and it may also be cheaper), questions of mental integrity, freedom of thought, agency and interference in the human condition, also need to be considered.

As regulators seek to answer these questions, the temporal framing of issues to be considered and resolved, should sit at the fore. Hospital brain scanners and EEG headsets, for example, are already being employed (albeit indirectly via expert witnesses in the case of hospital brain scanners) in some criminal justice institutions. Implanted neural devices that modulate brain activity are also in use, although not as rehabilitative tools in sentencing. Cognitive enhancement, on the other hand, is more technically complicated and commercially distant. Against this backdrop, some commentators have cautioned about hype and the perils of anticipatory ethics.[114] The takeaway is that when regulators speculate about developments in criminal justice, time frame needs to be a central consideration. Excessive regulation risks both wasting resources avoiding scenarios that never materialize, and/or unnecessarily thwarting the development of beneficial technologies. A focus on extant technologies however may mean that laws become redundant soon after (or even before) they are promulgated.

CONCLUSION

While much of the technology discussed in this paper is not widely dispersed in society (and in some cases not yet developed) it is likely that in the medium term, neurotechnology will become significantly more sophisticated thereby gaining wider adoption in society. Given some of the potential upsides, particularly in relation to the treatment of neurological and psychiatric conditions, such advancement is to be welcomed. In light of this, human rights entities need to focus on the management of risks, but remain mindful of the possibility that overregulation may have negative human rights implications through for example making the realization of the right to health less achievable. Such risk management is a difficult task given that the picture is emerging rather than complete. If legal responses only take into account existing technologies, they may become outdated before coming into force; but if they stray too far into anticipated futures, they may regulate imaginary problems that never emerge, together with bringing unintended side-effects that cause more harm than good. As a result of this, consideration needs to be given to temporal framing and finding a balance between an empirical approach which looks for actual problems that have emerged, and an anticipatory approach which addresses hypothetical scenarios resulting from a technologically reasonable extrapolation of scientific and engineering trends.

With respect to monitoring and decoding it may be that neurotechnology becomes used as a tool for identification, and an increased capacity to surveil populations emerges, perhaps with neurotechnology used to supplement existing forms of surveillance. This emerging capacity must be recognized as a possibility and needs consideration from policy-makers. Surveillance might take place in a commercial and governmental context and while some forms of consensual neuromarketing might not be problematic from a human rights perspective, frameworks of consent will require evaluation for legitimacy and effectiveness.

In the workplace, neurotechnologies may provide upsides, such as enhanced safety. These need to be weighed against issues of consent given the power imbalance between employees and employers, and the weighing process must be mindful of concerns about increased capacity to surveil workers, perhaps in a way that is an affront to dignity or that might enable forms of discrimination.

The capacity to monitor and decode neural activity is advancing ahead of the capacity to enhance humans, but cognitive enhancements may at some point increase our understanding of the world and improve decision-making enabling better responses to the problems that challenge us. Of course, the term 'better' is a normatively loaded term and thinking is needed about what it means to be 'better', and how such benefits might be distributed fairly. Conceivably, the way that questions of distribution are answered might exacerbate existing inequalities, both individual and/or national, or it could diminish them. This is an important issue to be considered when addressing possible responses to neurotechnological development.

Another significant issue relates to competition. In a workplace people may compete for promotion and if one's peers are cognitively enhancing then this may create a pressure to do the same. Similarly military enhancement might also take place in atmosphere of international competition, with participants including nations with poor records of belligerency. This may only add to any problems that might emerge from AI competition among nations.

Themes of monitoring, decoding and enhancement all play out in this paper's section on criminal justice. Issues of mental privacy and concerns about the right not to incriminate oneself resulting from the monitoring and decoding of brain states have already started to emerge in some jurisdictions. Concerns around consent emerge here more strikingly than in the employment context. One need only think of a frightened suspect in detention who 'consents' to a neural examination involving an external headset, to see how there could be a debate about what it means to consent. Similarly, if offenders can be 'enhanced' through neural devices that both monitor and stimulate their brains to address their criminogenic tendencies, might they consent to use such a device to avoid going to jail. Is this real consent given the choice faced? And what is it to be 'enhanced' and is that really different from being pacified in a way that is an affront to dignity? Certainly, the idea of treating offenders for their criminogenic tendencies raises a much older question about what punishment is for that policy-makers will need to address. Finally, a more macro point worthy of consideration is that when one thinks about a criminal justice system enabled by neurotechnology *as a whole*[115], what kind of properties emerge and how might these properties have human rights implications?

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END NOTES

1 Neurotechnology – electronic devices, techniques or processes that access/connect to/interface with human neuronal activity – generally fall into two categories. First, where an external system manipulates brain activity, for example by applying electrical currents, to achieve a desired result such as halting a tremor. Second, where an external system recognizes specific patterns of brain activity and translates them into technical commands such as text or movement. See further, E. Harper (2023) The Evolving Neurotechnology Landscape: Examining the Role and Importance of Human Rights in Regulation Geneva Academy.

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7 Notes were taken at the event and these played a role in shaping the direction of this paper, including by considering works of others referred to.

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