Issues of Ethics, Privacy, and Cognitive Liberty in Computing

Jessica K. Barfield

School of Information Science and Intelligent Robotics Arm Lab
University of Kentucky, Lexington
jessicabarfield@uky.edu

ABSTRACT

Introduction. This papers reviews developments in brain-computer interface devices (BCI) and discusses challenges to computer science implicated by the design and use of such devices. Contributing to the discussion of undone science in computer science the paper outlines issues of ethics implicated in the development of BCI devices that are currently not addressed in the design cycle of such devices including the software development cycle for BCIs.

Emerging computing platforms in the form of BCI devices and neuroprostheses are beginning to enter society leading to a range of "undone science in computer science" issues which are of increasing importance to the computer science community (Bublitz, 2024). While BCIs are used for medical applications they are also used in fields such as entertainment, marketing, and education (Takabi, Bhalotiya, and Alohaly, 2016). BCIs can change human behavior by linking thought to action, by assisting in restoring cognitive functions, and by providing neuro-feed back to train attention. Regardless of the application new issues for computer science to consider are becoming apparent from the use of BCI devices which relate to ethics, privacy, and the idea that a BCI device could affect the very nature of our memory and ability to think (Rainey, Maslen, and Savulescu, 2020). For example, BCI technologies with wireless ability could be accessed by a third party which could lead to false memories implanted within an individual's mind or their memories to be edited (Bublitz, 2024). This seemingly future-oriented possibility is not a concern for future generations of computer scientists but a pressing concern for current computer scientists. To illustrate this, Ramirez et al. (2013) showed the possible negative outcomes which could result from the use of BCIs. In their study a fear conditioned memory was created in mice by optogenetically manipulating memory engram-bearing cells in the hippocampus. From the recording of the neural activity associated with a "fear memory" the memory was successfully reactivated in a different context with a different animal, thus implying that the memory experienced by the first animal had been successfully transferred to the second. From this finding and later developments in the use of BCIs a cognitive liberty or neuro-rights movement developed. For example, in 2021, Chile, considered a "neurorights" bill to protect cognitive liberty by creating a legal framework to safeguard the human mind from potential misuse resulting from advanced neurotechnologies (Alejandram et al. 2021).

Computer Science Plays a Role. As background, a BCI device can be considered a system that translates brain activity into commands to control an external device; whereas, a neuroprosthesis controlled by a BCI, can be considered a device that replaces or restores a lost bodily function (Morgan et al. 2019). As an example, a BCI may allow individuals with paralysis to control robotic limbs, move computer cursors, or restore speech by directly decoding the individual's neural signals into desired actions. The role of computer scientists in creating a BCI device is to develop the algorithms for signal processing, employ machine learning techniques for neural decoding, and write software to translate brain activity into commands which may allow people to communicate and control technology, or even augment human capabilities (Coin and Dubljević, 2021). Further, algorithms written by computer scientists can be used to decode brain signals to identify the user's intended actions, such as movement or speech, and to provide tactile feedback

from a prosthetic device back to the brain to allow users to "feel" what they are touching. Among others, the role of computer scientists in developing BCI devices has led to issues of undone science in computer science as the ethical implications of BCI devices has remained a relatively unaddressed topic among computer science researchers especially as BCI technologies have begun to support commercial applications. Another issue for computer scientists is to consider is the use of open versus closed hardware. Open hardware refers to BCI devices whose designs, schematics, and often software are made publicly available, allowing researchers and developers to build, modify, and customize the technology without licensing restrictions thus lowering the barrier to entry and foster innovation in the field. Whereas, closed hardware refers to proprietary BCI devices, typically developed by commercial companies, where the hardware specifications, schematics, and design are kept confidential and are not intended for third-party modification.

Undone Science in Computer Science and Issues of Ethics. As stated by Burwell, Sample, and Racine (2013) the direct connection created by a BCI between human brains and computer hardware and software raises various ethical, social, and legal challenges that merit examination and represents a shift in our current discussion on the ethical use of computing technology. What I consider a new issue of undue science for computer science is the idea that BCI devices with computational ability are not separate from the body but integrated into the body itself operating through a closed-loop feedback system (Aggarwal and Chugh, 2020). Essentially this means that computer science has not only entered the body but the brain itself.

Considering the ethical issues impacted by the use of BCI- devices they include human dignity, personhood and autonomy, user safety, stigma and discrimination, privacy and security, responsibility, research ethics, and social justice (including access to BCI technology). And while existing principles of ethics such as the ACM Code of Ethics and Professional Conduct provide an initial guiding framework, they should be revised in the current landscape so as to be responsive to challenges posed by the development and use of BCIs. As another example of undone science in computer science, the themes of humanity and personhood deal with whether a BCI will become part of the user's "body schema" and thus considered part of the body (Sample et al. 2019). Further, the themes of stigma and normality apply if the BCI device is used to aid a person with a lost limb or other physical disability- the issue here is whether having a BCI device becomes stigmatized in society (Aas and Wasserman, 2016). In addition, the issue of responsibility is also important in ethical discussions dealing with BCI devices. If a negative action were to be carried out by someone using a BCI, would it be considered the user's fault or the fault of the technology?

The issue of autonomy, or one's ability to act independently and of their own volition, is another issue impacted by a BCI device. How is autonomy affected if an action is possible only because of BCI technology? In contrast, autonomy may be increased if individuals equipped with a BCI device is able to do things on their own that once required supervision and assistance by a caregiver (Friedrich et al. 2021). Further, the nature of a BCI sending brain signals directly to a computer raises the possibility of hacking the brain (Bublitz, 2024; Ienca and Haselager, 2016). This issue is connected to concerns regarding privacy and security of the mind. Another ethical concern discussed by Burwell et al. (2017) is justice. For example, the concern is that BCIs could potentially exacerbate existing inequalities between individuals and social strata, creating a scenario in which a BCI technology that provides cognitive or physical enhancement is only available to the wealthy.

Summary. This abstract discussed the concept of undone science in computer science by noting that techniques of computer science are fully integrated into the design and use of BCI devices that can potentially impact our fundamental rights such as freedom of thought and privacy of the mind (Ligthart et al. 2017). Going forward, ethical guidelines will need to be developed to protect the basic rights of people equipped with BCIs and aimed at governments, corporations, and third party entities.

References

Aas, S., and Wasserman, D., Brain–Computer Interfaces and Disability: Extending Embodiment, Reducing Stigma? *Journal of Medical Ethics*, Vol. 42(1), 37-40, 2016.

Aggarwal, S., Chugh, N., Ethical Implications of Closed Loop Brain Device: 10-Year Review. *Minds & Machines*, Vol. 30, 145–170, 2020.

Alejandram, Z-F., Villavicencio, M. L., Zaror, M. D., Salas, V. R., and Maretin, H., Chapter Seven - Neurorights in Chile: Between Neuroscience and Legal Science, in *Developments in Neuroethics and Bioethics*, Academic Press, 165-179, 2021.

Bublitz, C., Neurotechnologies and Human Rights: Restating and Reaffirming the Multi-layered Protection of the Person, *The International Journal of Human Rights*, Vol. 28(5), 782–807, 2024.

Burwell, S., Sample, M., and Racine, E., Ethical Aspects of Brain Computer Interfaces: A Scoping Review, *BMC Med Ethics,* Vol. 18, 60, 2017.

Coin, A., and Dubljević, V., The Authenticity of Machine-Augmented Human Intelligence: Therapy, Enhancement, and the Extended Mind, *Neuroethics,* Vol. 14, 283–290, 2021.

Friedrich, O., Racine, E., Steinert, S. *et al.,* An Analysis of the Impact of Brain-Computer Interfaces on Autonomy, *Neuroethics,* Vol. 14, 17–29, 2021.

Ienca, M., Haselager, P., Hacking the Brain: Brain–Computer Interfacing Technology and the Ethics of Neurosecurity, *Ethics Inf Technol*., Vol. 18, 117–129, 2016.

Ligthart S, Ienca M, Meynen G, et al. Minding Rights: Mapping Ethical and Legal Foundations of 'Neurorights.' *Cambridge Quarterly of Healthcare Ethics*, Vol. 32(4), 461-481, 2023.

Morgan B. L., Kramer, D. R., Peng, T., Barbaro, M. F., Liu, C. Y., Kellis, S., and Lee, B., Clinical Neuroprosthetics: Today and Tomorrow, *Journal of Clinical Neuroscience,* Vol. 68, 13-19, 2019.

Rainey, S., Maslen, H., and Savulescu, J., When Thinking is Doing: Responsibility for BCI-Mediated Action, *AJOB Neuroscience*, Vol. 11(1), 46–58, 2020.

Ramirez, S., Liu, X., Lin, P-A., Suh, J., Pignatelli, M., Redondo, R. L., Ryan, T. J., and Tonegawa, S., Creating a False Memory in the Hippocampus, *Science*, Jul 26, 341(6144), 387-391, 2013.

Sample, M. *et al*., Brain–Computer Interfaces and Personhood: Interdisciplinary Deliberations on Neural Technology, *J. Neural Eng.,* Vol. 16 (6), 2019.

Takabi, H., Bhalotiya, A., and Alohaly, M., Brain Computer Interface (BCI) Applications: Privacy Threats and Countermeasures, *IEEE 2nd International Conference on Collaboration and Internet Computing (CIC)*, 102-111, 2016.

Author Bio: Jessica K. Barfield is an assistant professor in the School of Information Science at the University of Kentucky and is with the College of Engineering Intelligent Robotics Arm Lab.