

Implant Neurotechnologies for Memory and Cognition: A Literary Approach to Memory Ethics and Medicine

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Introduction

- Intersection of nanotechnology, biotechnology, information technology, and cognitive science (NBIC) should be discussed in relation to the following six themes: overall potential, human cognition and communication, human health and physical capabilities, group and societal outcomes, security, and science and education (Roco & Bainbridge, 2002).
- Neurotechnologies for memory and cognition (NMC) have been successful in invasive and noninvasive brain-computer interface (BCI) and brain-to-brain interface (BTBI) applications.
- There is a need for neuroethical scholarship and discourse on implant neurotechnologies for memory and cognition (INMC). Theoretical and empirical scholarship together sophisticate an understanding of ethics.

Thought Experiment

A prior thought experiment explores via a dystopian narrative INMC (Nagam). The dystopia maximizes productivity with an ever-present cognitive state, achieved via erasing cognitive activity (originating from both the senses and internally within the brain) accumulated by citizens on a daily basis using neurally implanted microchips. Sensory cognitive activity is captured by the microchips and uploaded into a supercomputer (called “One”) for processing by government officials. Information deemed contributory to productivity and/or a stable sense of self and continuity is reuploaded via signaling from microchips into citizens’ brains. This conceptual model suggests an alleviation of the cognitive “burdens” or capacity of the individual for information self-processing and autoeosis away from the present (Nagam). Conceptually, the supercomputer serves as an external memory store, which together with citizens constitutes an extended (transactive) memory system—(Hansson, 2005; Michaelian & Sutton, 2017; Nagam, 2020).

The protagonist narrative involves a citizen working as a One technician—who is always able to remember her knowledge and learnings of One assembly and operation manuals, never requires more than a single workday to resolve her technical caseworks, and is indifferent to information that does not affect her work. As she suddenly gains a desire to learn for learning’s sake—and with the help of a voice recording app to preserve her learnings and thoughts—she gradually realizes how the dystopian nation-state philosophies and the microchip-One system apply to and affect her daily life (e.g., becoming aware of her memory loss and déjà vu). Her “anarchist” (or, “revolutionary”, depending on perspective) ideologies to “reroute the information within One back to citizens from whom the neural data was acquired” are discovered by the government through tracking of her sensory neural data and voice recordings (Nagam).

Discussion and Analysis: Thought Experiment

- Citizens exhibit impairments in reasoning and intelligence—specifically in deductive reasoning more so than inductive reasoning, and in fluid and crystallized intelligence in different means.
- Citizens store limited information in long-term semantic, episodic, autobiographical, and nondeclarative memory, and display relatively limited autoeotic consciousness (for the past and future) compared to noetic consciousness. Other forms and phenomena of memory, such as déjà vu and Rilkean memory, may still be intact. Consequently, episodic feelings of knowing (FOKs) are diminished relative to noetic or semantic FOKs; additionally, FOKs are biased by the perception of the microchip-One system.
- The source problem, between retained and reuploaded memories, must be considered, even if only true memories are reuploaded. Memory markers may be important to and hold much value for the government, but not so from the perspective of citizens.
- Though state curiosity, intrigue, and interest being relatively absent, the trait affect versions thereof are interestingly selectively present as relevant to productivity.
- Past-directed emotions are present in citizens.
- Sense of self and identity is stable in citizens.
- The microchip-One system facilitates a population-wide transactive memory system over which citizens themselves have limited control, with accompanying implications for cognitive responsibilities, privacy, and implicit selection for those most “fit” to function in such an epistemological environment.
- It is unclear how specifically counterfactual scenarios without the microchip-One system would compare in the aforementioned respects; a possible counterfactual scenario could be taken as people in present-day societies.

Implant Neurotechnologies and Memory Ethics

- A paradox of memory is that the ability to remember is important for organismal functioning, while the ability to forget is natural exercise of brain function and beneficial in reducing and focusing cognitive workload—imbalances in both remembering and forgetting can be debilitating, as seen in patients with amnesia and hyperthymesia respectively (Racine & Affleck, 2016; Yehuda et al., 2010). We term this specific paradox of memory the “paradox of remembrance”.
- Clarified account of the following concepts closely related to, yet distinct from, autoeosis: reminiscence, recollection, retrospection, and anticipation.
 - Autoeotic consciousness is a complex self-awareness enabling rich imagination and construction of past and future experiences; reminiscence is recalling of past, often pleasurable, experiences; recollection is vivid and detailed remembrance of past experiences; retrospection is the process of reviewing or reflecting upon past experiences; and anticipation is the looking forward to the future generally or specifically (e.g., towards an event or state) (Havighurst & Glasser, 1972; Michaelian & Sutton, 2017; Vandekerckhove & Panksepp, 2009; VandenBos, 2007).
 - The said four terms are all relevant to understanding the implications of autobiographical memory, and may all occur in a directed, purposive, or spontaneous fashion; recollection may be a type or sub-level of autoeosis—specifically past-oriented autoeosis; reminiscence is less vivid and detailed than recollection; reminiscence is not vivid and detailed enough to be considered autoeosis, and may be a relatively casual, less demanding means to consider the past; retrospection may be a type or sub-level of past-oriented autoeosis more analytical in nature; and anticipation may be a type or sub-level of future-oriented autoeosis but that usually occurs in contexts involving affect (Van Boven & Ashworth, 2007).
- Though a relatively little discussed concept, memory markers may be important to consider with the advent of neural monitoring technologies, both invasive and noninvasive.
- Metacognitive appraisals may create bias in remembering, as well as accompanying FOK.
- Nostalgia would need to be preceded by reminiscence or autoeotic reconstruction, and then retrospection, of a past experience, to bring to mind and appraise the experience as “better” in some way than the present, respectively. Only after this sequence could nostalgia, longing for that past experience, occur.
- Emotions directed towards past memories or past-oriented processes should be characterized as past-directed.
- Self-questioning of identity may stem from a lack of memory, which may or may not occur even in normal and healthy patients.
- Use of external memory stores (e.g., by extended, distributed, or transactive accounts) must be carefully characterized, especially in research with potential operational definitions. Extended or distributed memory systems, but not transactive memory systems, may engender ethical concerns on memory modification, given their close relationship with and centered on the rememberer.

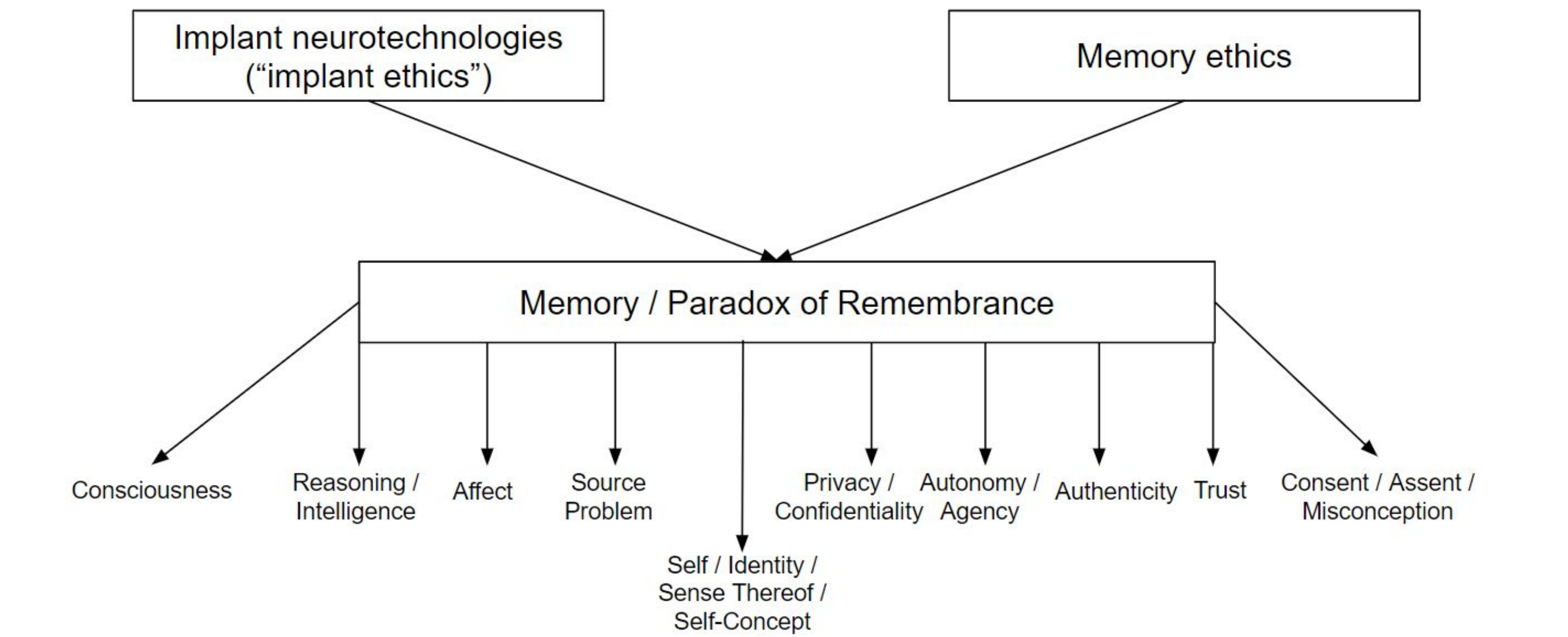


Figure 1. Network diagram of neuroethical concepts involved with implant neurotechnologies for memory and cognition (INMC) arising from implant ethics and memory ethics. The ten concepts shown are complexly interrelated, unidirectionally or bidirectionally influencing each other.

Neurotechnologies and Patient Care

- Is an INMC intervention “worth it” for the patient? All potential effects of neurotechnologies to patients should be considered, and conveyed to involved parties (patients, caregivers, etc.) prior to administration or implantation of the intervention in an objective, unbiased manner, maintaining the integrity of informed consent.
 - Separating neural implants from actions specifically directed or engendered within the patient’s “control” or “autonomous jurisdiction” is a thorny task, raising questions of responsibility and liability.
 - Guidelines for memory and cognitive markers may need to be developed taking into account the nature of the data collected, patient states and self-reports, and accordingly reasonably analyzing and extrapolating the data to conclusions.
 - NMC, including BCIs and BTBIs, hold immense potential for medical practice—not only as medical interventions for patients, but also for diagnostics in sophisticated monitoring of internal states of patients.
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- Now, more than before, the use of digital technologies has pertinent implications for our health, unique from other human activities, that should be given its due consideration.
 - Digital addictive patterns (what we term as “digital addiction”) are particularly closely linked to a unique range of health problems and phenomena—including but not limited to the COVID-19 pandemic and ocular diagnoses such as premypopia and computer vision syndrome—potentially warranting standardization on its own in medical guidelines (Coronel-Ocampos et al., 2022; Dossari et al., 2022; Ekemiri et al., 2022; Wang et al., 2022; Wangsan et al., 2022).
 - The specific effects and permanence of memory systems with external memory technologies must be assessed (Michaelian & Sutton, 2017; Nagam, 2022).
 - Equity and accessibility are important to consider with digital technologies. Are those who can adapt to shifts of in-person activities to virtual Internet-based mediums more “fit” (Nagam, 2022; Risko & Dunn, 2015; Storm et al., 2017)? How should telehealth be delivered for older patients and populations with complex needs, such as patients with chronic diseases and also potentially patients with digital addiction, who may otherwise be disproportionately impacted during the COVID-19 pandemic (Nouri et al., 2020; *Public Opinion About the Internet and Information Technologies*)? Inequities in digital accessibility may lead to other forms of disparities, such as epistemic disparities in health knowledge and consequently disparities in health outcomes.
 - Given the online format of the provided health services themselves, how effective would telehealth-based medical consultation and treatment for digital addiction be?

Responsibilities of Stakeholders

The ethical discussion thus far calls for responsibilities of governments, manufacturers of neurotechnologies, medical providers, patients, researchers and scholars, and the public on the reconciliation of the ethics of neurotechnologies impacting memory and cognition. Governments, manufacturers, and providers bear the responsibility to ensure equity and accessibility of neurotechnologies (Nagam, 2020). Providers must be proactive in utilizing alternative means of communication (e.g., secure medical messaging) with patients and to promote equity and accessibility of health resources and care. Patients must know and fulfill their responsibilities in both research studies and clinical practice. Scholarship must actively identify and investigate points of research that could potentially benefit, and improve understandings of, the patient-provider relationship today.

Conclusion

In analyzing a prior thought experiment, we impart a novel and consolidated account of the metaphysical and ethical implications of neurotechnologies for memory and cognition, presented in Figure 1. We posit novel insights on memory and cognition applicable to research and patient care today, and accordingly responsibilities for all stakeholders involved. We underscore the importance of literary and humanities approaches in engaging stakeholders with neuroethics.

References

