

## MEDICINE AND SOCIETY

### Manipulating Memories: The Ethics of Yesterday's Science Fiction and Today's Reality

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#### Abstract

The paper addresses recent advances in memory manipulation from the perspective of the four key pillars of neuroethics: the self, social policy, neurotechnology, and education and outreach. We provide examples for each pillar, assess their neuroethical implications, and conclude with a call for an ethics framework that is specifically tailored for the ethical challenges of memory manipulation.

#### Introduction

Understanding the basis of memory and treating memory disorders has been a focus of neuroscientists, physicians, and philosophers alike for over 2,000 years, starting with Aristotle's early comparison of memories with impressions in wax [1]. Advances using cutting-edge techniques such as optogenetics (a technique that involves the use of light to control brain cells) [2] and neural network analysis (programs and data structures patterned after the operation of the human brain) [3] reveal that memory is indeed like a wax impression: able to be formed and re-formed in surprising ways. Memory research now extends beyond questions about the consolidation and retrieval of past memories to explorations of the selective removal and addition of memories through pharmacological means, such as drugs, and technological means, such as direct or indirect brain stimulation [4], and in a range of organisms, from the microscopic worm *C. elegans* to humans.

Science fiction and other cinematographic genres have exploited the imagined potential of memory manipulation for half a century. In 1962, the Cold War suspense thriller, *The Manchurian Candidate*, told the story of a Korean War soldier who is brainwashed and reprogrammed to be an assassin. The story line includes the implantation of false memories during the mind-control process, a neuroscience-inspired phenomenon associated with the work of Pavlov and others in classical conditioning [5]. It is thus not surprising that in *The Manchurian Candidate*, the physician responsible for the brainwashing operations is affiliated with a fictional Pavlov Institute. The mystery and suspense of implanting thoughts and ideas into the human subconscious retains its wide appeal today. The 2010 drama, *Inception*, tells a tale of dream invasion and idea implantation inspired by lucid dreaming.

Cinema productions have also tackled the selective erasure of memories. For example, in the 2004 movie, *Eternal Sunshine of the Spotless Mind*, the protagonist undergoes a memory-erasing procedure to ease the pain of heartbreak. The movie also brings to the fore critical neuroethical challenges of memory manipulation, such as the interconnectedness of memory with learning, moral behavior, social harms, privacy, commercialization, and conflict of interest.

Since these films were released, neuroscientists have made great strides in understanding memory, with both clinical and social goals in mind. For example, they have investigated how emotional content can become dissociated from memories of specific events [6], which may play an important role in the treatment of post-traumatic stress disorder (PTSD), and the unreliable nature of eyewitness memory, which has significant implications for the justice system [7]. In animal models, the selective erasure of fear memories has been achieved through the ablation of specific groups of brain cells [8]. These investigations raise profound ethical questions.

### **Can Altered Memory Change the Notion of Self?**

Philosopher John Locke suggested that memory provides the basis for personal identity [9]. Indeed, many scientists and philosophers today argue that identity is closely linked to autobiographical memory (a combination of episodic and semantic memories about a person's life) [10, 11]. Evidence supports that an integral component of the relationship between memory and identity is awareness: studies of people with dementia-related memory loss show that low levels of awareness about the extent of a person's memory loss are associated with poorer autobiographical recall and a more positive, sharper sense of identity [12]. Thus, it is hypothesized that a lack of awareness of memory loss may be protective against dementia's threat to identity.

However, the idea that memory is integral to identity is not uniformly supported by the evidence or universally accepted. The German philosopher Martin Heidegger, among others, argued that who we are is not limited to our self-reflective abilities but encompasses our relationships with others and how we are situated in the world [13]. Scientists have explored this hypothesis empirically, with sometimes surprising results [14]. Others argue that identity can be more closely tied to other personal characteristics. For example, Strohminger and Nichols studied 248 patients with frontotemporal dementia, Alzheimer's disease, or amyotrophic lateral sclerosis and found that changes in the patients' moral behavior, not memory loss, had the greatest impact on perceived identity [15]. More recent work based on the principles of affect control theory, which proposes that people maintain culturally based, emotional meanings in their interactions with others, suggests that affective identities (e.g., family, social, or professional roles) of older adult residents in long-term care facilities are preserved to some extent despite memory loss [16].

Given these findings, we can still ask, are the effects of selective memory erasure akin to the effects of dementia-related memory loss? In many ways, they are: in both cases, memory loss can lead to different experiences and different emotions in response to an environmental stimulus, and in both cases, other aspects of identity, such as relationships and affect, can be preserved [8, 16]. However, memory manipulation that is selective, desired (i.e., consented to), and static (i.e., not dynamic or degenerative) has different implications for the notion of self than dementia-related memory loss. For example, despite memory loss, people with Alzheimer's disease maintain social relations, personal preferences and character, the ability to value, and other facets of identity [17, 18], but they have no control over which autobiographical memories are lost or at what rate. Conversely, the selective manipulation of good and [bad memories](#) and of the emotions associated with them has implications for how people consciously construct their notion of self, and how they adhere to social norms.

### **Are Social and Public Policies Needed to Complement Clinical Guidelines?**

Central to social and public policy concerns are questions about the role of memory manipulation, particularly in coercion. For example, should invasive memory erasure techniques involving surgical procedures like [deep brain stimulation](#) be used to prevent recidivism in criminals despite the potential risks of the procedure [19]? Would it be ethical to modify the emotional valence of a memory to alleviate the symptoms of a child suffering from PTSD if the long-term consequences of such a treatment are unknown? As the understanding of memory is deepened through science and medicine and selective manipulation of memories is investigated, it is imperative to consider these repercussions and develop relevant social policies [20]. To ensure that potential societal harms are limited, the upstream engagement of key stakeholders (e.g., researchers, members of the legal profession, patient advocacy representatives, and policymakers) in the research process is vital. While laws do not exist to regulate memory manipulation specifically, the importance of these issues is recognized by national and international initiatives such as the Presidential Commission on the Study of Bioethical Issues and the newly created ethics research area of the National Institutes of Health Brain Research through Advancing Innovative Neurotechnologies® ([BRAIN](#)) Initiative.

### **How Should Ethics Inquiry and Practice Respond to the Potential for Memory Manipulation?**

Psychiatric neurosurgery is responding to intractable diseases of mental well-being through neurotechnological innovations such as deep brain stimulation, which is under investigation for treatment-resistant depression [21] and obsessive-compulsive disorder [22], for example. Some techniques are precise and irreversible (e.g., deep brain stimulation). Other interventions are reversible but less precise (e.g., transcranial direct current stimulation). The trade-offs for neurosurgical treatments of psychiatric illness, like the trade-offs for memory manipulations, must be measured in terms of both

professional responsibility for appropriate use of invasive interventions that directly modulate brain function and fair allocation of resources among the most vulnerable people in society [23]. These trade-offs will need to be managed through consultation with relevant stakeholders using a clinical ethics framework that takes into account medical indications, patient preferences, quality of life, and contextual features [24]. What lies in the future—human stem cells to restore or even enhance memory? Gene editing to record analog memories in the DNA of human cells? Extraordinary new capabilities in neurosurgery and emerging biotechnologies are giving rise to an ever-greater need for ethics frameworks that proactively consider and protect potential recipients of these treatments. The science fiction of yesterday may well be tomorrow's reality.

### **How Should Advances in Memory Manipulation Be Disseminated to the Public?**

Advances in research and technology have accelerated the pace of discoveries about memory manipulation, but the processes underlying memory storage and consolidation still remain poorly understood. Communicating about memory manipulation thus presents challenges distinct from other areas of neuroscience in that the [connections between brain and mind](#), mind and personality, personality and identity, and identity and the fundamental concept of being are still being explored. Compounding the complexity of this challenge is hype promulgated by both traditional and new media, which tends to exaggerate the benefits of memory manipulation and minimize the risks; overly positive representations can lead to misunderstandings and false hope [25-28]. In addition, sensationalized findings about memory manipulation may encourage the early adoption, use, and promotion of unproven interventions, not unlike in other areas of biomedicine such as cancer and regenerative medicine [29]. Overly simplified, headline-driven communication may also compromise perceptions of expertise and authority, reducing public trust in science. Communicators, such as members of the media, academic journal editors, and scientists and clinicians themselves, will need to embrace participatory communication models, frame the science of memory manipulation in nonsensationalized, lay-friendly terms, and consider how to harness new media to deliver ethical and responsible reporting.

### **Conclusion**

Memory manipulation represents a particularly complex challenge for scientists, who conduct research, and for clinicians, who seek to use the results to heal patients or reduce their suffering. It also represents a challenge for ethicists who bring questions and frameworks to bear on the issues to ensure that ethical science is not hampered, that the allocation of benefits is just, that risk is mitigated in research, and that the dissemination of discoveries and new knowledge benefits society as a whole.

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