Axiomathes (2022) 32:1281–1295
https://doi.org/10.1007/s10516-021-09580-5

ORIGINAL PAPER

Engineering the Minds of the Future: An Intergenerational Approach to Cognitive Technology

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Received: 20 May 2021 / Accepted: 10 July 2021 / Published online: 24 July 2021

Abstract
The first part of this article makes the case that human cognition is an intergenerational project enabled by the inheritance and bequeathal of cognitive technology (Sects. 2–4). The final two sections of the article (Sects. 5 and 6) explore the normative significance of this claim. My case for the intergenerational claim draws results from multiple disciplines: philosophy (Sect. 2), cultural evolutionary approaches in cognitive science (Sect. 3), and developmental psychology and neuroscience (Sect. 4). In Sect. 5, I propose that cognitive technology should be given to future generations in accordance with principles of pluralism and transparency. In the final main section of the article, Sect. 6, I apply these principles to topics such as the preservation of information, environmental offloading of cognition, and thinking itself.

Keywords Cognitive technology · Information engineering · Cognitive enhancement · Extended mind · Future generations

1 Introduction

Research in embodied and extended cognition from the past several decades suggests that human cognitive achievements are enabled by the way we use particular artifacts in our environment, by artifacts that are types of cognitive technology.[1] Standard examples of cognitive technology, as I mean the term, would be the written word and contemporary information technology (following Clark 2014, chapter 8). The research suggests that human cognition is, by nature, an intergenerational process. This article is an attempt to address the normative implications of that result,

[1] There is a large literature on the topic, but some main texts include: Donald (1993), Kirsch (1995), Hutchins (1995), Clark (1998), Clark and Chalmers (1998), Tomasello (1999), Sterelny (2003), Menary (2010), Malafouris (2013).

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for it is a result suggesting that the cognitive technologies that we pass on to future generations will play a significant role in determining the cognitive abilities for our descendants. The decisions that we make now regarding cognitive technologies will turn out to be engineering decisions about the minds of the future. A main point of this article is that we ought to develop an empirically-informed and principled normative basis for making these decisions. My initial suggestion here is that the principles of *pluralism* and *transparency* offer a modest start along these lines.

Here is the order in which I will proceed. In Sects. 2 and 3, I make the case, drawing from philosophy and cognitive science, that the story of human cognition is one that involves the intergenerational inheritance and bequeathal of cognitive technology. In Sect. 4, I present evidence that cognitive technology plays a strong role in cognitive development. Then, in Sect. 5, I offer reasons for a commitment to pluralism and transparency in decisions about how to bequeath cognitive technology to future generations. In the Sect. 6 of the article, I address some of the more concrete issues that arise in the application of my recommended principles, issues having to do with preservation, environmental offloading of tasks, and thinking itself.

2 Philosophical Precursors

I will begin with some of the historical precursors to my thinking. The cross-generational perspective on cognition through the cycle of inheritance and bequeathal of technology is somewhat new to contemporary philosophy of mind and cognitive science, but it is not new to the history of thought. Among modern thinkers, an emphasis on the mind as an historical process can be found in Hegel's grand philosophical system of absolute idealism. For Hegel, the absolute mind develops towards self-realization through an historical process (Taylor 1975), whereas on the view being explored here, cognitive abilities develop through the historical process of technological change.[2] Appropriating Hegel, Marx expressed something close to what I have in mind in his suggestion that the material conditions of human existence, especially including tools and technologies, shape our mental lives:

> The mode of production of material life conditions the general process of social, political and intellectual life. It is not the consciousness of men that determines their existence, but their social existence that determines their consciousness. (Marx 1859/2014: 76)

As the conditions of material life change over time with evolving technology, we might expect a corresponding process of change in the human mind.

In addition to the Hegelian lineage, there is a thematic overlap with Husserl's work. In notable passages from his earliest (1900/1993: 123–128) and latest writings (1954/1970: 366), Husserl expresses claims that deeply influenced subsequent

[2] For a recent treatment of the historical trajectory of technology from a Hegelian perspective, see Kislev (2020).

work in phenomenological philosophy of technology.[3] The technology that Husserl addresses is our exemplar cognitive technology: the written symbol. He notes that we would not have made much progress in mathematics if mathematicians had to think through, to prove again, every previous result upon which they wish to build. By writing down meaningful symbols, humanity struck upon a powerful new method of postponing the inevitable loss of all things into the past, in this case the loss of intellectual insight. In line with Husserl's point here, historians of mathematics have traced the interplay between innovations in symbolic notation and mathematical results. For example, there is the claim that replacing Roman numerals with the Arabic system enabled mathematical advancement (Danzig 1954 cited in Tomasello 1999: 46).[4] Common wisdom has it that mathematics is a foundation for technology, but Husserl's insight reverses that proposition. Technology is the foundation for mathematics.

3 Tomasello's Ratchet

Let us now turn from our philosophical inheritance to the beginnings of our technological inheritance. The focus here will be on the cultural transmission of tools for humans, but it is important to note that there is evidence for tool culture in other species as well (Whiten et al. 2005; Auersperg et al. 2014). Hominids have been using tools on earth for around 2.5 million years. But the tools did not change very much for about 90% that time. Our ancestors used flaked stones until the emergence of the hand ax, which was approximately 1.65 million years ago.[5] Technology remained static until about 250,000 years ago when the technological trajectory began and modern humans arrived on the scene. What happened?

Michael Tomasello has developed a convincing answer to that question. According to his account, there are two conditions in place to trigger and sustain technological development. First, there must be innovation. But innovation alone is not sufficient due to the fact that an innovation may not be preserved by subsequent generations. In addition to innovation, there must be imitation. The imitation required is not a mere mindless mirroring of limb movements. The type of imitation required to guarantee technological change is one in which the conspecific is understood as having *intentions*. Once we can understand the intention behind an innovation, then we can imitate it and modify it. Tomasello illustrates his theory with a helpful metaphor:

[3] For instance, we see the influence of Husserl's focus on the written word in the work of Jacques Derrida (1989) and Bernard Stiegler (1998, 2009, 2015) as well as in the "postphenomenological" project of Don Ihde (1990, 2009). It would be valuable, though well beyond the scope of this article, to consider my claims here in engagement with the corpora of Stiegler and Ihde. There are areas of thematic overlap between my approach and theirs, but also important differences. My methodology draws from empirical work in cognitive science and my focus here is on the intergenerational nature of cognitive technologies.

[4] See the recent *Synthese* special issue on Mathematical Cognition and Enculturation for a treatment of related topics by contemporary cognitive science (Pantsar and Dutilh Novaes 2020).

[5] Sterelny (2003: 117–118), Mithen (1996: chapter 2).

> The metaphor of the ratchet in this context is meant to capture the fact that imitative learning (with or without active instruction) enables the kind of faithful transmission that is necessary to hold the novel variant in place in the group so as to provide a platform for further innovations themselves varying in the degree to which they are individual or social/cooperative. (1999: 39)

The ratchet is illustrative here because gains in the direction of rotation cannot be undone with backwards rotation. Similarly, once imitation is at work in the species, technological gains through innovation are not lost to history. The gains are imitated and modified across generations. Even if there is no modification, the gains are not lost because the material tools can be passed down across generations. Stone and metal outlast flesh and blood. Tomasello's ratchet is a fascinating suggestion on its own, but it is also relevant for our purposes here. His theory offers an account of the psychological mechanisms that drive the very trajectory that is the target of our analysis.

In addition to innovation and imitation, the third psychological (or social) feature driving technological development is *cooperation*. In his work on this topic, Kim Sterelny has emphasized the fact that cooperation plays a large role in the turning of Tomasello's ratchet. In particular, cooperation enables us actively to construct our living environment in a way that promotes the expansion of cognitive technology. Human niche construction can be understood as collaborative epistemic engineering. Sterelny explains:

> Agents act to change the informational character of their environment. Downstream informational engineeringchanging the informational character of the next generation's environment – becomes an important form of informational inheritance. (2003: 153)

Our cooperative practices promote divisions of labor that allow the group to use technologies in order to achieve cognitive feats of ever-increasing complexity. Sterelny goes on:

> Hominids make aspects of the physical and social world more salient by marking them physically, linguistically, or behaviorally. Collectively, then, hominid groups buffer the increasing cognitive demands placed on them by their own technologies … Such buffering allows the further expansion of information-hungry techniques by reducing the burden of such techniques on individual agents. (157)

We construct our living environment in ways that divide and simplify cognitively demanding tasks. This practice of epistemic engineering provides subsequent generations a sort of cognitive inheritance in virtue of the spaces that we inhabit together. Since the cognitive inheritance is physical, not biological, it can outlast individual humans and change with the modifications of each passing generation. As I show in the following section, the physical inheritance of cognitive technology also shapes the minds of each new generation that receives it.

4 Cognitive Technology for the Developing Mind

The cognitive development and capabilities of new generations are shaped by the technological environment that they inherit and inhabit. The cognitive abilities of each generation are shaped by the cognitive technologies that they take up. We use our minds to change the technological environment that we inherit, but the technological environment that we inherit has always already shaped our minds.

A well-known and early expression of this point can be found in Plato's *Phaedrus*, where Socrates gives an account of the wise Egyptian king Thamus rejecting the gift of the written word from the god Thoth. According to Socrates, Thames says:

> If men learn this, it will implant forgetfulness in their souls; they will cease to exercise memory because they rely on that which is written, calling things to remembrance no longer from within themselves, but by means of external marks. What you have discovered is a recipe not for memory but for reminder. (275a-b)

The powers of memory atrophy as we take up the cognitive technology of the written word.[6] Of course, there are individuals today who are capable of great feats of memory, but the point is that the cognitive technology offers an alternative, less effortful, form of storing our information. Children born into environments full of print media inherit a world in which stories are stored primarily in books, not in brains. Children born in the twenty-first century inherit a world in which stories are increasingly stored as digital media and appear on screens.

Apart from the purported amnesiac effects of the written word on human cognition, there are complex questions about more subtle influences of immersion into cognitive technologies of different varieties. Consider the range of interaction with cognitive technology that occurs in primary education today: there is typically the written word in both print and digital form, multimedia content, as well as educational games in physical and digital format. Some are enthusiastic about introducing fully immersive technology such as virtual reality. Then we must consider the question of how to test for the general cognitive effects of using these technologies. Assuming we can find an adequate testing methodology, finding causal relationships among the correlations in test results is highly challenging.

There is a vast literature on this topic; here are some suggestive results. One meta-analysis involving over 600,000 participants found a clear positive correlation between the duration of formal education and performance on intelligence tests (Ritchie and Tucker-Drob 2018). Since formal education is a prolonged systematic exposure to cognitive technology, one could reasonably conclude from the meta-analysis that the technology improves biologically-based cognitive ability. But since correlation may not indicate causation, keep in mind that individuals with higher natural propensity may tend to spend more time in school. This challenge for

[6] Derrida took up this theme from Plato in an early and well-known essay, "Plato's Pharmacy" (1981). Stiegler develops the theme into a central part of his philosophical thought as *pharmacologie* (2015).

interpreting the results is an instance of the more general challenge that we face in efforts to understand the impact of cognitive technology upon natural cognitive ability. Going from intelligence tests to the neurophysiological level, there is evidence that time spent reading correlates with advanced development of white matter in the brain (Takeuchi et al. 2016). This result fits well with research into human neuroplasticity over the past several decades, work demonstrating that tool use and other environmental factors continuously alter the neural structure in adult humans (Pascual-Leone et al. 2005). Finally, I'll note that the details of the cognitive technology seem to matter. The literature suggests that traditional forms of reading do promote functional literacy among adolescents, while text messaging does not (Zebroff and Kaufman 2017).

Generalizing from the topic of the written word, there are other important ways in which cognition is shaped by the environment that we inherit. A great deal of research in developmental psychology examines how children learn to engage with artifacts by reading the intentions of caregivers and then imitating them (Tomasello et al, 2005). In order to detect another's intention, one makes use of the other's visibly observable behavior. For humans, the behavior constituting intentional action tends to be behavior that engages with technology of some form. The behavioral data to be interpreted depends upon the way of using the tool. Pounding a nail with a hammer looks different than chopping vegetables with a knife, and both of those activities look very different than reading a book or swiping at a screen.

The experimental evidence suggests that children naturally bring a normative attitude to their engagement with technology. They assume that the manner of interaction that they initially observe is the "correct" way of using a tool, and they become indignant when this norm is violated (Casler et al. 2009). Along the same lines, they generally lack the flexibility for innovating new ways to make use of a tool (Cutting et al. 2011). These results suggest that children do not only inherit the technological environment. They also inherit the modes of bodily engagement with that environment displayed by their forebears. We do what our ancestors have been doing because we have inherited their artificial environment and imitate their interaction with it. In the case of some cognitive technology, doing what our ancestors have been doing means thinking what they have been thinking. An example of this process would be ritualistic study of texts that are held sacred in a tradition.

These examples of cognitive development in the inherited informationally engineered environment all illustrate Tomasello's ratchet effect. He elaborates that the effect:

> radically changed the nature of the ontogenetic niche in which human children develop so that, in effect, modern children encounter and interact with their social worlds almost totally through the mediating lenses of preexisting cultural artifacts, which embody something of the inventors' and users' intentional relations to the world when using them. (1999: 202)

We initially encounter our world through the artificial environment that we inherit. The installation of massive wireless infrastructure today, along with the proliferation of screens, suggests that the primary encounter with the world that we bequest to future generations will be digitally mediated. It is time to consider the cognitive abilities that we will engender in the future through the digital informational environment currently under development.

5 How to Bequeath Cognitive Technology: Pluralism and Transparency

So far I have made the case that our decisions now about creating and preserving cognitive technology are decisions that will determine the cognitive abilities of future generations. Now let us consider some of the principles that we might take up in making these decisions.[7] What sorts of minds do we want future generations to have? This question is not an easy one to answer. But if the considerations presented above are on the mark, our decisions now will shape the minds of future generations whether we proceed deliberately or not. Humans have been engineering the minds of their future generations for a quarter of a million years. Only now are we realizing that we do so. With that realization comes responsibility.

I do maintain that it is our responsibility to work towards a robust answer to the question of what sorts of minds we wish for future generations of humans. Taking this question seriously involves making a commitment to passing on cognitive technology in a *deliberate* manner, rejecting, for example, the passive "click-bait" transmission of information that has emerged through the internet. Even if one makes this commitment, finding such an answer to the question of what sorts of minds we wish for the future is a large and difficult project, a project well beyond the scope of this article. Short of a robust answer to the question of what sorts of minds we wish for the future of humanity, I propose that we can begin at least with the humble answer that we, to the extent possible, enable future generations to determine their own cognitive abilities. Since cognitive abilities rely on cognitive technologies, humility demands then that we bequeath cognitive technology in a *pluralistic* manner. In order to grant the self-determination of cognitive abilities to future generations, we should also share what we know (and what we do not know) about the ways that technologies shape cognition. Doing so will require that we also bequeath cognitive technology in a *transparent* manner.

Thus, as a *first* step in taking responsibility for engineering the minds of the future, I recommend pluralism and transparency.[8] What I mean with pluralism is that we should maximize the options for the cognitive technologies that our descendants will be able to utilize. When new innovations eclipse older artifacts,

[7] I should make a quick note on the issue of technological determinism. If one is committed to a strong version of technological determinism according to which humans have no genuine agency over the course of technological development, then there is no point in developing principles for developing and sharing cognitive technology. I am approaching the topic with the assumption that we have some role in determining the trajectory of cognitive technology over time, a view that is compatible with a sort of soft determinism (Heilbroner 1967).

[8] I thank a referee for pointing out that pluralism and transparency are analogous to diversity and parsimony in statistical modelling. Since machine learning is dominated by statistical modelling, we might gain new insight here into the relationship between machine learning and cognitive technology.

it is our responsibility to guard against obsolescence. We should value our archives (and archivists). Most importantly, we should remain open to the possibility that older forms of technology enable cognitive practices that are different in subtle yet profoundly important ways from new forms (as in Illich 1993). This pluralism that I recommend is motivated by results from cognitive science, but it is similar to views that have been developed and defended in the field of information ethics (Floridi 2002, 2013).[9] I will return to some main themes in this field when I address practical issues in the following section.

Before looking at practical concerns, consider the second value that I recommend: transparency. I am not alone in recommending transparency in the ethics of cognitive technology. In his article on this topic, Marcello Ienca (2019) includes transparency as one of the six principles for "democratizing" the technology. Ienca's main instances of cognitive technology involve neurotechnologies, such as the brain-computer interface, and artificial intelligence. Thus, his discussion differs from mine in that his focus is more narrowly on emerging technology while I include well-worn cognitive technologies such as the written word. I'd like to pick up on his recommendation for transparency and add a modification.

Ienca defines transparency as "the principle of enabling a general public understanding of the internal processes of cognitive technologies" (2019). He raises the important issue of artificial neural networks that operate with a kind of opacity that prevents humans from understanding the reasoning behind their operations. He recommends that the public be educated with regard to the goals as well as the data being used for artificially intelligent cognitive technologies. As Ienca notes, educational goals such as this will be especially challenging. If one considers the fact that many highly educated people understand little of the internal workings of familiar technologies, then one might have little optimism for educating the public about emerging technologies involving artificial intelligence.[10]

In light of the profound challenge that we face in educating the public about the inner workings of emerging technology, perhaps we might try an alternative approach to transparency. Instead of focusing only on the mechanisms of emerging technologies themselves, I suggest that the public should also receive education about the ways that cognitive technologies, understood more broadly, might shape and determine the mind of *the user* (following Dascal and Dror 2005). The research surveyed above, in Sects. 2–4, suggests that the cognitive environment that we inherit deeply shapes our minds (and our brains). This lesson deserves a place of prominence in all discussions of ethical innovation, both for ourselves and for posterity. The challenge, of course, is that the ability to specify exactly how cognitive technology changes our minds is a goal of ongoing research with its own methodological difficulties, as noted in Sect. 4 (also see Heersmink 2016).

[9] Thus we arrive at a convergence between the "downstream informational engineering" of Sterelny (2003) and Floridi's concept of the "infosphere" (2014), despite the fact that the two thinkers are somewhat removed from one another in methodology and tradition. An examination of this convergence is beyond the scope of this article.

[10] I thank an anonymous referee for raising this point.

In any case, there is an important step that we can take now in the name of transparency that does not face methodological difficulties. It is to disabuse ourselves and our children of the myth that human cognition is an ability that exists statically in each of us independently of cognitive technology. The cognitive abilities shown by any particular human being are always dependent upon an intergenerational process that extends beyond the lifespan of any one human, a process made possible through the transmission of cognitive technology in the form of inorganic matter. Considered from this perspective, cognition is not an ability that is mine or yours. It is a dynamic project that is propelled through history through the two interdependent vehicles of human organisms and their inorganic material culture. Taking this (somewhat neo-Hegelian?) perspective is a necessary step in order to bequeath cognitive technology in a transparent manner.

6 Examples: Preserving, Offloading, and Thinking

In this final main section of the article, I will explore the application of my recommendations, pluralism and transparency, in three areas: preservation, offloading, and thinking.

One way to bequeath cognitive technology in a pluralistic fashion would be through the *preservation* of media and the information that they carry. As mentioned above, this normative claim overlaps with the central normative claim of Luciano Floridi's information ethics. For Floridi, we ought to preserve information against its natural dissolution through entropy (2013: 71). On his view, information has an intrinsic moral value. The approach that I recommend here is different from Floridi's in part because I do not claim that the value of information is intrinsic. Instead, some forms of information are instrumentally valuable insofar as they may play the role of a cognitive technology for us and for future generations. This distinction enables me to include pragmatic considerations in determining which information entities ought to be preserved.

The general guiding principle is that we ought to preserve in a pluralistic manner for the sake of enabling future generations to have options in the kinds of cognitive abilities that they develop. This principle offers a robust basis for preservation, more robust than sentimental appeals to posterity. But the principle does not offer a single formula; it does not provide an answer for every specific question of media preservation. Prudence will still be required. Floridi himself has written on some of the difficult decisions that will arise due to the fragility of digital memory:

> Contrary to what we experienced in the past, the life expectancies of our data supports are today dangerously synchronized. This is why you may think of this as a sort of 'baby boom': big data will age and become dead data together. Clearly, huge quantities of data will need to be rerecorded and transferred to new supports at regular intervals. Indeed they already are. But which data are going to make it to the other side of any technological transition? (2014: 19)

My argument here offers a general strategy for answering this question. We should prioritize the data and the storage media that facilitate cognition for future generations in a pluralistic fashion. Due to the deep dependence of cognition on material culture more generally (Malafouris 2013), we might also be vigilant to preserve other tools and technologies in support of data and storage media. My suggestion means prioritizing the data and media that have some likelihood of being used as cognitive technology for human beings, used, for example, as an aid to memory, calculation, reasoning, perception, or well-being. Digital curation will require knowledge of cognitive science in the sense that it will require an understanding of which media formats support which kinds of cognitive processes. Literacy and its mental effects will need to be understood relative to media types, as in the distinction between deep reading of a printed book and scanning of web pages (Carr 2010). The plurality of media from which we read highlights the value of a pluralistic understanding of literacy itself: print literacy, computer literacy, media literacy, and so on.

Now let us consider the second area in which we might apply my suggestion: *offloading* cognition. Two activities central to human cognition are belief-formation and deliberative agency. With access to the artificial intelligence enabled through wireless connectivity and mobile devices, both of these activities are being rapidly offloaded onto external processes.

Humans have long offloaded mechanisms of belief-formation by, for example, deference to experts and authorities, such as religious or academic authority. The rise of mass media brought powerful new ways of swaying public opinion through newspapers in the nineteenth and television in the twentieth centuries. Cognitive technology has reached a point such that an individual today can passively receive a steady stream of information with the algorithmic precision to reinforce existing beliefs—taking full advantage of confirmation bias—while manipulating new belief formation in subtle ways.

The rapid development and proliferation of wireless infrastructure also invites the offloading of agency itself. Our handheld devices enable us to conduct a range of activities that would previously require change of location and full bodily engagement—rather than the engagement of only hands and eyes. These activities includes social communication, shopping, ordering food, and looking for a mate. The devices are designed to work transparently, so that we do not even notice their mediation (Wheeler 2019). It is also possible, though still uncommon, to operate robotic actuators using remote devices through telepresence. Considering the operation of robotic limbs, it is difficult to think of an action that could not be performed through the use of a smart phone (apart, I suppose, from some bodily functions).

It is crucial to note here the fact that these actions are mediated through the user interface (UI). The UI is specifically designed to be used without any comprehension of the inner workings of the device. This design goal is thus in tension with the principle of transparency. Perhaps more importantly, the design of the UI opens up the possibility that we suffer illusions of agency while interacting with our devices. We feel as if we are in control even though we are not in fact. It is well-known from experimental psychology that illusions of agency are possible (Wegner 2002). All of the experimental work on the sense of agency lead to the conclusion that there are two distinct cues likely to generate the sense of agency: predictability and fluency. In their guide for building new apps, Microsoft and Apple urge creators to include two features into their user interface: predictability and fluency.[11] When we replace the physical action itself with a proxy command—a finger swipe—into the user interface, we may be offloading more than the physical action; we may be offloading control of our actions. We do not notice that our agency is compromised due to the fact that we have an illusory sense of agency, an illusion created by the predictability and fluency of interaction with the user interface.

The cognitive niche that we are now constructing is one that invites minimal cognitive burden from the biological mind. Beliefs—ranging from ephemeral pop trends to elaborated worldviews, pernicious or noble – can be fed into the brain through the screen, along with their supporting “evidence” of text, image, and video, at a steady and precise rate. Rational agency, or a simulacrum thereof, becomes merely a matter of reacting appropriately to the prompts and nudges and alerts issuing forth from the device. The trajectory of cognitive technology relinquishes control to the environment and away from the individual human organism.

Now consider this state of affairs in the context of the intergenerational nature of human cognition through the bequeathal and inheritance of technology. Let us apply the principles of pluralism and transparency to the informational infrastructure that we have engineered for future generations. Pluralism would demand that we give future generations the capacity to opt-out of offloading. Doing so will require preservation of the techniques that enable the cognitive achievement without a cognitive aid. Examples here might be various mnemonic techniques, mental arithmetic, or even face-to-face storytelling.

The more interesting normative application for the case of offloading is that of transparency. When belief formation and agency are offloaded into the digital network, the activities themselves are altered in important ways. More of our beliefs are increasingly caused by mediated information (screens) instead of perceptually unmediated experiences. Our agency becomes distributed with causal input from our brains complemented by real-time nudges from artificially intelligent connected devices. In order to give this technology to future generations in a fully transparent manner, we must learn how to articulate or re-conceive of these cognitive practices that have been hitherto conceptualized as achievements of the individual mind. Networked cognition is different in important ways from the cognition of the relatively individual mind of days past, of days when one’s “social network” and library access depended upon physical proximity. The interdisciplinary challenge now is to articulate those differences in a message that can be delivered in primary education.

[11] For a review of evidence that *predictability* is a main cue for generating the sense of agency, see Farrer and Frith (2002) and Farrer et al. (2008). In order to see the case for *fluency* as a main cue, see Chambon et al. (2014). Both Microsoft and Apple advise app designers to create a user interface (UI) that incorporates both predictability and fluency. For example, “An experience feels intuitive when it behaves the way the user expects it to. By using established controls and patterns and taking advantage of platform support for accessibility and globalization, you create an effortless experience … Fluent experiences use controls and patterns consistently, so they behave in ways the user has learned to expect.” The quotation was accessed on March 13, 2020 at https://docs.microsoft.com/en-us/windows/apps/fluent-design-system.

The final example for applying my normative principles to cognitive technology is that of *thinking* itself. The philosophical tradition that we know depends upon a type of cognitive technology, the written word. As Walter Ong writes:

> Philosophy and all the sciences … depend for their existence on writing, which is to say that they are produced not by the unaided human mind but by the mind making use of a technology that has been deeply interiorized, incorporated into mental processes themselves. The mind interacts with the material world around it more profoundly and creatively than has hitherto been thought. Philosophy, it seems, should be reflectively aware of itself as a technological product … (1982: 169)

Following Ong's cue, consider the possibility that the cognitive technology itself has an influence upon which philosophical views that we find appealing, or even which views we find intelligible. If this influence is causally significant, then it may follow that our choices in the cognitive technologies that we bequeath to descendants will determine, to some degree, the philosophical thought of the future.

We may even look to history to see an example of innovation in cognitive technology determining philosophical thinking. Ivan Illich cites Plato and Aristotle in support of the claim that one of the most important developments in the history of cognitive technology, the written alphabet, played a central role in one of the most important developments in metaphysics, atomism. He writes, "As the alphabet began to make it obvious that speech can be fixed and sliced into visible units, it became a new means to think of the world as well… Some Greeks [such as Leucippus and Democritus] turned this symbolic alphabetization of utterance into a paradigm of the metaphysical constitution of the universe" (1993: 40, citing Plato's *Cratylus* 424d and Aristotle's *Metaphysics* 985b). Moving from the alphabet to the internet, Nicholas Carr (2010: 222) cites Heidegger in order to make a similar point about the influence of technology on thought itself. Carr notes Heidegger's worry from his *Discourse on Thinking* that advanced technology may create a situation in which "calculative" thinking becomes the only form of thinking, entirely eliminating "meditative" thinking.

This idea that cognitive technology may, in some way, determine philosophical thinking is worth taking seriously. If it is true, then our bequeathal of cognitive technology to future generations is an act that could determine the way that our descendants *understand reality itself*. We might even view the history of religions and of pure (rather than applied) science as bequeathing cognitive technologies with the goal of helping future generations to understand the nature of reality. What we have gained now is a more complete self-awareness of our role in this process, of its heavy dependence upon material culture, and of the broad range of choices that we now face. Again, I suggest that the principles of pluralism and transparency are helpful and, in this case, interrelated. The possibility that I am exploring here suggests a pluralism with regard both to thinking and reading as activities: distinct types of thinking and distinct types of reading. These types may be determined in part by the methods of the thinker (or reader) and in part by the details of the cognitive technologies put to use. We can foster a pluralism about types of thinking and reading through transparency, through explicitly identifying different kinds of cognitive technology as affording different kinds of thinking and reading. As Illich puts it, he wants "to encourage the reader to venture into the shelves of the library and experiment with distinct types of reading" (1993: 5). We no longer need the library for this kind of experimentation. With newly emerging cognitive technologies combining constant connectivity, brain-computer interfaces, cognitive enhancement, immersive technology, artificial intelligence, and ubiquitous computing, the new opportunities for experiments in reading and thinking are vast. But we should be clear about what may be at stake in these experiments: the very way that we think about reality.

7 Conclusion

Results from cognitive science have suggested that human cognition is enabled by cognitive technology and that this technology undergoes continuous modification across generations. One purpose of this article has been to explore the normative implications of this discovery. In a first attempt at doing so, I have argued that we should bequeath cognitive technology to our descendants through principles of pluralism and transparency. As I hope to have shown in the preceding section, these principles offer some guidance for concrete issues surrounding the way in which we innovate and pass down our cognitive technologies. The preceding section also highlights a number of areas in which we need further research in order to make informed and ethical decisions in this domain. The project of engineering the minds of the future began long ago with the written word and other cognitive technologies, but now we can begin to see the project more clearly, to see how much the human mind is dependent upon human material culture. This insight calls for new and careful attention to the creation, innovation, and preservation of the material, of the cognitive technology, that enables the mind.

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