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Commentary

Expanding Cognition: A Brief Consideration of Technological Advances over the Past 4000 Years

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Marsh and Rajaram (2019) provide an excellent summary of work to date on how frequent use of the Internet may affect individual cognition. After reviewing ten properties of the Internet and its use, they discuss questions psychologists and others have asked about how the Internet affects cognition. However, many (perhaps most) of the investigations thus far have been on possible negative effects of Internet usage rather than on its mind-expanding capabilities. For example, they describe experimental work showing that when people have easy-to-use and reliable access to the Internet, they (a) often forgo the trouble of remembering information and rely instead on Internet searches, (b) are more likely to be contaminated by misinformation, (c) are distracted and more likely to process information shallowly, (d) are more likely to accidentally or intentionally plagiarize, and (e) are more likely to form ideological echo chambers with like-minded people. On the other hand, regular social media use may help us craft more positively biased autobiographical memories. In short, overreliance on the Internet and other technological tools for thinking seem to lead to various forms of cognitive loafing. This is a strange sense of "mind expansion."

Perhaps it is worth pausing to state the obvious. The second author can remember the days (say, 1975) when writing a review paper like the one under consideration would involve numerous trips to the library, copying articles in journals, checking out books, lugging the whole business back to his office, and poring over it before writing (on a typewriter or by hand) a first draft. Now the same feat of reviewing the literature can be accomplished while sitting in front of a computer and accessing all the same sources and finding many more of them, all a few clicks away. The mind is more easily expanded in academia today than it was in the past. So yes, there can be downsides to Internet usage, but let's not forget about the upside embedded in the title of the article. The world's knowledge is at our fingertips, often for good (as well as bad).

The worry that overreliance on external cognitive tools might be bad for our thinking abilities dates back at least 2400 years, and probably further. In his dialog with Phaedrus, Socrates asked Phaedrus if he knew the legend of how humans learned to write (Plato, 1980). According to the story, when the Egyptian god Theuth gave King Thamus the art of writing, Thamus protested. He worried that if people put their trust in this new art, forgetfulness would take hold of their souls. This was not actually an art for remembering, he exclaimed, but an art for reminding. If people could record and recite things without actually knowing them, writing would grant only an illusion of wisdom. Because wisdom was not inscribed in their minds/souls (i.e., memorized), people would in fact not actually know anything, and would thus be ignorant and difficult to govern. Contemporary readers may grant that Thamus' concern was prescient; Marsh and Rajaram (2019) and the literature they discuss certainly seem to concur with the Socratic analysis. But is this the right way to conceptualize the impact of technology on cognition?

We might ask, as technological tools for thinking have become progressively more efficient, sophisticated, and widely adopted, have our "onboard" mental capacities been steadily shrinking since the invention of writing (dated from at least four thousand years before the common era)? We suspect not; writing (and the later invention of movable type and books in the 1400s) greatly expanded cognition, even though books can reduce the need to memorize and can contain erroneous information. As Marsh and Rajaram (2019) point out, many of the Internet's attributes do not represent a qualitative break from older, less sophisticated technologies (e.g. books and libraries), although they do differ in the quantity of information available, ease of

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use, and speed. It is undeniable that contemporary cognitive activities—say, theory construction during the iterative process of writing and re-writing (Menary, 2007), or discovering patterns latent in complex data—can be orders of magnitude more powerful than were possible in Theban Egypt. How then, do we reconcile the empirical evidence that Internet use apparently "makes us stupid" (Carr, 2008) with the fact that we can accomplish cognitive activities that would have been quite literally unthinkable in previous generations?

We argue that this apparent contradiction arises from psychology's traditional methodological individualism (Fodor, 1991). In focusing on unaided human cognition (i.e., what the "naked" brain is capable of) rather than integrated human-cognitive tool systems, such analyses miss precisely what is unique about human cognition. Our ability to orchestrate hybrid cognitive systems incorporating both biological and external components allows us to amplify our abilities far beyond anything the onboard mental capacities can accomplish on their own (Clark & Chalmers, 1998; Sutton, 2010). This is why we build and use cognitive technologies like the Internet in the first place. When we draw the boundary of the cognitive system around the brain, offloading looks like loafing. When we draw the boundary of the cognitive system around the brain and the full set of tools out in the world that it recruits and coordinates to help it accomplish complex cognitive tasks, then we see how cognitive technologies might "expand the mind" (Clark, 2011).

This brings us to the question of whether or not the Internet enables a historically unique "expansion" of human cognition. Marsh and Rajaram (2019) state that our cognitive systems evolved in a very different world than the one in which we currently live. This is in many ways undoubtedly true: these days we rarely have to remember where the safest waterhole was or where on the savannah we found the best tubers last week (Nairne & Pandeirada, 2008). But in other ways, particularly as regards our reliance on external cognitive tools and symbol stores, it is questionable whether the advent of the Internet represents a qualitative leap in the natural history of augmented cognition. Non-biological tools for thinking, both information-bearing objects in the external world and sophisticated cultural practices like the famous *ars memoriae* of the ancient and medieval worlds (Carruthers, 1990; Yates, 1966/2010), are not recent inventions. The first major leaps occurred when humans started intentionally encoding information in the environment rather than in biological memory. Depending on which technology we choose, this leap could have happened either 40,000 years ago with the first visuo-graphic representations, 6000 years ago with ideographic writing, or 4000 years ago with phonetic writing. We choose phonetic writing as our starting place, hence the subtitle of our article. Although in some ways an arbitrary starting point, there are scholars who have argued that it is with phonetic writing that the cascade of externalized information really exploded (e.g., Donald, 1991; Gleick, 2011; Ong, 2002). In any case, with each revolution in cognitive technology, humans were able more and more efficiently to externalize information storage and manipulation; Merlin Donald (1991) coined the term *exograms* for these external "memory" records, by analogy to Semon's (1921) *engrams* as memory traces within the brain. Our exograms have steadily increased in volume and complexity over time.

The ability to externalize and interact with physical symbols, rather than relying purely on episodic and narrative memory, led human cultures to accumulate a vast external symbol store—all the information that humans preserve in writing, graphics, structures, and other public symbols (Donald, 1991; Sterelny, 2010). Since then, cognitive enculturation and education in most societies have been oriented toward embedding young humans within this vast network of exograms (Menary, 2013). Although psychologists' tools are equipped to study cognition of the individual in relatively impoverished situations, modern human cognition (as opposed to that of our pre-exogram using hominid ancestors) cannot be extricated from the technological matrix in which we live. The study of human cognition in its fullest sense must recognize the integration of internal, brain-based resources and the "extended phenotypes" (Dawkins, 1982), which are the information rich, cognitive ecosystems we weave around ourselves. Cognition in this broader sense very frequently includes cultural tools that are not themselves biological; as the philosopher Andy Clark rather dramatically put it, we are already and have always been cognitive cyborgs (Clark, 2003).

How different is this new technology, the Internet, from those that have come before? In Table 1, we consider just a few of the most important advances in cognitive technology over the past 4000 years, beginning with phonetic writing. The rows represent technologies and the columns represent the ten principles of the Internet that Marsh and Rajaram (2019) provide. A *Yes* indicates that a technology has the property in question, although we do not distinguish among levels of the variable (e.g., the Internet doubtless has more information on any given day than radio does). By "written text" in the first row we mean to include the invention of writing itself, the development of books and the printing press, and the advent of well-organized libraries. Written texts were the first medium that permitted the broad spread of information, at least among the literate part of the population. The other technological developments we have chosen to include come from the last 130 years: radio, television and the Internet. Although some might quibble with a few of our classifications, looking at the increasing number of *Yesses* in the table as technologies advanced seems to indicate that the Internet represents a new technology for extended human cognition and communication in some ways, but that in other ways it simply adds to huge advances permitted by radio and television. These last two technologies share many properties with those of the Internet. The primary new features provided by the Internet (so far) are authorship (blog posts, Wikipedia authorship, and dozens more forms) and social communication (Facebook, Instagram, Twitter, et al.). In addition, the Internet is doubtless speedier and has more information than TV or radio, but these are changes in degree and not kind. It may well be that the potential for misinformation is greater than in radio and TV (which are often edited by other people) and that the propensity for anonymity (and false authorship) is greater. Access to all the technologies is probably limited in some ways. Marsh and Rajaram (2019) report an estimate that 53% of people in the world (approximately four billion) have access to the Internet; that still leaves

Table 1
Technological Attribute by Medium

Category	Attribute	Medium				
		Written texts	Telegraph	Radio	Television	Internet
Content	Vast information	*Yes*		*Moderate*	*Moderate*	*Yes*
	Misinformation	*Yes*		*Yes*	*Yes*	*Yes*
	Frequent change			*Yes*	*Yes*	*Yes*
	Many distractions			*Yes*	*Yes*	*Yes*
Usage	Easy access	*Moderate*		*Yes*	*Yes*	*Yes*
	Requires search	*Yes*	*Yes*	*Some*	*Some*	*Yes*
	Speedy results		*Moderate*	*Yes*	*Yes*	*Yes*
Community	Authorship possible	*Not usually*	*Yes*	*Not usually*	*Not usually*	*Yes*
	Source is clear	*Yes*	*Yes*	*Yes*	*Yes*	*Sometimes*
	Facilitates social interaction	*Sometimes*	*Yes*			*Yes*

47% or three and a half billion people without access. Whether access to radio and TV is greater would be hard to ascertain, but it may well be so (and certainly different levels of Internet sophistication would be expected among the populations that do use the Internet).

The more ecological framework for understanding human cognition outlined above has two implications for a discussion of how the Internet might expand or contract the mind. First, from an evolutionary perspective, the fact that humans are deeply embedded in cultural and technological tools for thinking is not new; we have always structured the external world so that we can use it to think with. Aside from issues of convenience and breadth of information, we might wonder whether the Internet represents the same sort of cognitive revolution as did, say, phonetic alphabets. Second, and critically important if we are to interpret the implications of the empirical literature Marsh and Rajaram (2019) review, when experimental psychologists focus on what unaided individuals remember when tested, they precisely miss the synergistic coupling of internal brain-based resources and external information-bearing tools that is the reason we use cognitive tools in the first place (Menary, 2010). The boon of cognitive tools is not that they make our basic, biological package per se more or less effective; it is that they allow us to leverage our somewhat limited cognitive capacities to much more powerful effect. This point seems to be missed in much of the experimental research cited by Marsh and Rajaram (2019). The methodology of psychological research is much more suited to studying individual capacity than the mind-expanding powers of individual cognitive systems aided by massively available resources.

Psychologists (and many others) retain a powerful belief that it is individual subjects who think, and that all component processes involved in this thinking are contained entirely inside of us, inside our brain, or at least inside our mind. Some cognitive scientists have referred to this as the "Cartesian prejudice" (Menary, 2010). Of course, in some sense, this is true. The human remains the critical component, for now, of human-technology systems (Nestojko, Finley, & Roediger, 2013). For most cognitive psychologists and researchers from related fields, the proper domain of study concerns representations and computations fully contained within the individual's mind. This seems intuitive to the point of being transparent; of course cognition is just what the brain is doing. To be sure, there is plenty to be learned by focusing methodology in this way.

Although a tremendous amount of useful information has been acquired by studying individual human cognition in laboratory settings, there is a limit to what cognitive scientists can learn about human cognition focusing on stand-alone individuals removed from the technological and cultural matrices in which they ordinarily operate (Hutchins, 1995). When a review on the "digital expansion of the mind" ends up being a list of detriments to cognition caused by Internet use, the epistemic cost of doing psychology this way becomes obvious. The usual psychological focus on what goes on inside people's heads may lead to misleading, or at least, very incomplete, conclusions about the negative impact of technology. The incorporation of external symbols into cognitive activities is relevant beyond philosophical thought exercises; it represents something fundamental about human cognition. For inquiries into how technologies like the Internet might "expand the mind," the proper unit of analysis is not the unaided participant, but the extended system in which individual minds are integrated within an assemblage of coordinated tools (Menary, 2007). Such assemblages certainly could be studied empirically, even in the laboratory, although we are only beginning to develop tools and methods to do so. However, the Cartesian prejudice that everything properly cognitive happens within the brain, or at least the individual mind, has largely restrained psychologists from pursuing these insights suggested by sister fields like cognitive anthropology and philosophy. This limitation is unfortunate, as there are many pressing phenomena that would strongly benefit from a better-integrated understanding of how brains, technology, and social networks interact (Latour, 1996). Proper understanding requires a multi-level framework in which individual level cognition, cognition in social interactions (Congleton & Rajaram, 2014; Coman, Momennejad, Drach, & Geana, 2016), and interaction with social technologies lead to the emergence of group-level phenomena (Vlasceanu, Enz, & Coman, 2018). We briefly discuss one such phenomenon, although this represents another case where the social aspect of the Internet (specifically, use of Facebook) leads to unfortunate results.

In August 2018, Facebook officially acknowledged that its platform had played an important role in the state-sponsored ethnic cleansing of Myanmar's Muslim Rohingya minority (Facebook Newsroom, Aug. 28, 2018). The Myanmar military had created hundreds of fake accounts, purporting to be pop stars and other celebrities, which gained large followings and were subsequently used to propagate inflammatory posts stoking fear and resentment against the Rohingya. This flood of fake news sparked massive violence against the Rohingya, culminating in what the UN characterized as a "textbook example of ethnic cleansing" and the murder of at least 10,000 people (Mozur, 2018). In response to the overwhelming violence, over 700,000 Rohingya refugees fled across the border into Bangladesh, where their future remains uncertain. How could a genocide be organized so quickly and efficiently?

The Myanmar military had adapted traditional methods of psychological warfare and amplified them using social media. Cognitive research has shown that people selectively prefer to attend to and communicate highly emotional, threat-related information (Blaine & Boyer, 2018; Harber & Cohen, 2005). They are especially likely to propagate such information in social network platforms when it is heavily moralized (Brady, Wills, Jost, Tucker, & Van Bavel, 2017); in the case of Myanmar, the Buddhist establishment served as a nationalist mouthpiece framing the Muslim Rohingya as a threat to religion and safety. Such cognitive insight into why the military's messages struck such a chord, however, is by itself insufficient to explain how the campaign was able to trigger such widespread violence so rapidly. These cognitive tendencies had to be paired with several technological and cultural factors. First, Myanmar is a country in which widespread use of the Internet is relatively recent; some have argued that as a consequence, people are less savvy at identifying questionable online sources. Second, Facebook is so ubiquitous in the country that it is reported many people do not clearly differentiate Facebook and the Internet (Mozur, 2018). When the military used the dominant platform as its vehicle to disseminate hateful postings, it was able to reach nearly everyone in the country with Internet access.

Thus, wide-scale violence emerged from the interaction of factors at the cognitive level—preferential attention, memory, and communication of highly arousing, moralized threat-related information—with technological tools for almost universal propagation of the message, and top-down orchestration by a committedgovernmental actor. Certainly, the Internet (and Facebook) are not required for genocide; too many examples predate the invention of either. But the case of the Rohingya genocide should motivate researchers to better understand how large-scale emergent phenomena might arise from the interaction of minds and technology, with some urgency. Other instances of fake news propagating over Facebook to incite violence have occurred in Sri Lanka (Goel, Kumar & Frenkel, 2018), Germany (Taub & Fisher, 2018), France (McNicoll, 2018), and the U.S. (Frenkel, 2018). For example, in Sri Lanka, after false rumors were started by Buddhist monks and spread by Facebook, mobs attacked Muslims who were the target of the rumor. A presidential advisor was quoted as saying, "The germs are ours, but Facebook is the wind" (Osnos, 2018). In these cases, the Internet is expanding communication of individuals and small groups in massive ways, creating havoc and tragedy.

Psychological researchers do have valuable contributions to make to this interdisciplinary project of studying mind-expanding powers of technology, but many of our discipline-bound habits of thought limit us. The Internet may indeed expand cognition, but not in the sense of improving the onboard, brain-based capacities we inherited from our Paleolithic ancestors. We must be willing to choose units of analysis that are not determined a priori by the Cartesian prejudice, taking the individual human as the correct unit of analysis.

Research on how the Internet affects human behavior is just beginning. Marsh and Rajaram (2019) provide a fine discussion of where the research has led so far. We expect and hope that future research will be directed at a larger unit of analysis, namely the human in the context of his or her cognitive technologies and devices that can be used to aid (and change) cognition and behavior in various ways.

Author Contributions

Both authors contributed to writing this article, and both authors approve of the submitted version of the manuscript.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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