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The philosophy of memory technologies: Metaphysics, knowledge, and values

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Abstract

Memory technologies are cultural artifacts that scaffold, transform, and are interwoven with human biological memory systems. The goal of this article is to provide a systematic and integrative survey of their philosophical dimensions, including their metaphysical, epistemological, and ethical dimensions, drawing together debates across the humanities, cognitive sciences, and social sciences. Metaphysical dimensions of memory technologies include their function, the nature of their informational properties, ways of classifying them, and their ontological status. Epistemological dimensions include the truth-conduciveness of external memory, the conditions under which external memory counts as knowledge, and the metacognitive monitoring of external memory processes. Finally, ethical and normative dimensions include the desirability of the effects memory technologies have on biological memory, their effects on self and culture, and their moral status. While the focus in the article is largely philosophical and conceptual, empirical issues such as the way we interact with memory technologies in various contexts are also discussed. We thus take a naturalistic approach in which philosophical and empirical concepts and approaches are seen as continuous.

Keywords

Cognitive enhancement, extended knowledge, extended mind, external memory, function, information, metacognition, neuroethics

Introduction

Human biological memory systems are complex, multifaceted phenomena. Technologies that scaffold, aid, and transform biological memory are likewise complex and multifaceted. Such technologies are studied by a variety of academic disciplines, including philosophy (Clark and Chalmers, 1998; Michaelian, 2012; Rowlands, 1999; Sutton, 2010), cognitive science (Risko and Dunn, 2015;

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Sparrow et al., 2011), media and cultural studies (Van Dijck, 2007), human–computer interaction (Van den Hoven, 2014), design studies (Norman, 1993), and cognitive archaeology (Jones, 2007). A full understanding of memory technologies thus requires an integrative and interdisciplinary approach. While the topics addressed in this article are mainly philosophical or conceptual, they are informed by empirical research from some of the disciplines just mentioned. We take a broadly naturalistic approach, which means that we see philosophical and empirical concepts and approaches on a continuum rather than strictly separated. From a naturalistic perspective, philosophy is closely allied with theoretical and experimental work in cognitive and social sciences. More concretely, metaphysical, epistemological, and ethical reflections on memory technologies are partly grounded in empirical research. Ongoing developments in the empirical sciences of memory technology are highly relevant for a philosophical understanding of such technologies.

Merlin Donald (1991) is one of the first cognitive theorists to draw attention to the importance of artifacts for better understanding our memory practices. Donald argues that memory technologies gave rise to a new stage in our cognitive evolution, one that is characterized by offloading memory storage onto the environment. He provides a detailed and elaborate overview of different ways of externalizing and materializing human thought, ranging from monument decorations, cave paintings, significant objects, knotted cords, clay tablets, alphabets, number systems, archives, maps, pictures, diagrams, calendars, musical scores, books, and computer applications. Such external symbols are referred to by Donald as exograms, as opposed to engrams. "An exogram is simply an external memory record of an idea," whereas an engram is "a single entry in the biological memory system" (Donald, 1991: 314). Exograms have different properties than engrams. Engrams are internalized and realized in the medium and format of the brain, whereas exograms are external and much less constrained in their format and capacity. The storage capacity of exograms far exceeds the storage capacity of both single entries and clusters of entries in biological memory. Exograms are flexible in that they can be reformatted and easily transmitted across different media, whereas engrams are less flexible. These differences certainly do not always apply, but when they do, they are enabled by the particular materiality, malleability, and format of external artifacts. The most important property of exograms, on Donald's view, is their capacity for continuous refinement. Exograms are human-made and are undergoing a process of iteration, testing, and improvement. Therefore, they allow us to externalize the products of thinking and to examine and change their content in an ongoing way, which is very difficult to do in the brain.

Donald argues that human biological memory systems are embedded in a cultural network of external memory nodes. Many others have subsequently argued that human remembering takes place in an ecology of informational objects and structures that scaffold as well as restructure our biological memory systems (Bell and Gemmell, 2009; Clowes, 2013, 2017; Hoskins, 2016; Hutchins, 2014; Michaelian and Sutton, 2013; Rowlands, 1999; Sutton, 2010, 2015). The rest of this article provides an overview of the philosophical issues concerning memory technologies in all their complexity, focusing on their metaphysical, epistemological, and ethical properties broadly construed. As these are the three branches of philosophy, they allow us to cover a substantial amount of conceptual–philosophical dimensions of memory technologies.

Metaphysics

It is difficult to define what metaphysics precisely is, but for the purpose of this article, we can define metaphysics as the branch of philosophy concerned with the nature of reality, focusing on better understanding the properties and categories of objects, structures, and processes. Metaphysical dimensions of memory technologies include their function, the nature of their informational properties, ways of classifying them, and their ontological status. Memory technologies can be characterized as material artifacts intentionally used to scaffold or aid memory processes, comprising a heterogeneous category of objects and structures. Many material artifacts unintentionally trigger internal memories. An old concert ticket used as a bookmark, for instance, may trigger memories of a concert you have seen. But if we include objects that accidentally or unintentionally trigger internal memories into the category of memory technologies, and then it seems that the category becomes unrealistically large and conceptually intractable. The phrase "memory techniques" may be used for internal mnemonics. A striking example is Japanese students who have learned to visualize the structure of an abacus and to internally manipulate the beads in their mind's eye as to perform calculations (De Cruz, 2008). In this case, the actual material abacus is no longer needed as its mnemonic functions are fully internalized.

Another example of a memory technique is the method of loci, whereby an agent memorizes certain spatial relations, for example, the rooms in a house, and has learned to associate certain items, for example, images, faces, or lists of words, with particular locations in rooms (Sutton, 2010). When trying to remember the items, the agent imagines walking through the rooms (i.e. the loci) which evokes memories of the associated items. For example, when using the method of loci to construct a shopping list, one would image walking through the house and put certain items on specific locations. A bottle of wine on the kitchen table, some cheese on the kitchen dresser, milk on the desk in the study room, a baguette near the front door, and so on. When in the supermarket, one re-imagines the same route through the house, which evokes memories of the wine, cheese, milk, and baguette, in that way allowing one to remember what one wants to buy. This technique or method does not involve interacting with physical artifacts and so should not be seen as part of the category of memory *technologies*. It does, however, demonstrate that even internal memory can be highly artificial, in that it is actively and intentionally constructed.

The category of memory technologies can be seen as a subcategory of cognitive artifacts. Cognitive artifacts are material objects used to aid not just memory, but all kinds of cognitive tasks and processes such as navigating, calculating, making inferences, and problem-solving (Heersmink, 2013, 2016c; Hutchins, 1999; Norman, 1991, 1993). The current debate in the metaphysics of technology concerning artifact function (e.g. Houkes and Vermaas, 2010; Preston, 2013) is relevant for better understanding memory technologies. Are functions established by the intentions of the designer or the intentions of the user? It seems that the intentions of the user are more important to establish the memory function of an artifact. If the intentions of the designer are necessary to establish the memory functions of an artifact, then we cannot account for improvised uses of artifacts (Preston, 2013). Leaving a DVD on your desk as a reminder to bring it back to the video store is an improvised mnemonic use of an artifact. We want to be able to include such improvised memory functions into the category of memory technologies. The intentions of the user and the cultural practices of artifact-use are more important than the intentions of the designer (but compare Vaccari, 2016). We therefore need a pluralist notion of memory technology that can account for both intended and improvised mnemonic functions.

How can we further divide or taxonomize this pluralist and heterogeneous category of objects and structures? John Sutton (2015) suggests three ways in which we can taxonomize external memory systems: by cognitive domain, type of resource, and timescale. That is, in terms of the specific memory capacity an external resource scaffolds (working, semantic, or episodic memory), what kind of resource is scaffolding that capacity (e.g. specific artifacts, other people, cultural institutions), and for how long it is scaffolding it (e.g. evolutionary timescales, ontogenetic timescales, or in the here-and-now). As Sutton says, 'The point of all such taxonomies is to seek more differentiated ontologies, or to be in a position then to study the particular ways the notion might apply in specific contexts' (p. 192).

Richard Heersmink (2013, 2016c) suggests a narrower and more specific approach to taxonomizing external memory systems, viz. in terms of the particular informational properties of the artifact in question. To this end, Heersmink takes as a starting point a distinction between representational and nonrepresentational information. Artifacts with representational properties function as stand-ins for their target system and have aboutness or representational content (Kirsh, 2010). A map of Sydney, for example, is an external representation of the layout of the city's roads and other infrastructures. There are different kinds of representational properties. A distinction between icons, indices, and symbols is borrowed from Charles Saunders Peirce (1935). Icons show relevant isomorphism to their target system. A map, for example, shows isomorphism to what it represents. Indices have a direct causal connection to their target system. A thermometer, for instance, is directly connected to the temperature. Symbols such as language and number systems obtain their meaning and content by means of logical rules and social agreement. Memory artifacts often have a combination of iconic, indexical, or symbolic properties, but one of those properties is typically predominant (Atkin, 2008).

Memory artifacts with nonrepresentational properties, by contrast, do not function as stand-ins for their target and do not have content. A key example of a nonrepresentational memory technology is described by David Kirsh (1995), who details how cooks place utensils and ingredients such that they facilitate the order of steps in the cocking process. In this example, the location of objects becomes cognitively meaningful to the user not through isomorphism, direct causal connections, or logical rules, but through what Kirsh calls "the intelligent use of space." Kirsh makes a tripartite distinction between spatial arrangements of objects that simplify choice, perception, or internal computation. Other nonrepresentational memory artifacts are related to autobiographical memory. Objects that are personally significant such as souvenirs, clothing, furniture, books, and musical instruments, are often connected to specific personal experiences or specific episodes from one's past. Sociologist Sherry Turkle (2007) refers to such objects as "evocative objects" as they invite us to reminisce about the past. Such objects connect us to our past but not necessarily by means of their representational properties. The mnemonic function of such objects is not established through isomorphism, direct causal connections, or symbolic properties, but through the meaning we subjectively attach to such objects. In the final section, we continue by outlining the relation between evocative objects, autobiographical memory, and the narrative self.

Finally, the ontological status of memory technologies is relational in that such technologies are defined in relation to human biological memory. Some philosophers go further and have argued that the external artifact is not just defined in relation to the human memory system, but can literally be part of an extended (Clark, 2003, 2008; Clark and Chalmers, 1998; Menary, 2007; Rowlands, 1999; Sutton, 2010) or distributed memory system (Hutchins, 1995; Michaelian and Sutton, 2013), whereas others have denied this (Adams and Aizawa, 2001; Rupert, 2013). A key example in the extended mind debate is Clark and Chalmers' case of "Otto" and his notebook. Otto is a man in the first stages of Alzheimer's disease and uses a notebook to compensate his deteriorating biological memory system. Clark and Chalmers (1998) claim that information in the notebook (e.g. addresses, phone numbers, appointments, etc.) plays a relevantly similar functional role as information in biological memory. Additionally, information in the notebook is reliable, trustworthy, easily accessible, and has been endorsed in the past and, indeed, is there because of this past endorsement. For these reasons, the notebook should be seen as a constitutive part of Otto's memory system.

Clark and Chalmers motivate their view with the parity principle:

> If, as we confront some task, a part of the world functions as a process which, were it done in the head, we would have no hesitation in recognizing as part of the cognitive process, then that part of the world is (so we claim) part of the cognitive process. (Clark and Chalmers, 1998: 8)

Donald has argued along similar lines. He writes, "External memory is best defined in functional terms: it is the *exact* external analogue of internal or biological memory, namely a storage and retrieval systems that allows humans to accumulate experience and knowledge" (Donald, 1991: 309, original italics). Both Donald (1991) and Clark and Chalmers (1998) emphasize functional isomorphism between the inner and outer. By doing so, they downplay differences between internal and external states and processes. It is, however, important to note that there are actually differences between internal and external memories. There are, for example, differences in how internal memories and external memories are stored and processed. Internal memories are stored in biological neural networks that are subject to blending and interfering. This implies that information stored in biomemory is shaped and updated on the basis of previously stored and new incoming information. External memories, by contrast, are stored in discrete format and are further static, less dynamic, and not automatically integrated with other information (Sutton, 2010). Biological memory is thus holistic and integrative, whereas external memory is not.

Given the problems associated with parity claims, Sutton has identified and developed a distinctive route to extended cognition based on what he refers to as the "complementarity principle":

> In extended cognitive systems, external states and processes need not mimic or replicate the formats, dynamics or functions of inner states and processes. Rather, different components of the overall (enduring or temporary) system can play quite different roles and have different properties while coupling in collective and complementary contributions to flexible thinking and acting. (Sutton, 2010: 194)

On such a view, memory technologies and other cognitive artifacts need not exhibit similar properties and functions to internal states and processes. Rather, they typically *complement* internal states and processes with *different* properties and functions. Complementarity claims are also found in Clark's own work. In a co-authored chapter with Rob Wilson, he writes, "Tracing and understanding such deep complementarity is, we claim, the single most important task confronting the study of situated cognition" (Wilson and Clark, 2009: 70). Clark is thus well-aware that external memories can be quite different from internal memories. Complementarity approaches to extended cognition focus on the degree of integration of agent and resource (Heersmink, 2015; Menary, 2007; Sutton et al., 2010). On this view, human cognitive systems and artifacts are integrated into wider systems that perform cognitive tasks.

Epistemology

Epistemology is the branch of philosophy concerned with the nature and sources of knowledge, focusing on notions of belief, truth, justification, and reasoning. The epistemological ramifications of memory technologies are striking. On the one hand, as Michael Lynch (2016) has noted, increased cognitive offloading provides new ways to acquire and store more information quickly and seamlessly (cf. Clark, 2015). For example, consider a high-tech twist on the extended cognition case of Otto (Clark and Chalmers, 1998), canvassed in §2. Suppose that (like many of us) Otto uses smartphone apps for storing a range of information that individuals have traditionally stored in biological memory: birthdays, phone numbers, diary events, deadlines, and so on. Suppose further (to borrow a case from Clark et al., 2017) that Otto relies on a range of other complex memory-assisting apps to organize his life. His Diaro app functions as his personal journal (cf., Carter and Pritchard, 2017a, 2017b) and his CPR Tempo app reminds him how to administer CPR in an emergency, and so on. Finally, suppose that Otto's reliance on this technology is consonant with the kinds of demands (see §2) Clark and Chalmers impose on genuine extended memory processes.

From an epistemological point of view, there are several things that can be said on Otto's behalf. For one thing, given that Otto is in such a circumstance practicing (by stipulation) good epistemic hygiene, (Clark, 2015), we should expect the epistemic status of the information stored in Otto's gadgets to be *at least* on a par with analogous information stored in biomemory (cf., Palermos, 2015; Pritchard, 2010; cf., Bernecker, 2010). Indeed, as J. Adam Carter (2017) has argued, there is even some reason to suppose that the epistemic status of the information stored in Otto's extended memory is comparatively *more* secure than analogous information stored in biomemory. This point can be made in terms of the comparative fragility of information stored in biomemory as opposed to extended memory, conditioned upon the initial acquisition of the stored information.

To appreciate this point, an example will be useful. Just suppose, to use a variation on a case from Carter (2017), you are told that the deadline for submitting an article to a journal is 13 April. If you do not think about this date again (viz., if you don't focus on it, rehearse it to yourself) the date will probably remain in short-term memory for up approximately 20 seconds (Revlin, 2012). Whether this information is transferred to long-term memory storage, however, typically depends on the kind of memory rehearsal that is undertaken. *Maintenance* rehearsal—for example, repeating out loud the date several times—generates the result that the information will remain in short-term memory storage longer than otherwise (Greene, 1987). However, some level of deeper processing—*elaborative rehearsal* (e.g. as when one not merely repeats the information, but connects the information to other information one already possesses)—will plausibly be needed if the date you've been told is to be transferred from short-term into long-term memory storage (Goldstein, 2011). Moreover, even in cases that feature elaborative rehearsal, various factors such as alcohol consumption can impair the transfer of information from short-term to long-term biomemory storage (Atkinson and Shiffrin, 1968).

The situation is very different—and arguably comparatively more epistemically safe—in the case of extended memory. Otto, for instance, to transfer information from short-term to long-term extended memory (e.g. in his phone app, electronic diary, etc.) requires no analogous kind of deeper processing. For Otto, such a transfer is entirely automatic; nor is the information subject to various kinds of defeaters (e.g. alcohol consumption, etc.) that can have a deleterious effect on the reliability of information stored exclusively in biomemory. This is, as Carter (2017) and Carter and Kallestrup (2016) have noted an epistemically relevant disanalogy between biomemory and extended memory which seems to speak in favor of the epistemic credentials of extended memory.

However, there is also some cause to be pessimistic about the epistemic status of information stored in extended memory. This point becomes clear when we think about the difference between biomemory and extended memory in terms of *knowledge* and *extended knowledge* (Pritchard, 2017). Does Otto attain memory-supported *knowledge* of the information stored in his apps? This question has been a focus of much recent discussion in the literature at the intersection of mainstream epistemology and extended memory cases (see, for example, the collections of papers in Carter and Palermos, 2015; Clark et al., 2012, 2014, 2017). Attempts to answer it have given rise to at least three distinct puzzles.

The first puzzle concerns extended memory and epistemic credit. According to one popular position in mainstream epistemology, *virtue epistemology* (e.g. Greco, 2003, 2010; Sosa, 2007, 2015; Zagzebski, 1996), one counts as *knowing* only if one's believing truly is primarily creditable to one's own cognitive abilities (cf., Lackey, 2007). However, as Krist Vaesen (2011) among others have argued, the kinds of cases that feature extended memory (by the lights of extended cognition) are plausibly not cases where the individual can be primarily credited with her cognitive success. To the extent that this is right, a vindication of the information stored in extra-organismic memory as genuine *knowledge* appears to be at tension with the core virtue epistemology insight. See, however, Christoph Kelp (2014) for an argument (*contra* Vaesen) that despite initial appearances these positions can be reconciled; see also Duncan Pritchard (2010) for an argument that virtue epistemology is compatible with extended knowledge only if the credit condition is suitably weakened.

The second and third puzzles concerning extended memory knowledge surround the issue of *reliability endorsement.* Obviously, we need not first endorse the reliability of our own biological memory in order to be justified in believing (as well as knowing) the deliverances of biological memory in ordinary circumstances. However, as Pritchard (2010) has argued, there is some epistemological pressure to suppose that additional demands are in place in the case of external memory. For example, on Pritchard's view, if one adds some new memory technology to one's cognitive architecture (say, one begins incorporating some new app or software in information storage and retrieval), one cannot be justified in blindly accepting the deliverances of the technology if one has no view as to whether the incorporated technology is reliable. Accordingly, Pritchard submits that extended memory *knowledge* requires that the agent incorporating the new technology at some point endorse its reliability.

We are now in a position to state the second and third puzzles concerning the extended memory knowledge. The first puzzle, due to Carter and Kallestrup (2017) is that *even* if such an endorsement condition could be unproblematically satisfied in cases where the memory technology is used as a kind of cognitive *enhancement* (i.e. with the aim of exceeding or complementing normal healthy levels of cognitive functioning), it is unclear how the condition could be satisfactorily met in cases where memory technology is relied on for *therapeutic* purposes—viz., in the service of correcting some cognitive defect or pathology. Consider again, our case of Otto: what mechanisms are available for Otto to endorse the reliability of his extended memory process in an epistemically respectable way? Here Carter and Kallestrup argue that Otto faces a dilemma: Otto's endorsement of the reliability of his extended memory is not epistemically respectable if, in the course of the endorsement of its reliability, he relies on his *failing* biological memory. The natural alternative is to endorse the reliability of his memory tech in a way that relies on the memory tech which he uses to compensate for his failing biological memory. But this kind of endorsement would be *epistemically circular*—viz., it would involve relying on a method to endorse the reliability of that very method (see, for example, Cohen, 2002). Thus, as Carter and Kallestrup argue, proponents of extended memory knowledge who embrace a reliability endorsement condition are left with a dilemma that is grounded in this circularity problem: either drop the kind of endorsement condition suggested by Pritchard and risk an over-inclusive view of extended knowledge, or embrace the condition and then explain how Otto could possibly satisfy it in an epistemically respectable (non-epistemically circular) way.

Clark (2015) has in a recent article has posed what constitutes a third kind of puzzle for the vindication of extended memory knowledge—a puzzle he calls the *extended knowledge dilemma*. Clark (2015) states the dilemma as follows:

> *Extended Knowledge Dilemma*: Otto must either consciously encounter the [sic. memory tech] as an object for epistemically hygienic practice, or not. If he does, this makes the [sic. memory tech] look, at that moment, more like external equipment (it may then be a source of knowledge while failing to be part of Otto). If he doesn't, it looks unable (even on these weakened forms of virtue epistemology) to act as a source of knowledge. (p. 3763)

Clark's key insight underwriting the dilemma is that the very act of conscious engagement with the equipment—conscious engagement which suitable epistemic hygiene plausibly demands—stands in at least prima facie tension with the kind of *uncritical engagement* with tech that would need to be in place for the artifact to play a functionally analogous role as biomemory. Clark (2015) himself has attempted to resolve this dilemma by appealing to sub-personal forms of epistemic hygiene; cf. Pritchard (2017) for a different take. Whether this and the other puzzles concerning the memory-technology grounded knowledge can be satisfactorily resolved remains a live and fruitful area of contemporary research at the intersection of epistemology and the philosophy of mind and cognitive science.

The foregoing three epistemological dilemmas reveal how the phenomenon of extracranially stored information interfaces with the central epistemic standing of theoretical interest in mainstream epistemology—viz., *propositional knowledge* (i.e. knowledge-that). However, the emergence of memory technologies has generated discussion amongst epistemologists about other epistemic standings as well, including *knowledge-how.*

Knowledge-how has been, since Gilbert Ryle (1949), taken to be something fundamentally distinct from propositional knowledge, at least, until Jason Stanley and Timothy Williamson (2001) influentially contested this distinction at around the turn of the 21st century. According to Stanley and Williamson (see also Stanley, 2011), knowing how to do something is a kind of propositional knowledge. For example, knowing how to ride a bike is just a matter of knowing, of some way, *w*, that *w* is the way for you to ride a bike. If Stanley and Williamson's position, *intellectualism*, is correct, then the notion of "extended knowledge-how" is not going to be interestingly different from the kinds of extended knowledge-that considered previously in this section.

The situation is, however, interestingly different if one embraces instead an *anti-intellectualist* model of know-how, according to which—following Ryle—knowing how is a matter of possessing certain *abilities* rather than holding certain propositional attitudes (Fantl, 2013). Of course, some abilities involve memory, and if memory processes can criss-cross the boundaries of brain, body and world, then plausibly so can memory abilities themselves which the anti-intellectualist identifies with memory supported knowledge-how. Consider, for example, the following case, taken from Carter and Czarnecki (2016), involving the ability to withdraw money from an ATM. In the normal (intracranial case), part of what it is to exercise the ability to withdraw money from an ATM is to be disposed to exercise the intracranial cognitive process of retrieving the information about one's PIN number stored in biomemory (along with information about how to properly enter this number). Now, suppose Clark and Chalmers' hero, Otto, uses an ATM machine in ways that are entirely ordinary except that he stores his PIN number and usage instructions in his notebook, which is (on the extended cognition model) part of his extended memory. To the extent that the anti-intellectualist will attribute know-how to an individual, in the intracranial case, in virtue of biomemory storage of PIN number (and usage) information, Carter and Czarnecki argue, we should attribute know-how to Otto in the extended case, in virtue of his extended memory ability, viz., an ability he has partly in virtue of information he has written in his notebook. To the extent that this thinking is on the right track, extracranial memory technologies might support attributions of not just knowledge-that, but also knowledge-how, on the basis of information stored outside the head.

While extended cognition offers one way to think of human memory outside of received intracranial bounds, there is a further form of "active externalism" (Carter et al., 2014; Clark and Chalmers, 1998)—viz., *distributed cognition*—which maintains that memory can be distributed across multiple individuals in collaboration. The suggestion that memory and memory processes could be realized by multiple individuals, from two-person transactive memory systems (Wegner, 1986; Wegner et al., 1985) to scientific research teams, raises important epistemological questions, and has been a topic of interest in recent work on collective knowledge (e.g., Michaelian and Arango-Muñoz, Forthcoming; Michaelian and Sutton, Forthcoming; Palermos, 2016a, 2016b).

Palermos (2016b), for example, drawing from John Greco's (2010) virtue reliabilist epistemology, argues that what he calls "social machines," a paradigmatic instance being the Wikipedia contributor community, are the proper subjects of distributed memory knowledge, provided certain conditions for reliable cooperative interaction are satisfied. Michaelian and Arango-Muñoz (Forthcoming) by contrast have called in to question whether collective memory processes involving nonhuman components should count as generating collective memory *knowledge* by virtue reliabilist lights, given that it is not clear how the nonhuman components of the system could (as per virtue reliabilism) properly deserve *credit* for the knowledge in question. Michaelian and Arango-Muñoz opt, instead, for a process reliabilist framework, a move that involves jettisoning the "ability" condition on knowledge.

We conclude this section by considering briefly some epistemological ramifications of memory technologies on *metacognition*—viz., cognitive processes and beliefs that have as their object our own (first-order) cognitive processes and knowledge states. As Evan Risko and Sam Gilbert (2016) have noted, reliance on memory technology can itself shape the way we think about our memory capacities as well as (in some cases) our capacities as knowers. In a study by Matthew Fisher et al. (2015), for example, it was shown that the process of online retrieval of information tends to lead individuals to believe that they have more knowledge "in the head" than they actually do (Carter and Gordon, 2016). Related studies reported by Risko and Gilbert (e.g., Ward, 2013; Wegner and Ward, 2013) showed that individuals reported increased "cognitive self-esteem" after recently retrieving external information. One potential conclusion to draw from such studies, as noted by Risko and Gilbert, is that a metacognitive ramification of relying on external cognitive offloading is a kind "blurring" of the difference between one's own knowledge and knowledge stored elsewhere (Carter and Gordon, 2016).

That we have increasing memory storage *options* itself raises new metacognitive challenges. Santiago Arango-Muñoz (2013) outlines two such problems: the *selection problem* which concerns the choice one faces regarding whether to store information internally or externally, a choice that (if not arbitrary) must be decided metacognitively in some way or another for any given memory task. Likewise, Arango-Muñoz notes a further problem concerning how to decide at the level of endorsement between a given internal as opposed to external output. On his view, such decisions are fruitfully modeled as mediated by *metamemory* in such a way as to be guided by metacognitive feelings (e.g. feeling of knowing, the feeling of confidence, the feeling of error and the tip-of-the-tongue phenomenon). To the extent that such a view is feasible, then it should be clear how reliance on memory technologies raises important new issues in the epistemology of metacognition as well as in the related area of the epistemology of emotions (e.g. Brady, 2013).

Ethics

Ethics is the branch of philosophy concerned with values and moral principles governing individual and collective behavior, focusing on systematizing, analyzing, and defending concepts of right and wrong conduct. It addresses norms on an individual, political, and societal level. Normative dimensions of memory technologies have received a great deal of attention in recent debates. A major normative concern about memory technologies is the desirability of their effects on biological memory. Such worries go back to Socrates who, in Plato's *Phaedrus*, claims that

> [Writing] will produce forgetfulness in the minds of those who learn to use it, because they will not practice their memory. Their trust in writing, produced by external characters which are no part of themselves, will discourage the use of their own memory. (Plato, 1925: 275a)

Socrates thus argues that writing has detrimental effects on biological memory as it allows us to store information in the environment, which, in turn, means we do not sufficiently practice our memory skills. Similar concerns have recently been expressed about the Internet. Nicolas Carr (2011) argues that relying on the Internet as an external memory system reduces the amount of facts we store in semantic memory, in that way making us less knowledgeable. Carr's book has hit a nerve and generated substantial debate in both popular and academic media.

Furthermore, Carr (2011) claims that it is not just our memory that is effected by relying on online information but also our identity and even our culture. "When we outsource our memory to a machine, we also outsource a very important part of our intellect and even our identity" (p. 195), a point that has been given a different interpretation by Heersmink (2016a) who argues that external information can be constitutive of one's autobiographical memory and thus also of one's diachronic self. To the extent that this is right, outsourcing our memory need not be interpreted as "outsourcing our *identity*," as such, but rather as *widening* the constitutive base that forms it.

On Carr's interpretation, however, one that focuses in the main on the relation between culture and memory, when the contents of biological memory become shallower, human culture becomes shallower as well. This is so because

> personal memory shapes and sustains the collective memory that underpins culture […] The offloading of memory to external data banks does not just threaten the depth and distinctiveness of the self. It threatens the depth and distinctiveness of the culture we all share. (Carr, 2011: 196)

Susan Greenfield (2014) expresses similar views when she writes, "Those with more facts at their immediate disposal can build richer constructs of reality and thus have a world view informed by a context that enables deeper understanding, more *wisdom*" (p. 221, original italics). On her view, Internet use thus generates a culture in which people are less wise. Due to constant information access, Carr sees a new kind of human self emerging. Quoting writer Richard Foreman, he concludes that we risk turning into "pancake people—spread wide and thin as we connect with that vast network of information accessed by the mere touch of a button" (Carr, 2011: 196). This quote is not meant to be descriptive but normative: we should not become pancake people. "To remain vital, culture must be renewed in the minds of the members of every generation. Outsource memory, and culture withers" (Carr, 2011: 197).

It seems that Carr and Greenfield prefer a thick and isolated mind, rather than a thin and wide mind. However, it is important to note that we have always have been pancake people. Several theorists argue that the human self is essentially a soft self. On Clark's (2003) view, for example, we are "natural-born cyborgs," that is, creatures who are essentially open to incorporate artifacts and technologies into their perceptual, behavioral, and cognitive systems as to enhance and complement their abilities. On his view, "our best tools and technologies literally become us: the human self emerges as a soft self, a constantly negotiable collection of resources easily able to straddle and criss-cross the boundaries between biology and artifact" (Clark, 2007: 278). Donald (1991) presents a similar view, but focuses more on the historical and evolutionary aspects of our soft selves. Debunking the myth of the isolated mind, Donald (2000) points out that throughout the recent evolution of our cognitive system, we have always relied on external information to aid and offload biological memory. Our goal should not be to prevent us from having a wide mind—we cannot, because we always had one—but to actively shape the kind of wide mind we want to have.

Carr and Greenfield's criticisms are largely based on research in cognitive psychology, showing that when we know trivial statements such as "an ostrich's eye is bigger than its brain" are available externally; we tend to put less effort into memorizing that information internally (Sparrow et al., 2011). Likewise, people taking pictures of objects in an art museum have less detailed memories of the photographed objects as compared with museum objects they had not photographed (Henkel, 2014). Benjamin Storm et al. (2016) show that using the Internet to retrieve information influences one's propensity to use the Internet again to retrieve more information. Participants using Google Search to answer difficult trivia questions are more likely to use it again when faced with easier trivia questions as compared with people who answered the initial difficult questions from memory. Therefore, perhaps unsurprisingly, one's history of Internet use partly determines one's future

Internet use. Amanda Ferguson et al. (2015) examined the impact of Internet access on the metacognitive processes that underlie our decision whether to answer general knowledge questions such as “of which country is Baghdad the capital?” When people have access to the Internet, it decreased their willingness to volunteer answers. The authors theorize that due to the large amount of information available online, participants “raise the bar” with respect to the evidence needed before volunteering answers based on their own internal knowledge stores.

Carr and Greenfield have used the research performed by Sparrow et al. (2011) to claim that the Internet makes us less knowledgeable, but the generalizability of this research to the Internet has been questioned, as Sparrow et al.’s research does not actually involve using the Internet (Heersmink, 2016b). Their research involves storing trivial statements in folders on a desktop computer in a psychology laboratory. Whether storing information on a desktop computer is relevantly similar to using the Internet in real-world situations as to justify the claims Sparrow et al. make about the Internet needs more justification. One key difference between trivia stored on one’s desktop and online information (such as, for example, Google Maps, a recipe, a train timetable, a weather forecast) is that using online information typically has real-world consequences (e.g., getting lost, wet, late, etc.). For this reason, it is more likely to be stored and remembered by the agent. Although it is very likely that the Internet transforms our biological memory systems (Ferguson et al., 2015; Storm et al., 2016), currently we do not yet have a full understanding of how using the Internet as an external memory system transforms our biological memory systems. We need more empirical evidence and conceptual analysis about the effects of Internet use on biological memory, and we need to work out how these changes are culturally significant.

In contrast to Carr and Greenfield’s negative views, others have argued that memory technologies can also have beneficial effects for memory, self, and human well-being (Heersmink, 2016a; Konrad et al., 2016). There is a close link between autobiographical memory and the self. Marya Schechtman (2011), for example, argues that we summarize our past experiences into an autobiographical narrative, which is constitutive of our diachronic self; our self as it unfolds over time. Who we are as persons is thus defined and constituted by our autobiographical narrative. Patients with memory disorders like amnesia, Alzheimer’s disease or other forms of dementia lack the capacity to consolidate new autobiographical memories, which has quite undesirable consequences for their self. To compensate for their memory loss, some patients use a SenseCam, which is small wearable camera worn around one’s neck that automatically takes a photo when its internal sensors detect a change in environmental conditions such as light, angle and position. At the end of the day, irrelevant photos are deleted and the meaningful photos are edited into a lifelog which contains a record of a patient’s daily activities. Empirical research in human–computer interaction has shown that reviewing a visual lifelog has beneficial effects on a patient’s autobiographical memory such as maintaining the integrity, delay the disintegration, or in some cases replace autobiographical memory (Doherty et al., 2012). Some go further and argue that lifelogs can be constitutive of autobiographical memory (Heersmink, 2016a). If this metaphysical claim is true, then the narrative self seems to be partly constituted by external memory devices and can thus under certain conditions be seen as extended or distributed.

Evocative objects (Turkle, 2007) can also be interwoven with our narrative self. Petrelli et al. (2008) conducted field studies in which participants gave an interviewer a tour through their homes describing how and why particular objects are autobiographically meaningful. Consider what a participant says about her mug:

> I feel very emotionally attached to it for some reason. […] I bought it in London, when I was working in London. I think it is the memory of working in publishing, living in London and going through a sort of fulfilling patch in my career. […] Also, I associate it with buying my first house. […] So, it is an object of

> continuity because I think I must have had it for … Ohh … let me think, I probably had it for nearly 20 years. (Petrelli et al., 2008: 56)

This quote shows that artifacts can provide connections to emotionally-laden past events and episodes for a long period, in that way providing long-term stable connections to past experiences. Reflecting on their empirical work, Petrelli and Whittaker (2010) write "Recollecting our lives makes use of both physical and narrative aspects: mementos mark events, while the narrative plot organizes these scattered points" (p. 154). On their view, evocative objects and narratives complement each other. Our embodied interactions with evocative objects trigger and sometimes constitute emotionally laden autobiographical memories. These memories are the building blocks of our narrative, which, in turn, helps us to make sense of our evocative objects. Empirical and ethnographic research can thus inform philosophical reflection on memory and the narrative self.

Human biological memory is prone to transience, bias, suggestibility, misattribution and various other "sins" (Schacter, 2001). Like Donald (1991), Viktor Mayer-Schonberger (2009) points out that digital memory technologies such as the Internet have very different properties as compared with biological memory. Online information storage is cheap and highly reliable, dissemination is easy, and access is global. In some cases, the Internet stores personal information (e.g. photos on social media, status updates, tweets, blogposts) we may want to forget. There are situations in which digital memory is too good, in that we cannot delete it and have no control over who can access it. Mayer-Schonberger points out that forgetting has an important social function and that digital memory can be quite unforgiving in that it does not forget. Once Google has archived (personal) information, it is very difficult to remove it from the Internet. He therefore suggests to include an expiration date into the metadata of personal information such that it is automatically deleted after that date, giving users control over their personal information. A number of theorists argue that we have a right to be forgotten (Ghezzi et al., 2014). There are obvious connections here to the notion of informational privacy as discussed in the field of information ethics. Informational privacy is an important moral value and is defined as the "interest of individuals in exercising control over access to information about themselves" (Van den Hoven et al., 2014). If our external memories are publicly accessible, then we should be more careful in generating certain online content. Others, however, have argued that this may lead to self-censorship, which limits human freedom (Mayer-Schonberger, 2009).

Memory technologies may have potentially undesirable effects on autonomy and agency (Reiner and Nagel, Forthcoming). For instance, empirical research in cognitive psychology shows that repeatedly using navigation systems results in a decrease in the level of detail in our internal cognitive maps (Burnett and Lee, 2005), thereby potentially diminishing our capacity to navigate without such devices. Do such memory devices make us more autonomous by allowing us to perform more cognitive tasks, or do they make us less autonomous by becoming too reliant on them? If they do make us less autonomous, is that necessarily a bad thing? One could argue that human agency has always depended on technologies. We are inherently tool-using creatures (Clark, 2003) that need technology for their basic survival.

Questions of responsibility arise when we use our external memory devices for important tasks such as navigating. When Apple introduced its new navigation app in 2012, there were initially some bugs in the system which led people to navigate onto a taxiway of an Alaskan airport and straight into the Australian desert, potentially resulting in dangerous situations. Who is responsible when our external memory system provides us with wrong information? The designer, user, or can we somehow blame the technology? Apple took responsibility by removing the vice president of iOS software from his position. Given the organizational structure of large companies, this makes sense. However, it also seems reasonable to attribute some responsibility to the users of the technology. We can expect users to be at least somewhat critical when their navigation system instructs them to drive onto the taxiway of an airport or into the desert. In his most recent book, Carr (2014) refers to blindly trusting one's navigation system as *automation bias*. When navigators uncritically take for granted the truth-value of navigation systems "their trust in the software becomes so strong that they ignore or discount other sources of information, including their own senses" (Carr, 2014: 69). Given our human tendency for automation bias, one may ask to what extend we are responsible for relying on our external memory. In ethics of technology, some philosophers have argued that we should design technology such that it is consistent with our moral values, which are referred to as *value-sensitive design* (Van den Hoven and Manders-Huits, 2009). Safety is an important moral value and so we ought to design navigation systems (as well as other external memory systems that are prone to generate automation bias) such that they are safer to use.

Finally, a number of philosophers have argued that memory technologies have a certain moral status. Clark and Chalmers (1998) point out that an implication of the extended mind thesis is that "in some cases interfering with someone's environment will have the same moral significance as interfering with their person" (p. 18). Further building on this insight, Johnny Søraker (2007) argues that "the case with Otto's notebook suggests that information and information technology can have moral status, but only if they are constitutive and irreplaceable in a strong sense" (p. 14). So because external memory can have the same ontological status as internal memory, it also has moral status. Their ontological status (as outlined in §2) thus has straightforward moral implications. Carter and Palermos (2016) argue that, for these reasons, stealing or otherwise intervening in one's extended mind should be seen as a personal assault. This has both ethical and legal consequences. Besides the traditional legal issues with theft and artifact ownership, this view provides an additional argument against intervening with someone's external memory. This implies there are fruitful but underexplored links between neuroethics, neurolaw, and extended cognition theory (Levy, 2007; Reiner and Nagel, Forthcoming).

Conclusion

Memory technologies continue to generate substantial debate in philosophy and cognitive science, but also in the humanities and social sciences more broadly. They are an exciting focal point for interdisciplinary research. To better understand their historical development, informational, functional and epistemic properties, cognitive and cultural consequences, and normative aspects, we need to take an interdisciplinary approach where philosophers can analyze and synthesize concepts and approaches from cognitive science, neuroscience, cultural studies, cognitive archaeology, and human–computer interaction. Informed by empirical research and thus taking a naturalistic approach, this article has given an integrative overview of the philosophical dimensions of memory technologies. It has drawn connections between their metaphysical, epistemological and ethical aspects, as well as identified some topics for future research.

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References

Adams F and Aizawa K (2001) The bounds of cognition. *Philosophical Psychology* 14(1): 43–64.

Arango-Muñoz S (2013) Scaffolded memory and metacognitive feelings. *Review of Philosophy and Psychology* 4(1): 135–152.
Atkin A (2008) Icon, index, and symbol. In: Hogan P (ed.) *The Cambridge Encyclopaedia of Language Sciences*. Cambridge: Cambridge University Press, pp. 367–368.
Atkinson R and Shiffrin R (1968) Human memory: a proposed system and its control processes. In: Spence KW (ed.) *The Psychology of Learning and Motivation: Advances in Research and Theory*. New York: Academic Press, pp. 89–195.
Bell G and Gemmell J (2009) *Total Recall: How the E-Memory Revolution Will Change Everything*. New York: Dutton.
Bernecker S (2010) *Memory: A Philosophical Study*. Oxford: Oxford University Press.
Brady MS (2013) *Emotional Insight: The Epistemic Role of Emotional Experience*. Oxford: Oxford University Press.
Burnett G and Lee K (2005) The effect of vehicle navigation systems on the formation of cognitive maps. In: Underwood G (ed.) *Traffic and Transport Psychology: Theory and Application*. Amsterdam: Elsevier, pp. 407–418.
Carr N (2011) *The Shallows: What the Internet Is Doing to Our Brain*. New York: W.W. Norton & Company.
Carr N (2014) *The Glass Cage: How Our Computers Are Changing Us*. New York: W.W. Norton & Company.
Carter and Palermos 2015 should be: Carter JA, Clark A, Kallestrup J, et al. (eds) (2017) *Extenced Epistemology*. Oxford: Oxford University Press.
Carter JA (2017) Virtue epistemology and extended cognition. In: Battaly H (ed.) *The Routledge Handbook for Virtue Epistemology*. London: Routledge.
Carter JA and Czarnecki B (2016) Extended knowledge—How. *Erkenntnis* 81(2): 259–273.
Carter JA and Gordon E (2016) *Is Searching the Internet making us intellectually arrogant?* Manuscript. Carter's affiliation: University of Glasgow. Gordon's affiliation: University of Edinburgh.
Carter JA and Kallestrup J (2016) Extended cognition and propositional memory. *Philosophy and Phenomenological Research* 92(3): 691–714.
Carter JA and Kallestrup J (2017) Extended circularity. In: Carter JA, Clark A, Kallestrup J, et al. (eds) *Extended Epistemology*. Oxford: Oxford University Press.
Carter JA, Kallestrup J, Palermos SO, et al. (2014) Extended knowledge. In: Carter JA, Kallestrup J, Palermos SO and Pritchard D (eds) *Philosophical Issues* 24(1): 1–482.
Carter JA and Palermos SO (2015) Epistemology and active externalism. *Oxford Bibliographies*. DOI: 10.1093/OBO/9780195396577-0285.
Carter JA and Palermos OS (2016) Is having your computer compromised a personal assault? The ethics of extended cognition. *Journal of the American Philosophical Association*. Epub ahead of print 21 December. DOI: 10.1017/apa.2016.28.
Carter JA and Pritchard D (2017a) Extended entitlement. In: Graham P and Pedersen N (eds) *Entitlement: New Essays*. Oxford: Oxford University Press.
Carter JA and Pritchard D (2017b) Extended self-knowledge. In: Kirsch J and Pedrini P (eds) *Third-Person Self-Knowledge, Self-Interpretation, and Narrative*. Dordrecht: Springer.
Clark A (2003) *Natural Born Cyborgs: Minds, Technologies and the Future of Human Intelligence*. New York: Oxford University Press.
Clark A (2007) Re-inventing ourselves: the plasticity of embodiment, sensing, and mind. *Journal of Philosophy and Medicine* 32(3): 263–282.
Clark A (2008) *Supersizing the Mind: Embodiment, Action, and Cognitive Extension*. Oxford: Oxford University Press.
Clark A (2015) What 'extended me' knows. *Synthese* 192(11): 3757–3775.
Clark A and Chalmers D (1998) The extended mind. *Analysis* 58(1): 10–23.
Clark A, Carter JA and Palermos SO (2017) New humans: ethics, trust and the extended mind. In: Carter JA, Clark A, Kallestrup J, et al. (eds) *Extended Epistemology*. Oxford: Oxford University Press.
Clark A, Pritchard D and Vaesen K (eds) (2012) Extended cognition and epistemology. *Philosophical Explorations* 15(2): 87–90.

Clowes R (2013) The cognitive integration of e-memory. *Review of Philosophy and Psychology* 4(1): 107–133.
Clowes R (2017) Extended memory. In: Bernecker S and Michaelian K (eds) *The Routledge Handbook of Philosophy of Memory*. London: Routledge.
Cohen S (2002) Basic knowledge and the problem of easy knowledge. *Philosophy and Phenomenological Research* 65(2): 309–329.
De Cruz H (2008) An extended mind perspective on natural number representation. *Philosophical Psychology* 21(4): 475–490.
Doherty AR, Pauly-Takacs K, Caprani N, et al. (2012) Experiences of aiding autobiographical memory using the SenseCam. *Human-Computer Interaction* 27(1–2): 151–174.
Donald M (1991) *Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition*. Cambridge, MA: Harvard University Press.
Donald M (2000) The central role of culture in cognitive evolution: a reflection on the myth of the isolated mind. In: Nucci L, Saxe GB and Turie E (eds) *Culture, Thought and Development*. Mahwah, NJ: Lawrence Erlbaum, pp. 39–48.
Fantl J (2013) Knowledge how. In: Zalta N (ed.) *Stanford Encyclopedia of Philosophy*. Available at: http://plato.stanford.edu/archives/spr2016/entries/knowledge-how
Ferguson AM, McLean D and Risko EF (2015) Answers at your fingertips: access to the Internet influences willingness to answer questions. *Consciousness and Cognition* 37: 91–102.
Fisher M, Goddu M and Keil F (2015) Searching for explanations: how the Internet inflates estimates of internal knowledge. *Journal of Experimental Psychology: General* 144(3): 674–687.
Ghezzi A, Pereira AG and Vesnic-Alujevic L (eds) (2014) *The Ethics of Memory in a Digital Age: Interrogating the Right to be Forgotten*. London: Palgrave McMillan.
Goldstein B (2011) Short Term and Working Memory and Long-Term Memory: Structure. *Cognitive Psychology: Connecting Mind, Research and Everyday Experience*. Belmont: Wadsworth Cenage Learning, 3(5-6): 116–160.
Greco J (2003) Knowledge as credit for true belief. In: DePaul M and Zagzebski L (eds) *Intellectual Virtue: Perspectives from Ethics and Epistemology*. Oxford: Oxford University Press, pp. 111–134.
Greco J (2010) *Achieving Knowledge*. Cambridge: Cambridge University Press.
Greene RL (1987) Effects of maintenance rehearsal on human memory. *Psychological Bulletin* 102(3): 403–413.
Greenfield S (2014) *Mind Change: How Digital Technologies Are Leaving Their Mark on Our Brains*. London: Rider Books.
Heersmink R (2013) A taxonomy of cognitive artifacts: function, information, and categories. *Review of Philosophy and Psychology* 4(3): 465–481.
Heersmink R (2016a) Distributed selves: personal identity and extended memory systems. *Synthese*. DOI: 10.1007/s11229-016-1102-4.
Heersmink R (2016b) The internet, cognitive enhancement, and the values of cognition. *Minds and Machines* 26(4): 389–407.
Heersmink R (2016c) The metaphysics of cognitive artefacts. *Philosophical Explorations* 19(1): 78–93.
Henkel L (2014) Point-and-shoot memories: the influence of taking photos on memory for a museum tour. *Psychological Science* 25(2): 396–402.
Hoskins A (2016) Memory ecologies. *Memory Studies* 9(3): 348–357.
Houkes W and Vermaas P (2010) *Technical Functions: On the Use and Design of Artefacts*. Dordrecht: Springer.
Hutchins E (1995) *Cognition in the Wild*. Cambridge, MA: MIT Press.
Hutchins E (1999) Cognitive artifacts. In: Wilson RA and Keil FC (eds) *The MIT Encyclopaedia of the Cognitive Sciences*. Cambridge, MA: MIT Press, pp. 126–128.
Hutchins E (2014) The cultural ecosystem of human cognition. *Philosophical Psychology* 27(1): 34–49.
Jones A (2007) *Memory and Material Culture*. Cambridge: Cambridge University Press.
Kelp C (2014) Extended cognition and robust virtue epistemology: response to Vaesen. *Erkenntnis* 79(3): 729–732.

Kirsh D (1995) The intelligent use of space. *Artificial Intelligence* 73(1–2): 1–52.

Kirsh D (2010) Thinking with external representations. *AI & Society* 25(4): 441–454.

Konrad A, Isaacs E and Whittaker S (2016) Technology mediated memory: is technology altering our memories and interfering with well-being? *ACM Transactions on Computer-Human Interaction* 23(4): 1–29.

Lackey J (2007) Why we don't deserve credit for everything we know. *Synthese* 158(3): 345–361.

Levy N (2007) *Neuroethics: Challenges for the 21th Century*. Cambridge: Cambridge University Press.

Lynch M (2016) *The Internet of Us: Knowing More and Understanding Less in the Age of Big Data*. New York: W.W. Norton and Company.

Mayer-Schonberger V (2009) *Delete: The Virtue of Forgetting in the Digital Age*. Princeton, NJ: Princeton University Press.

Menary R (2007) *Cognitive Integration: Mind and Cognition Unbounded*. London: Palgrave McMillan.

Michaelian K (2012) Is external memory, memory? Biological memory and extended mind. *Consciousness and Cognition* 21(3): 1154–1165.

Michaelian K and Arango-Muñoz S (Forthcoming) Collaborative memory knowledge: a distributed reliabilist perspective. In: Meade M, Barnier A, Van Bergen P, et al. (eds) *Collaborative Remembering: How Remembering with Others Influences Memory*. Oxford: Oxford University Press.

Michaelian K and Sutton J (2013) Distributed cognition and memory research: history and current directions. *Review of Philosophy and Psychology* 4(1): 1–24.

Michaelian K and Sutton J (Forthcoming) Collective memory. In: Jankovic M and Ludwig K (eds) *Routledge Handbook of Collective Intentionality*. London: Routledge.

Norman D (1991) Cognitive artifacts. In: Carroll JM (ed.) *Designing Interaction: Psychology at the Human-Computer Interface*. Cambridge: Cambridge University Press, pp. 17–38.

Norman D (1993) *Things that Make Us Smart: Defending Human Attributes in the Age of the Machine*. New York: Basic Books.

Palermos SO (2015) Knowledge and cognitive integration. *Synthese* 191(8): 1931–1951.

Palermos SO (2016a) Social machines: a philosophical engineering. *Phenomenology and the Cognitive Sciences*. Epub ahead of print 17 October. DOI: 10: 1007/s11097-016-9489-4.

Palermos SO (2016b) The dynamics of group cognition. *Minds and Machines* 26(4): 409–440.

Peirce CS (1935) *The Collected Papers of Charles S. Peirce*, vol. 3. Cambridge, MA: Harvard University Press.

Petrelli D and Whittaker S (2010) Family memories in the home: contrasting physical and digital mementos. *Personal and Ubiquitous Computing* 14(2): 153–169.

Petrelli D, Whittaker S and Brockmeier J (2008) Autotopography: what can physical mementos tell us about digital memories? In: *Proceedings of CHI 2008*, Florence, 5–10 April, pp. 53–62. New York: Association for Computing Machinery.

Plato (1925) *Phaedrus* (trans. HN Fowler). Cambridge, MA: Harvard University Press.

Preston B (2013) *A Philosophy of Material Culture: Action, Function, and Mind*. London: Routledge.

Pritchard D (2010) Cognitive ability and the extended cognition thesis. *Synthese* 175(1): 133–151.

Pritchard D (2017) Extended knowledge. In: Carter JA, Clark A, Kallestrup J, et al. (eds) *Extended epistemology*. Oxford: Oxford University Press.

Reiner PB and Nagel SK (Forthcoming) Technologies of the extended mind: defining the issues. In: Illes J and Hossain S (eds) *Neuroethics: Anticipating the Future*. Oxford: Oxford University Press.

Revlin R (2012) *Cognition: Theory and Practice*. Worth Publishers. ISBN 978-0-7167-5667-5.

Risko EF and Dunn TL (2015) Storing information in-the-world: metacognition and cognitive offloading in a short-term memory task. *Consciousness and Cognition* 36: 61–74.

Risko EF and Gilbert SJ (2016) Cognitive offloading. *Trends in Cognitive Science* 20(9): 676–688.

Rowlands M (1999) *The Body in Mind: Understanding Cognitive Processes*. Cambridge: Cambridge University Press.

Rupert R (2013) Memory, natural kinds, and cognitive extension; or, Martians don't remember, and cognitive science is not about cognition. *Review of Philosophy and Psychology* 4(1): 25–47.

Ryle G (1949) *The Concept of Mind*. Chicago, IL: Chicago University Press.

Schacter D (2001) *The Seven Sins of Memory: How the Mind Forgets and Remembers*. Boston, MA: Houghton Mifflin.

Schechtman M (2011) The narrative self. In: Gallagher S (ed.) *The Oxford Handbook of the Self*. Oxford: Oxford University Press, pp. 394–416.

Søraker JH (2007) The moral status of information and information technology: a relational theory of moral status. In: Hongladarom S and Ess C (eds) *Information Technology Ethics: Cultural Perspectives*. Hershey, PA: Idea Group Publishing, pp. 1–19.

Sosa E (2007) *A Virtue Epistemology: Apt Belief and Reflective Knowledge*, vol. 1. Oxford: Oxford University Press.

Sosa E (2015) *Judgment and Agency*. Oxford: Oxford University Press.

Sparrow B, Liu J and Wegner D (2011) Google effects on memory: cognitive consequences of having information at our fingertips. *Science* 333(6043): 776–778.

Stanley J (2011) *Know How*. Oxford: Oxford University Press.

Stanley J and Williamson T (2001) Knowing how. *Journal of Philosophy* 98(8): 411–444.

Storm BC, Stone SM and Benjamin AS (2016) Using the internet to access information inflates future use of the internet to access other information. *Memory*. Epub ahead of print 18 July. DOI: 10.1080/09658211.2016.1210171.

Sutton J (2010) Exograms and interdisciplinarity: history, the extended mind, and the civilizing process. In: Menary R (ed.) *The Extended Mind*. Cambridge, MA: MIT Press, pp. 189–225.

Sutton J (2015) Scaffolding memory: themes, taxonomies, puzzles. In: Bietti L and Stone CB (eds) *Contextualizing Human Memory: An Interdisciplinary Approach to How Individuals and Groups Remember their Pasts*. London: Routledge, pp. 187–205.

Sutton J, Harris CB, Keil P, et al. (2010) The psychology of memory, extended cognition, and socially distributed remembering. *Phenomenology and the Cognitive Sciences* 9(4): 521–560.

Turkle S (ed.) (2007) *Evocative Objects: Things We Think with*. Cambridge, MA: MIT Press.

Vaccari AP (2016) Against cognitive artifacts: extended cognition and the problem of defining artifact. *Phenomenology and the Cognitive Sciences*. Epub ahead of print 13 September. DOI: 10.1007/s11097-016-9484-9.

Van den Hoven E (2014) A future-proof past: designing for remembering experiences. *Memory Studies* 7(3): 373–387.

Van den Hoven J and Manders-Huits N (2009) Value-sensitive design. In: Olsen JKB, Pedersen SA and Hendricks VF (eds) *A Companion to the Philosophy of Technology*. Sussex: Wiley-Blackwell, pp. 477–480.

Van den Hoven J, Blauw M, Pieters W, et al. (2014) Privacy and information technology. In: Zalta N (ed.) *Stanford Encyclopedia of Philosophy*. Available at: http://plato.stanford.edu/entries/it-privacy/

Van Dijck J (2007) *Mediated Memories in the Digital Age*. Stanford, CA: Stanford University Press.

Vaesen K (2011) Knowledge without credit, exhibit 4: extended cognition. *Synthese* 181(3): 515–529.

Ward AF (2013) Supernormal: how the Internet is changing our memories and our minds. *Psychological Inquiry* 24: 341–348.

Wegner DM (1986) Transactive memory: a contemporary analysis of the group mind. In: Mullen B and Goethals GR (eds) *Theories of Group Behavior*. New York: Springer, pp. 185–208.

Wegner DM and Ward AF (2013) How Google is changing your brain. *Scientific American* 309: 58–61.

Wegner DM, Giuliano T and Hertel P (1985) Cognitive interdependence in close relationships. In: Ickes WJ (ed.) *Compatible and Incompatible Relationships*. New York: Springer, pp. 253–276.

Wilson R and Clark A (2009) How to situate cognition: letting nature take its course. In: Robbins P and Aydede M (eds) *The Cambridge Handbook of Situated Cognition*. Cambridge: Cambridge University Press, pp. 55–77.

Zagzebski L (1996) *Virtues of the Mind*. Cambridge: Cambridge University Press.

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