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RESEARCH ARTICLE

Thinking in the Cloud: The Cognitive Incorporation of Cloud-Based Technology

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Abstract Technologies and artefacts have long played a role in the structure of human memory and our cognitive lives more generally. Recent years have seen an explosion in the production and use of a new regime of information technologies that might have powerful implications for our minds. Electronic-Memory (E-Memory), powerful, portable and wearable digital gadgetry and "the cloud" of ever-present data services allow us to record, store and access an ever-expanding range of information both about and of relevance to our lives. Already, for a decade we have been carrying around expansive gadgetry which allows us to collect, store and use what would have been almost unimaginable amounts of digital information only a short time ago. Now, thanks to the wireless internet adding vast processing and storage potential to the powerful portable devices which many of us carry constantly or wear, this information can be accessed and customised in an ever-greater variety of ways. How should we assess the implications of the new portable and pervasive cognitive technologies on offer? Does E-Memory and the wider panoply of cloud-enabled cognitive technologies really promise (as some see it), or threaten (as others do), a radical change to the human cognitive abilities and perhaps the very nature of our minds? If so, how are we to assess the possibilities and attempt to understand whether they offer a hopeful or dangerous turn in the human condition? This investigation is structured around four related factors of the new technology: Totality, Practical Incorporability, Autonomy and Entanglement. We use these factors to inquire into the implications of this cloud-based memory technology for our minds and our sense of self.

Keywords Extended cognition · Cognitive scaffolding · Cognitive penetration · Cognitive augmentation · Cognitive diminishment · Unity of mind · Epistemic possession · Extended memory · Cloud computing

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1 Introduction

Human nature and intelligence is not just a matter of our genetic endowment but relies heavily on a variety of factors including our cultural background, historically specific modes of thought and, not least, the pre-existing artefactual world into which we are born. Artefacts have in a variety of ways altered the lives of human beings and, directly or indirectly, the way we think. Technologies which work more directly on our cognitive abilities we can call *cognitive technologies*.

The central interest of this paper is in what happens as our minds come to rely on a new and very particular environment of cognitive technology, especially, portable digital recording and storage technology (MP3 players, megapixel cameras, digital dictaphones), handheld and wearable devices (GPS, smart phones, iPads) and all the paraphernalia of the mobile internet. As these technologies rapidly converge to take advantage of always-on internet data and processing services, we can discuss a new regime of cognitive technologies: Cloud-enabled cognitive technologies or Cloud-Tech (throughout this article I will refer to this wireless internet of data and processing services as *the cloud*). These technologies do not merely provide us with a range of local information capture and processing on our devices, but are connected to a wireless internet that provides data-warehousing and, increasingly, processing capacities that moreover track and collect information on the minutiae of our lives. As these technologies become increasingly pervasive in our lives and culture, it becomes important to ask not just what the implications are for our society, but what, if anything, might be happening to our minds and sense of self as we adapt to an environment and culture increasingly populated by pervasive smart technology.

Much of this treatment grows out of an examination of E-Memory and an examination of its adoption in recent years and its interaction with our biological (O-Memory) systems. O-Memory—a term I and others use to refer to organic or, perhaps better, organismic memory—refers to an undoubtedly heterogeneous set of systems and processes which underlie the ways in which human beings and their brains retain, organise and deploy knowledge during episodes of experience and which they can later bring to mind to put to work in a variety of ways (I'll also use the term biological memory interchangeably and refer more broadly to biological and internal systems). The term E-Memory similarly is used to refer to a heterogeneous bunch of devices and systems which fulfil similar functions either by replacement, extension or augmentation.

One recent study (Sellen and Whittaker 2010) details how E-Memory[1] systems can support a range of human memory functions, including what the authors call the five Rs, namely: *recollecting, reminiscing, retrieving, reflecting and remembering intention* (the latter referring to way certain software, such as Microsoft Outlook, allow us to track tasks, projects and actions that we intend to perform). Still, we should remember that the E/O-Memory distinction is a conceptual division and that our biological resources have been embedded in an environment of artefactual cognitive resources for thousands of years. It is better to think of E-Memory systems, rather than "impacting" on the virgin territory of our minds, as entering into, and restructuring the pre-existing, and always developing, bio-technological complex of our minds. Our primary interest in this article is to shift our focus toward the current and future hybrid

[1] The authors were actually specifically discussing lifelogging, which we shall come to shortly.

systems that are being forged as E-Memory systems enter into and restructure this hybrid[2] cognitive complex.

By Cloud-Tech, I refer to "the cloud" of distributed Internet mediated data-technologies and associated devices that provide wireless network services to us through, and with, artefacts and devices that we carry and increasingly wear. The cloud can be seen as a central part of the current material realization of ubiquitous computing (Weiser 1991) whereby computer processing technology has come to be an ever-present part of our lives. The distinctive form this cloud technology takes is a bunch of highly personalised data services and associated applications which we can access and which track us through a variety of devices including our personal computers, but now most especially, our mobile and smart phones. E-Memory and cloud-tech can be seen as symbiotic, with Cloud-Tech providing the infrastructure that carries E-Memory services, and providing constant access to E-Memory stores. However, the cloud provides much more than that. By supplying a range of data services which watch and respond to our activities, it provides a set of 'smart', highly tailored and personalised computer services that are always available to support our cognitive processes. Thus, E-Memory and Cloud-Tech can be viewed as just the latest in a line of cognitive technologies that change the human cognitive profile.

In fact, many developments of tools and technologies can bring with them changes in the modes or scope of human thinking. An apparently unlikely example is cooking. The invention of cooking appears to have wrought long-term changes in human physiology as we no longer required the large teeth and facial muscles to rip our food apart and chew our food. It also took a significant burden from our guts as various cooking techniques help release nutrients and neutralize poisons with less prolonged digestion. Developing the ability to barbecue, braise and boil our food with fire, along with other food processing skills dramatically reduced the amount of time our ancestors needed to find, eat and digest their food (Wrangham 2009). An even more significant implication of the development of cooking for human development may have been the time it released for us to pursue new and potentially more ennobling ends than hunting and gathering: Time in which to think, invent new technologies and uses for those technologies, tell stories around campfires and ultimately, perhaps, invent sophisticated culture. The development of cooking may then have had profound cognitive effects, yet pragmatically, including cooking as a directly cognitive technology makes the scope of any enquiry very large even if its cognitive implications may be profound. We have to narrow this scope somehow.

One approach to defining such technologies comes from Donald Norman who defines cognitive artefacts as "those artificial devices that maintain, display, or operate upon information in order to serve a representational function and that affect human cognitive performance" (Norman 1990). Norman here refers to cognitive artefacts rather than cognitive technology (cognitive artefacts can perhaps be thought of as concrete particulars or instances of cognitive technologies). Although Norman's approach is widely cited,[3] given that there is no agreed consensus on what information (or the implied notion of representation) is within the cognitive science community, this is

[2] Hybrid in the sense of Menary (2010).

[3] Heersmink (2012), for example, referred to Norman's approach at the conference where an earlier version of this paper (Clowes 2012) was given.

bound to be controversial. Moreover, the role of representation and whether it is a necessary criterion of cognition is also at the moment hotly controversial. A more ecumenical approach might hold then that a cognitive artefact is just an artificial device which carries out the same function as a part of the mind/brain. This idea echoes the *parity principle* so often invoked in discussion of the extended mind, albeit noting that cognitive technologies need not be part of anyone's mind. However, it has been pointed out—and as we will reflect on in this article—many cognitive artefacts and technologies do their work not because they duplicate some internal function but because they complement already existing internal function (John Sutton 2010). Provisionally and pragmatically then in this article we shall define cognitive artefacts as artificial devices which either perform functions that, were they carried out in the brain should count as cognitive, or significantly support, extend or complement such functions. There is no implication from this definition that cognitive artefacts or technologies need be counted as actual parts of anyone's mind (this would be begging the question), or that they fall into any sort of natural kind; we leave open the possibility that cognitive artefacts do their work in very heterogeneous ways. At this stage, we need not defend a strong position on whether cognitive technologies can become actual parts of our minds, and thus extend our minds, as the thesis of the extended mind contends (Clark 2008; Clark and Chalmers 1998), or merely act as a new sort of environment (Rupert 2004), niche or scaffold (Sterelny 2010) in which our minds operate. We merely hold that we, and our minds, have undergone profound changes, as we create and adopt new cognitive technologies. This is not to say that these different frameworks might not pose importantly different implications for how we view the adoption of cognitive technologies and indeed this will be a major point of this investigation (we shall return to these questions in Section 3 below but see also Clowes 2013; Michaelian and Sutton 2013).

On the rough, and in several ways problematic, definition of cognitive technology just offered, we are spending ever-increasing amounts of time interacting with a new regime of E-Memory systems and Cloud-Tech that have already become a constant background to a variety of everyday cognitive tasks. Google, Wikipedia and the ever-enlarging panoply of smart phones, personal gadgets, devices and software technologies, seem to be performing a variety of cognitive functions which either structure, replace or augment our biological systems, or perhaps more accurately, structure, replace or augment the previous bio-technological cognitive matrix. As these technologies, and our habitual use of them, increasingly become a part of everyday life, the tendency is for them to become invisible, fading into the background of cognition and skilled action. Whereas drugs that may produce cognitive enhancements or more direct brain-machine interfaces garner great academic and popular attention, it almost seems as though Cloud-Tech is already becoming so widespread and everyday that we scarcely bother to examine it deeply.

What are the cognitive implications of relying heavily on these particular technologies which fulfil tasks and functions that we once would have performed either with our brains alone, or with radically different set of cognitive artefacts? Such questions have not passed entirely unnoticed in the wider culture; there are a series of authors who are deeply worried about what might be happening to us (e.g., Carr 2008, 2010; Greenfield 2008; Lanier 2010; Pariser 2011; Turkle 2011) in the process of our mass adoption of these technologies. Some of this work is a serious attempt to engage with what these technologies might be doing in interaction with our minds and some of it

has a more sensationalist cast.[4] This rather pessimistic outlook on what might be born out of this interaction between the mind and the new cognitive technologies is interesting in the light of some of the more utopian things that have previously been written about the internet's cognitive implications (Negroponte 1996; Shirky 2010; Tapscott 1998). Sometimes, an author will move between balanced and sensationalist claims in short succession in the very same article; when we do try to assess the cognitive implications of these technologies, there is often something febrile about our attempts.[5]

In order to get better bearings on this question, the next section of this article (Section 2) will focus on some key properties of the new media: *totality, incorporability, autonomy and entanglement* which have important cognitive implications. Understanding them is, I claim, essential to assessing the real cognitive implications of Cloud-Tech and E-Memory. Section 3 will then critically examine the case that these technologies readily meet four conditions—constancy, facility, trust and prior endorsement—that were taken by Clark and Chalmers (1998) to indicate that a cognitive technology should count not just as contributing cognitively to our behaviour, but as an actual part of our mind. From a careful examination of implications of these technologies, I shall argue that meeting these basic four conditions is not enough and that it is necessary to meet two additional conditions, *personalisation and entrenchment* (Sterelny 2010), and *epistemic possession*, developed here. These tougher conditions put much tighter limits on what artefacts should be considered parts of our minds, and thus imply that many of the new cognitive technologies are better conceived of as a new kind of cognitively significant scaffolding, rather than parts of our minds. Nevertheless even some current uses of the technology appear to meet the strengthened set of conditions. To illustrate this case, Section 4 then turns its focus onto memory, and especially the way that some users of E-Memory technologies are already using artefacts in ways that make them appear as more unified and coherent agents when including their technological artefact as parts of themselves, than when we exclude such resources. Section 5 examines whether the forms of E-Memory capture and the cognitive interaction they make available should count as significant forms of epistemic possession, paying special attention to the importance of different timescales of interaction. This section also explores how some uses of deeply incorporated E-Memory technologies might already be considered forms of cognitive enhancement. Section 6 then addresses how the theoretical frameworks we use—especially the frameworks of

[4] One such popular article by a well know scientist: *How Facebook Addiction is damaging your child's brain* (Greenfield 2009) made a series of unevidenced claims about the dangers of social networks. Greenfield's claim that a growth in autism might be caused by using social network sites was later debunked by one of her colleagues (Bishop 2011) who pointed out that autism is a developmental disorder that can be identified in toddlers, long before an exposure to Facebook.

[5] If anything, we are currently going through a backlash against such previous optimistic (or as some would have it utopian) thinking about the internet and so now, more than ever, we need to keep open the possibility that technology can add (cognitive enhancement), as well as subtract (cognitive diminishment), from the mind (Clowes 2011a, b). Arguably, the history of technology and the mind up until now has been one where technologies with the most important intellectual implications, from writing, to the book, to the telescope, to the microscope have given to the mind more than they have taken away. This article is an attempt to get a grasp on how cloud-tech (especially cloud-enabled digital memory technology) might already be having profound effects not just on organic (biological and traditional practices) of memory, but on our sense of self, and our wider processes of thinking.

the extended mind and cognitive scaffolding—have implications for whether our use of E-Memory and Cloud-Tech should count as cognitive enhancements or diminishments. Section 7 then looks at how the new Google Glass technology is an exemplar of many of the technological trends we discussed around the properties of totality, incorporability, autonomy and entanglement. We use it to reconsider how shape as cognitive agent might undergo changes as we make extensive use of such technologies and the roll that human agency continues to play in our appropriation of them.

2 E-Memory, Cloud-Tech and their Cognitive Implications

Just as the amount, type and density of information that is being recorded about us in everyday life is ever-increasing (Mayer-Schönberger 2011; Pariser 2011), so the ability of everyone to record the sound, images and many other sorts of digital traces of his or her own life are showing a similar expansion (Gemmell and Bell 2009). The early twenty-first century has already seen a massive increase in the cheapness, availability and capacity of digital recording, storage and retrieval technologies. These have placed an ever-expanding arsenal of external memory technology in the hands of millions of people. The availability of cheap digital voice recorders and megapixel cameras embedded in mobile phones, as well as the powerful smart phones and tablets that many carry about, all connected to the invisible "cloud" of data services, all mean that increasing numbers of us are recording and regularly accessing detailed digital records of our lives in ways which would have been scarcely credible only a few years ago. In addition, apps on smart phones and tablets are placing an arsenal of new software in people's hands that can put this information to innovative and exotic purposes. The invention and widespread permeation of these technologies seem sure to have deep and important social consequences and perhaps offer to transform the way that both individuals and a society recollect and give meaning to both their personal and collective pasts.

If there is little doubt that we have seen a *technical* E-Memory revolution, then should we expect that our O-Memory systems will change and adapt to accommodate it? Before tackling this question directly, however, it is worth asking whether what we are seeing is really novel. E-Memory is far from being the first technology to change how we use our organic systems. Arguably, the history of the human race is in part of the history of how our O-Memory systems have been undergoing a constant process of elaboration and adaptation as we have created wave after wave of extended memory technologies (Donald 2001; Vygotsky 1978). From spoken language—if it can be counted a technology (Donald 1993)—through drawing and painting (Mithen 1996), to the development of counting systems, knots in rope, to writing systems (Olson 1994; Ong 1982), the development of record-keeping bureaucracies, the whole history of human art and technology can be seen as a history of revolutions in memory. And that is not even to make mention of techniques which have sought to reorganise (generally, upgrade) human memory, from classical training in mnemotechnics, to the medieval use of memory palaces (Olson 1994), to the rote-learning systems practiced in twentieth-century schools. All of these inventions can be seen as important historical moments when our relationship with the technology of memory has undergone fundamental changes.

It may be highly contestable that the purported reorganization of memory around particular technologies today is really historically unprecedented. Yet it is surely worth pondering what, if anything, is new or distinctive about the particular cognitive technologies which are currently being developed. Only then can we decide if they might have novel cognitive and psychological implications for the human race. I suggest there are four aspects of the current crop of E-Memory technologies that have important qualitative or quantitative differences from previous memory technologies (Mem-Tech) and that we should focus our attention here to understand what is really new. They are:

1. Totality: E-Memory promises to record our everyday activities on a scale and with a fidelity and completeness that would have been practicably unimaginable under previous regimes of memory technology. Cloud-Tech brings to this picture an ever-present repository of "memory traces" that can be retrieved and brought to bear on ongoing cognition.[6]
2. Practical Cognitive Incorporability: E-Memory and Cloud-Tech are rapidly becoming a constant context to many cognitive processes. The devices which present this technology increasingly possess a transparency-in-use that makes them competitors (or complements) with certain of our internal resources. It is often as easy, or easier, to rely upon these technologies to carry out certain cognitive tasks than internal organic resources. They are thus poised for deep and pervasive integration with our organic cognitive systems.
3. Autonomy: E-Memory repositories increasingly do not merely store data but actively process it. Thanks to tagging, indexing from AI systems resident on our devices and in the cloud, we can expect E-Memory systems to not merely store and retrieve memory traces and other information, but process, restructure and re-present them in ways that are independent of, but tightly coupled to, our native cognitive profile.
4. Entanglement: E-Memory often tracks interactions between people (or people and organisations). Many of the cloud services we use rely on collective data-storage and interactions collected from a mass of users. However it is presented back as narrowcast and tightly coupled to the activities of us as individuals. The data that composes many E-Memory stores and cloud services is thus inherently two-sided in relying on the interaction of these collective and individual dimensions.[7]

Although there are no doubt many other dimensions of E-Memory technology which could have profound implications, this cluster of properties I suggest pick out fundamental aspects of the new cloud and memory technology. Morever, each is also a candidate for having important implications for O-memory, our minds more widely, our sense of self and even our humanity. We will now look in more detail at what is potentially novel about each of these aspects of the technologies before returning to their cognitive and psychological implications.

Totality is potentially the most psychologically novel aspect of E-Memory. It promises to be able to record, and perhaps help us recall, just about everything we

[6] This factor was previously described as Capaciousness and Comprehensiveness.
[7] The inspiration for this notion comes from data-entanglement, see: Gemmell and Bell (2009).

might experience. The dream (or phantom) of totality is based on the ideas of total capture (Sellen and Whittaker 2010) and total recall (Bell and Gemmell 2009). According to these conceptions of present and future E-Memory technologies, we will shortly be able to capture and recall the sum total of the experiential world.[8] Perhaps the trend or idea that brings this out most clearly is lifelogging.

Lifelogging consists of using E-Memory technology to create a personal and ever more detailed digital multimedia record of one's life as it happens. Compared to any previous regime of memory technology it makes an important departure: Rather than making the decision and effort to take a photo or record a telephone conversation, make an entry in a diary or record ones everyday interactions with others; recording becomes the default setting.[9] Perhaps the most thoroughgoing and pervasive experiment so far attempted in this vein has been carried out by Gordon Bell and Jim Gemmell and is called *MyLifeBits*.[10] Bell is a septuagenarian researcher with Microsoft and was an early pioneer of the networked computer. As Bell tells the story, the project began with his desire to digitise, store and catalogue the books and articles he had written over the years. But, as the project progressed, Bell was no longer content with simply backing-up hardcopy but, as the technologies came online, Bell's aspiration became the creation of a digital record of everything he hears, thinks and sees. With this new orientation, the *MyLifeBits* project turned its focus to capturing the ongoing stream of sensory information more or less as Bell himself received it: Total capture. As of 2009 and the publication of Bell and Gemmell's *Total Recall* (2009), Bell not only had software on his computer to record and capture his every webpage visit, but also wearable technology to capture a moment-by-moment approximation of his sensory experience. Bell wears a SenseCam—a device which can be set to detect the presence of faces and automatically take pictures of those its wearer encounters (Hodges et al. 2006). The *MyLifeBits* system also does similar things with audio technology; which records and attempts to categorise all of Bell's conversations as he has them; and not just those on the phone! Bell is unusually explicit in the aspiration of this project. He aims at total capture, recording the sum of sensory experience, and total recall, the aspiration to use the information thus gathered to "recollect" any event in his past with total fidelity.

Bell understands his quest in the tradition of inscription found at the entrance to the Oracle of Delphi: Know Thyself. He sees *MyLifeBits* as allowing him to develop new form of self-knowledge that is a historic departure for the human race. But Bell's project also reflects a wave of experimentation outside of the research labs. Such extreme lifelogging may be only making explicit a trend which is already deeply embedded among heavy users of the new digital technologies. The availability of cheap portable digital recording gadgetry connected wirelessly to the vast storage and

[8] I have previously labelled this property Capaciousness and Comprehensiveness but in deference to wider usage I shall here refer to this property just as Totality. One of the problems with this terminology—and indeed the idea behind it—is that totality may really be a chimera. It is not really clear what it would mean to gain a total view of ourselves through memory or in any other way, nor importantly how such knowledge would be integrated in our viewpoint. We shall return to this point below.

[9] Practices which foreshadow lifelogging can be traced back at least to the 1980s in the work of such pioneers as Steve Mann who was experimenting with using digital cameras to record his everyday activities. In 1994, Mann set about using a wireless webcam to record is daily life 24/7 for artistic, experimental and in part also political reasons. Mann's project was political in that he was seeking to invert trends toward the surveillance of public space with an ever-growing arsenal of CCTV cameras; he aimed to surveil the surveillers.

[10] A detailed description of this project and Bell´s motivations can be found in Bell and Gemmell (2009).

processing resources of the cloud mean that a large and ever-increasing portion of humanity is recording and storing ever more digital memory traces of their lives. At the time of writing, the Google Glass technology is promising (or threatening—if such is your view) to make lifelogging and indeed certain forms of total capture vastly easier and—for many commentators—vastly more worrying (we discuss Google Glass at the end of this article). Bell's work seemed futuristic only a short while ago. It may soon seem to be banally quotidian.

Viktor Mayer-Schönberger is one researcher who believes that the possibilities of E-Memory and 'recording as default setting' portend profound effects on us, but he is far less sanguine about the prospects than Bell. At the very least, he thinks totality forces us to confront a new problem: How to forget:

> through millennia, forgetting has remained just a bit easier and cheaper than remembering. How much we remembered and how much we forgot changed over time, with tools and devices emerging to aid our memory. But, fundamentally, we remembered what we somehow perceived as important enough to expend that extra bit of effort on, and forgot most of the rest. Until recently, the fact that remembering has always been at least a little bit harder than forgetting helped us humans avoid the fundamental question of whether we would like to remember everything forever if we could. Not anymore (Mayer-Schönberger 2011) pg. 49).

Mayer-Schönberger believes we are on the cusp of changing a fundamental feature of our psychological lives with E-Memory technology. He worries that total capture, rather than putting us in deeper touch with ourselves, might reshape and even undermine our sense of self in profound ways. Much of this turns not so much on how much information we might store, but the psychological implications of how we are starting to use it (we shall return to this issue in Section 4 below).

Our second factor, Practical Cognitive Incorporability (or just incorporability), deals with the ways in which the new brand of portable cognitive and memory technologies are poised for incorporation into a wide range of everyday cognitive tasks. In large part, this depends upon the way that this technology embodies the strong tendency to become useable in such an unreflective way that it becomes second nature to its user. Many of the new cognitive technologies tend strongly towards such an everyday unreflective facility in use that we are scarcely aware we are using them. To use a more technical term, they become *transparent-in-use*. The sense here derives ultimately from Heidegger's (1927) observation that when we use a piece of equipment with which we are skilfully familiar, we cease to notice it as an object in itself with its own properties and our attention instead flows toward the task at hand and object on which we are working. Many technologies, including, in Heidegger's example, the humble hammer, can become transparent to the skilled user in the relevant respect. But arguably, there are aspects of how E-Memory and Cloud-Tech systems become transparent-in-use that are qualitatively new.

There are several technical innovations behind these cognitive technologies, but of central importance is the availability of high bandwidth mobile connections, massive

databases, powerful mobile devices, cloud computing and, centrally, internet search. This increasingly ubiquitous computing technology makes it possible for us to have constant access to huge amounts of data and mobile data applications that already compete with our organismic resources in terms of accessibility, authority and sheer scope of information. As these technologies become more mobile (effectively a constant in our lives), ever easier to interact with, and our skills in using them deepen, it is likely we will tend to rely on them—incorporate them in our cognitive world—to an ever-greater extent (Clowes 2013). The implications of what happens when such a density and scope of new cognitive technologies become transparent-in-use in this way, is unknown and to a great extent unexplored.

Consider an example now familiar to many millions of users: Google Search. The Internet-based technology for finding information has for some time been used by many office workers dozens of times a day. As these search applications are increasingly accessed by mobile devices, they are rapidly becoming a constant part of the epistemic backdrops of our lives. With Google Search, it is often quicker and easier to find out facts we might otherwise recall using biological memory systems. Consider the act of bringing to mind the first name of an artist whose name is on the tip of your tongue, say the drummer with a band you once loved but haven't thought about in years. In the recent past, you might wrack your brains trying to recall the name or try to think of something else assuming it will come to you in a short while. Today, for millions of users of desktop computers and mobile devices you might instead type what you remember into the Google search engine (I just typed 'drummer roxy mudic', I meant to type 'drummer Roxy Music', but my inaccuracy doesn't matter as the answer 'Paul Thompson' comes back in 0.3 seconds). Typing a search query now often seems easier and in some cases more accurate than relying on our native O-Memory systems. In such circumstances, typing search queries (or speaking into iPhones), has already become an everyday part of the recollection process itself.

Could there ever come a point where it is just generally easier to rely on ambient (or even biologically grafted in) memory devices than our own native O-Memory resources? We will examine a set of case-studies and some empirical work that suggest that the ever-present background of the internet and especially cloud-enabled E-Memory is already allowing some important rebalancing of our cognitive lives. A central question becomes whether these technologies should now, or in the near future, count as parts of our extended cognitive architecture and thus a part of us. It is useful to view all cognitive technologies on a continuum between shallow and deep incorporation, where shallowly incorporated cognitive technologies are those we rely upon rarely and for highly specific needs, and those that we rely upon almost inevitably and to a point such that it is difficult to draw an easy line between user and technology.[11]

Deep incorporation will turn on several factors of our use of these technologies. Of importance here is not merely how easy it is to interact with facility and effortlessness with our E-Memory devices, but how available they are to be incorporated into the patterns of everyday activities and thinking. It is not merely how transparent-in-use

[11] However, this division need not imply that deeply incorporated technologies should actually count as parts of our minds. As I will argue in Sections 3 and 4, even technologies that consistently and deeply rely upon may be better regarded as deeply incorporated cognitive scaffolding rather than actual parts of our minds if this paper's arguments are along the right lines.

they become to us. Other issues of importance are: The constancy and reliability of the resources; the constancy of our reliance on them; and perhaps centrally, our trust in them.[12] Factors that influence this trust are likely to depend heavily on the social and institutional landscape in which these technologies emerge. The incorporability of these technologies does not merely depend on technical aspects such as bandwidth or ease of use but on how comfortable we become with the idea of relying on E-Memory and Cloud-Tech systems to make important decisions in our lives (we shall return in detail to these questions in Sections 3 and 4).

Autonomy is our third property. When one wrote an entry in one's diary—even if one were using it in the way of Otto from Clark and Chalmer's thought experiment (Clark and Chalmers 1998)—one might reasonably expect the record to remain the same when one next came to look at it. Indeed one of the main ways in which external memory stores have historically contrasted with internal (biological) ones is that the former tend to have more stability, durability and task-independence than the latter (Donald 1991; Sutton 2010); in this sense, they are complementary. Cloud-Tech and E-Memory technologies, however, tend to have an ever more active and labile profile. Anything recorded with current tech is likely to be able to be re-presented back to its user in any number of augmented ways. E-memory devices can increasingly be expected to have the capacity to reorganise and repurpose the information they present in ways that are increasingly open-ended and reconfigurable. E-Memory 'stores' are really active repositories which increasingly transform and augment the data they hold. More generally, cloud technology can be considered less a mere storage system and more of an active processing system for reusing and repurposing data.

To elaborate further, it is not merely that Google is easy to use and returns information quickly but that it is itself an active memory. Google, by storing pointers to, and ratings of, the mass of information which is available through the internet can return a page rank on any search term in a fraction of a second. Its database of content is constantly updated but, more importantly for us, so are the algorithms and processes that are used to find that information. Information is not passively retained by Google but—in the pursuit of its twin goals of being useful and turning a profit—it is constantly being sifted and sorted with ever more sophisticated techniques with information undergoing processing and augmentation in various ways (this is without even mentioning projects such as Street View where Google is also creating huge new databases from scratch and using this to augment the information it holds and points at).

Thanks to the relative autonomy and active processing nature of E-Memory, we can expect that it will become ever more transparent-in-use, and at the same time more *opaque in its workings*. The implications of this are that we may use it with felicity but increasingly have less idea of how it works. It is not just that technologies such as Google Search may be passing beyond our powers of easy analysis but that technology companies, in order to protect their competitive advantage, will continue to try to obscure the deep working of their technology. There is of course a partial equivalence here with our organic systems here, as we do not understand the deep workings of their minds either. It has been the job of scientific psychology to attempt to understand the

[12] All of which can be seen as the flipside of the conditions of constancy, facility and trust that were held to characterise and agent's relationship with a technology that should count as part of her mind in Clark and Chalmers' original (1998) Extended Mind Paper.

principles of organic human memory and there remains much work to be done. And yet, do we not also have some sense of why we hold many of our beliefs, why we arrive at a certain decisions or at least are often able to usefully reconstruct such processes? The type autonomy implemented in many E-Memory resources implies that the user's relationship with it is likely to be very different to his relationship with his organic memory. The main reason is arguably nothing to do with the technology per se but that the companies who are building E-Memory systems are likely to have different interests from the users of the technology. This may ultimately be a limit on how our trust relationships with the new cognitive technologies develop and perhaps upon whether we should ever ontologically consider such technologies as a part of our extended mind.

E-Memory's autonomy is perhaps the qualitative dimension which sets it most apart most from previous memory technology regimes. In some ways, its fluidity and potentially reconstructive nature more resembles biological memory than pervious technological memory systems. It is likely that ever more active and perhaps autonomous E-memory systems will become increasingly pervasive. The way that E-Memory is likely to be organised, at least in the short term, is as much around the interests of corporations making software as anything individuals decide. What is made visible to others may not be what we desire them to see. Individuals may largely be unaware of the conditions under which their information is made visible. How we adjust cognitively and socially to this autonomy will be key in our future relationship with E-Memory systems and Cloud-Tech more widely.

This brings us to our fourth issue: Entanglement. In large part, this property can be understood as the consequence of much of the internet morphing into the social web. As it does so, much of the data stored and accessed via the Internet is refracted through a series of real-world and online relationships which not only give the data meaning, but situate its content relative to the activities of other users. One type of entangled system is Wikipedia, the content of which is produced and maintained by the aggregated distributed activities of millions of people. However, social media systems like Facebook are the signal form of entangled media and have been the main driver of this trend. Unlike Wikipedia, Facebook users do not share the same view onto the aggregated data, but experience a highly personalised viewpoint of a huge database which has been personalised to the individual user by a process outside of his or her knowledge or control.

EdgeRank, the algorithm which Facebook uses to present timelines to its users is not in the public domain (de facto cognitively impenetrable). Most users are not even aware that they do not see a large proportion of the updates of their 'friends'. Given the large amount of information that flows through systems like Facebook, such selective presentation is necessary, but this surely also has ethical and cognitive implications, especially if these systems become deeply entwined with our minds. The facebook interface re-presents aggregated data back to individual users as a timeline of status updates. Every data item on the timeline (or edge in Facebook's terminology) will only be shown, however, depending on whether it is considered personally relevant to that user. The EdgeRank algorithm was once thought to consist in three terms: affinity (a measure of how interested the viewing user is in the content of the viewed user), popularity (a measure of how often the particular data item has been viewed) and Time Decay (newer items will tend to show up over older ones). Exactly what any individual

user of such a system sees thus depends upon the sum of relationships the multitude of users refracted through whatever set of algorithms is used to present back the data. Since I first wrote about EdgeRank (Clowes 2012) the algorithm used to present newsfeeds has become radically more complex. Recent reports on the web (McGee 2013) state there may be as many as 100,000 terms now used to calculate what a user sees. Even if this is a wild exaggeration,[13] the trend is clear: increasingly more complex algorithms present personalised views onto data in ways which are likely to become ever more cognitive impenetrable to us, their users.

The forms of entanglement being developed around social media are changing rapidly. Consider how someone might today use an EdgeRank-mediated Facebook timeline in the way people might have used diaries in the past. A social network diary must function for very different purposes and presumably plays a different role for the individual from its static paper equivalent. What systems like Facebook really track are patterns of interaction between its users which are then data-mined for patterns of salience. Thanks to the EdgeRank algorithm, clicking on any piece of content in Facebook operates as a sort of vote, meaning that piece of data will tend to be more salient in the future.[14] The lines of who owns what in this world are morally (if not legally) very blurred. Some of our most personal "memory traces" increasingly gain meaning not simply from their relation to us, but through their entanglement with the lives of others.

The idea of Entanglement can also be applied (and was developed) in the context of memory as what we might remember or forget in a context that depends in part on how others have encountered, commented on, or simply ignored our data. We can observe E-Memory entanglement in the way that much of the data we create and store then takes on a new life of its own in relationship to the activities of a myriad of others. Consider digital photos taken with our mobile phones. As we take photos today, many of us make use of automated cloud-based systems that not only upload the data to our personal stores, but share it with others, tag it for various points of interest, including location and who is in the picture, and even decide who among our acquaintances might be interested in that picture and how significant it might be to them. The memory traces created in this way often have great personal significance for individuals and groups. While we as individuals may use such traces in ways that appear personal—signalling a special event in our lives or acting as a note-to-self—its meaning and use, and the way it will be presented back to us, often depend on the interconnections between a mass of individual users, and especially—in systems like Facebook—with the patterns of usage and interest of those around us.

Facebook's EdgeRank algorithm is not a passive memory of our interactions with others. Indeed its workings are opaque to us—and in part this is the flipside to transparency-in-use—so that we are not even aware of the criteria by which it might

[13] It is very difficult to get any highly verified information on exactly what algorithms Facebook or any of its competitors use to rank data. Such information is a commercial secret and tends to be highly protected and even the subject of misinformation. When I first wrote about EdgeRank, the information I used was apparently already a year and a half out of date; but since Facebook generally neither confirms nor denies how it currently does things, exactly how such algorithms work will always be partly a matter of speculation.

[14] See a more detailed discussion of the cognitive implications of EdgeRank in Clowes (2013)..

help us recall certain interactions with others. The properties of future E-Memory/O-Memory hybrid systems are likely to turn heavily on these sorts of properties and, as we shall now discuss in more detail, they have implications for whether these tools should be understood as part of a new cognitive ecology, or actual parts of our minds. These questions are not of mere theoretical concern but shall turn out to have great importance for shaping our practical and ethical outlook on what is happening to our minds as we embrace (or reject) these technologies.

3 Limning the Boundaries of Mind

Can E-Memory resources and other cloud-based cognitive technologies become so deeply incorporated into our cognitive lives that they should be counted as parts of our minds rather than parts of the environment? Much discussion has turned on whether several factors, first identified in the original extended mind paper (Clark and Chalmers 1998) correctly identified the conditions when it made sense to think of our use of artefacts just as tools. And when, (and if) that usage should become so intimate that it makes more sense to think of those artefacts as parts of our minds and ourselves. In that paper, four criteria were offered to help identify when a cognitive prop might better be regarded as an actual part of an agent's mind[15]:

1. Constancy: A cognitive technology should be relatively constantly accessible and, where appropriate, accessed by an agent. Where information it contains would be so useful that the agent rarely takes action without consulting it.
2. Facility: The cognitive technology can be accessed with ease and the information it makes available can be incorporated into ongoing cognition without great difficulty.
3. Trust: Upon retrieving information the agent automatically endorses it.
4. Prior endorsement: The information a cognitive technology presents has been consciously endorsed or accepted by the agent at some time in the past.

Sterelny (2010) has argued that the original conditions were rather too readily met. They don't separate cases where cognitive credit should be assigned to artefacts, from those where technologies should, in addition, count as parts of someone's mind. In order to do so, Sterelny claimed they need to meet an additional condition:

5. Entrenchment and personalisation: A cognitive technology is customised to an agent's individual usage and at the same time the agent's own cognitive routines and predispositions are altered to incorporate the resulting personalised artefact.

While many have accepted the metaphysical possibility that our artefacts and technologies might become proper parts of our minds—even some of the view's critics

[15] It should be noted that in the original paper these conditions were mainly offered as heuristic; still if we take seriously the division between cognitive artefacts that count as important environments and scaffolds for mind, from those that are actually part of the mind. the original conditions still appear to be as good a starting point as any.

such as Rupert—Sterelny has argued that finding objects, instruments or artefacts that meet all five conditions is hard indeed (Sterelny 2010). This comment may seem surprising given that E-Memory technology, especially the sorts of E-Memory technologies embodied in Cloud-Tech, appear to meet the original four conditions rather readily (e.g. see discussion of the iPhone in Chalmers 2007).[16] Any smart phone device seems to easily meet the constancy criterion. In virtue of the constant push toward building ever more felicitous user-interfaces, alongside the steadily increasing familiarity we have with these technologies, it seems likely that the facility criterion is also ever more likely to be met by our mobile devices.

The trust condition appears to be widely met even by very collective, and entangled resources, as many users of services such as Google Search and Wikipedia apparently automatically, or at least uncritically, endorse what they read. Whether the prior endorsement condition can be met turns out to be a more difficult matter. In the original thought experiment it is clearly *his* notebook whose contents Otto is to endorse. In the case of cloud-tech, it is much more uncertain what we should endorse; a product, or process, a software company or particular form or brand of social media? But even if we can sort this out, there are questions about whether we should or can trust very autonomous and entangled cognitive resources. Thanks to the property of autonomy, resources like Wikipedia can and do alter their contents dynamically in a highly dynamic manner and indeed this is precisely one reason many *do* rely on its results. Yet this makes it easy to imagine circumstances where individuals operate with a blanket endorsement of information sources that they regard as trustworthy where individual contents should not be trusted as all.[17] Should autonomy then count as an absolute barrier on these technologies counting as deeply integrated parts of our minds?

In fact, even in their original (1998) paper, Clark and Chalmers note that prior endorsement cannot be regarded as an absolute criterion on what should count as parts of our minds. Otherwise, certain internal cognitive systems might—via the parity principle—also be excluded. If parts of our organic mind do not meet the fourth criterion then why should this operate as a barrier on whether artefacts should count as parts of our extended mind? We might just abandon this condition but, as we shall see, it points in an important direction. There are good reasons to think that Cloud-Tech should be understood as making a cognitive contribution, without it thereby counting as a part of anyone's mind. Insofar as we both take and have little epistemic possession or responsibility for Cloud-Tech artefacts; they might be better regarded as parts of the environment.

One place where one of the authors of the extended mind paper (Clark) considers the case of a "web-extended mind" is the paper of Halpin et al. (2010), where the original

[16] Smart (2012) has argued that the web is not a good medium to be considered as a potential mind extender on the grounds that its resources are somewhat difficult to manipulate and not well-poised for cognitive integration. I have argued that the new, highly incorporable media embodied in cloud-tech tend and especially E-Memory technologies seem to avoid many of these concerns (Clowes 2013).

[17] One implication here is that very credulous individuals may seem to have more extended minds than those who are more suspicious about the cognitive technology they use (Clowes 2013). This seems to be a perverse result.

Otto and Inga thought experiment is reworked to a case involving Otto and Inga both using a Cloud-Tech device to access the MOMA. The authors write:

> One could imagine Otto trying to find his way to the Museum of Modern Art, and instead of a notebook having a personal digital assistant with access to a map on the Web. Likewise Inga, having access to the exact same map via her personal digital assistant. Since both Otto and Inga are sharing the exact same representation and because they are both using it in the same manner, Inga and Otto can be said to share at least some of the same cognitive state, due to the fact that their individual cognitive states are causally dependent on accessing the same representation. (Halpin et al. 2010, p.3)

Perhaps, but it is not clear that the idea of sharing a cognitive state in this sense is very different from more classical situations involving externalist ideas of meaning. The argument here turns on the idea that as each internet resource has a unique uniform resource identifier (URI) each is unique and can therefore they are using the very same cognitive resources. How different is this to a scenario where two people use identical ordinance survey maps which are copies of the same original? In both cases, we could say the content of the representation is partly determined by use of "the same" map but it seems strange to say the paper map is part of anyone's mental state. If all that is meant here is that they partially share mental contents then this is not a very radical suggestion. But the idea of the extended mind view is often treated as synonymous with the idea of *active* externalism: That it is, cognitive processes themselves which are extended, not just their contents or meaning in some sense.

In fact, there is quite a bit of work on the so-called transactive memory that demonstrates that social groupings such as families and especially intimate partners such as husband and wife do tend to distribute memory between persons and indeed rely on each other in ways that suggest that the cognitive states of one's spouse (for instance) can, under certain circumstances, be treated as though they are one's own (Sutton et al. 2010; Wegner 1987). Even if we accept these as legitimate cases of the extended mind, cases where cognitive states are anonymously distributed over the Internet are clearly very different. Cloud-Otto and Cloud-Inga may then be said to share, or at least access, common cognitive resources when they use the same PDA map, but this does not indicate that they therefore share parts of each others' minds. Sterelny's fifth condition, personalisation and entrenchment, helps us see why.

Sterelny notes that many (cognitive and other) artefacts we use can, in principle, be used by others just as well as by ourselves. Artefacts and their uses develop in large part as a collective activity and an artefact continues to be used and trusted not because it should count as a part of anyone's mind but because it supports the use of a multitude of individuals. Sterelny uses another map example, this time of the British Tube to make his point. The tube map is precisely trustable because it is used by millions to find their way around the British underground. But, as it is no-one's personal resource, it is not a good candidate for counting as part of anyone's mind. It is precisely because it is used by many different agents in an interchangeable manner that it is better understood as a *common* resource. On Sterelny's scaffolding hypothesis, the primary way we should understand the cognitive contribution of the artefactual and technological world is as providing environmental supports for our

cognitive labours.[18] This is because most cases of the cognitive credit of artefacts are generally best understood as analogous to the environments, or (following the ecological idea) niches (Laland et al. 2000) in which our minds work and develop. Yes, there may be cases where we should use the extended mind framework, but, there are few of these.

Dror and Harnad (2008) have suggested the notion of a *cognitive commons* to capture the idea of how a common cognitive resource, when developed and constrained by multiple users and creators, should be conceptualised. The notion helps illustrate how a cognitive resource that we draw upon to structure our cognitive processes, and may even partially maintain or create, need not count as a proper part of our minds. Thinking and other mental operations—as we have seen—generally rely on a background of cognitive technologies that allow us to perform cognitive tasks in manners that we would not be able to otherwise. On this analysis, the social internet affords just a new set of means for making use of these collective cognitive resources. Dror and Harnad contend that the resources of the *cognitive commons* should not be viewed as actually extending our minds but instead should be treated as a new sort of environment, or common resource on which our cognitive processes can draw. This approach comports with Sterelny's idea that many of the cases analysed under the rubric of the extended mind might be better understood under the alternative framework of cognitive scaffolding (Sterelny 2010) and with Rupert's *Hypothesis of Embedded Cognition* (HEMC) (Rupert 2009) which holds that artefacts can have cognitive credit but they are still better not considered as actual parts of our minds. It also nicely chimes with ideas of distributed cognition (Hutchins 1991, 1995; Hutchins and Klausen 1990). This approach locates the internet as a new sort of cognitive environment or tool which we can expect the dynamic resources of our brains to constantly factor in. Such an approach would agree that our minds are shaped or scaffolded (in Sterelny's sense) by the new technological environment, but hold that this does not imply that the sorts of cognitive technology afforded by E-Memory and Cloud-Tech should be considered as proper parts of our minds. Indeed, Dror and Harnad, albeit for distinct reasons, reject that view.

[18] The term itself: *cognitive scaffolding* does however seem a little problematic. It plainly inherits from the everyday usage of the term scaffold as something that is used to support the construction or repair of something else. However, scaffolding is then taken down when whatever is being supported is constructed. When the scaffold is taken away, the cognitive edifice remains upright. This usage accords with the way Bruner apparently thought of scaffolds in a developmental sense; as structures that allowed and supported a developing skill while it was developing. But what happens when an organism continues to rely on a scaffold, as appears to be the case in many of Sterelny's examples? Are they still scaffolds? Given this nomenclature problem, it might be better to use another term. Another metaphor that is sometimes used is that of a "situation" of cognition which might also be rather problematic because as Cloud-Tech becomes ever more portable, it is rapidly becoming a sort of constant situation for all human thought. One alternative (borrowed from ethology) is the idea of an ecological niche. By extension, cognitive niches are continually involved in an organism's activities over its lifetime, or in a subset of its activities, providing contextual resources and constraints that give ongoing structure to cognitive episodes. For these reasons, the better metaphors for what Sterelny is attempting to conceptualise might be the cognitive niche, or cognitive embedding or cognitive ecology. Having noted the problems, I shall use the terms relatively interchangeably in this article. These problems of nomenclature still leave us to try and draw distinctions that illuminate when cognitive technologies should be considered part of the environment or embedding of our thinking and when they are so deeply entrenched (incorporated) that they might count as parts of us.

Yet Sterelny's entrenchment and personalisation condition implies an important exception here. A resource might plausibly be considered as a proper part of an individual's mind, if it were customised (or personalised) to that individual's particular patterns of use. Especially if it were further entrenched by that individual in the sense that his or her mental processes have come to be shaped by and rely upon the particular way in which we he or she has personalised and customised the resource. The entrenchment condition helps to foreground the active role an agent takes in really making a resource its own and, perhaps, part of itself. Meeting the entrenchment condition might be a crucial difference because it signals at least one form of possession or *mineness* a resource or artefact can possess. If Sterelny is correct that cognitive resources seldom meet the entrenchment and personalization condition, then the scaffolding framework is the normal rule.

Yet Cloud-Tech, of the sort we have been discussing in this article, may be the exception to Sterelny's rule. One exceptional feature of Cloud-Tech is its extreme customizability. My own device of choice at the moment is a Samsung Android G7000 phone/tablet. Although I am far from plumbing its depths, the phone is highly customised to my usage in several ways. First, I have added any number of apps to it, or moved existing apps to its central screen in order to call upon them with greater ease. Some of these I use on a daily basis such as the maps app, or the translation app. Some, such as the email app, I use on something closer to an hourly basis, the device politely and softly beeping to let me know I have mail or that I need to perform some task I have previously scheduled. I increasingly use the device as a memory aid photographing things of which I fear I will forget the visual detail, or simply adding a reminder to the image so I can temporarily forget it and concentrate on something else. Moreover, it is highly customised in the sense that it is connected to an ecology of Google (and other) data systems which I use not just on my Samsung Note but whenever I log into a computer browser. Google's systems steadily record my every search, my use of gmail, perhaps my every keyboard tap. Moreover, this information is used to automatically narrowcast information back to me in a way that is entirely particular to my Google profile and is itself a form of personalisation.

The way Google and related systems now use fine-grain surveillance of one's personal information technology usage to the point that it is almost as though you have your own press agency/or personal censor, catering to, supplying and constraining what you can see on the internet, has been christened The Bubble (Pariser 2011). Such technology may have many problems considered from a social or political perspective. It does however seem to readily meet the personalisation aspect of Sterelny's condition. But does it meet the entrenchment part of the condition? Certainly, I have come to rely on the particular customization of my G7000—the ways I have tailored its interface and arrangement of screens, the apps it contains and the data services it connects to, it is highly customised to me. In addition, I have subscribed to and come to rely on certain data services which both store information I require and regulate themselves to my patterns of my usage. Insofar as I have come to rely on these customizations, I have entrenched the use the G7000 along with many of the cloud-based data services that stand behind it. It is difficult to see how such forms of entrenchment will not continue apace in the future so that future systems will increasingly tend to meet this criterion and thus be ripe for certain types of incorporation. So can my G7000, or some of its applications, be regarded as a part of my mind?

A second thought experiment about Cloud-Otto that Halpin et al. suggest, speaks to this idea that it is the actual mechanisms of thought that need to be extended (or shared) in order for there to be an interesting case of the extended mind:

> Imagine not only that Inga and Otto are using a map-producing Web site that allows users to add annotations and corrections, a sort of wiki of maps. Inga, noticing that the main entrance to the Museum of Modern Art is closed temporarily due to construction and so the entrance has moved a block, add this annotation to the map, correcting the error as regards where the Museum of Modern Art should be. This correction is propagated at speeds very close to real-time back to the central database behind the Web site. (…) This active manipulation with updating of an external representation lets Inga and Otto possess some form of dynamically-changing collective cognitive state.

Clearly here, the map deserves some cognitive credit for Cloud-Otto's success in arriving at the museum. But does this imply that Cloud-Otto's mind possesses some dynamically changing collective cognitive states as one of its parts?

Let us suppose they do constitute part of Otto's mind. One problem here is that it appears that Cloud-Otto's cognitive states can vary independently of any of his actions, cogitations or intentions. In the original thought experiment, Otto's notebook was very clearly *his* notebook and it was clear that he had responsibility for policing its boundaries. That it was *Otto's* notebook, depended not just on his trust in its contents, his felicitous use of it, and his habitual dependence on it, or even that he had (in Sterelny's sense) personalised and entrenched it, but that it was *he* who manipulated, changed and crucially controlled changes to its contents. In part, this is a function of the artefactual properties of the paper notebook and that standard ways of using it; although of course the purposes Otto is putting them to are unusual. One writes into a notebook, annotate, cross out sections, pages which are often used fall open. We might presume for instance Otto was able to recognise his own handwriting, and therefore spot any malicious changes. Insofar as Otto can spot and reconstruct changes that might have happened to its contents, the diary is to a significant degree cognitively penetrable. Moreover, a degree of epistemic control and policability are built into the artefact. By contrast, Cloud-Otto's wiki-map might not support, or at least not make available such cognitive penetrability and epistemic controls to anything like the same degree and Cloud-Otto should expect its content will change in ways that are generally beyond his purview.

Cloud-Otto might meet the original four conditions plus Sterelny's more restrictive personalisation and entrenchment criteria and yet still be a problematic case. For it is easy to see how Cloud-Otto might access the wiki-map through a highly customised (i.e. personalised) interface which he heavily relies upon (entrenched), and yet still we have good reasons to doubt that those resources should count as proper parts of his mind. Cloud-Otto, in virtue of not being able to revise, police or cognitively penetrate the putative cognitive states the map makes available, is quite a passive onlooker on the cognitive technologies he uses. One way of putting this problem is to say that Cloud-Otto cannot take epistemic responsibility for, or possession of the cognitive resources he uses. What do we mean here? Cloud-Otto has little ability to control

changes that happen to the wiki map, or even notice when they have happened. Even imagining that the wiki-map is set up so that changes become very evident, this may undermine its transparency-in-use. Arguably a cognitive resource is poised for deep incorporation insofar as it can be used—at least in the moment required—rather unthinkingly. It is difficult then to see how Otto can be said to have epistemic responsibility for resources which are cognitively impenetrable, unpoliceable and unrevisable by Otto personally. The problem is not just that Cloud-Otto may be unaware of significant changes that are happening or have happened to cognitive resources. Rather, Cloud-Otto seems to lack significant agency and control of his mental life.

The idea of a mind as some sort of self-governing unity is deeply embedded in our folk psychology. This idea is deeply challenged by the notion that our minds can be partly composed of anonymously sourced web resources we neither control nor have knowledge about how and when they change. It is possible to challenge the idea that unity and agential responsibility are necessary for all aspects of mind, but it is questionable whether minds that have such slight grip on their constituent parts, and what counts as part of their knowledge base should count as unified, and thus singular minds at all. Cloud-Otto is neither principally the agent of change of his cognitive resources, nor is he able to police their boundaries of his cognitive resources in the way standard Otto could. Rather, he just trusts that the wiki-maps—for good or ill—are reliable. These basic dissimilarities in the cases look important. If Otto cannot cognitively penetrate, review changes and have some level of control of his own cognitive resources, it is difficult to see why the resources should count as part of Otto's mind, and not just part of the cognitive commons Otto is able to use. Moreover, because of the very autonomous and entangled resources that Cloud-Tech is starting to now make available, we may well start to suspect that this is a quite general result, even if it is possible to imagine ways in which certain technological changes might override some of these concerns.

We might here offer a sixth constraint on cases of genuinely extended cognition:

6. Epistemic possession: A cognitive technology should only be considered a proper part of an agent when the resource is minimally cognitively penetrable, policable and revisable by that agent.

To be clear this should not be taken to imply that our cognitive resources need be diaphanous and fully open to personal interrogation. Cognitive penetration can only ever be partial, and many of our core cognitive resources might be quite impenetrable. But we do typically have some sense of why we draw certain inferences, how we have made up our mind and are often able to revise our beliefs, and it is partly these factors that give us some agential unity.

4 E-Memory, Epistemic Possession and Cognitive Integration

Making these points in relation to abstract thought experiments is perhaps unlikely to convince the sceptic, in part because email and search may not appear to be cognitive operations at all, but rather various other sorts of merely para-cognitive activity. Such

cases perhaps have more force when the examples are drawn around more uncontroversial cognitive operations, and so, in this section we return to E-Memory technology and its usage both by people (like Otto) with compromised biological memory systems—it is perhaps here that examples of personal cognitive extension seem most compelling—but also with those who are using E-Memory technologies in ways which can be regarded as cognitive enhancements.

Just as the central thought experiment to illustrate the idea of the extended mind in the original (1998) article featured Otto, a man with Alzheimer's who used his notebook in order to store and recall information for which the rest of us can use organic memory, so, some of the most suggestive illustrations of the bonding of E-Memory and O-Memory have involved those attempting to cope with organic memory deficits. Take for examples Deacon Patrick Jones, who suffered traumatic brain injury, leaving him with anterograde amnesia (difficulties in acquiring new long-term memories) and difficulties in making use of existing ones. We can get an idea of the profundity of some of Deacon Jones' difficulties in the everyday context of meeting his children: "When they walk through the door, I don't know whether they will be three or thirty, I just try to interact with them as I find them."(Marcus 2008)

Nevertheless Deacon Jones has made considerable inroads into overcoming at least some of his cognitive problems by leaning upon his cloud-enabled E-Memory resources. He uses the note-taking software Evernote and the mind-mapping software Curio on his computer, through his iPhone or on his tablet to support and, at times perhaps replace certain O-Memory functions. Jones uses Evernote as a sort of long-term prosthetic for episodic or autobiographical memory and Curio as an extension to his working memory. Many cognitive tasks that would be done entirely internally, and mainly with organic memory resources by people without memory deficits, Jones handles by heavily supporting his own compromised organic resources with deep interactions with his E-Memory systems. Thanks to cloud computing, this software and his data store is available to him whenever he needs and access to this data store is pretty much a constant in his life. It is also clear that Jones significantly personalised and entrenched his devices by filling his Evernote and Curio stores with huge amounts of information about his life and—importantly for us—the workings and traces of his own cogitations.

Jones' use of E-Memory is not merely a matter of providing some cognitive scaffolding to allow existing (damaged) cognitive resources to work better.[19] Instead, he uses E-Memory technologies as though they were parts his cognitive resources, relying on the information they provide and, crucially for the argument being developed here, using E-Memory resources to check and validate the development and reasoning behind his decision making processes. One relevant example

[19] Most of the account here is based on Jones' Blog and a series of interviews especially for *Psychology Today* (Marcus 2008). This is perhaps something less than the gold standard of scientific enquiry. However as I review in another article (Clowes 2013) there is starting to be a number of empirical enquiries into the practical uses of E-Memory which broadly sustain the notion that existing memory function can be supported by their usage (Kalnikaite et al. 2010; Kalnikaite and Whittaker 2008). Jones' and Bell's reports are useful as they help us build intuitions about the subjective side of the use of memory technology, especially the more phenomenological questions of how these technologies fit into his life.

from the *Psychology Today* story and his interview with the story's author Gary Marcus:

> First, I got your email and had no idea who you were or why [we] were talking. The history in the email didn't help much. So I searched "Gary Marcus" in my Mac's Spotlight, which turned up an Evernote [note] on who you are and why we're interacting, who put us in touch with each other, a log of our interactions, etc. (Marcus 2008)

Here, Jones is able to use his E-Memory system to check why he is having a certain conversation. This allows him to check up on his previous deeds and undertakings, make connections with them, and make informed and coherent decisions about how to continue the conversation, drawing on his personal history.

In many ways, Jones' use of the technology here is little different from the way many of us now use various software systems on a daily basis. The main differences are that Jones' biological memory is that much more fragile, he is that much more reliant on his E-Memory systems and his habits of mind mean that he is that much more likely to consult and rely on his E-Memory than an average member of the population. It is these habits of mind which means that he meets Sterelny's personalisation and entrenchment condition. The systems are clearly personalised just by the fact that Jones has uploaded so much personal data into them and has put so much effort into organising his notes through them. They are entrenched insofar has relies heavily on these resources in order to conduct his everyday life. Crucially, however, Jones also uses these systems to track and audit the development of his decision-making, and he can do this because those systems are cognitively penetrable to the point he can search them and make some valid inferences about how and why information has gotten into them. Jones' E-Memory resources allow him to be epistemically responsible and he is clearly interested in using these systems to inform his actions and pursue a coherent mental life. He is, in terms we have just developed, able and interested enough to take *epistemic possession* of his E-Memory systems as cognitive resources.

It will perhaps always be easier to see individuals with biological deficits as more easily accommodated to the extended mind perspective than those of us who use E-Memory for purposes of Augmentation. Deacon Jones' use of his E-Memory technology appears to have been hugely significant in allowing him to rebuild his life in what is on the face of it a significant disability. His ability to make sense of himself, organise his life, pursue his goals and nurture those around him, to make use of this complex to edit a blog and look after a ministry (he has become ordained *since* suffering the most serious aspects of memory loss) is impressive, even inspirational. Given the profundity of his O-Memory deficits, Jones' ability to live his life in a positive manner is undoubtedly extraordinary. It also indicates some of the possibilities of E-Memory systems when integrated in the life and mind of an agent. Importantly for us it is a compelling story of how—even when faced with much tougher conditions that those supposed in the original extended mind article—we can find cases where an individual's use of technology makes a compelling case for an actually existing example of a technological extended mind in the strongest sense.

But, consider again Gordon Bell's *MyLifeBits* project. Implicitly, a major aim of the project appears to be to build an E-Memory system that supports natural memory

decline through aging. Bell is already embracing a further step up the cognitive integration ladder where his E-Memory resources are not merely passive storage devices or workspaces which can be appropriated by organic memory resources but incorporate elements of autonomous processing. Gordon Bell, as we have seen, conceives of the *MyLifeBits* project as a sort of practical Delphic investigation into self-knowledge. We need to take seriously the claim that, using systems like this, we could come to reflect on and know ourselves in ways that only this technology could make available. But should such systems really be understood as extensions of Bell's mind rather than cognitive scaffolding on which he increasingly relies?

Let us first consider some objections: It could be argued that Bell's dream of achieving an enhanced (perhaps even total?) form of self-knowledge with *MyLifeBits* is premised on a mistake about what self-knowledge is. Bell may be collecting and digitizing data about himself with an unprecedented comprehensiveness, but that does not make it *self*-knowledge. To count as self-knowledge it should, in addition, be (minimally) open or accessible to him or otherwise in some way integrated with his cognitive processes or contributing toward his sense of himself. Insofar as Bell just stores away information about himself that he does not, or could not, access or otherwise interact with, then Bell is just accumulating data, or potential memory traces. However, Bell is doing something more than this.

Self-knowledge, is not merely information or even knowledge about oneself, but is only a distinctive category insofar as it is really the agent's *own* knowledge. To put this point another way, self-knowledge proper has to not merely be knowledge about the agent but belong to, or be integrated into the agent in such a way such that it can be said to have the property of *mineness*. Of course, this does not solve the problem as we now have to be clear about what it would mean for an E-Memory (or indeed any cognitive) system to have this property. One possibility of what we should want to mean by mineness is that the agent is able to take epistemic responsibility for the way knowledge is stored and manipulated in the way we have just discussed. In the case of E-Memory this might mean (again minimally) some interface that makes E-Memory traces searchable or in some other way cognitively penetrable to the agent. This form of penetrability might have to be quite extensive in order for a cognitive system to be considered deeply enough integrated with the agent to form part of its perspective, or point of view.

But this opens up a problem. Earlier in the article, I noted how it is precisely transparency-in-use (phenomenologically transparency) that makes technologies likely to be ripe for deep incorporation. Yet, I am now claiming that cognitively penetrability—by which I mean the mechanisms being at least partly open to scrutiny—must also be necessary. The problem is that such phenomenological transparency can be taken as a consequence of the mechanistic properties of technologies disappearing from phenomenology so that all that we see is the goal or content.[20] Don't these properties run exactly counter to each other? In fact, the relationship is a little more complex. Cognitive penetrability really just requires that the technology is open to some form of scrutiny when needed, not that it is always open in this way and especially it need not be penetrable when in use. Thus, it is quite possible that a technology is indeed

[20] For a revealing recent discussion of the relationship between the phenomenology of transparency and cognitive enhancement see Zawidzki (2012).

transparent-in-use but still has the right sort of cognitive penetrability qualities to allow epistemic possession.

Consider how the SenseCam hangs around Bell's neck all day automatically taking and storing images. The images taken with it are—in at least one very literal sense—from Bell's point of view (or close to it), and thus have one, perhaps rather shallow, form of mineness. Arguably, this is not however the relevant sense of the term, for while the SenseCam may record information from Bell's point of view, it does not form *part* of his point of view. Yet, Bell does not merely accumulate memory traces but interacts with those traces. Bell can, thanks to *MyLifeBits*, review a day's activities by watching a rapid-fire visual summary of the images taken by the SenseCam on the evening of the day itself, or access that day again a year later. Because of all of the automatic tagging, he can search and 'recall' with great precision what he was doing, what webpage he was accessing, who he was talking to on the phone, or even who he ran into while walking down the corridor. It can be argued that the technology is transparent-in-use, both in the sense that Bell does to use much effort to take pictures, presumably he just wears and switches on the SenseCam, but also in the ways he can further interact with the memory traces he is accumulating. That the technology either is, or could be, highly transparent-in-use, is primarily a factor of the technology being well-designed and Bell being a practised user of it. Bell's ongoing use and interaction with the data accumulated by his SenseCam mean that the memory traces *MyLifeBits* accumulates are strong candidates to count as proper parts of his mind.

One objection here is that it is highly questionable as to how well-poised information made available by systems like *MyLifeBits* is for cognitive integration in ways that mirror the integration of sub-systems of our organic thought processes.[21] Even if the data-repository that stores Bell's memory traces actively processes the information and produces new and productive inferences based on this information, the inferences they produce are not really integrated into Bell, merely their results. One aspect of this problem is that the purportedly extended cognitive systems with which we interact through perceptual and actional channels just cannot, as a brute physical fact, achieve the same order of informational and especially inferential integration with the rest of our cognitive resources that brain-based internal systems can. This is because perceptual routines are slower than the information propagation that can go on within the brain. The problem with the deep incorporation of Cloud-Tech or E-Memory is its relative informational encapsulation of systems that interact with our organic cognitive systems through our senses. On this analysis, subsystems that only integrate (slowly) through the senses, just cannot be inferentially promiscuous enough to count as a proper part of the mind. Such systems are just not deeply integrated enough in a way that makes abductive inferences between subsystems available. Arguably then, insofar as Bell's E-Memory traces do not share deep inferential promiscuity with his O-Memory systems in a wide abductive sense (remaining inferentially chaste), they should not be considered true parts of his mind. Memory traces created by the sensecam plus *MyLifeBits* therefore can't count as parts of Bell's point or really be contribute to his point of view because they do not interact with his core organic cognitive processes

[21] Paul Smart as we have seen has made a similar observation about the aptness of webpages for cognitive incorporation (Smart 2012)

in the right inferentially promiscuous manner. The processing subsystems of *MyLifeBits* are just too informationally and inferentially encapsulated.

Yet it is not only *extended* cognitive technologies whose functions may be encapsulated in this way, both from point of view of the wider cognitive economy of the mind and the possibilities of introspection. Fodor, among others, developed the notion of modularity in order to express something about of the nature of cognitive economy where the workings of some parts of the mind are relatively insulated from, or impenetrable to, others (Fodor 1983). For Fodor, at least, it was typically perceptual systems[22] that could be understood in this way; insulated away from central general purpose reasoning systems and our capacity to introspect. It is thus typical of certain of our organic cognitive systems that they are cognitively impenetrable. If this is right, much human knowledge can be understood as encapsulated away in the modular sub-systems of our brains. Perhaps we should regard E-Memory systems and Cloud-Tech as more like perceptual systems in this regard as they are similarly not open to introspection, or perhaps certain other important forms of cognitive penetration. In fact, Fodor argued that even central systems may only be very partially open to introspection, but through the process of [at least] abduction they were supposed to be promiscuously open to inferential processes. Information held in the general store is [in principle] open to all other central cognitive processes.

The extended mind theorist might at this point counter that for parity-type reasons it does not matter that part of our purported extended mind is relatively encapsulated and/or relatively cognitively impenetrable, so long as we come to interact with them in the right sort of way. If a technology is so integrated into our decision-making that it makes more sense to grasp us as agents when we factor in the technology, then perhaps we just need to be more liberal about the timescale of inferential integration we are prepared to allow. But let us consider the way that *MyLifeBits* incorporates some autonomous technologies.

Bell incorporates face-recognition software into his E-Memory setup that can, on a real-time basis, report the name of a person he might meet while walking through his place of work and also report further contextual information—such as the last time Bell met a given acquaintance or the contents of an email from them. So where Bell might have otherwise forgotten a one-time colleague's name, or some important information about her, his good devices are able to give the appropriate cue just as he needs it. Bell's *MyLifeBits* system can be used, like Jones' E-Memory systems, to support existing O-Memory as a prosthetic. It would be natural if a septuagenarian forgot the name of the odd colleague as he meets him walking through the corridor. But Bell is also using active systems to seek and process and search for information in quite autonomous manners. The face-recognition software incorporated in *MyLifeBits* does not merely remind Bell of the name of a colleague he has forgotten or even some other forgotten contextual information. It can in addition access the internet and find information on Bell's colleague that he has never seen before and perhaps even couldn't have been a part of his organic memory. Bell's devices do not merely scaffold but—thanks to their entanglement and autonomy—augment his biological memory: *MyLifeBits* is a system for cognitive augmentation. Does this imply *MyLifeBits* should be seen as a cognitive scaffold rather than a part of Bell's mind? The answers I claim lie around the ways in

[22] Others since have extended the idea to central processing systems (Carruthers 2005).

which Bell has entrenched and personalised but also in the way he is able to take epistemic possession of *MyLifeBits*.

Bell has clearly personalised and (perhaps to a lesser degree than Deacon Jones) also entrenched his *MyLifeBits* system. The particular form of personalisation that Bell has achieved is also important here. The data (memory traces) amassed and categorised with *MyLifeBits* are in one important sense *about Bell*. They have been collected, in good lifelogging fashion, as he goes about his everyday life and are taken from his viewpoint. This I contend is a relevant form of mineness.[23] The ways that *MyLifeBits* allows Bell to contextually access and bring back memory traces so that they can be integrated in his current thought processes further enhances this sense. What about entrenchment? One good criterion for whether he has entrenched it enough is, as Sterelny has argued, swapability. Consider what would happen if Jones and Bell were to swap their memory equipment with that of another user of the same system.[24] In the case of both, the swap would be damaging, in Jones' case perhaps catastrophically so, to their respective abilities to function. The same cannot be said for Cloud-Otto and Cloud-Inga. Their use of the wiki-map is based partly on the resource being relatively interchangeable and serving the cognitive purposes of a wide collectively of users including Cloud-Inga and Otto. The degree of dependence is important for entrenchment. Entrenched resources are those whose cognitive function we really rely on in our cognitive life. Personalised resources are those we have customised to our cognitive need and one important way we can do this is by storing information about ourselves in them. The connection between lifelogging and the extended mind is then clear. Sterelny, it seems, is correct about personalisation and entrenchment being (at least in part) criterial for deciding cases that would best be understood as really extending the mind and those that are better thought of as scaffolding.[25] But as I have argued here this is not the whole story.

The other good reasons that Bell's systems should count as parts of his mind are in virtue of the extensive opportunities for epistemic possession that *MyLifeBits* makes possible for Bell. Bell can take epistemic responsibility for *MyLifeBits* in ways that few other users of such systems can just because Bell, and his team, have built the systems. It is thus in a variety of ways cognitively penetrable to him. *MyLifeBits*' algorithms were largely set up by and for Bell himself to achieve cognitive purposes that he has great insight into, both in terms of the purposes for which they were set up, and in terms of the actual mechanics by which those systems work. In addition, as Bell has built those systems, he is likely to have a good sense of how far he can trust, rely upon and even defer to them. His ability to trust *MyLifeBits* is therefore likely to be well-founded. Such properties may not be maintained intact if someone else, who knew little about its

[23] It should be pointed out here that I do not mean to imply that Bell's memory traces exhibit *ownership* in quite the way the term is used in some recent philosophical discussion (Campbell 1999; De Vignemont 2007; Gallagher 2000). Nevertheless, worthy of further investigation. Unfortunately, this goes beyond the scope of this article.

[24] Granted this would be difficult in Bell's case because, at least in its most advanced form, Bell is the only user of *MyLifeBits* and it has been customised heavily to him.

[25] Yet when Sterelny argues that there may be few genuine cases of the extended mind he may already be being overtaken by technological events. The types of usage that Jones and Bell are pioneering already use the technology in ways which appear to easily meet the criteria. If the criteria are good Sterelny should have to admit that much future use of cognitive technology is to be better understood as examples of extended mind rather than scaffolding.

workings, used the systems. The cognitive opacity of such systems to a naïve user of such a system, should—if this discussion is on the right lines—be good reasons *not* to count them as proper parts of that user's mind. Such a user would not know enough to trust such a system even if he or she claimed they did. *MyLifeBits* is, for Bell at least, deeply cognitively penetrable.[26] To the extent he, in addition, relies on and entrenches those systems in his cognitive life, they can be naturally seen as extending his cognitive economy.

Some may still feel inclined to argue here that Deacon Jones' and Gordon Bell's use of E-Memory technology are best understood as cases of strong dependence on a particular cognitive tool without holding that either set of artefacts and technologies should count as part of Bell's and Jones' cognitive processes. However, this would be, I think, to underestimate the importance of personalisation and entrenchment and, as I have argued, epistemic possession.

If Bell and Jones had just deeply personalised and entrenched their E-Memory systems, without taking deeper epistemic possession of them, there would be a case to be made that they should still count merely as cognitive tools. But Jones and Bell are to different degrees able to access and check up on the history of their mental lives through their technologies, and they can bring this to bear on ongoing cognition. In part, this is precisely because these are E-Memory systems, rather than some other cognitive functions. This cognitive penetrability of these systems alongside the ability to check and potentially revise decision-making, in addition to the other aspects of epistemic possession they make available, allow us to view Bell and Jones and their cognitive artefacts as unified cognitive systems. Both Bell and (especially) Jones makes more sense as agents when considered as extended systems, with their cognitive technologies deeply incorporated, than without them.

5 Augmentation, Diminishment and the Extended Mind

The question of whether a given cognitive resource should be regarded as part of our minds or as scaffolding may strike some as a theoretical question with few practical implications. One area where it can be shown to have important implications however is around the question of whether the incorporation of Cloud-Tech and E-Memory should count as cognitive enhancement, or cognitive diminishment. For those committed to more traditional accounts of the bounds of cognition, it may appear that any outsourcing of our cognition is a straightforward case of cognitive diminishment. The scaffolding theorist may fill compelled to go along with this position, because in virtue of cognitive scaffolding counting as gaining cognitive credit as an *external* device, that cognitive credit cannot accrue to the agent. The extended mind theorist on the other hand views our usage (of at least some) of our cognitive technology as a form of deep incorporation, and therefore its usage may count as cognitive enhancement.

[26] Deeply penetrable but clearly cognitive penetrability is always a relative factor. The extent to which we can understand the conditions of our knowledge and the take responsibility for our cognitive life will always be partial. Our biological cognitive resources are clearly only partially cognitively penetrable and certain parts of them not penetrable at all. The degree to which an extended cognitive resource is required to be penetrable to convincingly count as part of our minds is, it must be admitted, a problem here.

There appears to be a degree of framework dependence in what might count as cognitive diminishment and what as cognitive enhancement. Consider a putative (imaginary) cognitive enhancement technology that would watch its owner's alcohol consumption—perhaps because he carries alcohol-level sensing chip in his gut—and registers an alert whenever its user is consuming potentially dangerous amounts of liquor, or else when carrying his car keys. Theorists pre-disposed towards using an extended mind framework will tend to see the usage of such cognitive technologies as at least potentially augmentation. This is because they will tend to view the bounds of the cognitive agent as including not just the organismic core but the extended constellation of cognitive technologies. The enhanced cognitive agent is now in much better control of his alcohol consumption. Those favouring a scaffolding view will tend to view any cognitive credit accrued as being accrued as a result of the *external* contribution of cognitive technology. The device user does not need to bother registering what he is drinking safe in the knowledge that his good devices will take care of it for him. Insofar as the device user loses the capacity to even (organically) notice whether his is getting drunk or not, this looks like cognitive diminishment. This may serve as an abstract comparison of the positions but in real-world cases things will seldom be so easy.

Let us take for an example satellite-navigation (Sat Nav) devices that many of us now use in our cars (or increasingly through our mobile devices to find our way in unfamiliar streets). One major difference with using these sorts of systems to the traditional maps is that one does not need to plan one's route before stepping into the car; you just climb in type your address and start driving. In this sense, one doesn't need to use anything like the cognitive resources one would have deployed to read a map, write down your route, and perhaps refer to the map or your notes as you drive along. One might expect then that one's ability to learn and remember the lay-out of the city would be dramatically curtailed by using the Sat Nav. In such cases, wouldn't it make sense to say some cognitive operations have been exteriorised out to the technology and that my memory systems and ability to form useful inferences about how to drive round a city were lost? But, now consider using a Sat Nav to find your way around an unfamiliar city over a period of weeks. It's possible to imagine that using the Sat Nav in this way might prevent one ever coming to learn the pattern of the city. Yet this does not seem to be the case. Instead, using the device over a period of weeks gradually familiarises the driver with the pattern of the roads in the city to the point the driver develops a good practical understanding of its navigation. Eventually it is no longer necessary to use the device, at least to go to more common destinations (in fact this has been exactly my experience of learning to navigate the streets of Lisbon by car). Really, this should be no surprise as our O-Memory systems do not just stop working because we employ E-Memory devices and the sorts of interactions that may take place in true complementarity are likely to be subtle and complex.

Many seem to regard the adoption of cognitive technologies as a zero-sum game. They think that if we start to use a technology to do what our organismic systems previously did, those organismic systems will rapidly atrophy away. It has to be admitted it is of course possible, that as we use E-Memory systems more intensively, we will start to be able to explicitly remember less with organic systems, at least with regards to certain domains of knowledge. But the integration of E and O systems may be more complex than a zero-sum game. The *complementarity principle* (Sutton 2006) holds that we will adopt extended resources insofar as they complement our basic (organic) cognitive architecture. The idea is that ambient resources will be useful insofar as they provide functions which, rather than

replace, *contrast* with the brain's native methods of cognition and representation. If this is right, one would expect us to make use of E-Memory insofar as it makes available resources that are new and different from our native organic (or otherwise already enhanced) memory resources. On this analysis, it is precisely because E-Memory—like other memory resources of the past—is offering something that is different from our native abilities, that there is a strong likelihood it will be incorporated.

If this analysis is along the right lines then rather than simply trading E-Memory for O-Memory, it makes more sense—especially within the broader history of memory technology—to think of an ongoing dovetailing process where technological and organic systems fuse in the overall organisation of the agent in a way that need not imply any necessary diminishment. The integration of complementary resources need not lead to diminishment but this does not imply there is no change. It is rather that we will have to try to assess changes on a case by case basic keeping our eye on the conditions that may allow us to view a given usage of a cognitive technology as a deep incorporation, and thus potentially an augmentation, and those that might signify a straightforward offloading onto our technological environment.

Consider a scenario first sketched by Andy Clark back in 2003 (Clark 2003, 2009) where a then future Internet-based system has become deeply linked to an individual's viewpoint through long usage. In a thought experiment, Clark describes a subscriber to the Mambo Chicken Bot, a web-bot of the then near future which "has been learning about, and contributing to, [his] taste for the weird and exotic for three and a half decades, coming online when [he] was five and first fell in love with astrophysical oddities" (Clark 2003, pp. 128–129). In the thought experiment, the subject has just discovered the Mambo Bot has been disabled for the last 3 months and connects this with his feeling flat and uninspired for a while.

Clark uses the Mambo Bot to argue that the very autonomous and deeply incorporated cognitive technologies of the near future may well contribute not only to our sense of self but what we are as individuals. The factors we have discussed in this paper point towards Clark's examples as being scarcely any longer in the realm of thought experiment and science fiction but already shading into everyday reality. For the purposes of our discussion here, what is interesting is the idea that a cognitive agent could incorporate a technology over a period of years which is slowly personalised and entrenched but makes an ongoing, if imperceptible, contribution to that agent's mental life. E-Memory systems or Cloud-Tech that are easily incorporable and autonomous but not deeply inferentially integrated—at least at within brain timescales—might nevertheless override concerns about inferential encapsulation just in virtue of being factored into the agent's cognitive life over an extended timescale of weeks months and years. It is interesting to consider that the Mambo Bot readily meets Sterelny's personalisation and entrenchment condition by dint of long usage rather than any particularly rapid interaction potential. Being liberal about timescales in this way may help us draw the proper boundaries of an agent.

However, the question of epistemic responsibility is more difficult. The user of Mambo Bot only notices rather indirectly its contribution to his mental life. Is this form of cognitive penetrability enough to allow the agent to take epistemic responsibility in the way I have argued is necessary to count as a part of one's mind? The question is a difficult one, but once again, we should note the potential for cognitive technologies to have important, even profound contributions to our minds, even if they should not count as actual parts of our minds.

Whether, we count such systems as real parts of a person, rather than adjuncts or parts of the environment may then turn on quite fine-grained matters. Whether the autonomy and entanglement of a given cognitive resource should be taken to outweigh its personalisation, entrenchment and openness to the various sorts of cognitive penetration that make epistemic responsibility possible, will be difficult to settle questions. Very entangled and autonomous systems may indeed form a constant backdrop to an agent's cognitive life, be highly factored into that agent's life, and indeed the agent may trust and have great facility in using the resource. Yet, if that agent cannot take epistemic responsibility for the resource it may still be better thought of as a very intimate cognitive niche than a part of the agent itself. Yet clearly, an agent's native, or internal, cognitive resources may still operate in radically different ways as a result of extended functioning within such an intimately developed niche. Thus, the various sorts of cognitive enhancement or diminishment that such embedded cognition implies may be profound, even if the technology is not to count as an actual part of one's mind.

6 Wearable Cloud-Tech: Augmentation and Integration?

There has been much attention given to technologies which might interface directly with our brains in recent times and indeed it was a major focus of the conference for which the original version of this paper was given (Clowes 2012 and this special issue). Perhaps it is natural to think that something which interfaces directly with our brain will have the deepest implications for our minds and for the human cognitive profile. I hope that the discussion here has demonstrated that devices that only interface "indirectly" with the brain through perception and action can also have profound consequences both for what goes on in our brains and our minds—the two are not equivalent—but also the sorts of beings we may come to be.

Consider Google Glass, a new science fiction-like technology that is supposedly soon to be released to the general public, and is already taking the technorati. Priced around US$1,500 in the first instance, by storm Google Glass promises to put lifelogging technologies of the sort that Gordon Bell employs, along with powerful augmented reality technologies, into the hands of the masses. Physically, the device resembles a pair of vision correcting spectacles. But, rather than correcting vision, this device is designed to hook its wearers up to their personal data cloud in a way that allows a new order of interactive possibilities. Google Glass incorporates a video camera, bone conducting speaker system, microphone and tiny screen and of course is enabled for the wireless internet; the device can apparently be controlled by voice, gesture and even blinking. Being cloud-enabled, it can both save any information it collects up to internet data-stores and simultaneously use cloud-based services to produce an ever-present augmented reality projected to one eye via the screen that, while tiny, takes up a sizable portion of the visual field. It uses GPS technologies to pinpoint the geographical location of the user, whom it can track, and offer a range of locale-specific augmented reality services. The device has is a "lifelog" mode which will take a picture every 5 s storing "memory traces" up to a cloud-based personal database. Apparently, Glass has the capability to live-stream video to the cloud, although this has (temporarily it is said) been deactivated by Google.

Google Glass makes very explicit certain trends we have highlighted throughout this article. The implications for the practical cognitive incorporability of such a device are rather mind-boggling. A head-mounted device that takes a photo every 5 s, or even sends a continuous video update to one's personal data cloud, is a lifelogger's dream. As an interface device, they go significantly beyond anything even Gordon Bell has been using. To take up just one cognitive implication, it is clear that such technologies are, at least in one sense, highly complementary (Sutton 2010). An E-Memory technology that allows one to easily "recall" in full HD whatever one was seeing or hearing from any moment of one's past has a radically different integration profile from any extended memory technology the human race has so far had access to. Its cognitive implications are rather uncertain but we can bet it will not be neutral. Some might expect this will lead to rapid atrophy of certain biological capabilities—a straightforward case of cognitive diminishment then. As we have argued over the case of the map user in Section 5, memory and indeed other cognitive facilities are not a zero-sum game in this way.

Google Glass, is no standalone device. Many of its properties will accrue from the way it is likely to be hooked into the full range of cloud-based data application and social media systems now available. It is hence potentially highly autonomous and entangled. Newspaper articles have already started to seriously worry about the implications for privacy and personal surveillance of a device which includes an always-on video camera, and there are clearly new questions posed for society by technologies that make possible such unprecedented levels of personal surveillance. But the cognitive possibilities afforded by being able to immediately retrieve video on command—to mention just one likely application—allow really new possibilities for the integration of E-Memory and the way we may start to integrate its usage with our organic systems. In fact, Glass is a natural candidate to be a "totality capture engine": A system that really allows us to record something like the sum totality of sensory experience. The possibilities this implies for certain types of visual recall, either by enhancement, replacement or diminishment are difficult to judge. Its ability to record video and audio along and tag it with location references that GPS makes possible—if integrated in the right way—allows such devices to offer various sorts of potential cognitive enhancement. Google Glass or related technology has the potential to move cloud-tech to ever deeper forms of cognitive incorporation by being a constant, transparently accessible interaction device married to highly personalised and entrenched data services.

Some cloud-tech systems similarly may become highly personalised and entrenched but also tend towards being highly autonomous and entangled. Autonomous technologies tend to be very double-sided from the point of view of being apt for deep incorporation. This is because autonomous system can be highly complementary offering potentially new cognitive functions. However, insofar as they are cognitively impenetrable: opaque and subject to change in both their contents and modes of operation, it is not wise or apposite to rely on them or count them as parts of our minds. Similar issues accrue from entanglement although they will depend on the precise nature of the entanglement. Resources on which we depend and which we use while reliant on others we trust or who are intimate to us, may still be potential cases of an extended mind. Cases with highly entangled and impersonal media like that discussed in the case of Cloud-Otto and Inga on balance should not. Cognitive technologies which are deeply entangled or autonomous reduce our sense that an agent can be individually responsible for some of its own cognitive successes or failures.

Even when they are deeply relied upon, it might be better to think about them as parts of our environment. These countervailing tendencies will tend to mean that quite a restricted range of Cloud-Tech may really count as part of our cognitive apparatus rather than part of the increasingly smarter environment that we inhabit.

E-Memory systems focused around *autobiographical* E-Memory—such as those employed by Gordon Bell and Deacon Patrick Jones—tend to push us towards cases where we both personalise and entrench technology. Whether we in addition can take some epistemic responsibility for the data and services these technologies make available will very much depend on whether the rights tools are made available and whether we use them in the right sorts of way. The agent's at least partial control of what is stored and what is seen are of great importance here. Cognitive technologies which are radically cognitively impenetrable in the way say of Google Search might be best conceptualised as cognitive scaffolds (in Sterelny's sense). They can and do deserve cognitive credit, but even when deeply personalised and entrenched, they may not be open to the intervention and scrutiny of the agent in the right kinds of ways. At best, such systems may be seen as analogues of perceptual systems, rather than core cognitive systems (it must be admitted here that many theorists to whom the idea of the extended mind is congenial will baulk at this separation between core and peripheral systems. Nevertheless, the distinction seems important here).

Prediction in all circumstances, but especially in a rapidly changing technological world, is dangerous. But it seems many of the current and next generation of cognitive technologies are indeed best conceptualised as systems that should be accorded some significant cognitive credit in our lives and minds, without needing to be treated as parts of us. Systems that tend to be more entangled and autonomous are likely best understood according to a scaffolding account, and indeed the commons approach is a nice way to theorize many of these. This is not I believe a purely theoretical question but will have important implications for how many seek to use these technologies and organise our various cognitive resources.

Yet, nevertheless, many users will favour systems that tend to maximise cognitive penetrability and personal control. They will do this for a variety of reasons, ranging from issues of trust to a variety of other epistemic and practical concerns. It is natural for agents to want to take care of their cognitive resources, especially the sorts of reflective creatures us humans are. This may operate as a block on the otherwise dominant tendencies toward entanglement and autonomy. However, even quite epistemically wary cognizers will use cognitive commons systems when it makes sense to do so and where their experience shows them that those resources are trustworthy in comparison to whatever other resources are available; including the fragile resources of biological memory. Those who build the cognitive tools of the future may even decide that cognitive penetrability is an important design goal for their systems.

Whether we should see such systems as cognitive enhancements is therefore highly nuanced and will require much future empirical research and informed philosophical reflection. Empirical research (Berry et al. 2007; Hodges et al. 2006; Kalnikaite et al. 2010; Kalnikaite and Whittaker 2008; Sparrow et al. 2011) suggests that certain E-Memory technologies can actually be very effective in aiding, and sometimes inhibiting, recall but context remains all important .[27] The precise details of how we

[27] I review some of this research in my article *The Cognitive Integration of E-Memory* (Clowes 2013).

use them and what we intend to get out of them are no less so. Philosophical research will be important not least because the questions about enhancement and diminishment are—as we have seen—theoretically loaded. Even an agent that straightforwardly externalises some cognitive function into a tool is not thereby necessarily cognitive diminished. Many other factors may tell here: Does the externalisation of a cognitive function in fact free resources for something more valuable? Does the use of cognitive scaffolding really offload a cognitive task onto a technological system, or is just that the cognitive burden is now shared differently between tool and agent? But most particular to our discussion here: Is that extra-bodily technology in fact so deeply integrated with the agent that it should in any case count as part of the agent's mind? All of these questions require sensitive analysis of the labile agent/technology boundary. As we have insisted throughout, even when a technology should better be understood as a scaffold or providing part of a cognitive commons it can still have important cognitive implications. This is not even to mention important ethical questions about which cognitive functions and abilities we really do and should care about. In fact, questions of cognitive enhancement and diminishment can never be pursued in an ethically neutral fashion.

It is a vision of extended cognition and cognitive enhancement that has led to the development of Google Glass. As was made clear in a 2009 statement by Google executive Eric Schmidt about where Google technology was then going.

> In the case of individuals, it's the model where the sum of what Google does becomes the third part of your brain—you know, there's a left brain, a right brain and there's a third part where the collaborative intelligence that Google can help bring to you really helps you get through every day. (Rowan 2009)

But whether Schmidt is correct here, that these technologies will act as a sort of extension of our brains (more exactly our minds) or should rather be counted as an intimate form of cognitive scaffolding will in large part depend on certain design decisions that Schmidt and his team are making, and importantly, how we, the users of these technologies will choose to appropriate them.

Whether such collaborative intelligence counts as a cognitive enhancement depends crucially on how we choose to use it. If we are content to rely on extended cognitive technologies of which we have little understanding, or abilities to take responsibility for, this does appear to be a recipe for a form of cognitive diminishment, where much personal epistemic responsibility and the real cognitive action is leached out to the smart systems that surround us. However this is an area where old-fashioned human agency can, and I believe will, still play a role, for we can—if we choose—develop patterns of usage that will be appropriate for the technology we use. Sometimes, it will be appropriate to treat and take advantage of that technology as a well-functioning cognitive commons. Other times proper use may require us to have a deeper grasp of exactly what certain intimate personal technologies can afford us if we are to be augmented rather than diminished by them. This article has attempted to begin an investigation of this new relationship and will have been successful if it has managed to trace just a few of its contours. But it is important to understand we are far from passive in such matters. As we have seen with Gordon Bell and Deacon Jones there are ways of using these technologies which do expand the boundaries of the agent without thereby diminishing him or her.

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