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The psychology of memory, extended cognition, and socially distributed remembering

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Abstract This paper introduces a new, expanded range of relevant cognitive psychological research on collaborative recall and social memory to the philosophical debate on extended and distributed cognition. We start by examining the case for extended cognition based on the complementarity of inner and outer resources, by which neural, bodily, social, and environmental resources with disparate but complementary properties are integrated into hybrid cognitive systems, transforming or augmenting the nature of remembering or decision-making. Adams and Aizawa, noting this distinctive complementarity argument, say that they agree with it completely: but they describe it as "a non-revolutionary approach" which leaves "the cognitive psychology of memory as the study of processes that take place, essentially without exception, within nervous systems." In response, we carve out, on distinct conceptual and empirical grounds, a rich middle ground between internalist forms of cognitivism and radical anti-cognitivism. Drawing both on extended cognition literature and on Sterelny's account of the "scaffolded mind" (this issue), we develop a multidimensional framework for understanding varying relations between agents and external resources, both technological and social. On this basis we argue that, independent of any more "revolutionary" metaphysical claims about the partial constitution of cognitive processes by external resources, a thesis of scaffolded or distributed cognition can substantially influence or transform explanatory practice in cognitive science. Critics also cite various empirical results as evidence against the idea that remembering can extend beyond skull and skin. We respond with a more principled, representative survey of the scientific psychology of memory, focussing in particular on robust recent empirical traditions for the study of collaborative recall and transactive social memory. We describe our own empirical research on socially distributed remembering, aimed at identifying conditions for mnemonic emergence in collaborative groups. Philosophical debates about extended, embedded, and distributed cognition can thus make richer, mutually beneficial contact with independently motivated research programs in the cognitive psychology of memory.

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Introduction

Talking about shared past experiences is a characteristic human activity, of considerable social and psychological significance. In central cases, people together remember experiences they have shared, where neither the original events nor the current activities of remembering are only accidentally shared (Barnier et al. 2008; Barnier and Sutton 2008). Such shared remembering is as ubiquitous a human activity as individual remembering, on which it obviously depends, but which it (perhaps less obviously) often transforms (Campbell 2003, 2006; Wilson 2005). A 12-year-old boy looks up from his homework and asks in a serious tone "Mom, what is my most important memory?" (Engel 1999, p. 24). Here is another mundane example, from an empirical study of our own which we discuss in more detail below: in this instance, an older couple are discussing the events of their honeymoon, some 40 years ago (Harris et al. 2010b, p. 133).

Wife: And we went to two shows, can you remember what they were called?
Husband: We did. One was a musical, or were they both? I don't... no... one...
W: John Hanson was in it.
H: Desert Song.
W: Desert Song, that's it, I couldn't remember what it was called, but yes, I knew John Hanson was in it.
H: Yes.

Although neither individual could immediately recall the name of the show, through interactive cross-cueing the couple jointly access the information (compare Wegner et al. 1985, p. 257; Weldon 2000, pp. 99–105). Certainly the information was in some sense already there, potentially available—the couple did not have to consult external memory aids or mementos—but it was not accessible until they engaged in this process of collaborative facilitation (compare Tulving and Pearlstone 1966). Their contributions complement each other, eliciting a shared product from which other stories can then flow in further elaboration.

This striking but entirely typical exchange exemplifies what we call socially distributed remembering. In addition to the intrinsic interest of this ordinary but under-theorized phenomenon, socially distributed remembering is a fruitful test case for evaluating and augmenting current ideas about extended, embedded, and distributed cognition. In this paper, we follow recent critics in testing such hypotheses against evidence from scientific psychology, and in particular against the cognitive psychology of memory (Rupert 2004, 2009; Adams and Aizawa 2008). But, we will suggest, the areas of the cognitive psychology of memory which have so far been cited in this context are unnecessarily selective. Both critics of and enthusiasts for extended cognition discuss solid yet narrow results about mechanisms governing, for example, how individuals learn lists of words: such results remain at a considerable distance from the kind of socially distributed remembering of emotionally significant shared experiences found in the case above. A few philosophers have touched on more

relevant empirical studies of transactive memory and collaborative recall (Wilson 2005; Tollefsen 2006; Theiner 2008); building on this work, we aim significantly to expand the range of psychological research discussed in the debate on extended cognition. In the second half of the paper, we therefore situate the study of collaborative recall within its field, against other recent and more representative developments in the sciences of memory, and conclude with a brief sketch of some of our own studies and results.

The empirical programs we describe below have their own momentum, independent of any connection with philosophical issues. In particular, we do not argue that the *Desert Song* case, or any of the other examples of collaborative recall which we discuss below, *entails* any particular view on whether cognition and memory are in fact often extended or distributed. Theorists *can* continue to treat each individual's cognitive processes in isolation, as occurring solely within the head and causally triggered or cued by non-cognitive external input. Although we think that it will be uneconomical and unrevealing to stick to such individualist treatments of every putative case of socially distributed cognition, our aims here are more modest than a thoroughgoing defence of this claim. However such cases of interaction in memory are ultimately interpreted, we want primarily to direct philosophers and psychologists alike to attend to them in more detail, to such cases in which "the flow of information and control is deeply, densely, multiply, and reciprocally interwoven" among disparate elements or (in these cases) people (Clark 2008, p. 136). Whether or not such remembering is actually "extended," it depends heavily and perhaps in unexpected ways on the individual's rich, dense interaction or coupling with external (for present purposes, primarily social) resources.

Such phenomena, we suggest, deserve detailed study by way of a variety of methods, whatever their theoretical implications. Relations of relevance and dependence between experimental and conceptual issues in this area are inevitably loose and complicated. Before we return to remembering, therefore, we explain in the first half of the paper how our approach to the cognitive psychology of memory relates to the broader dispute between stronger views of cognition as sometimes extended or distributed across brain, body, and world,[1] and weaker views of cognition as merely embedded in body and world.[2] Firstly, we again articulate and

[1] While the labels 'distributed cognition' (Hutchins 1995, 2010a) and 'extended cognition' are often used interchangeably, we try to use the former for a broader range of approaches which stress the methodological importance of studying rich interactions across heterogeneous resources, more than metaphysical claims about the location and constitution of cognition. Although our goal here is to articulate and defend the more modest claims of the distributed cognition framework, understood in this way, rather than the more ambitious metaphysics of extended cognition, we believe the two approaches are entirely compatible.

[2] The literature on extended cognition in philosophy alone is now extensive and multifaceted, and we don't try to deal with many issues central to the current debate. Further, in discussing critics of extended cognition we focus here primarily on Adams and Aizawa's work. On some points, Robert Rupert's distinct critical analyses (2004, 2009) require different responses: although we believe that the current argument can also begin to ground such responses to Rupert, we keep a full treatment for another occasion. In particular, Rupert offers a more fully developed vision of the form and content of a view of cognition as embedded but *not* extended (2009, chapters 9-11). Although we'll argue, like Rupert, that the positive contributions of novel approaches in philosophy of cognition and in cognitive science itself can be acknowledged without jettisoning either computationalism or the representational theory of mind, we disagree with his view that no 'philosophically significant' departures from orthodoxy are required to develop and apply a rich enough, thoroughly embedded vision in cognitive scientific practice (2009, p.193). But while our current treatment of memory is intended to exemplify this claim, we postpone a direct response to another occasion.

defend one of the two primary routes to extended cognition, the case based on the *complementarity* of disparate inner and outer resources, which contrasts with arguments from the *parity* or functional equivalence of neural and external components. We respond to a claim by Adams and Aizawa that this case from complementarity is "non-revolutionary" and entirely individualist in implication, by developing a multidimensional framework for the study of embedded memory and cognition which we compare with Kim Sterelny's "scaffolded mind" thesis (this issue). Placing different cases within such a multidimensional framework is a more fruitful empirical project than continuing to debate whether cognition or memory is "really" extended or "merely" embedded. Detailed attention to rich interaction in socially distributed remembering, we suggest, motivates new questions and research trajectories in the cognitive psychology of memory. It drives a more representative survey of relevant scientific work than has been featured in recent literature and potentially affords an illuminating understanding of a range of relevant phenomena.

To foreshadow the key moves in what follows, then, our framework has four central characteristics which differentiate it from much of the recent literature. Firstly, we defend a *complementarity*-based approach to extended and distributed cognition. Secondly, we focus attention on *socially* distributed cognition and memory rather than on cognitive artifacts and objects alone. Thirdly, we argue that thorough and detailed study of densely coupled (or scaffolded, or distributed) cognition is of sufficient theoretical interest, quite independent of stronger metaphysical claims about the partial constitution of cognition by external resources. Finally, for the case of memory we seek to introduce a much richer spread of relevant research in cognitive psychology than either critics or proponents of extended cognition have yet discussed.

The case from complementarity

In *Being There,* Andy Clark argued that we often draw in rich interactive ways on the capacities of certain external resources—media, cultural institutions, or social networks—which are

> alien but *complementary* to the brain's style of storage and computation. The brain need not waste its time *replicating* such capacities. Rather, it must learn to interface with the external media in ways that maximally exploit their peculiar virtues.
> (Clark 1997, p. 220, italics in original).

Rather than merely supplementing "real" cognitive processes in the head, such genuinely complementary external elements are according to Clark, in certain circumstances, equal (though different) partners in coordinated, coupled larger cognitive systems. This approach stresses that biological resources and external resources—engrams and exograms, for example—need have little in common in terms of their formats and dynamics. So this *complementarity framework* for extended cognition is quite unlike arguments based on parity between or functional

isomorphism of neural and extra-neural features.[3] The focus is not on whether or how much the internal and external resources have features in common, but on how they operate together in driving more-or-less intelligent thought and action.

Clark acknowledged the priority of this principle of complementarity when responding to Gerard O'Brien (1998) in a *Metascience* symposium. Clark identified "a potential tension between two components of the extended mind story": one stresses the similarity or functional isomorphism between neural and extra-neural resources, while the other turns "on the way external elements may play a role different from, but complementary to, the inner ones" (1998, p. 99). Assessing these two distinct lines of thought, Clark saw complementarity between heterogeneous inner and outer resources as grounding "the more interesting and plausible argument":

> The argument for the extended mind thus turns primarily on the way disparate inner and outer components may co-operate so as to yield integrated larger systems capable of supporting various (often quite advanced) forms of adaptive success. The external factors and operations, in this model, are most unlikely to be computationally identical to the ones supported directly in the wetware... (Clark 1998, p. 99)

Clark has consistently argued that it is this complementarity between external or self-created cognitive technologies and our "basic biological modes of processing" that creates 'extended cognitive systems whose computational and problem-solving profiles are quite different from those of the naked brain' (2001a, p. 134; also 2006a, *passim*; 2006b, pp. 371–372; 2008, p. 99; 2010b, pp. 93–96; Wilson and Clark 2009, pp. 70–73). So this is in no sense a subsidiary theme in his work. Considerations of complementarity also lie at the heart of the way a number of other writers have motivated extended cognition (Haugeland 1998; Rowlands 1999; Sutton 2002, 2006; Wilson 2004; Menary 2006), sometimes under alternative labels like "integrationism" (Menary 2007) and "the amalgamated mind" (Rowlands 2010).

In a previous paper, the current first author argued that complementarity subsumes and takes precedence over parity as a distinct second wave of the extended cognition movement (Sutton 2010).[4] Complementarity best captures the spirit of extended cognition, reuniting philosophical treatments with key ancestors and allies, notably with theorists of distributed cognition in cognitive anthropology and science studies (Hutchins 1995, 2010a; Kirsh 1995, 2006; Latour 1996; Lave 1988; Salomon 1993), and with Merlin Donald's theories of cultural cognition (Donald 1991). Complementarity also returns philosophical treatments of extended

[3] We will be happy if the parity principle (Clark and Chalmers 1998) can subsequently be reconstructed, freed of what Clark identifies as "persistent misreading" (2008, p. 114), in a form that renders it fully compatible with complementarity (Wheeler 2010a, b). But complementarity takes precedence: we note that when parity is under pressure Clark often rightly resorts to considering larger hybrids such as "Otto-and-the-notebook" as "a single, integrated system" (2005a, p. 7), which in our terms is precisely to shift to complementarity.

[4] Although that paper 'Exograms and Interdisciplinarity' was published only in 2010, its core ideas were presented at the Extended Mind conference, University of Hertfordshire 2001: the paper circulated in draft from 2005, and critical responses to that draft are discussed below.

cognition to their roots in connectionism: because distributed connectionist systems employ superpositional storage, informational stability over time is achieved not through the explicit preservation of discrete representations, but in part through context-dependent reconstruction (Sutton 1998, 2009a). The human brain is a leaky associative engine (Clark 1993), shaped in both evolution and development so as actively to integrate and coopt external resources such as media, objects, and other people. So at least one common argument against extended cognition – what Rowlands (2010) calls "the differences argument"—has no force against complementarity. Critics point out that biological memory is active, prone to blending and interference, whereas the information retained in some external resources—like Otto's notebook in Clark and Chalmers' (1998) thought experiment—exhibits no intrinsic dynamics or activity (Butler 1998, pp. 211–212; Adams and Aizawa 2001, pp. 55 and 59; Fodor 2009, p. 15; Bernecker 2010, pp. 178–179). But Clark and other post-connectionist theorists of extended cognition are of course entirely aware of this (Clark 1989, chap.5; 2005a, 2008, pp. 97–99; Rowlands 1999). The case for extended cognition based on complementarity precisely "both predicts and requires" such differences between engrams and exograms (Rowlands 2010, p. 89; Sutton 2010).

When a focus on complementarity is firmly maintained, it is also clear that extended cognition does not imply that certain artifacts think, remember, and feel on their own. In adapting Arjun Appadurai's (1986) studies of the social life of things and the cultural biographies of objects into the concept of "the cognitive life of things" (Sutton 2002, 2008b; Malafouris and Renfrew 2010), Sutton's idea was not, as one critic suggests, that "the black tie I wear at the funeral [is] doing my grieving for me" (Harris 2004, p. 729). Neither, after all, do uncoupled brains typically perform their cognitive functions in disconnected isolation from body and world (on dreaming, however, see Sutton 2009b). The point was rather to highlight the cooperation and coordination, at a range of different timescales, of quite disparate internal and external resources—neural, affective, bodily, social, technological, institutional, and so on—all with their own histories and dynamics. Complementarity thus directs our attention to rich, full, and often idiosyncratic cognitive ecologies (Kirsh 2006; Hutchins 2010a, b; Tribble and Keene 2010) in which "the computational power and expertise is spread across a *heterogeneous* assembly of brains, bodies, artifacts, and other external structures" (Clark 1997, p. 77, our emphasis).[5]

So, to repeat, the cooperation of disparate but complementary inner and outer resources provides what Clark saw as the primary, more interesting, and more

[5] Sutton (2010) also argues that complementarity considerations clearly allow—again, contrary to the vision of extended cognition assumed by some critics, such as Grush (2003)—that both the brain and the persisting organism play special roles in extended cognitive systems. This means both that cognitive neuroscience retains its central status in the sciences of the mind, and that the study of differences in the stable characteristics of persisting individuals remains crucial as we seek to understand distinctive patterns of and potentials for coupling, decoupling, and recoupling. As we argue below, these are not concessions signaling a conservative strand of the extended cognition movement, but more precise pinpointing of the framework's real force. That paper also argues, against critics like Butler (1998, p. 222) and Adams and Aizawa (2001, p. 58), that interdisciplinary study of the unique properties of historically and culturally diverse artifacts is not just compatible with but required by extended cognition, properly understood.

plausible argument for extended cognition. But, surprisingly, in much of the philosophical debate over the last 10 years extended cognition has been characterized—by some enthusiasts as well as by critics—in ways quite foreign to this case from complementarity, grounding the thesis instead in considerations of parity or functional isomorphism, or focusing on the link between extended cognition and functionalism at large (Sprevak 2009; Drayson 2010; Wheeler 2010a, b; Walter 2010). Yet, as we have noted, some common objections to parity- or functionalism-based extended cognition do not apply to complementarity-based extended cognition: in turn, the latter view may face different challenges of its own. Complementarity therefore deserves fuller and independent exploration if we want to evaluate the overall case for extended cognition. One tack for such constructive exploration involves detailed application of complementarity considerations to the key domain of memory, and this is the driving aim of the research program we describe in the second half of this paper. Firstly, we need to examine responses to complementarity.

Adams and Aizawa on complementarity and revolution

Critics of extended cognition have considered complementarity briefly: here, we devote some attention to Adams and Aizawa's discussion.[6] After quoting Clark (1998) and Sutton's (2010) exposition of the complementarity principle, Adams and Aizawa write "We agree with this completely." We are delighted that they accept the basic claims of the complementarity argument. But this is no conversion: there's a catch. Adams and Aizawa continue "Only, we do not think this in any way supports the hypothesis that cognitive processes extend from the brain into the body and environment" (2008, p. 145).[7] The complementarity principle makes it very plausible, Adams and Aizawa acknowledge, that there are extended cognitive *systems*, but not that cognitive *processing* extends (pp. 145—146).[8] In particular, they argue, complementarity would leave intact the study of the *components* of extended cognitive systems, including pre-eminently the brain. Even within a new enterprise based on complementarity, "the study of these intracranial processes ("the kinds of processes that take place in the brain") will remain a scientifically valid and important subject": such an enterprise would not "have the revolutionary consequences of denying intracranial cognition" (2008, p. 146).

We are bewildered at the dialectic on which Adams and Aizawa rely. We are entirely happy to treat study of 'the kinds of processes that take place in the brain' as scientifically valid, and to accept intracranial cognition: we have never argued otherwise, and nor to our knowledge has Clark (nor Rowlands, nor Wilson). Cognition is not *necessarily* or *always* extended (Wilson and Clark 2009, p. 74;

[6] Rupert's treatment of complementarity considerations (2009, pp. 112 and 118–130) focuses instead on the case of language as a putative cognitive artifact.

[7] Compare Adams and Aizawa (2010): 'the discovery of complementarity is a peculiar basis upon which to argue for extended cognition'.

[8] We do not have space to discuss the distinction Adams and Aizawa draw here, or the fact that they *accept* extended cognitive systems (2008, pp. 106–132).

Sutton 2010, p. 191; Rowlands 2010). And even when it *is* extended, the brain remains a unique part of the extended system, performing operations which are distinct from (though complementary to) those of the external resources (Clark 2010a; Sutton 2010). Adams and Aizawa misunderstand the nature of the extended cognition thesis: the revolutionary flag which they belittle is not one we have ever saluted.[9] In defending a complementarity-based case for extended cognition, neither we nor Clark ally ourselves with radical anti-cognitivism, whether of dynamicist, enactivist, phenomenological, or Wittgensteinian stripe. This is why our version of the thesis has real bite. We may adopt some of the constructive (rather than the critical) aspects of these movements, but ultimately we are playing the same game as Adams and Aizawa: we too maintain a version of the representational-computational theory of mind, even if ours is a somewhat revised and amended version (Clark 2001b).[10] This is why complementarity-based theorists of distributed and extended cognition are in turn sometimes criticised by more extreme anti-cognitivists for "not proposing that the very idea of cognition is itself a mistake," and because we do "not renounce cognitive science" (Button 2008, pp. 88–89; compare Malafouris 2004, Dreyfus 2007). While we respond vigorously to such critiques, and seek more precisely to differentiate our views from these truly radical alternatives,[11] these critics do in these respects characterize our position more accurately than Adams and Aizawa, who wrongly think that the hypothesis of extended cognition *requires* wholesale rejection of intracranial cognitive processes and their neural and psychological study.[12]

So Adams and Aizawa first treat extended cognition as a "revolutionary" thesis which denies intracranial cognition, and then suggest that complementarity fails to deliver on the revolutionary promise. They are thus seeking to trap the extended cognition theorist in a dilemma: either maintain the extreme "revolutionary"

[9] We do not believe that arguments from parity are intended to deny the possibility of intracranial cognition either, but for current purposes again we focus only on arguments from complementarity.

[10] In the case of our own specific research program, furthermore, our interdisciplinary research is (as we show below) explicitly set *within* the cognitive psychology of memory, seeking to employ and expand its best theories and methods.

[11] For attempts to distinguish representationalist versions of extended mind theses from more extreme anti-cognitivist versions, see Sutton 2008b; Wheeler 2010c. There remain of course substantial residual questions about what representations might be within a distributed cognition framework (Chemero 2009; Steiner 2010). Anti-representationalism is not, however, the only direction by which extended cognition might be further radicalized. On the one hand, we will seek analyses which directly relate neural and worldly processes, or the subpersonal and the social, refiguring our understanding of brain dynamics too as arising from interanimating mechanisms of coordination which pay no heed to the location of the resources recruited (Clark 2008; Rowlands 2010). On the other hand, we will seek to tie the approach to social memory developed here back, in richer experimental ethnographies, to the study of artifacts and places, and of the routines and skilful practices by which individuals and groups actively integrate such disparate resources (see Sutton 2008a, b, 2010, p. 213 for initial remarks on a distinct "third wave" in extended cognition).

[12] Likewise, we are surprised at Adams and Aizawa's (in press) claim that Clark shies away from or rejects cognitivism, where this is understood as the view that cognition "involves certain sorts of manipulations of non-derived representations." Clark not only accepts cognitivism as a general thesis, but specifically is willing to grant Adams and Aizawa that cognition involves manipulations of non-derived representations, while arguing that it *also* often involves manipulations of derived representations as well (Clark 2010b, c, d).

position, or collapse back into individualism. But we reject the alleged dilemma. Along with Clark and the others, we inhabit a rich middle ground, one which this paper continues to develop, which is entirely distinct both from *internalist* forms of cognitivism and from externalist *anti*-cognitivism. Yet when Adams and Aizawa do accurately acknowledge that our views are not anti-cognitivist, they try to assimilate us to a more conservative internalism. They lump Sutton's treatment of memory together with the work of Lakoff and Gallagher on embodied cognition as examples "of a non-revolutionary approach" (2008, p. 179). Their aim is to deny the existence of that middle ground, and to assimilate any view which is not radically anti-cognitivist to a much more orthodox individualism. Sutton's project, they say, 'can be undertaken while leaving much of the cognitive psychology of memory as the study of processes that take place, essentially without exception, within nervous systems' (2008, p. 179). We disagree: this reversion to internalism is not an implication of Sutton's view. As the cognitive psychological research on memory which we describe below demonstrates, the scientific study of memory is not and should not be restricted to the examination of processes occurring within the brain.

These claims of Adams and Aizawa's are not easy to parse, but their aim is perhaps further elucidated by the passage which immediately follows, the closing peroration of their book:

> One does not have to insist that the hypothesis of intracranial processes of memory processing is a mere relic of an unexamined Cartesian prejudice. Instead one can maintain, as we do, that there is a scientifically and philosophically motivated reason to believe that there are psychological processes that are found in brains that are unlike processes that span brains, bodies, and environments. (2008, p.179)

This rhetoric is particularly puzzling from the point of view of a complementarity theorist, whose projects precisely rest on analyzing such differences between coordinated internal and external processes. In characterizing Sutton's work as "non-revolutionary", then, Adams and Aizawa must be construing a truly "revolutionary" form of extended cognition as the view that external resources *always* constitute psychological processes, and that thus memory processing, for example, is *never* intracranial: but this dramatically extremised view is not one that complementarity theorists, at least, have ever defended.[13]

[13] Likewise, in other remarks on complementarity, Adams and Aizawa note that once we acknowledge that the interacting components of extended cognitive systems operate on distinct principles, we will then "naturally want to know what the brain contributes and what principles it is governed by." Again, we agree. They then suggest that "the complementarity arguments for extended cognition lead back to the view that one should take very seriously the standard view that there are intracranial cognitive processes" (2008, p. 176). We find this particularly unclear. We all agree that complementarity is *compatible* with the existence of intracranial cognition, so this cannot be Adams and Aizawa's point. They intend, we think, a stronger and more individualistic form of the "standard view": not just 'that there are intracranial cognitive processes' but that there are *only ever* intracranial cognitive processes. This is suggested by their comment that complementarity considerations open the door to "the hypothesis that there exist distinct kinds of processes plausibly described as cognitive that take place only within the brain" (2008, pp. 175–176). This is Adams and Aizawa's dilemma in operation again: either complementarity is an implausibly radical form of anti-cognitivism, or else it reverts to an individualist kind of "standard view". We respond to the second horn of this dilemma in the next section below, arguing again that these are not the only available options.

Our constructive agenda, then, is to make space for and delineate the cognitive externalist middle ground that stretches between such extreme anti-cognitivism and an entirely conservative, "non-revolutionary" defence of individualist orthodoxy. As noted, we see the study of extended cognitive systems as complementing rather than replacing cognitive psychology, as Adams and Aizawa recommend (2008, p.146). Indeed, in our view the study of extended cognitive systems naturally emerges from and *relies* on basic research in cognitive psychology and related areas of the cognitive sciences (compare Wilson 1994, 2004; Clark 1997, 2008; Rowlands 1999, 2010; Sutton 2004; Wheeler 2005; Menary 2007). Yet considerations of complementarity can and should nonetheless substantially influence, and in certain cases significantly transform, the theory and practice of cognitive psychology. In particular, we offer independent reasons, arising *within* cognitive psychology as well as from alien philosophical considerations, to treat the study of intracranial processes as only *part* (though a fully legitimate part) of a mature cognitive science of memory.

These issues then are matters of degree, as they should be. How large a part of psychology is the study of neural processes, and how large is the part which also studies extended and hybrid cognitive systems? How frequent are the exceptions to intracranial-only cognition which Adams and Aizawa countenance (2008, p. 179, quoted above)? These are good questions to ask, ones encouraged by the multidimensional framework we will shortly describe. There is no consensus on what counts as a "revolutionary approach" in cognitive science, or in science at large. Any assessment of revolution gets a grip only relative to some particular *status quo,* or to the location or direction of gaze of the assessor: often, the association of revolutionary rhetoric with any view in the philosophy of cognition has more to do with the general intellectual and literary style of the theorists in question than with any essential features of that view. Revolutions do not usually occur in one fell swoop, through a single telling argument or one crucial experiment: any dramatic change is likely to be the gradual outcome of disparate but cumulative and incremental movements, which in our fields tend to be some mix of empirical and conceptual results.[14]

Indeed, critics are occasionally more likely to characterize a target position in extremist fashion as more revolutionary than its proponents might see it. Like Adams and Aizawa, Robert Rupert argues that "we are not undergoing the revolution promised by situated theorists and their philosophical interpreters": he hopes instead that more conservative accounts of cognition as embedded and embodied (and not extended) will lead to "more of a nudging than a coup" (2009, p. 242).[15] So the language of coups and revolutions does not derive from proponents of

[14] Margaret Boden's extraordinary history of the cognitive sciences (2006) shows how often grand and revolutionary rhetoric in fact coexists with, and occasionally helps to drive, what later looks clearly to have been specialist and incremental change.

[15] Compare Margaret Wilson's deflationary treatment of distributed cognition (2002, p.631). She too sets up and criticizes an extreme "strong view of distributed cognition" as the idea "that a cognitive system *cannot in principle* be taken to comprise only an individual mind" (our emphasis), and goes on to recommend an opposing conservative position, that the study of the situation instead be considered as merely "a promising supplementary avenue of investigation," when "the idea of distributed cognition loses much of its radical cache."

complementarity-based extended cognition: indeed, we follow Clark in suggesting that the research cited in this movement "signals not a radical shift as much as a natural progression in the maturing of the sciences of the mind" (2008, p. 219).

But in thus refusing to embrace the revolutionary spirit, have we thereby given up on the search for an alternative to classical internalism? We have so far conclusively rejected one horn of Adams and Aizawa's dilemma: complementarity theorists do not take the extreme anti-cognitivist option, and do not deny intracranial cognition. But we now need to address the other horn of the dilemma: is complementarity *so* "non-revolutionary" as to be fundamentally indistinguishable from orthodox individualism? The brunt of our response to this challenge is borne by our constructive multidimensional framework and by our consideration of cognitive psychological work on interactive socially distributed remembering. In final preparation for this treatment, we briefly discuss its implications for the more general debate.

Cognition: extended, embedded, or distributed-scaffolded?

The complementarity-based account of socially distributed remembering which we develop could be interpreted in a number of different ways, as follows:

> Option #1 (roughly, *extended cognition*):complementarity is the basis for a revised and restated version of the extended cognition thesis in which cognitive processes can sometimes be partly *constituted* by external processes; or,
> Option #2 (roughly, *merely embedded cognition*): complementarity is or suggests an incompatible *alternative* to extended cognition, by which cognition *causally interacts* with external resources but remains *always* entirely intracranial, and by which cognitive psychology should primarily study *only* processes occurring within nervous systems; or,
> Option #3 (roughly, *distributed,* or *scaffolded cognition*)[16]: complementarity drives the claim that cognitive processes involve substantial and perhaps surprising *interactive coupling* between disparate internal and external resources, such that cognitive psychology should (among other things) study these distributed processes.

Much of the philosophical literature about extended cognition has dealt exclusively with options #1 and #2, either defending one or the other view or offering more or less sceptical assessments of the promise of a conclusive decision between them. We suspect, with Clark (2010c) that "this debate, though scientifically important, and able to be scientifically informed, looks increasingly unlikely to admit of straightforward scientific resolution." In contrast, in this paper we address the difference between options #2 and #3, arguing in favour of option #3. Option #3 is compatible with (but does not entail) option #1, which some of us also

[16] We offer these labels for the three options for ease of reference, but we do not place too much weight on the specific labels: in particular, as we note below, the label "embedded cognition" as used elsewhere in the literature often fails to distinguish between options #2 and #3. We use the label "scaffolded cognition" roughly as suggested by Sterelny (this issue), on which more below.

accept, but which we do not defend here. Our contribution to the debate is to develop option #3 as a distinct and legitimate alternative, one which neither *requires* a full extended cognition thesis (option #1) *nor* collapses into the entirely deflationary and conservative option #2.

Uses of the label "embedded cognition" in the literature do not adequately distinguish between the options, and we suggest the label "merely embedded cognition" for the more conservative option #2. Adams and Aizawa, for example, in seeking to assimilate complementarity theorists like Sutton to a "much more conservative segment of the embodied and embedded cognitive science literature," acknowledge in principle the need to "take positive steps forward in cognitive science by spelling out the kinds and scope of causal dependencies between cognition, body, and environment" (2008, p. 177). This is meant to constitute "an advance" on the entirely "orthodox view" that "cognitive processes are causally dependent on bodily and environmental processes." But nothing in Adams and Aizawa's work puts this search for richer positive steps into practice.[17] We show this in detail for the case of memory below, but we first note another typical passage in which Adams and Aizawa claim to be doing justice to the notion of densely coupled dynamical interactions between brain, body, and world, but actually fail to capture anything like the richness of profoundly embedded interactive systems of intricately coordinated but radically heterogeneous resources. Adams and Aizawa accept that very often "a behavior cannot be understood in isolation from the environment, that one cannot possibly understand why a given cognitive process is taking its course without attention to the external environment." But they are thinking here of bare stimuli, isolated inputs and outputs: their idea is merely that a scientist needs to know what someone is doing at a time in order to understand their cognitive processes and intelligent behaviour. They ask, for example, "How could ethologists know about fixed action patterns, fixed behavioral sequences that run to a standard completion in response to a sign stimulus, without attending to an organism's stimuli?" (2008, p. 111). Although Adams and Aizawa couch this as a concession, the thin acceptance "that cognitive psychologists typically do relate behavior and cognitive processing to environmental and bodily processes in order to understand them" (p. 111) does not do enough. If this was all it takes to treat cognition as "embedded", it would fully justify Rowlands' complaint that "the thesis of the embedded mind has tended to be used as a sort of neo-Cartesian fallback position" (2010, p. 70): we argue this further below in revealing the extend of the gulf between Adams and Aizawa's residually individualistic picture of the sciences of memory and the richly embedded multidimensional vision of social remembering available elsewhere in cognitive psychology. It is against this genuinely conservative individualist orthodoxy (option #2 above) that we underline a richer, more detailed form of scaffolded or distributed cognition (option #3).

[17] The context of this passage is revealing. Adams and Aizawa ask extended cognition theorists: "Why make a radical break from orthodoxy? Why seek a revolutionary scientific approach, one that overthrows the orthodox view of what cognition is and where it is to be found? Why not aim for a scientific and philosophical contribution that is empirically plausible and interesting?" (2008, p. 177). Such a contribution is precisely what we seek in the case of memory: but it requires much more detailed and systematic investigations of richer and more enduring causal interactions or couplings between brain, body, and world than are countenanced by Adams and Aizawa.

A number of philosophers have recently offered a deflationary diagnosis of the debate between extended and embedded cognition. Mark Sprevak, for example, writes that

> A working cognitive scientist could switch between the two frameworks [extended cognition and embedded cognition] with little or no modification of her empirical work. The turn from individualism to embedded cognition is radical, but once that turn has been made, there is little to choose, in terms of explanatory value to cognitive science, between the two frameworks. (Sprevak 2009, p. 524).

But this is correct *only* if the notion of 'embedded cognition' means substantially more in practice than the bare acceptance that many cognitive processes are responses to external stimuli. *Only* once cognitive scientific research was really animated by attention to the complementary interactions of disparate inner and outer components, and the richly looping coordination of heterogeneous neural, bodily, social, and cultural resources, would the label "embedded cognition" really earn its keep, as Sprevak suggests, as the result of a "turn [away] from individualism".[18]

Sprevak also offers a concrete assessment of the current state of explanatory and scientific practice. He suggests that in fact "externalism has already won. Transcranial kinds are already doing useful work in psychology... And today no one seriously believes that cognition can wholly be explained in the internalist way" (Sprevak 2010). We disagree—although (as we will show for the case of memory) there are indeed strands of cognitive psychology which do deal in transcranial kinds and processes, the issues are far from settled: the battles that do matter, those between option #2 and option #3, are very much still raging. Internalist individualism, in particular, remains in both philosophy and psychology, driving the selection of research topics as well as method and theory. The most effective way to combat it, we suggest, is not to insist flatly on the metaphysical superiority of a hypothesis of extended cognition: as recent commentators speculate, there may well be a deflationary, non-extended interpretation available for any individual case or experimental outcome (Clark 2007, 2008; Barker 2010; Weiskopf 2010; Klein 2010; Sprevak 2010). We agree with Klein in particular that any progress here requires models which "lie in the mid-range: general enough to give a theoretically unified account of a wide variety of our interactions with the environment... but specific enough to make useful predictions in individual cases" (Klein 2010). So this is the kind of territory we map out in the case of memory, following Clark's suggestions (2002a, 2010a) that there are already many relevant hybrid sciences of heterogeneous systems. We will give a number of examples in which ideas about the complementarity and coordination of resources drive new questions and suggest new

[18] In other words, we interpret Sprevak here as confirming that there are deep and important differences, with consequences for cognitive scientific practice, between option #2 (the *merely* embedded individualist internalism of Adams and Aizawa) and option #3, but fewer practical and explanatory differences between option #1 and option #3. Once the focus really is on profoundly interactive systems of intricately coordinated but radically heterogeneous resources, then perhaps the metaphysical difference between *genuinely* embedded cognition (our "scaffolded cognition", option #3 above) and extended cognition (option #1) will have "vanishingly little traction on the day-to-day work of cognitive science" (Sprevak 2009, p. 527; compare Barker 2010).

research trajectories in cognitive psychology.[19] It's in the context of such specific subdisciplinary projects and paradigms, with their own independent interest, that any quieter but more enduring revolution—a coup-by-nudges—might be born.

Multidimensional frameworks for scaffolded and socially distributed cognition

With the complementarity argument in mind, questions about extended or distributed cognition can be set within a broader multidimensional cognitive scientific framework. The primary task is to identify and study key dimensions on which relations between internal and external resources vary. Many extended cognition theorists have suggested criteria to distinguish cases in which external resources are indeed contributing parts of distributed cognitive processing from those in which they are more like mere external triggers or cues. Of course these conditions are not always satisfied, and not always to the same extent. So the complementarity theorist, with an eye to turning philosophers' distinctions into empirically accessible dimensions, interprets and evaluates these suggestions as candidate dimensions for the study of the biotechnological and biosocial mind.

Clark and Chalmers' original criteria of trust and glue (1998), for example, are matters of degree. How much of a constant in Otto's life is his notebook? Is it difficult to access and employ, or has it become largely transparent in use? How much consideration or evaluation of the information in the notebook does Otto undertake before it informs his action? Wilson and Clark (2009) offer related but simpler dimensions for analysis of extended computational systems. They focus first on the nature of the non-neural resources in play, which can take many different forms—natural, technological, and socio-cultural (compare Sutton 2006 for a slightly more fine-grained taxonomy): not all relevant external resources are like Otto's notebook (Sutton 2010). Like Clark and Chalmers, Wilson and Clark stress the reliability of the external resources: but they add the important dimension of durability. Some resources may be highly reliable, and when used involve high levels of interactive engagement and feedback, but nonetheless feature only in transient larger problem-solving ensembles, "geared toward a specific purpose (e.g., doing the accounts, writing a play, locating a star in the night sky)... At other times, they involve more stable and permanent relationships between biological agents and extended cognitive resources" (Wilson and Clark 2009, p. 64). If durability is a central component of our best notion of an integrated cognitive system (Wilson 2002, pp. 630–631; Rupert 2009), we will then focus more on such cases of stable coupling.[20]

Putting these potential dimensions of variation together, we envisage a multidimensional framework which allows for a range of different relationships

[19] Our strategy for the case of memory is thus precisely parallel to that of Griffiths and Scarantino in developing what they call a "situationist perspective" on emotion, which "does not require denying the results produced by other theoretical traditions in psychology… [but] shifts our theoretical focus to neglected phenomena and questions" (2009, p. 438).

[20] Some theorists seek to integrate these dimensions within a broader notion of emergence: Poirier and Chicoisne (2006) and Theiner (2010, cf. Theiner and O'Connor 2010) apply Wimsatt's (1986) formal notion of emergence as failure of aggregativity.

between agents and artifacts, and between engrams and exograms. Particular cases will fall (and particular types of case will tend to fall) in specific regions of the resulting multidimensional space. In one corner of this space are cases which score low on all the relevant dimensions: these will occur, for instance, when an isolated agent (perhaps with some difficulty) exploits on a one-off basis a single static external resource which she does not especially trust, with no ongoing interactivity between agent and resource, and when any information transmitted between them is not transformed but perhaps simply adds to her existing knowledge base. In such a case, the internal cognitive economy in this episode of processing is relatively shielded from interactive reliance on or coupling with the external resources. Even though the agent relies of course on a complex history of interaction with other resources, from an occurrent or synchronic point of view at least there is minimal distribution or extension. This is not the naked brain operating entirely on its own, insulating cognition from all occurrent external influence, as may be the case for the armchair thinker, or in (most forms of) dreaming (Sutton 2009b), but its interaction with worldly resources is still decidedly monocausal. Cases like this are real and thus important for the sciences of mind: they occur perhaps most obviously when we interact with an entirely unfamiliar environment or object, or when we sit alone in a psychology laboratory learning lists of random words, or answering questions on a computer screen at an experimenter's request. We do want an overarching framework to deal with such cases and to understand their differences from the familiar mediated socio-technological cognitive ecologies in which we typically dwell. But the broader, more innovative job is to map the entire space, including also cases which score much higher on the various dimensions, in which novel cognitive activity emerges from ongoing fluent interaction between reliable components of a stable, enduring, hybrid system.[21]

Wilson and Clark relate their dimensional analysis back to the special case of the "extended mind" thesis put forward by Clark and Chalmers: "the notion of an extended mind is nothing more than the notion of a cognitive extension... that scores rather more highly on the (dimensions) of durability and reliability" (Wilson and Clark 2009, p. 66).

> There is already much research that fruitfully explores extended cognitive systems... the question, in each case, is where it is that we find functionally integrated systems that allow their bearers to perform cognitive tasks. We think that some of these are found solely in the head, and that some of them cross the cranial boundary and incorporate cognitive resources in an individual's environment. That is nature's way. (Wilson and Clark 2009, p. 74).

Noting that Wilson and Clark treat this approach as a robust *defence* of a complementarity-based extended cognition thesis, we can now fruitfully compare Kim Sterelny's (2010) biologically inspired account of the "scaffolded mind".

[21] External and conventional cognitive resources with complex cultural histories—from simple mnemonics and specific forms of imagery to the heavily crafted medieval arts of memory or specialist forms of scientific thinking—are often subsequently internalized so successfully that they need not still exist in the agent's current physical environment to have their transformative effect. If location really is not the important issue, then resources can be extended in the relevant explanatory sense even when they are not literally external (Clark 2005b; Sutton 2010, pp. 207–213).

Although Sterelny too proposes a valuable and specific set of dimensions for the study of relations between agents and external resources (whether social, technological, or environmental), he pitches his account as if in some tension with the extended cognition thesis, which he construes as arising solely from the parity principle. In our view, however, Sterelny's perspective clearly offers the same kind of multidimensional framework as the complementarity argument we are defending here.

Developing ideas from niche construction theory in philosophy of biology, and focussing in particular on social learning, Sterelny identifies three key dimensions of variation in the relationship between agents and resources. We have already discussed one, the dimension of trust and reliability. A second significant dimension involves the extent to which external resources have been sculpted specifically for and by particular users, often through a process of interactive mutual modification over time: Sterelny gives the examples of a chef's set of knives and a cricket batter's individualised bat, where in both cases the external resource is "entrenched" in the agent's repertoire of action possibilities, rather than a standardised and wholly interchangeable artefact. He also discusses in this context the cognitive roles of other familiar agents, on which more below.[22] Sterelny suggests that "the extended mind framework seems most natural with highly individualised and entrenched cognitive resources" (Sterelny 2010), but points out correctly that the sciences of mind also need to study more transportable or interchangeable resources, and the stable capacities which mobile agents bring to each interaction.[23] Finally, Sterelny notes that some external resources are props produced and used solely by individuals, whereas others are involved in the highly collective activities of integrated social

[22] We are not quite sure how to interpret Sterelny's discussion of this point (Sterelny 2010). He criticises extended mind theorists for rarely treating other agents as part of an extended mind. As Sterelny notes, other agents can be "reliably and easily available, routinely used, substituting for imperfect memory and trusted by default": he gives the example of mothers' cognitive roles for their young children. But he goes on to suggest that in fact other agents "resist individualisation". It is true that parents do have other functions, and in general people do not possess each other entirely in the way that chefs or batters might guard their treasured artifacts. Yet in some contexts, social niches are at least as stable as relations between individuals and specific objects. Remembering that these are all matters of degree, we might query Sterelny's assertion that "I cannot adapt [other agents'] minds to my purposes, not in a permanent, sustained and reliable way": though incomplete and fallible, this mutual adaptation is precisely what occurs in some significant degree both in long-term relationships of various kinds and in parent–child interaction. Five-year olds *do*, to some extent, *contra* Sterelny, individualise their mother, even if in a more mutual and bidirectional fashion than the way Otto may have designed his notebook. Our studies of transactive memory in older couples (see below) pursue related themes in empirical contexts.

[23] We are tempted to subsume this 'interchangeable-or-individualised' dimension under the dimension of ease or difficulty of use. The questions of whether or not a *specific* artifact can be successfully transferred to another agent, and whether or not one user can adapt to numerically different but similar artifacts, are often less pressing than the slightly different question of how hard it is for an agent to use an artifact no matter what its provenance. In other words, we see this as an issue about the meeting of the more or less skilful agent with equipment which, relative to that agent, is more or less transparent in use. This focus on skill and expertise is entirely compatible with Sterelny's broader perspective, and highlights vital but undernoticed questions in the scaffolded and extended mind literature about the proceduralization of our interaction with external resources: artifacts which require ungainly struggles to deploy will not qualify, and the process by which they gradually become "transparent equipment with which you confront the wider world" (Clark 2008, p. 72) requires more attention. For a brilliant integration of extended mind themes with the phenomenology of absorbed coping see Wheeler 2005; see also Sutton 2007 on embodied skill.

groups: such collective resources, as he points out, develop through distinctive cultural and intergenerational pathways, and we generally become skilled experts in their use by way of sustained apprenticeship. Building on his previous discussions of cross-generation effects in cognitive niche construction (Sterelny 2009), Sterelny plausibly identifies these "cumulatively built, collectively provided tools for thinking" as "the most critical, mind-and-brain-shaping environmental supports for cognition" (this issue, p. xx).[24]

But on this last dimension—the individual and the collective—Sterelny thinks that extended cognition theorists only embrace "single-user resources", at the individual end of this spectrum, and that case studies of genuinely collective activity are "hard to shoehorn... into the extended mind model" (pp.16 and 14): we disagree, and discuss this important issue below. In other respects, Sterelny's assessment of the relation between scaffolded and extended minds matches ours, despite the difference in surrounding spin. In contrast to other critics of extended cognition who see cognition as *never* extended but *always* at most merely embedded in (causally triggered by) the social and natural environment, Sterelny argues that "the Extended Mind picture is not false": its "most compelling and plausible cases... are limiting special cases of scaffolded minds" (Sterelny 2010). We agree with this entirely, and with Sterelny's further point that the driving scientific focus should be on the identification and exploration of this multidimensional space of agent–environment interactions which amplify or transform cognitive capacities and practices, rather than any metaphysical claim about whether mind in general does or does not extend into the world.[25]

So as we see it, Sterelny is embracing and further developing the complementarity argument by refining the relevant dimensions of inquiry, and asking new questions about the multidimensional framework concerning, for example, "the dynamics of movement in the space" and the means by which "resources become individualised and entrenched" (Sterelny 2010). But before applying this picture to the case of memory, we need to revisit the apparent difference of opinion concerning socially integrated and collective forms of cognitive scaffolding. Sterelny had previously

[24] These diachronic aspects of some collective cognitive activity—concerning its origin and adaptation, and the transmission of the relevant skills over time—have also been underdiscussed in the philosophical literature, which has tended to focus on active occurrent external interactions. Biological, anthropological, and linguistic studies of scaffolded and distributed cognition again have much to offer here (Kirsh 2010).

[25] Nonetheless, like Wilson and Clark, who also set fully extended cognition within a broader framework as those cases in which external resources are highly reliable and highly durable, we suggest that these regions of Sterelny's space are of considerable interest both in their own right and in pointing up their differences from less extended cases. We do not particularly care about either 'reserving a special label ["extended"] for this region of space' or marking any non-arbitrary line between it and other forms of scaffolded mind (Sterelny 2010): if this is to give up on revolution, so be it, but we can still get on with the interesting work of characterizing the phenomena of this region among others. For those who engage genuinely over time in that difficult work, however, we suspect that use of that extra label of "extended cognition" for such stronger cases of enduringly interactive coupling will come to seem less of an outrageous denial of all that's good and true in current science, and more of a catchy reminder that "where ongoing human cognitive activity is concerned, there are usually many boundaries in play, many different kinds of capacity and resource in action, and a complex and somewhat anarchic flux of recruitment, retrieval, and processing defined across these shifting, heterogeneous, multifaceted wholes" (Clark 2008, p. 138).

complained, in relation to some of Andy Clark's ideas about extended cognition, that "cognition, for [Clark], remains paradigmatically a solitary vice, though one prosthetically enhanced by wideware" (Sterelny 2004, p. 246). Much of Clark's attention has indeed been devoted to various ways that human cognition is uniquely augmented by new technologies and artifacts, so we understand why Sterelny reads some of the philosophical literature on extended cognition in this way. But any relative neglect to date of socially distributed cognition is a contingent outcome of Clark's own research interests, rather than an intrinsic feature of the extended cognition framework (Sutton 2010; Tribble and Keene 2010).[26] Closely related research in anthropology and the social sciences naturally continues to focus on socially distributed cognition, even when (as often) the reliable and enduring social system is also enmeshed and mutually coordinated with vast and uneven technical assemblages (Hutchins 1995, 2010a, b; Enfield and Levinson 2006; Kirsh 2009; Preston 2010). Our claim that collective and collaborative cognitive activity is in no sense intrinsically foreign to the extended cognition framework is reinforced when we recall a key passage from Clark and Chalmers (1998, p. 17):

> What about socially extended cognition? Could my mental states be partly constituted by the states of other thinkers? We see no reason why not, in principle. In an unusually interdependent couple, it is entirely possible that one partner's beliefs will play the same sort of role for the other as the notebook plays for Otto. What is central is a high degree of trust, reliance, and accessibility.

Putting some empirical flesh on such speculation, in the remainder of this paper we consider cases and implications of socially distributed cognition (see also Wilson 2005; Tollefsen 2006). We focus on relations between extended cognition and the cognitive psychology of memory, a field in which social interaction has played a much more central role than interaction between agents and artifacts.[27]

[26] In response to Hutchins' (2010c) statement of a similar point, Clark acknowledges his "prolonged and continuing neglect of the massive social and cultural dimensions that shape and enable our actual cognitive practices" (2010a). The guilt is somewhat overstated: in other strands of his work Clark has provided rich and suggestive ingredients towards an original analysis of these dimensions: building in part on his earlier work on moral cognition (1996), Clark has for example showed how collaboratively devised maxims, normative policies, and shared strategies combine iteratively into cascades of distributed cognitive architectures, as we transform our own linguistic, educational, physical, affective, and institutional environments so as to open up entirely new spaces and possibilities for thinking, feeling, and acting together (2002b, 2005b, c, 2006a, b; compare Sutton 2010, p. 211). Nonetheless, Hutchins' point that Clark does not naturally think *first* of socio-cultural contexts and practices when seeking to understand the sources of organization and coordination of distributed cognitive assemblies does ring true.

[27] Although there is also a cognitive psychology of mnemonic artifact interaction, such as Habermas and Paha's (2002) research on the mnemonic role of souvenirs at points of life transition or Jones and Martin's (2006) empirical studies of "mnemoactive objects", that topic has been addressed more extensively in cognitive anthropology and in material culture studies, while cognitive psychologists have more often studied *social* memory processes (Ross et al. 2008a). In many cases, of course, a relatively stable socio-cognitive system in a relatively stable niche crucially involves interaction with artifacts. When we are considering putative socially distributed cognition in contrast to Otto's notebook, however, the relevant external resources are clearly highly dynamic and active.

Real psychologies of memory

For the last few years, we have been studying collaborative recall and related phenomena of social memory: couples and families, or other enduring and integrated small groups such as old school friends, veterans, sports teams, committee members, or business partners often and repeatedly jointly remember significant episodes they have gone through together.[28]

Our interdisciplinary project aims to draw on and contribute to distinct, independently motivated questions in cognitive psychology and the philosophy of mind, while also seeking mutual benefits in each domain which might be invisible without this broader scope. This is not "experimental philosophy," but an attempt to make both foundational and explanatory contributions directly within scientific psychology, while simultaneously bringing back representative and diverse results from psychology to enrich philosophical debate, in the classic mould of mutual adjustment of theories through co-evolution. Because our ultimate target phenomena are psychologically and culturally complex, and barely amenable to the typical controlled experimental methods of cognitive psychology, we have (like most in the area) also employed simpler laboratory studies: we abstract away temporarily from one or more key dimensions of the ordinary phenomena in question, starting for example with simple material (such as word lists) rather than emotionally charged personal memories, or working with convenience groups of strangers rather than couples or friends, and then gradually reinstating complexity, in order to tease apart the contributions of distinct factors. Specifically, we build on and extend robust traditions of empirical research in cognitive psychologists' established "collaborative recall" paradigm (Harris et al. 2008), while also trying gradually to extend our experimental range to more ambitious projects on "transactive memory systems" (Wegner 1987) which mix quantitative and qualitative methods (Harris et al. 2010b, c).

It is not only because our interdisciplinary team includes a philosopher that our research program in the cognitive psychology of collaborative recall draws inspiration from the extended and distributed cognition frameworks: other cognitive psychologists have independently for some years been seeking to integrate their empirical paradigms with theoretical frameworks for studying extended and distributed cognition. For example, Mary Weldon, who developed the core methods now standardly used in collaborative recall experiments (Weldon and Bellinger 1997; Weldon et al. 2000), worked explicitly from the vision of 'memory as a social process' developed both by Bartlett (1932) and by theorists of distributed cognition such as Hutchins, while trying "to figure out how to incorporate this perspective into one's theories and methods in cognitive psychology" (Weldon 2000, p. 68). Likewise, William Hirst and his colleagues, who have undertaken innovative empirical studies of shared remembering in families and in a range of conversational

[28] So our interest lies in particular in similar or shared autobiographical memories, which are among the most puzzling of the many phenomena of social memory. Other cognitive psychologists study the social aspects and analogues of semantic or procedural memory. Unlike some radical critics of individualist cognitive science (Toth and Hunt 1999; Danziger 2008), we are entirely happy to work outward from the basis of the established taxonomy of individual memory (Sutton 2003), while acknowledging that there's no definitive consensus on the criteria for individuating putative "memory systems", and while we stress their interactivity in practice.

situations (Hirst and Manier 1996; Cuc et al. 2006, 2007), explicitly aim to integrate cognitive psychological results with theoretical ideas about situated and distributed memory, while dispelling conceptual confusions in prevailing uses of the term 'collective memory' (Manier 2004; Hirst and Manier 2008; Coman et al. 2009).

But while both cognitive and developmental psychologists have been extending ideas about socially distributed remembering, this interest has not in general been reciprocated by philosophers. This is surprising, given that most parties to recent philosophical debate about extended cognition rightly wish to evaluate the hypothesis against its integration with and relevance to scientific psychology (Rupert 2004, 2009; Clark 2008; Adams and Aizawa 2008), and rightly treat memory as an emblematic object lesson in the extended cognition debate, such that "what goes for memory goes for cognition in general" (Rupert 2004, pp. 407–408; Wheeler 2010a, p. 252).[29] Indeed, when seeking to enforce their wish "to keep cognitive psychology on track" against the "outrageous hypothesis" of extended cognition (Adams and Aizawa 2008, pp. ix and vii), one strategy employed by the critics is to stick close to a range of results from the real cognitive psychology of memory. But while we applaud this intention, in practice neither Adams and Aizawa nor Rupert (2004, 2009) offer a sufficiently representative account of the cognitive psychology of memory against which either to evaluate an extended approach to remembering or to develop a sufficiently rich, *strongly* embedded approach. Here we focus on the case made by Adams and Aizawa.[30]

Adams and Aizawa cite a range of empirical results on memory to illuminate 'the kinds of mechanisms that are involved' in cognitive processes (2008, p.57). Drawing on the first (1995) edition of John Anderson's textbook *Learning and Memory,* they summarise data on, for example, primacy and recency effects in the free recall of word lists, forgetting curves in learning paired associates, the notion of depth of

[29] Memory also affords us more secure conceptions of the domain, in both common sense and scientific psychology, than we have for the general notions of 'mind' and 'cognition'. The concepts of 'cognition' and 'mind' have suspect and fluid histories and are subject to considerable cross-linguistic variation (Macdonald 2003; Wierzbicka 1992). Most importantly, they play less of a live role in the daily activities of scientific psychologists than do concepts like memory, emotion, and vision, or even decision-making, imagining, and dreaming. This is in itself no objection to the general idea of a quest for a unifying 'mark of the cognitive' to specify what all these different processes and capacities might have in common (Adams 2010), but simply a cautionary note that staying closer to scientific practice might mandate a less abstract scope. Likewise, we have no principled objection to the quest for a unifying 'mark of memory', for what makes some processes and not others *memory* processes, and we acknowledge the need to respond to Robert Rupert's complaint (2004) that the notion of memory with which we operate is overly generic: in this paper, however, we are concerned to demonstrate that theorizing and experimenting on socially distributed remembering is an entirely pervasive activity in mainstream cognitive psychology.

[30] Rupert's (2004) use of results from the cognitive psychology of memory to challenge extended cognition has other features which demand separate treatment on another occasion. Although Rupert discusses some additional topics, including interference effects, memory in conversation, and the notion of long-term working memory, however, he too neglects the sorts of mainstream work on both autobiographical memory and collaborative recall on which we focus here. In distinct strands of his argument, Rupert suggests firstly that empirical results demonstrate significant 'mismatch between memory as we know it in the standard case and what is alleged to be extended memory' (2004, p.410), and then that there is more unity to and explanatory utility in the variety of internal memory systems than there would be in any coarse-grained notion of 'generic memory' that covered larger hybrid systems (pp. 418–421). Our response to Adams and Aizawa is relevant primarily to the first strand of Rupert's argument: we will discuss the second strand elsewhere alongside a response to Rupert's broader critique of social ontology (Rupert 2005).

processing (roughly, the semantic integration of learned information), and the generation effect, by which I remember word pairs in which I have come up with the paired associate myself better than pairs provided by an experimenter.

These are all solid results taken from one reputable textbook in the cognitive psychology of memory, and the mechanisms putatively driving at least some of these phenomena are the kind of computational mechanisms in which cognitive science more generally hopes to traffic. But the lessons which Adams and Aizawa want to draw from this survey and apply to the possibility of extended or distributed remembering are not easy to pin down. They 'do not claim that all cognition must contain exactly the mechanisms found in human cognition' (2008, p. 57): but in subsequent discussion their major concern is with the fact that Otto's memory performance will differ from Inga's on at least some of these dimensions, such that 'there is a distinctly human kind of memory processing that Inga has, but that Otto does not' (p. 140). There is thus an ongoing debate in the literature about whether the failure of the coupled Otto-notebook system to exhibit the generation effect entails that this system does not have 'memory'. This is not our topic here, although we are disposed to side with Mike Wheeler's argument in favour of a robust but more generic notion of memory which could apply whether or not the generation effect happened to hold (2010a, pp. 251–258; compare Rowlands 2010, pp. 101–103).[31] Our concern here instead is with the relevance of the cited principles of human memory themselves. We cast no doubt on these or similar results: we are not taking the option, foreshadowed by Adams and Aizawa, of proposing to "reject the putative discoveries of cognitive psychologists" (2008, p. 141). Far from it: we wish rather to expand the range of such discoveries discussed in this debate, and to bring more empirical and theoretical work in psychology to bear. Neither do we hold that the methods used by cognitive psychologists to discover these results "have held them back from a better understanding of the mind' (Adams and Aizawa 2008, p. 141). These results do derive from laboratory studies of single subjects, employing impersonal stimuli with no personal significance, and Adams and Aizawa are portraying the cognitive psychology of memory of some 15–20 years ago, still anchored in earlier verbal learning traditions, when the spirit of Ebbinghaus still dominated the spirit of Bartlett, and before laboratory methods were integrated with some success by Neisser and others with the study of memory in everyday contexts (Neisser 1997; Neisser and Hyman 2000; Sutton 2009a). But our case for a fuller, active, critical engagement with cognitive psychology, against which to assess the case for extended or distributed remembering, is in no way built on a rejection of traditional laboratory methods, which we employ ourselves in seeking, across any interconnected program of empirical studies, to balance control with general applicability. Our concern is with the choice of topics and results: not all work in

[31] In addition, though, there is indeed a group or socially distributed generation effect—see the discussion below of our work in collaborative recall. We also note here the tension between Adams and Aizawa's wish to respect cognitive scientific practice and their scepticism about a notion of memory even sufficiently general to cover canine memory and mollusk memory as well as human memory (2008, p. 141). There are all kinds of live issues about which forms of memory are found in which non-human animals, but we suspect that neither neuroscientists nor cognitive ethologists will stop thinking they study memory if it should turn out that sea slugs, mice, chimpanzees, or scrub jays do not exhibit the generation effect. See also Clark, in press.

the cognitive psychology of memory is on primacy and recency or on the generation effect. So it is illegitimate to cite selective results from cognitive psychology which show minimal agent–environment interactivity, as if they clearly ruled out or even weighed against the possibility of extended or distributed remembering.

Our idea, then, is to canvas areas of scientific psychology of memory which may be more relevant to exploring the scaffolded or even extended mind. Below we describe research fields which explicitly address social collaboration in memory. But first, we situate this research in a broader array of more embedded ways of researching individual memory. Some features of personal memory, in particular, may make it apt for various forms of integration into larger sociocognitive-mnemonic systems (Wilson 2005; Sutton 2008a, 2009a): we believe that "progress in understanding complex social memory phenomena will naturally build on the more mature sciences of individual memory" (Barnier and Sutton 2008, p. 181). Again, if this is non-revolutionary relative to the extreme views which Adams and Aizawa take themselves to be attacking, so be it: again, however, the positive picture which emerges is of a dramatically more deeply embedded and scaffolded mind than that which appears in classical individualist philosophy and cognitive science.

The results cited by Adams and Aizawa do not treat the individual as entirely isolated, to be sure, but they do clearly involve external resources only as single, transient causal influences on internal processing.[32] In contrast, even if we still restrict initial attention to long-established and relatively dry old principles in memory research, empirical traditions on the context-dependence of remembering and the encoding specificity principle offer a richer sense of the ongoing interactivity of internal and external processes. Tulving and Thomson argued that the context of encoding determines what is stored in memory, and that 'what is stored determines what retrieval cues are effective in providing access to what is stored' (1973, p. 353). Encoding operations, firstly, are "some sort of interaction between the perceptual input and its cognitive environment," and in turn remembering is "the joint product of information stored in the past and information present in the immediate cognitive environment of the rememberer" (pp. 352 and 369). The "cognitive environment", here, is "the totality of conditions determining the encoding of a perceived item", which as Tulving and Thomson noted, thus includes "factors that cannot as yet be adequately identified or labelled" (p. 369).[33] As well as dramatic experimental

[32] They are the equivalent, in the case of memory research, of the examples which Adams and Aizawa cite, as mentioned above, to show that cognitive psychologists *do* attend to "environmental and bodily processes": they ask "How could one understand why a person's eyes dilate at a given time, if one does not know that she is playing Texas Hold 'em and has just drawn the top full house? How could one understand why a person is thinking about a bandage without knowing that the person cut her finger with a knife?' (2008, p. 111). These are not cases of coupling at all, but of simple causal interaction.

[33] Tulving and Thomson offer an intriguing historical glimpse at what, in 1973, they called 'the current transition from traditional associationism to information processing and organizational points of view about human memory', the impact as we'd now see it of the 'New Look' psychology on memory research. They contrast their interactionist account of retrieval, by which we must consider both relations between the contexts of encoding and of retrieval and relations between agent and environment, with the earlier verbal learning tradition in which 'memory was still a matter of acquisition, retention, transfer, and interference of associations between stimuli and responses' (1973, p.352). Adams and Aizawa's picture of the psychology of memory, in contrast, is in the main drawn from research originally undertaken before the cognitive revolution.

results, such as the fact that divers who learn material underwater recall that same material better underwater than on land (Godden and Baddeley 1975), the encoding specificity principle continues to drive rich research traditions in both cognitive and clinical psychology on, for example, mood-dependent memory (Eich and Macaulay 2007). Most generally, an individual's failure to retrieve in one context—as when, for example, one member of a couple cannot on their own recall the name of the show they went to on their honeymoon—does not mean that the information is permanently unavailable, only that under the current conditions it is inaccessible (Tulving and Pearlstone 1966). While this basic feature of human memory in no way underplays the importance of relevant neural structures and internal processes, it implies that they are often not accessed or activated appropriately without significant interaction between engrams and environment: following Richard Semon, Tulving called this conspiratorial interaction of present cues and circumstances with the trace 'synergistic ecphory' (Tulving 1982; Schacter 1982, pp.181–189; Moscovitch 2007, p.18).

To simplify the history dramatically, these ideas were one fundamental driving force behind the emerging consensus in the cognitive psychology of the 1980s and 1990s on the significantly constructive nature of remembering (Schacter 1995; Sutton 2003). The idea that memory is profoundly open to contextual influence is, we suggest, one way to see how Clark and Chalmers' speculations about socially extended cognition may be implemented. The *Desert Song* case, with which we began the paper, exemplifies the interactive cross-cuing prevalent in many dyads and small groups whether or not they are, in Clark and Chalmers' terms, 'unusually interdependent' (1998, p. 17). In that case, the memories involved were autobiographical memories, even though they are shared. On all the major models of the nature and dynamics of autobiographical memory developed over the last 20 years, autobiographical remembering operates across multiple levels, integrating neural, cognitive, affective, and social processes. Some stress the motivational and identity-maintaining function of remembering specific episodes from the personal past (Conway 2005), others the multimodal coordination of many interacting systems at distinctive timescales (Rubin 2006), others the future-oriented, action-guiding nature of both involuntary memories and constructive episodic simulation (Schacter and Addis 2007; Berntsen 2010), others again the shaping and enduring role of listeners' interactive uptake of autobiographical narratives (Pasupathi 2001; Nelson and Fivush 2004), others the ongoing interpersonal role of talking about and re-evaluating the past together (Alea and Bluck 2003). These models all depict autobiographical memory as a complex open system, involving many distinguishable but coordinated kinds of processes, not a single isolated or homogeneous neural system: all treat remembering as a contextually embedded aspect of temporally extended agency, and some explicitly focus empirical attention on the shared environment which in many cases, in iterative looping processes, sculpts the content as well as the expression of personal and shared memories. Relations between these models are under negotiation, for these are maturing sciences of highly dynamic systems: yet they have already produced results just as robust as primacy and recency effects. While the models do draw on surrounding subdisciplines like developmental psychology, this no more undermines their standing as *cognitive* theories than does their parallel firm reliance on neuroscientific work: cognitive

psychology is an extraordinarily heterogeneous enterprise with no firm boundaries, as we would expect of a project committed to identifying interactive mechanisms at multiple levels, in which researchers naturally look down, around, *and* up (Bechtel 2009).

Adams and Aizawa might respond, however, by pointing to other traditions in cognitive psychology which also explicitly address social influences on autobiographical memory, but which treat the topic in much more individualist fashion. Research on "false memory" has focused on malign forms of influence, on distortions or misleading additions inserted into the individual's mind by external sources. Elizabeth Loftus writes, for example, that "misinformation has the potential for invading our memories when we talk to other people" (1997, p. 51). In these traditions, construction is sometimes equated with distortion, malleability with unreliability. Building on misinformation studies, recent research investigates "memory conformity" (Gabbert et al. 2003; Hope et al. 2008) and the "social contagion of memory" (Meade and Roediger 2002). In some of this work, the unsullied individual memory appears as the gold standard, and social influence as a primarily negative intrusion: clever experiments create conditions in which subjects yield to another person's version of the past.[34]

But with our multidimensional approach in mind, there is no straight theoretical choice to be made within the cognitive psychology of memory between more individualist and more distributed or extended approaches. In some circumstances, social influences on remembering *do* operate in monocausal fashion: an authority figure who questions a witness powerfully in advance of a court appearance, for example, remains entirely external to that individual's memory whether or not their words have enduring influence. So our concerns with work on misinformation and conformity arise when results are generalized away from forensic contexts, with their unusual features, and applied across the board to social influence in general. Having shown that individualism is alive and well in at least one influential corner of the cognitive psychology of memory, we can then begin to cast doubts on its more general applicability, for a number of reasons (Barnier et al. 2008; Sutton 2008a). While all in this debate accept the strongly constructive nature of remembering, false memory researchers on occasion minimize the adaptability of memory's intrinsic dynamics, by which the very mechanisms that underlie generalization can in certain circumstances lead us astray (McClelland 1995; Schacter 1999; Boyer 2009; Sutton 2009c; Michaelian 2010a). But true memories are constructed too, and any neural or psychological patterns of difference are subtle tendencies rather than clear distinctions (Slotnick and Schacter 2004; Bernstein and Loftus 2009): in our view, constructive processes are generally reliable enough in part *because* they encourage external and social support (Sutton 2009a). Furthermore, the causal theory of memory is compatible with some degree of transformation and elaboration as well as selection and reduction of content (Michaelian 2010b). Even disregarding other

[34] French et al. (2008), for example, showed slightly different versions of a film to two people who think they are watching the same film. After discussion about the film's key incidents, some individuals' memory comes to incorporate elements of what the other person saw and mentioned. Couples were more likely to "yield" to each other's version of events, possibly because they trusted each other's access to a putatively shared reality: people are thus, French et al. concluded, "even more susceptible to memory distortion when someone they know provides the misleading information" (2008, p.271).

functions of remembering, values like truth, accuracy, and fidelity are complex and context-sensitive: our attempts to be faithful to the past, or to retain integrity in dealing with it, can just as easily be scaffolded and facilitated as disrupted by other people, because sharing and renegotiating the past in company is a mundane and significant feature of our lives (Campbell 2003, 2006). Here then, as we seek counterparts in empirical research for these theoretical reasons to resist the view of social influences on memory as inevitably negative, is where extended and distributed cognition meets quite independent traditions in cognitive psychology.

Emergence in socially distributed remembering and collaborative recall

A number of active research programs explore emergent phenomena in social memory. Given the general multidimensional framework we sketched above, we distinguish between a range of possible cases (Barnier et al. 2008; Sutton 2008a). Encoding can be shared or unshared, and where it is shared, this can be due to mere accident (as when a number of bystanders happen to witness the same incident on a street corner) or to a history of joint action. Retrieval can occur in isolation (in various ways and for various purposes), or under a range of increasingly collaborative conditions with other people, in groups of varying size, function, and durability. In the following discussion of some empirical memory research, we show how at least some of these dimensions can be systematically manipulated as we distinguish the characteristics of collaborative recall under various conditions. Although this swift survey is highly selective, we stress that the experimental paradigms in question reflect mainstream science. We stick to recent *cognitive* psychology, omitting for example closely related work on shared mental models, information sampling, and shared situation awareness in organizational psychology. Before we get to transactive memory and the collaborative recall paradigm, we mention two other distinct areas in which we have sought carefully to build bridges between individual and shared memory, identifying forms of emergence and convergence both during and as a result of remembering together. In each case, we show that the theoretical framework we have described directly inspires new scientific questions and research trajectories, as we seek to connect established results from simpler, more heavily controlled laboratory studies in a step-by-step fashion back up or out to the parallel phenomena in the more complex cognitive ecologies in which remembering occurs in the wild.

Retrieval-induced forgetting (RIF), firstly, is a striking empirical result on individual memory that has come to prominence only over the last 15-20 years (Anderson et al. 1994). In the basic experimental scenario, I learn information from two domains, and then practice or rehearse *some* of the information from only *one* of the two domains. It is not surprising that I later remember best the specific information I have rehearsed. The surprising and robust finding is that my memory for the *non*-rehearsed information from the same domain as the information that was rehearsed is now *worse* than the information from the (other) domain that wasn't rehearsed at all. Retrieving some information, therefore, induces forgetting of associated information, relative to information of other types, as a result of either interference or inhibition (Anderson 2003). Much initial work on RIF used word

pairs with little personal or emotional significance, but Barnier et al. (2004) showed that RIF also operates on autobiographical memories: in other words, people also selectively forget unpractised memories of their own personal past experiences that compete with practised memories, compared to other baseline memories (see also Harris et al. 2010d, e). Meanwhile, RIF for semantic material was shown not only for the person retrieving the information, but also for a person listening, or for both parties in a free-flowing conversation (Cuc et al. 2007; Stone et al. 2010), an effect now known as socially-shared retrieval-induced forgetting (SS-RIF). We then combined these methods to demonstrate that this socially-shared forgetting occurs even when the practised material consists of one participant's autobiographical memories (Stone et al., submitted for publication). More importantly in the current context, such conversations (in which only a subset of the material from a subset of topics is rehearsed or discussed) have enduring and transformative effects on the participants' individual memories, which converge on the same shared representation of the past, in that each person later fails to recall the same items on which their conversation had been silent (Stone et al. 2010). Given the ubiquity of conversations about both personal and factual aspects of the past, and of our exposure to public rehearsal of only selective features of past events, the mechanisms driving socially shared retrieval-induced forgetting may be one means by which certain processes of transmission permit 'individual memories [to] converge onto a unified and stable rendering of the past' (Hirst and Echterhoff 2008, p. 203). If a politician wants people to forget an inconvenient truth about some past episode—the fact, for example, that one particular reason was given for going to war—then SS-RIF offers the surprising prediction that this will be achieved better *not* by now avoiding the entire topic, but by selectively discussing the *other* reasons given for going to war.

Moving on to a second example, we have also extended established methods from research on individual autobiographical memory in the case of recall of emotionally significant public events. In the individual case, this is known as "flashbulb memory" (Conway 1995). In our study, student participants first answered a questionnaire individually, describing their (unshared but more or less similar) memories of hearing of the death of Steve Irwin, the Australian "Crocodile Hunter", including factual details of their circumstances at the time and of the event itself, and their own reactions to the news (Harris et al. 2010a). Participants told us, for example, that Irwin "will be remembered throughout Australia and worldwide history forever," or that "it is unbelievable how much he affected everybody's lives," while another noted that "I still feel shock and sadness, simply because why him? He is such a good person." In the next phase of free recall, participants either discussed the event in groups of three or wrote about the event on their own. Many of the group discussions, in this Australian student cohort, involved negotiation about the meaning or emotional significance of the event, as in this sample dialogue between three participants with quite distinct attitudes:

K: I know people that cried when they were watching the memorial service when Bindi was doing her speech.
M: Yeah, that was really sad! I don't know anybody who actually cried...
E: Did you cry?

K: Can't say that I did.
E: Do you know anybody that cares at all?
M: I don't think a lot of people...
K: I think people feel bad for him. A lot of people...
E: People die every day.

Finally, participants completed the original questionnaire again, both 1 week and again 1 month after the free recall phase. Despite our lack of control on participants' other discussions about this event, we found that those who had engaged in our experimental group discussion had significantly altered later individual memories. Specifically, participants who discussed the event in a group setting later remembered themselves as being less shocked and less emotional, relative both to their own original reports and to the participants who had not engaged in group discussion. Our qualitative analysis revealed that even this brief conversational interaction with a group of strangers led (in this cohort) to emotion minimisation, as more extreme emotional responses initially offered by some participants (both in the first individual recall, and at the outset of the group interaction) were (in some cases and to some extent) schematised and normalized: this collaborative discussion of appropriate responses had enduring effects on individual participants' memories for their own emotions even a month later (Harris et al. 2010a).

Returning to the study of shared autobiographical memories, in Daniel Wegner's theory a "transactive memory system" (TMS) is "a set of individual memory systems in combination with the communication that takes place between individuals" (Wegner 1987, p. 186). A TMS is a socially coupled dynamical system with emergent properties, which in certain cases can be highly integrated and enduring, and exhibit high levels of continuous reciprocal causation. As Wegner and colleagues put it in relation to established intimate couples,

> individual memory stores are physically separated. Yet it is perfectly reasonable to say that one partner may know, at least to a degree, what is in the other's memory. Thus, one's memory is 'connected' to the other's, and it is possible to consider how information is arranged in the dyadic system as a whole. A transactive memory structure thus can be said to reside in the memories of both individuals—when they are considered as a combined system. (Wegner et al. 1985, p. 257)

A transactive memory system requires both a set of practices and mechanisms of coordination and communication (the process components), and an awareness of the actual or likely distribution of information across individuals within the system (the knowledge component). In ongoing integrative process, the members of a successful transactive memory system will turn what may initially be differentiated knowledge into shared new emergent knowledge.

> Aircraft mechanics who are asked about a plane's safety, for example, might each volunteer different facts; Betty might note an unexplained bit of oil on the runway, while Veronica remembers that a hydraulic indicator light was not functioning. Taken one at a time, these observations may not be noteworthy. Taken together, however, they point to an oil leak, and this integration could turn out to be significant indeed. (Wegner 1987, p. 197)

Where there is mnemonic division of labour, the point of such differentiation is thus potential new integration, utilizing and integrating distributed expertise. So transactive memory theory predicts benefits from working together in encoding and retrieving information, with no requirement of cognitive homogeneity across the members of the group. The theory clearly sits well with our understanding of socially distributed cognition (compare Theiner et al. 2010; Theiner and O'Connor 2010), and it has been implemented and tested widely in organizational psychology (Lewis 2003). However, much of this research has focused solely on higher-order knowledge about the spread of information, and has rarely measured either the accuracy or the effects of members' perceptions of the distribution of cognitive tasks. So while we continue to try to test transactive memory theory in empirical practice, we have so far mainly worked within the related but more stringent experimental paradigm of collaborative recall, which delivers some apparently recalcitrant results.

In a typical collaborative recall (CR) experiment, subjects are presented with stimuli (usually words) on a computer screen and instructed to remember them. Subsequently, subjects recall these words either in a group or alone (Recall 1). Finally, all subjects recall alone again (Recall 2). The effect of collaboration on recall is indexed by a (between-subjects) comparison of the number of items recalled by groups vs. individuals on Recall 1, as well as a comparison of the number of items recalled by collaborative groups and "nominal groups". Nominal group recall is calculated by pooling non-overlapping items recalled by the same number of lone individuals as in the collaborating group. The robust finding is that collaborative groups recall more than individuals alone, but less than nominal groups (Weldon and Bellinger 1997; Basden et al. 2000; Harris et al. 2008). This deficit is called "*collaborative inhibition*" and is usually attributed to the disruption of individual retrieval strategies.

Many CR experiments, however, have studied only a narrow range of groups and memory materials. Most research has involved individuals separately learning mundane, identical material that is at best only accidentally shared, and then recalling it together in convenience groups of mere acquaintances or strangers, often in a minimally collaborative fashion. It is less of a surprise that collaborative inhibition is invariably found in CR experiments of this type. Such studies fail to capture the kinds of groups and material that Wegner aimed to explain with transactive memory theory, and explore only a small corner of the space of social memory phenomena.[35]

So we have recently introduced new dimensions in CR research, for example using emotionally significant material rather than word lists, or unshared but similar

[35] Indeed in the mainstream CR literature, even the standard ways to *diminish* collaborative inhibition have minimized interactivity, seeking to allow individuals more chance to adopt and implement their own distinct retrieval strategies, for example by requiring strict turn-taking in the group recall rather than allowing a free-flowing interactive discussion. This all but eliminates in advance any possibility of emergent socially distributed memory (Barnier et al. 2008; Harris 2009). So while the claim we cited above by Sprevak (2010) that externalism has already won in cognitive psychology is thus dramatically premature, there are here as in many domains a range of live options about explanatory scope and method, as well as about the interpretation of empirical results, which both reflect and can feed back in to more informed attitudes about embedded and extended memory and cognition.

autobiographical memories, and working with groups of friends rather than strangers. Notably, when we encourage participants to work together to coordinate retrieval, or allow groups to engage in shared encoding by generating their own material in the learning phase, collaborative inhibition is reduced or even eliminated: we have also found that collaborative groups were more accurate than nominal groups, more successfully eliminating false memories (Ross et al. 2008b; Harris et al., submitted for publication). Our finding that shared encoding by group members eliminates collaborative inhibition is particularly significant in the current context. It is a social version of the generation effect, as predicted by Wegner et al. (1985, p. 259) but in some tension with portrayals of the generation effect as only an intra-individual phenomenon (Rupert 2004, pp. 416–418; Adams and Aizawa 2008, p. 139): a mnemonic advantage arises when group members work together in generating material to be learned that is meaningful to them, and also encourages the employment of shared strategies at retrieval.

From this and other recent research, such as a finding that expert pilots show collaborative facilitation (rather than inhibition) when remembering aviation-related material (Meade et al. 2009), it appears that any negative consequences of remembering with others can in certain circumstances be abolished or even reversed (Harris 2009). However, CR remains a laboratory paradigm at some distance from the kind of socially distributed remembering envisaged by Clark and Chalmers. So in the final set of studies we discuss here, we examine the products and processes of shared remembering among older couples. We seek to integrate the kind of controlled studies inspired by CR with the cognitive psychology of memory in aging (Dixon et al. 2001; Dixon 2010), and with the richer qualitative empirical analyses suggested by developmental and ethnographic research on shared and family memory (Middleton and Brown 2005; Bohanek et al. 2006; Habermas and de Silveira 2008; Shore 2009). But we also draw directly on Andy Clark's speculations about the role of social and environmental support in potentially buffering older adults against the incipient effects of mild cognitive impairment and early stage dementias, when other people are key parts of a rich "cognitive reserve" which allows for successful functioning even despite partial neural degeneration (Clark 2001b, p. 157; Drayson and Clark 2010). Again, extended and distributed cognition can play a significant (though of course only partial) role in shaping empirical research agendas.[36]

We interviewed 12 older couples at their homes over two occasions a week apart—individually first, then together. On each occasion, the couples learned and recalled lists of words, recalled various personally relevant semantic information (such as the names of their fellow club members, and the holidays they had taken as a couple over the years), and engaged in extensive

[36] See also the highly original ethnographic study by Wu et al. (2008), explicitly inspired by Hutchins' distributed cognition framework, of the coordination of social and technological supports for people with amnesia, who are liable to get lost or forget key appointments or actions. This work is notable not only for its effective critique of existing literature on and technologies for cognitive rehabilitation, which focus on individual independence and neglect the extraordinary interpersonal efforts by which families cope with memory impairments, but also for its specific examination of differently balanced practical solutions, across different families, to the dynamic management of redundancy and information-distribution in situations of substantial and stressful memory volatility.

autobiographical remembering as they talked about significant events in their personal and shared past, such as their engagement, wedding, and honeymoon. We could then compare the individual recall with the collaborative recall on each task. There is no space here to go through our results in any detail, but we summarise the general shape of the findings (Harris et al. 2010b, c).

We found no *general* inhibitory or facilitatory effect of collaboration either across couples or across tasks—certainly collaborative inhibition is not inevitable among long-term intimate couples—but, as might be expected, a wide range of differences across the couples in the way that talking together altered or shaped the content and form of their memories of past events. In the word list recall task, for example, the couples used a range of different strategies, some explicit, some already well entrenched to deal with individuals' unique styles of remembering. In one couple where the man had a memory impairment, his wife waited on each occasion for him to recall until blocked before she recalled items. In another couple, the man made actions for each item at encoding that were then reproduced to aid and cue his wife's recall during collaboration. In the more free-flowing autobiographical memory interviews, there was a general pattern for collaborative recall to bring more specific episodic memories, richer detail, and altered experience of remembering, than were apparent in individual recall: but again there were systematic differences in collaborative style across the couples (Harris et al. 2010c). While some couples adopt an interactive style, dynamically reconstructing an episode together, in other cases attempts at cross-cueing are unsuccessful, and sometimes fail to get started. There are also a range of disagreements about strategy, as in the following dialogue in which a couple are trying to describe what they did on their first date:

Husband: yeah, well, it was a sort of classic movie of its time.
Wife: [No] it was [a stage production].
H: [and a] and one that's been very popular for us ever since, you know, frequently watch it if it's on television or [*inaudible*].
W: [Not South] Pacific, we watch my...
H: Yeah, I'm talking about ahm... Sound of Music.
W: That was for our engagement 7 years later.
H: Yeah ok.
W: We were talking about the first.
H: Oh I see alright, OK. We saw Hatari pretty early on.
W: Yeah we did *(sarcastic tone)*.
H: Cause I remember we had all sorts of problems with that. The seats that I got were right on the very side of the cinema and it was very difficult to see.
W: [I thought] that was two years into the relationship.
H: But yeah, OK well as I said that's the thing but going to the movies early on was a common way of sharing our enjoyment with one another.

Here, the continued correction of the man by the woman does not allow for joint remembering, and they fail to construct a joint narrative for the event in question.

Across interviews we found that couples did not consider precise accuracy in recall to be the most important aspect of joint remembering. Corrections, for example, were problematic for collaborative recall: they are not in the spirit of

everyday joint remembering, which might be aimed at telling an entertaining or coherent story as much as at strict historical accuracy. As one man explained:

> *Husband*: I remember we used to have a rule that if we're telling a story and I say there were ten wild dogs in the back garden, I don't want [wife] to tell me, no, there's only two. I said if I'm telling a good story and I said there were ten wild dogs, there were ten wild dogs.

Most couples said that they did not often particularly try to resolve disagreements in memory over minor details.

But for all the couples, there was within the autobiographical interview at least one event that they collaborated to recall in a dynamic, interactive manner, where the speaker role rapidly shifted back and forth and the narrative was jointly constructed. Consider the following brief example, in which a couple are discussing the beginning of their relationship:

> *Husband*: No, I asked her out that night, but she said she couldn't go.
> *Wife*: No, that's right.
> *H*: So then I started to pester her the next week.
> *W*: You did, you turned up after my [classes.]
> *H*: [Cooking classes.]
> *W*: On Monday night.
> *H*: That'd be it.
> *W*: And took me for coffee.
> *H*: Yes, the next Monday night.
> *W*: And impressed me.
> *H*: Yes.

Compare this collaborative recall to the way this same event was described in their separate individual interviews:

> *H*: Ah, I used to turn up down her, she used to give, umm, what do you call it, teaching, she used to teach, umm, women in Manly how to cook. So she ran teaching classes. So I used to turn up there after, and take her out for coffee or something.
> ...
> *W*: And then the next week he appeared at my work after the evening class had finished, taking me out for coffee—that was the beginning of the courtship.

Compared with the more general semantic descriptions provided in the individual interviews, the joint description of this event in the collaborative interview was emotionally richer and more detailed at a phenomenological and linguistic level, as the couple co-construct an account of his "pestering", and of her being "impressed".

So overall, memories were richly shared in these long-term couples. In some cases, the distribution of information was so redundant and so transparent that individuals claimed memories for events that they themselves had never experienced. Consider the following example, where the husband corrected his wife and claimed memory for an event that he did not experience himself.

W: I didn't have a passport, oh yes I did have a passport.
H: Yes you did, you'd been on a cruise, dear.
W: I did, I had a passport. [That was my new passport.]
H: [See how's that for a memory.]
W: Wonderful dear.
Interviewer: Hmmmm, because I remember you said that Fiji was your first time out of Australia, umm, but, umm.
W: I forgot about the cruise, that was the first time on an airplane, on a big airplane.
H: Yes, you went there [on a cruise before.]
W: [I did, I went on a cruise.] I forgot all about that. Gee, it couldn't have been very memorable.
H: I remember.
I: Were you there?
H: No.

Similarly, both members of another couple specifically described the inherently shared nature of their memories, attributing this cognitive interdependence to their shared experiences. The woman stated "Each could tell the other's stories," and later, her husband said "Hmmmm, well what we find is because we've done everything together someone will start telling a story, and then the next person will try to take over and tell another funny part of the story, and if you're not careful you don't know who has the right to the story' (Harris et al. 2010c). Successful collaboration in remembering can be based in specialized, asymmetric distributions of information, but perhaps only when the individuals' recall strategies mesh in a complementary fashion (compare Bratman 1992 on the necessity of 'meshing subplans' or co-compatible strategies in shared cooperative activity).

Not surprisingly, therefore, long-term intimate couples have evolved many distinctive ways of managing and integrating the shared past, with different balances of episodic and semantic detail, different standards for success in remembering, a range of mechanisms for resolving memory conflicts, distinctive social distributions of memory competence and expertise, and different kinds and levels of reliance on external records and objects to drive and cue memory. Many instances of remembering together do *not* involve richly interactive or dynamic coupled processes, and end up producing more disjointed aggregate outcomes: but in other cases each partner offers distinct but complementary contributions to a shared emergent product. Collaboration is itself cognitively and interpersonally costly, and perhaps will have significant benefits only at certain points of balance between individual cognitive capacities and the effort involved in maintaining the transactive communication (Rauers et al. 2010). But over many years of interactive relationship, the older couples with whom we worked have had many looping and iterative mutual influences on each other's memory, emotion, and cognition.

In ongoing research, we are extending these mixed-method studies, employing both experimental cognitive and qualitative ethnographic methods, to test the collaborative recall performance of younger and older couples and strangers using a range of materials and interactive practices. We hope to begin to get a clearer grip on the question of whether and when remembering with certain

other people can compensate for the impact of cognitive decline on memory performance.

Overall, this glimpse of ongoing research using a range of methods in cognitive psychology reveals that, despite the complexity of real-world socially distributed remembering, its dimensions and nature are amenable to careful empirical study. This is, we suggest, one route towards a richer interactive engagement between the philosophical literature on embedded, extended, and distributed cognition and the relevant parts of scientific psychology. There is clearly no conflict with the foundational assumptions of cognitive psychology here, and yet the focus of attention is firmly on the coordination of heterogeneous but complementary resources across disparate but interacting internal and external resources. Building on the insights of the multidimensional framework we developed out of the case from complementarity, we believe that the most robust cognitive psychology of memory is *not* entirely restricted, as Adams and Aizawa argued, to 'the study of processes that take place, essentially without exception, within nervous systems' (2008, p. 179). In contrast, we have argued, some of the most intriguing experimental research in the cognitive psychology of memory specifically studies processes that span brain, body, and world.

The empirical and conceptual approach we have developed in this paper departs from much of the philosophical literature on extended cognition in a number of significant ways. We argue for the precedence of *complementarity* over parity in understanding why we might see cognitive processes as either extended or distributed across internal and external resources. We focus on cases of *socially* distributed cognition over cases of the use of artifacts like Otto's notebook. We argue that significant interest is generated, sufficient at least heavily to nudge if not transform existing orthodoxies, by a genuine investigation of the rich coupling or embedding of individual cognition in its social and environmental situations, whether or not we also think that cognition is partly constituted by such external resources: to catch this view, we have suggested the use of the labels "distributed cognition" or (following Sterelny) "scaffolded cognition," as opposed to merely "embedded cognition," since mere embedding can be no more than the bare and isolated causal interaction of inner and outer resources. And, finally but most importantly, we have introduced to the extended cognition debate a more principled, representative, and wide-ranging array of research in the cognitive psychology of memory. In future, no assessment of any case for either extended or distributed cognition against the sciences of memory can reasonably be based solely on a selective survey of narrowly individualist results: rather it must engage directly and in detail with the broader range of experimental and theoretical projects and approaches which we have briefly surveyed here. We do not suggest that these psychological paradigms definitively support a particular view in the philosophical debate: we do, however, think that the mutually beneficial interaction between philosophy and psychology which all parties to that debate seek can be significantly enhanced if we pay attention to both the phenomena and the sciences of collaborative recall and socially distributed remembering.

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