THINKING OUTSIDE THE HEAD: COGNITIVE ECOLOGIES AND EVOLUTIONARY PSYCHOLOGY

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Man's nervous system does not merely enable him to acquire culture; it positively demands that he do so if it is going to function at all. Rather than culture acting only to supplement, develop, and extend organically based capacities logically and genetically prior to it, it would seem to be ingredient to those capacities themselves.

~ Clifford Geertz, 1973, p. 68

Some of these pathways happen to be located outside the physical individual, others inside; but the characteristics of the system are in no way dependent upon any boundary lines which we may superpose upon the communicational map.

~Gregory Bateson, 1960, p.251

That may sound like a strange idea. But it is hardly stranger, on reflection, than the commonplace idea that the activity of *brain-meat* realizes all that matters about human cognition.

~ Andy Clark, 2007, p.164

1. WHY HASN'T EVOLUTION REVOLUTIONIZED THE SOCIAL SCIENCES?

Humans have colonized virtually every habitat on the planet, and have transformed the earth's environments to such an extent that there is a strong push to name the current geological epoch the "Anthropocene" (Steffen et al. 2011; Smith and Zeder 2013). Understanding how humans have achieved such a feat—and how to deal with the unforeseen consequences of these actions—requires a massive, multi-disciplinary effort, of which evolutionary-informed analyses of human behaviour must surely play a part. Indeed, some researchers claim that an evolutionarily-informed and integrated social science is essential to make any headway on this issue (e.g., Mesoudi 2011).[1] In particular, great claims have been made about the revolutionary promise of evolutionary psychology: how it will transform and unite the social sciences, providing us with a better, more complete, explanation of the human mind (e.g., Tooby and Cosmides 1992, 2005).

There is a complication here, however. Darwin's theory of natural selection was published over 150 years ago; if evolutionary theory were going to transform psychology, and the social sciences more broadly, surely it would have done so by now? The fact that it hasn't suggests that evolutionary theorising may not be as useful to psychology and the other social sciences as we would like to think—non-evolutionary types simply may have different questions, interests and explanatory targets; evolutionary ideas do no additional work, and thus add little value to their research projects. After all, many biochemists do not specifically test evolutionary theories, despite recognizing the power of evolutionary thinking in the biological sciences.

An alternative argument—one made more frequently— is that the social sciences are immune to the power of evolutionary thinking because of motivated resistance (Burke 2014; Jonason and Dane 2014). Many in the social sciences are alleged either to reject the notion that there is an evolved biological basis to our psychology—preferring instead a view of the human mind purely as product of culture— or to reject science altogether, viewing as just another mode of discourse, and disputing any claims it might make to authority in explaining the natural world (see Ross 1996, Barkow 2006). With respect to the latter, there is

[1] Although sympathetic to the idea that evolutionary approaches enrich the human sciences, and enable us to offer a more complete explanation of human behaviour, I am less enamoured of the idea that all the social sciences *must* be united and integrated under the banner of Darwinism. I therefore adopt a pluralist stance: one that recognises an overt evolutionary framework is not always necessary to answer some of the interesting questions we wish to ask about human lifeways.

little one can do to convince the committed post-structuralist; any of the arguments one could put forward to defend a scientific stance are simply grist to their mill. The absolute best we can do is to agree to disagree, and even that concession may stick in the throat of parties on both sides.

It would, however, be foolish to dismiss all work that casts a critical eye on science and its methods. There are number of excellent, thoughtful scholars (some of whom were or are practicing scientists) who tackle issues in the history and sociology of science, and provide a useful perspective on science as a human, and hence imperfect, social activity (e.g., Shapin and Schaffer 1985; Daston & Gallison 2007; Marks 2009; Pickering 2010; Shapin 2010). Moreover, once understood in context, arguments against certain applications of evolutionary theory to humans hold genuine currency: in anthropology, for example, it is readily apparent that early biological and evolutionary theorising was both reductionist, racist, and linked strongly to colonialism (Marks 2009; Sussman 2014). Ongoing suspicion of biological explanations is not difficult to understand given that, at certain times and places, the biological explanations on offer were indeed suspect.

At the same time, it is apparent that some social scientists have simply failed to register the shifts in evolutionary thinking that have taken place over the last century, often due to a lack of appropriate background (see e.g., Park 2007; Burke 2014 for discussion). The arguments raised against evolutionary thinking often describe positions that have been superseded both theoretically and empirically, including the idea that there are simple linear relationships between genes and behaviour. Such outdated positions allow social scientists to persist with the argument that biologically-based explanations are both heavily reductionist and deterministic (see also Barkow 2006). But this couldn't be further from the position now held by the majority of geneticists and biologists. As Fisher (2006, p.270) puts it, referring expressly to cognition: 'Genes do not specify behaviours or cognitive processes; they make regulatory factors, signalling molecules, receptors, enzymes, and so on, that interact in highly complex networks, modulated by environmental influences, in order to build and maintain the brain.' In all fairness, however, it should also be mentioned, that some evolutionary psychological studies do, in fact, display elements of simplistic evolutionary reasoning (e.g., Jonason et al. 2013). Moreover, its cause often can be traced to the same source—a reliance on outdated evolutionary thinking, particularly from the 1970s—which West et al. (2011) refer to as the 'disco problem'. Thus, not all the criticism levelled at the human evolutionary sciences necessarily misses its mark.

Analysing the tensions within and between the natural and social sciences suggests we are confronting two problems, one more tractable than the other (see also Barkow (2006) for a thoughtful and detailed discussion of these issues and possible solutions). As already noted, there is no hope of convincing the committed anti-scientific post-structuralist, so we can abandon that as a non-starter. The more tractable problem is whether other social scientists can be persuaded by modern evolutionary thinking. My suggestion— and the focus of this chapter— is that the latter might succeed if evolutionary social scientists engaged more fully with current thinking in philosophy of mind and cognitive science. From this, it may be possible, as Rowlands (2010) suggests, to build a new science of the mind— one that will appeal to both social and natural scientists alike—because it presents a different conception of what minds are.

2. REAL REVOLUTION

The problem, then, is that evolutionary thinking in psychology is not that evolutionary thinking is too revolutionary; rather, it is just not revolutionary enough. Evolutionary psychology, after all, sticks pretty closely to standard cognitivist views of 'Individualism, Intellectualism, and Internalism' (Hutto 2013, p. 175), where cognitive processes are considered to be purely brain-bound individual computational-representational processes and that '…the mind's main concern is not acting but thinking, and that paradigmatically thinking is directed at ascertaining truths' (Fodor 2008, p.8). EP is simply business as usual. The advantage of EP is that is provides a means to ground psychology as a discipline (at least in principle), by providing an explanation (or set of explanations) about what our minds are for, and why our cognitive architecture takes the form that it does. What EP doesn't do, however, is question this model of the mind. The same is true of cognitive anthropology (e.g., Sperber 1996) and gene-culture co-evolutionary theory, which also accept a standard cognitivist approach to mind, with culture often operationally defined culture as information inside people's head (although, of course, it does deals more explicitly with human culture as

a system of inheritance distinct from our biology) (Richerson and Boyd 2005; Mesoudi 2011; Henrich 2016).[2]

3. PICTURES OF THE MIND

The picture of the mind to which both evolutionary psychology and traditional cognitive psychology adhere is one that, as Rowlands (1999, p.) puts it '…began life as a controversial philosophical thesis and then evolved into common sense.' The philosophical thesis referred to was laid out by Descartes, who proposed that minds can be conceived of as objects which possess certain properties, much like other organs of the body. These properties enable minds to carry out a particular function, and the function of the mind is to think. For Descartes, the difference between the mind and our other bodily organs was that the mind was a non-physical substance. This came about because of Descartes' commitment to a mechanical universe and the atomism of the scientific revolution: the physical world was governed by purely mechanical principles, and the behaviour of any macroscopic body could be explained in terms of the motions of the atoms of which it was made. In the context of the 'body machine', Descartes could conceive of many functions that could be instituted mechanically, specifically 'the reception by the external sense organs of light, sounds, smell, tastes, heat and other such qualities…the imprinting of the idea of these qualities in the organ of the "common" sense and the imagination, the retention or stamping of these ideas in the memory, the internal movements of the appetites and passions and finally the external movements of all the limbs' but he could not conceive of a way in which rational thought could be explained mechanically: 'it is for all practical purposes impossible for a machine to have enough different organs to make it act in all the contingencies of life in the way that reason makes us act.'[3] (Descartes, 1637, the *Discourse*: Cottingham et al. 1985, p. 140). If thought could not be mechanised then, by definition, it could not be physical. Hence, humans possessed a material brain that operated on mechanical principles, but a non-physical mind that operated according to the principles of reason. This view of the mind as a "ghost in the machine" (Ryle 1949) is one that has received fierce criticism and universal rejection by psychologists and neuroscientists alike; today, we consider mind to have a material basis, and noone would admit to being a substance dualist in Descartes' sense. Moreover, the notion that mind cannot be mechanised has also been roundly rejected with the rise of the computational theory of mind; nowhere more so than within evolutionary psychology, with its emphasis on functionally specialized problem-solving algorithms.

As Rowlands (1999) points out, however, there is another facet to the Ryle's expression: the ghostly mind is to be found *in* the machine. Although non-material, Descartes nevertheless assumed that the mind was a wholly internal entity, to be found inside the skin of the organism that possessed it. While substance dualism was rejected, the assumption of internalism was subject to no criticism at all. Thus ignored, internalism has remained intact and unquestioned to this day. Exorcising the ghost from the machine has not, therefore, eliminated all elements of the Cartesian conception of mind: although the mind itself is now material (and to some, mechanical), it continues to remain bound securely within the skin and skull, and it is this picture that informs the human evolutionary sciences.

Other pictures are possible, however, and continuous efforts have been made to think differently about the mind over the course of the twentieth century. As Hutchins (2010) points out, early pioneers were the anthropologist, Gregory Bateson, who took the first steps to an "ecology of mind', the experimental psychologist, James Gibson, father of 'ecological psychology, and the Russian developmental psychologist, Lev Vygotsky, who was instrumental to the rise of cultural-historical activity theory (CHAT). John Dewey, the American pragmatist philosopher should also be included as one of the "ancestors of a modern synthesis of cognitive ecology approaches" (Hutchins 2010, p.709), extending its provenance back into the 19th century. In each case, organism-environment relations were 'seen in terms of coupling, coordination, emergence and self-organization, rather than the transduction of information across a barrier.' (Hutchins 2010, p.710).

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[2] Human Behavioural ecology meanwhile has tended to ignore the mind altogether, choosing instead to investigate the extent to which formal models developed to explain non-human animal behaviour can account for the patterns seen in human populations; again this is not revolutionary to behavioural ecologists and, for the most part, HBE simply fails to address the concerns and interests of non-evolutionary anthropologists and sociologists, who are more interested in what people think and why, rather than the functional consequences of their behaviour in terms of reproductive outcomes.

[3] Descartes, as should be apparent, would not have been a fan of massive modularity.

Consequently, the environment was seen not merely as the background against which behaviour played out, but as an interface at which essential processes took place. In all cases, however, these ideas and research programs failed to gain sufficient traction to overcome the dominant Cartesian conception.

More recently, there has been a renewed effort to unseat the internalist view, and demonstrate that the prevailing picture is not the only way we to think about minds. These dissenting views fall under the umbrella term of 4E cognition (i.e., where the Es stand for embodied, embedded, enactive and extended) (see Rowlands 2010 for a review). Although there are some important differences between the different schools of thought encompassed by 4E cognition, all share in common the idea that: 1. the evolutionary origins of mind and cognition are to be found in the control of perception and motor action in a dynamic environment 2. As a consequence, cognition cannot be divorced from its bodily and environmental contexts. 3. Hence, it is a mistake to attribute cognitive processes to brains alone, rather cognitive processes must be understood as contextual, relational phenomena, reflecting the nested arrangement of brains, bodies and environments. Cognitive processes therefore spread beyond the brain, into the body, and out into the environment (e.g., Clark 1997, 2008; Clark and Chalmers 1998; Rowlands 1999; Chemero 2009; Barrett 2011).

What this means is that, if cognitive processes have an environmental component, then we cannot understand such processes by focusing exclusively on what goes on inside the skin of the individual subject. They are positions that argue for what van Dijk (2016) calls a 'horizontal attitude'. By this, he means a strategy that 'looks sideways' at the contexts of behaviour and its environmental supports, rather than assuming the answer will be found by digging below the surface to identify a unique form of cognitive machinery (the standard "vertical" approach). I want to emphasize this point because, in previous work where my colleagues and I offered a 4E view as an alternative to the evolutionary psychological computational model of the mind (Barrett et al. 2014), critics and commentators argued that we had done no such thing: given that 4E cognition does not rule out the idea that minds and cognitive processes are computational, it does not offer an alternative to the dominant view of the mind within EP. This is accurate, but misses the point. What we were rejecting was not computationalism[4], but internalism.

A new science of the mind based on externalist principles will, I hope, be more conducive to engagement with the other social sciences, by resituating our understanding of the mental, we will naturally incorporate elements of their subject matter: anthropology and sociology, in particular, are concerned with social processes as relational phenomena, and do not focus on the individual as a unit of explanation. Rather, the focus is on the relations and networks that help define people, and the groups in which they live, the dense webs of meaning we create through social practices, as well as the manufacture and use of artifacts, and the formation of various institutions (and other supra-individual structures), that are both created by and shape individual decision-making processes. In addition, the view of human nature that follows from a 4E approach helps undercut the distinction between culture and biology, nature and nurture, and may finally rid us of the ongoing, but sterile, debate regarding their relative importance.

4. A SURVEY OF COGNITIVE ECOLOGIES

Rejecting internalism is not, however, an all or nothing enterprise. There are a variety of positions one can take, some more conservative than others. Again, there is much debate over these distinctions and the relative plausibility of the various positions but, again, they all resemble each other, by viewing all cognitive processes (and minds) as fundamentally and intimately tied to the manipulation of environmental resources, props and scaffolds of various kinds, with various feedback, feedforward and looping effects (Clark 2008). Here, the environment is not simply a source of input to the cognitive system, but a necessary component.

Given this, a rejection of internalism is also a rejection of the idea that psychology can, and should be, a conventional laboratory science. Currently, we assume we can explain the mechanisms of psychology

[4] Although I do, in fact, disagree with many aspects of computational-representational theories of mind, and are sympathetic to radical enactivist views (e.g., Hutto & Myin 2013) which argue that 'basic minds', i.e., pre- or non-linguistic, minds are non-representational. For my purposes here, however, I can remain neutral on the issue: arguing that cognitive processes have a large environmental component does not require one to take any particular stand on the issue of computationalism.

irrespective of the environment where the organism is located. Although we need the environment to construct evolutionary and developmental hypotheses concerning our capacities, the capacities themselves are viewed as purely internal. If cognitive processes are not fully internal, however, then standard laboratory set-ups may fail to capture the phenomenon of interest, or they may mistake behaviour scaffolded by the environment as the product of internal processes. This does not mean psychology cannot be an experimental science, but it does mean that any such science must informed by an understanding of the cultural practice of experimentation itself (Hutchins 2008).

In what follows, I offer a brief survey of the externalist landscape, in order to introduce these ideas to unfamiliar readers, and provide a sense of how thinking differently about the mind leads to a new conception of how we can study the mind scientifically.

Distributed Cognition

One of the pioneers of what we could call the 'second wave' of cognitive ecologists, following the earlier efforts of Bateson and Gibson, is Edwin Hutchins (Hutchins 1995, 2008, 2010). His form of cognitive ecology, which is often known by the term 'distributed cognition', places the emphasis on collective activity, rather than individual capacities, thus generating cognitive states that are socially distributed, i.e, the group as a whole is viewed as the entity that possesses a certain kind of knowledge or is attributed a particular belief or other mental state. Combined with the use of environmental resources and tools, cognitive states are thus spread over brain, body and world. On Hutchins' account, cognition is also precisely defined with respect to symbol manipulation (something that is not true in general, where cognition and mind are often used interchangeably, and cognition itself is also defined vaguely), hence cognitive processes are strongly social and cultural in origin, and (seemingly) apply to humans alone. Indeed, one of Hutchin's most interesting points concerning the standard cognitivist, computational view, is that cognitive scientists have not actually been modelling cognition itself, but rather the formal symbolic tools and systems that human cognition itself created and has now adapted to—consequently, computational models of the mind are themselves cultural symbolic tools.

Hutchins' (1995) classic work '*Cognition in the Wild*' deals with the art of navigation, providing a detailed analysis of the process in the Western military, along with a fascinating comparison to Micronesian navigation. His ethnographic study of an amphibious helicopter transport vessel revealed that navigation is a feat that no single individual can achieve alone. Instead, the task is accomplished via the layout of the ship, the way tasks are delegated across different individuals, the social hierarchy, and the way information is combined using specialised tools. This generates the knowledge needed to safely guide the vessel to harbour, but it is knowledge that resides in the entire sociocultural system of the ship, with no one individual possesses all the knowledge and know-how needed to complete the task.

Another classic study in "distributed cognitive ecologies" is Lynn Tribble's analysis of how Elizabethan actors in the Globe Theatre were able to learn a repertory of half a dozen plays, without full scripts or dedicated rehearsal time, by means of distributing the cognitive tasks involved across other players, the lay-out and organisation of the stage, and the use of various external props and prompts (Tribble 2011; see also Sutton 2006). Distributed cognition, then, places most of its emphasis on how cognition is *socially* distributed; a feature I return to below. This distinguishes it from a number of the other externalist views, which are more concerned with the individual mind.

Enactivism and Extensive Cognition

Possibly the most radical view on offer is the idea that the human mind or cognitive system[5] is unbounded, as John Dewey would put it (Dewey 1916, 1981; see also Vaesen 2014), or, as Hutto & Myin (2013) would say, "extensive". This view is most closely associated with the school of thought known as enactivism. This draws on work in dynamical systems theory, and views cognitive processes as dynamic relations (or transactions) between organism and environment. In this view, minds (or cognitive systems) are never confined to the head because, by definition, they are world-involving processes: there simply is no boundary to be drawn. This unboundedness is a source of continuity across the animal kingdom—all

[5] As noted in the discussion of Hutchins, there is a distinction to be made between minds, mental states and cognitive systems, but from here on I use the term interchangeably following the lead of the authors' whose work I discuss.

organisms exploit bodily and environmental sources in order to generate flexible, adaptive behaviour in their particular niches (see Barrett 2011 for a review)—and also a source of difference between humans and other animals: the sheer number and complexity of the external resources that humans have at their disposal is vast compared to those of other species.

Some in the classic enactivist camp make an even stronger argument, suggesting that any attempt to distinguish cognition from other kinds of processes is, essentially, meaningless, and consider all life to be inherently cognitive (Varela et al. 1992). More specifically, Thompson (2007) offers us the position that "life and mind share a set of basic organizational properties, and the organizational properties of mind are an enriched version of those fundamental to life. Mind is life-like, and life is mind-like" (p.128).

Although there are some potential problems with this argument,[6] from my perspective here it does help to make the broader point that enactivism, and indeed 4E views in general, are explicitly evolutionary, making use of what Rowlands (1999) refers to as the "barking dog principle" (based on the adage: why buy a dog, and then bark yourself?). Specifically, if the environment already contains structures that be recruited and exploited to solve an organisms' problems, then a thrifty evolutionary process will select for this solution, rather than the alternative of evolving expensive brain tissue to recreate these environmental structures as internal brain-based structures (but see Shapiro 2010). As Brooks (1999) has shown, it often pays dividends simply to "use the world as its own best model".[7]

Extended Minds

An equally radical position is the Extended Mind hypothesis (Clark and Chalmers (1998) where, again, the environmental resources we use and exploit in the service of adaptive behaviour are argued to literally form part of an individual's cognitive system: humans are, in Andy Clark's (2003) words, 'natural-born cyborgs', whose cognitive states are distributed across brain, body and world.[8] As Clark (2001) puts it: 'The intelligent process just *is* the spatially and temporally extended one which zig-zags between brain, body, and world'. Importantly, external resources are only considered as parts of the mind when they are coupled in a robust, reliable and persistent way to internal processes, and they count as part of the mind only during the execution of the relevant task (which is when this crucial form of coupling occurs). Thus, not all and every environmental resource we use forms part of our cognitive system.[9]

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[6] One major problem with this position, as some see it, is that, if everything is cognitive, then nothing is (van Duijn et al. 2006): that is, we are left no means of getting to grips with why a bacterium differs from a baboon or a blowfly from a badger. Lack of space prevents me from addressing this further.

[7] Radical embodied and enactivist views are also distinguished by a rejection of the computational and representational mind that defines modern cognitive psychology (or at least for non-linguistic or pre-linguistic creatures like non-human animals and human babies). This position arises directly from a commitment to an unbounded mind but, for present purposes, we do not need to consider why this in any further detail.

[8] Radical enactivists, however, argue that the extended mind thesis implicitly accepts the idea of an internal cognitive system: if cognitive processes extend out from the brain and body into the world, this suggests there is a fixed boundary to the mind beyond which extension occurs. Some extended mind theorists seem to consider this to be a terminological argument and that nothing of importance hangs on this distinction (e.g., Sutton 2015). From my perspective here, the two positions are equally radical with respect to the picture of the mind they offer.

[9] I emphasize this point because the extended mind thesis is the one that has come in for most criticism, with dissenters arguing that tools and other external resources are not literal constituents of our minds, but are only causally related to them—a stance known as the "coupling-constitution fallacy" (Adams and Aizawa 2001, 2011). Part of the reason for offering such criticism is a fear of "cognitive bloat"; that is, of drawing the bounds too widely, so that everything becomes a part of the human cognitive system, resulting in a motley assortment of external props and resources from which it will prove impossible to construct a useful, empirical science. This is a real concern and not one to be taken lightly, but for our purposes here, I do not need to get into the details of these philosophical discussions, not least because there is no consensus on what should count as a 'mark of the cognitive' and so define where the boundary is drawn, i.e., what distinguishes between a constitutive versus merely causal contribution to cognitive processes. As Hurly (2010) has noted, this could simply be the source of another kind of error: if neither side in the debate can demonstrate conclusively where the bounds of the cognitive system should be drawn, why assume that any such boundary will favour internalism? Given this, many theorists have suggested that issue is an empirical one, to be decided by scientific efforts, and not by a priori philosophical theorising.

The classic example used by Clark and Chalmers (1998) is that of the fictional Otto, who has a mild form of Alzheimer's disease. Otto relies on a notebook containing all the relevant information he needs to function. Otto wishes to visit the Museum of Modern Art in New York City, consults his notebook and makes his way to 53rd Street. Clark and Chalmers (1998) argue that Otto undergoes precisely the same process as his friend, Inga, who uses her internal biological memory to retrieve MoMA's address: both act on the belief that it is located on 53rd Street. This being the case, we have no reason, bar a neurocentric prejudice, to treat the notebook as any different to biological memory—that is, it is possible for a mental state to be externally located.

We can see this even more clearly by raising the possibility that Otto locates the address of MoMA via a chip implanted in his brain. Under these circumstances, the process of retrieval would take place internally—within Otto's brain—and we would have no hesitation including the chip as part of Otto's cognitive system. Why then should we think differently about Otto's external "chip", the notebook that he keeps in his pocket, rather than inside his head? Clark and Chalmers (1998) thus make the case that what matters is the role played by the various components of the cognitive system, not what these are made of, or where they are located.

As the above example makes clear, Clark and Chalmers (1998) argue for what they called "the parity principle" between the use of external and internal resources (i.e., one directly replaces or stands in for the other), but other theorists have suggested that external resources can be complementary to internal functions, in ways that augment and enhance internal processes, a position known as cognitive integration (Menary 2007, 2010; Sutton 2010). External resources can do this because they can store information in ways that are inherently more stable than biological processes, and also do not depend on a particular modality or the execution of a particular kind of task. A flash-drive (memory stick) is more stable than our biological memory, for example, as the former is altered by the process of retrieval. Consequently, external resources can also improve on our biological capacities, rather than simply substitute for them (Menary 2007, 2010; Sutton 2010). In both first and second wave extended mind views, there is no explicit stance taken on the nature of internal cognitive processes (these can take an entirely conventional computational-representational form), and the question of interest is where the bounds of the cognitive system should be drawn.

Embedded or Scaffolded Minds

Perhaps the least radical of the 4E positions on offer (although still pretty radical from a standard internalist position) is the idea that minds and cognitive processes are "embedded": certain behaviours and cognitive skills are so strongly scaffolded by environmental resources that the processes in question would simply not be possible without such environmental supports (Rupert 2009; Sterelny 2010). In this view, there is an acceptance that cognitive processes are distributed across brain, body and environment, but a rejection of the idea that one should therefore treat external resources as literal parts of the mind. This is because treating external resources as literal components of our minds/cognitive processes does no unique explanatory work: we can achieve the same insights by viewing cognitive processes as transcranial hybrids—part mental, part non-mental—because it is the transcranial nature of such processes that is crucial, not whether we consider environmental resources as literal parts of our minds or cognitive processes (see Sprevak 2010 for a more detailed consideration of the claims of extended versus embedded mind).

Sterelny (2010) offers a justification for this position by referring to "extended digestion". Cooking and food preparation are widely acknowledged to have transformed hominin physiology by altering the selection pressures acting on jaws, teeth and guts, and by extension, our brains. We have reduced the demands of eating by chopping and slicing our food, and processes like heating, soaking, pounding, and fermentation have altered the chemical composition of food, improving its digestibility and nutritional value. This, in turn, is argued to have altered selection pressures on our gut, and released a constraint on brain size evolution: cooking reduces the demands on digestion, with the result that the energy previously required to fuel expensive gut tissue could be diverted into brain growth. In addition, as Sterelny (2010) points out, we have also improved the nutritional value of our plant food resources via domestication and selective breeding.

The human gustatory niche is thus a heavily engineered one, and our digestion is environmentally scaffolded by all manner of technological props and supports. Indeed, we are now obligatory cooks: it is

almost impossible for humans to subsist on a diet of raw food alone (Wrangham 2009). Now Sterelny (2010) springs his trap, asking whether this means that "…my soup pot, my food processor and my fine collection of choppers [are] part of my digestive system? As far as I know, no one has defended an extended stomach hypothesis, treating routine kitchen equipment as part of an agent's digestive system" (p.468). As Sterelny (2010) goes on to point out, one reason why this might be is simply an accident of our intellectual history. That is, we could argue that digestion is extended in exactly the same way that Clark and others have argued that cognition is extended. But, Sterelny (2010) suggests, once we have acknowledged and appreciated the vital role that environmental scaffolds play in supporting our behaviour, there is no further explanatory mileage to be had in supposing that "digestion takes place on my stove as well as in my body".[10] Personally, I have no trouble with a notion of an 'extended stomach', especially given our increasing knowledge of the human microbiota—the bacterial communities that occupy the human gut (see e.g., Nicholson et al. 2012). Noone disputes that these form an integral part of our digestive processes, yet they are not an integral part of our bodies: we off-load part of our digestive system onto these organisms. The difference between regarding cooking as part of digestion and the microbiota as part of digestion seems to rest purely on the fact that one operates outside and one inside the body, which is precisely the internalist prejudice that Clark and others are attempting to break down with respect to cognition. Indeed, this is partly why Clark (2008) makes the case for an extended view rather than a more conservative embedded view—only the former genuinely unseats our standard picture of the mind, whereas the embedded view allows us to keep that picture intact.

Sterelny's (2010) preference for scaffolding (embedding) over the extended mind is more subtle than it first appears, however. For Sterelny, environmental scaffolds occupy a multi-dimensional space, which amplify and augment an agent's cognitive capacity to varying degrees. On this view, the extended mind shouldn't be opposed to the embedded mind, or given a special label, because this obscures the fact that extended minds are just a special case of a more general phenomenon; they occupy a particular niche in the overall landscape. To illustrate this, Sterelny (2010) discusses a number of these dimensions, and how they vary. For example, certain environmental resources should inspire a higher level of trust than others—Otto's notebook, for example, strikes Sterelny as vulnerable to malicious alternation—the removal of vital information or the addition of falsehoods—whereas subway maps and other publicly shared resources can be treated as much more reliable precisely because they are shared (it's much easier to interfere with a single notebook than the signage of an entire subway system). Environmental resources can also vary from being interchangeable to highly individualised or personalised: a tennis player prefers a certain kind of racquet, with specific grip and tension, a chef has a special set of personal knives. There is also a process of mutual modification: the person adjusts to fit the specific demands of the tools, just as the tools become shaped to the person, and the use of that tool becomes "entrenched", not just individualised: if forced to use

[10] Paul Thagard has offered a similar criticism in a Psychology Today blog post, where he introduces the notion of "extended breath" as a parody of the extended mind. Once again the hapless Otto is pressed into service, this time suffering from emphysema, and thus placed on a respirator. Otto's ability to continue breathing thus demonstrates that "…breathing is not just a lung process, but can be extended into the world by machines such as ventilators". Thagard goes on "Critics will undoubtedly complain that the extended breath hypothesis uses obvious observations about machines and interactions to obscure the fact that lungs are in fact the key organs for performing respiration' , thus making the point that environmental props and resources need not and should not be considered constitutive parts of the process. As Paul Patton, a commentator on the piece, points out, however, Thagard makes a key blunder. Respiration is a cellular process that takes place in the mitochondria, and lungs are simply the sites of gas exchange. As such, lungs *are* part of a larger system, and do not perform respiration alone. Even if we assume Thagard is really talking about breathing, Patton suggests, his criticism is still wide of the mark, because lungs also do not breathe on their own. They need to be situated in a chest cavity with a rib cage and a contractile diaphragm, plus the external atmosphere needs to contain an appropriate partial pressure of oxygen. As Patton argues, once explained correctly, breathing clearly is an embodied, embedded process, and there are real benefits to be had from adopting such a view: "Consider a respiratory doctor who knew only about gas exchange in the alveoli of the lungs, and was clueless about every other aspect of respiration. He or she wouldn't realize that polio, a disease that causes weakness of the diaphragm, could result in impaired breathing." The use of an iron lung in such cases is, clearly, an example of extended breath, because it does the work of the diaphragm. Similarly, a doctor ignorant of the role the external atmosphere plays in respiration wouldn't recommend supplemental oxygen to mountain climbers, an oversight that could also have fatal consequences. Thagard's parody actually makes the argument he set out to ridicule. https://www.psychologytoday.com/blog/hot-thought/201310/the-extended-breath, retrieved March 14th 2017, 16:45pm.

an alternative to her preferred racquet, the tennis player may well seem clumsy and less skilled. In contrast, we can usually swap between different pencils, or cutlery, without deficit—these tools are interchangeable. Finally, Sterelny (2010) discusses whether the skills in questions can be assigned to individuals or form part of a collective. In his view, certain kinds of skills are best seen as properties of collectives of people and their surrounds—that is, they are socially distributed in the way that Hutchins (1995, 2010) describes—and not of individuals alone, and in this sense it becomes difficult to fit them into the extended mind framework.

Thus, Sterelny's (2010) dimensional analysis suggests that extended processes occupy the corner of the landscape where there are high levels of trust, high levels of personalisation and where the cognitive processes are individual achievements, not those of a collective. Moreover, Sterelny (2010) concludes that extended mind cases probably occupy a much smaller area than many might think because many of the environmental resources that extended mind theorists consider to be individual are actually collective. Much of the environment that humans exploit consists of the products of past cultural activity, and young humans are shaped by growing up in a highly engineered, cultural niche. The various resources that, in the extended view, become part of our individual minds are produced by a history of invention by others. In that sense, they are collective resources, produced by and through cultural and social practices that existed prior to our use. Extended minds must therefore also be social and collective—at least partly—with cognitive states shared across other people, through the tools we use, and the manner we learn to engage with them. We have, in other words, come full circle back to Hutchins.

From this brief survey, it should be apparent that, if we acknowledge that our cultural-technological practices—the way people make and do things together— make a fundamental contribution to human cognition, we are faced with the rather large problem of how to make this fit with the dominant picture that privileges isolated, individual minds and internal, abstracted processes. As Hutchins (1995, p.354) puts it, '[t]he early researchers in cognitive science placed a bet that the modularity of human cognition would be such that culture, context and history could be safely ignored at the outset, and then integrated in later. The bet did not pay off.' Consequently, "some of what has been done in cognitive science must now be undone so that these things can be brought into the cognitive picture" (Hutchins 1995, p. 354). There is, as they say, no time like the present.

5. MOVING FROM EVOLUTIONARY PSYCHOLOGY TO COGNITIVE ECOLOGIES

A 4E view of cognition, then, offers an evolutionary-grounded view of human cognitive abilities that treats human social and cultural practices and technologies as integral to those cognitive abilities, and not simply their product (Barrett et al. 2014). Once we recognize the role played by extra-neural bodily and environmental resources in our on-going activity, it becomes harder to see where the mind ends and the rest of the world begins. Hopefully, it is also clear that an externalist picture of the mind neither denies the importance of the brain, nor the existence of internal processes. Rather, it simply expands our conception of what it means to be a cognitive system. In other words, the contribution of e-cognition, and the extended-scaffolded view in particular, is entirely positive: to expand the explanatory resources we have available in our studies of psychology and cognitive science (see Sprevak 2010). This being the case, what implications does this view hold for how we actually study psychological processes? There are two answers to this. As far as "classic" cognitive psychologists are concerned, the answer is: not much. As hinted at above, adopting an extended (or embedded or scaffolded or distributed) perspective does not entail that we abandon the study of individual capacities. To argue that notebooks can (sometimes) function in the same way as biological memory—or whatever extended system we are interested in—is not to argue *against* investigating individual cognition in the traditional way, attending to the fine-grained specifics of individual performance.

Doing so, however, does require us to more closely scrutinize the strategy of methodological individualism (or solipsism) that has long dominated psychology. If our cognitive capacities extend to include parts of the environment (or even if they are only scaffolded), then bracketing off everything outside the individual subject may be counter-productive to a full understanding of human cognition and behaviour. One can make an analogy with studies of non-human animals, where studies of natural behaviour sometimes suggest the possession of cognitive capacities that cannot then be demonstrated under laboratory conditions. One explanation given for this is that a lack of experimental control encourages an overly liberal, and often anthropomorphic, interpretation of behaviour under natural observational conditions. Another possibility, however, is that, under natural conditions, animals lean on the environment in ways that

improve their problem-solving (or other) abilities (Barrett 2012). If laboratory set-ups fail to include such environmental supports, under the assumption that the brain does all the heavy-lifting, then the animal will obviously fail to manifest these abilities in the laboratory. The "classical" cognitivist might say, with justification, this is because the animal lacks the requisite cognitive abilities (because these are, by definition, brain-bound processes). What the cognitivist cannot do, however, is explain why the animal performs as it does in the wild, nor would there be any justification for the claim that natural observations are necessarily mistaken because the behaviour cannot be reproduced in the laboratory (precisely because the behaviour may now be crucially dependent on environmental supports). The extended/extensive mind advocate would say that, as the experiment (potentially) excludes part of the animal's cognitive system, we cannot say one way or another if the animal possesses the ability in question. We can only do so by investigating the intact system. If we design experiments that can do so, and reproduce the wild behaviour in the laboratory, we will then have a deeper understanding of the animal's "cognition in the wild"—and this is true for both the cognitivist and the extended mind theorist. The same would seem to be true of human performance.

Thus, even the committed cognitivist may benefit from the extended/scaffolded view by becoming more aware of environmental structure, and how it can be exploited, within a cognitivist paradigm. For example, Landy and Goldstone (2007a) showed an effect of perceptual grouping on mathematical problem-solving where, for example, the physical spacing used in formal equations had a large impact on whether they were judged as valid or not (see also Landy and Goldtone 2007b, 2010). That is, the physical format mattered to task success. A failure to recognise this, as Landy and Goldstone (2007a) note, could risk modelling this process as conceptual and interpretative, when aspects of it are actually perceptual. Similarly, Lock (2013), in her analysis of Alzheimer's disease, argues that more attention should be given to public health approaches to prevention, care and coping—strategies that recognise the entanglement of minds and environments—rather than focusing purely on biomedical strategies aimed at studying the brain in isolation in an effort to find a cure. This, in turn, echoes a point made by Clark (2008), who describes how many people with Alzheimer's disease function much more effectively than one would predict thanks to the strategies they use to ensure their environment can compensate for deficits in their "on-board" memory, and allow them to remain independent (e.g., post-it notes in strategic places, ensuring the layout remains stable and supports the memory functions they have lost).

One obvious response to the above would be to say, as Payne et al. (2001) do, that while the off-loading of cognition, and the use and exploitation of external tools, is indeed widespread and useful, it is the human agent that, when all is said and done, determines the relative balance of internal versus external strategies employed. This is similar to the objections levelled at the extended mind argument, which argue that the brain ultimately has the final say for much the same reason (e.g., Adams and Aizawa 2010). The person—or brain—is the controller of action in a way that other things, like iPhones and notebooks, are not. Although stating that the person has agency may be more appropriate than saying the brain itself has agency (which would be to commit the so-called mereological fallacy: Bennett and Hacker 2003), such a stance does seem to beg the question: it assumes we know what agency is, and that it is endogenously generated, when both of these assumptions can be, and indeed are, contested. Another way to say this is that it is precisely this idea of a "privileged user" of our various non-neural and neural tools that the extended mind is designed to upend.

The problem with arguing that that the brain must have the final say is that, in any given instance, there may be parts of the brain that are not actively involved. This being the case, does this mean that, for example, it is only the frontal lobes that have the final word? The problem with such an argument should be apparent, because what if, having done the necessary empirical work, we find that no unique sub-system has the final word in any given process? Would this mean that the thinking agent has disappeared? The answer to this is obviously no: if we were to demonstrate such a thing, this wouldn't mean that we as thinking agents would suddenly disappear in a puff of smoke. What it does means, however, is that, as Clark (2008, 2014) suggests, we need to think more deeply about what it means to be a thinking agent, and what we mean when we speak of control, minds and selves. We also need to consider more seriously the possibility that we just *are* a shifting coalition of tools, "soft selves" assembled and reassembled from the "grab-bag of neural, bodily and worldly elements" (Clark 2014). In this sense, the case for the extended mind is a promissory note for a new science of the mind, not a new science of the mind in and of itself: it

presents us with an opportunity to develop the kinds of methods and research designs that are needed in order to be able to test whether a given process shows, in the words of Sprevak (2010, p.20) "internal self-sufficiency" ("mental processes are largely self-sufficient, and can be studied largely in isolation from environmental props") or is "externally dependent" (mental processes depend intimately on environmental resources, and should be studied within the context of those resources").

The second answer regarding the implications an extended/scaffolded approach concerns the evolutionary human sciences. In this case, an extended mind approach requires reconsideration of the notion that 'our modern skulls house a stone age mind', where environmental resources serve purely as inputs to our evolved cognitive architecture (Cosmides and Tooby 1997). This position leads to the argument that we are often mismatched to our present environments (i.e., that many aspects of modern society and our cultural practices are sources of disruption to our evolved cognitive programs), which raises the problematic issue of how we create and cope with novelty, despite having minds apparently ill-equipped to cope with novel circumstances. Although more recent theoretical treatments of EP avoid this conclusion, they do not allow environmental resources themselves to contribute to cognitive processes, not even as scaffolds (e.g., Barrett and Kurzban 2006; Barrett 2015). The picture remains fully internalist: cultural artifacts and practices are not picked out as being any different from other environmental inputs, nor do they exert any transformative influence on cognitive processes themselves. Hence, cultural activities remain distinct from, and firmly outside, the mind.

The same is true of gene-culture co-evolutionary approaches, where culture is conceived of as internal mental representations (Richerson and Boyd 2009, Mesoudi 2011), and where the internalist mind sets limits on the kinds of cultural artifacts we produce and the practices in which we engage (Sperber 1994). None of these positions recognize Clark's (2008) and Sterelny's (2010) point that cultural artefacts and practices can "turbo-charge" our cognitive abilities, via the way these outputs can serve as further inputs to our cognitive system (in much the same way that the exhaust flow in a turbo-charged engine is used to drive more air into the cylinders and so burn more fuel). Refocusing efforts along externalist lines may not be too difficult to achieve given that cultural influences are integral to this research program—cultural practices need to span brain, body and world, and not simply be assumed to lie in the head alone. In some instances, this may simply require new operational definitions for the terms used in formal models. For example, the level of information assigned to individual A's memory could be increased by also adding information present in the memory of individuals in A's social network (e.g., Gintis 2016, p. 101), while material artifacts could be modelled as amplifiers of the skills/knowledge possessed by demonstrators, or could themselves be assigned the ability to influence performance, decoupled from the presence of a skilled human actor. Classic ethnographic work along with more theoretically-driven work (e.g., elements of Latour's (2005) actor-network theory) could also be mined for information on how cognitive processes are orchestrated by technology and cultural practices, and provide a more detailed understanding of certain social contexts.

No doubt many current evolutionarily-oriented researchers will argue that they are already focused on context but, for the most part, this represents an acknowledgment that environmental contexts vary, and that such variation leads to behavioural differences. Truly attending to context means working toward an understanding of how cultural practices and technologies contribute to the outcomes achieved, and the impact they have on internal processes themselves. As Wheeler and Clark (2008, p.3571) put it, '[a] child whose early experience is shaped by the special environments provided by books and software programs, and whose own emerging cognitive profile favours certain elements within that culturally enabled nexus over other elements, will end up with a cognitive system that is not just superficially, but profoundly, different from that of a differently encultured child.' It is promising to note some indications that a more externalist view of mind is beginning to infiltrate— Henrich (2016), for example, refers to the abacus as a 'mental prosthesis'—but clearly we have a long way to go.

Interestingly, a leading proponent of EP has made the opposite criticism of gene-culture approaches, arguing that the inclusion of culture into evolutionary accounts is literally 'mindless'. Specifically, Cosmides (2016) has claimed that treating cultural processes as a second form inheritance system, independent of the process of genetic evolution, 'invites the inference that cultural inheritance can exist, be identified and understood without discovering the information processing architecture of the *many* evolved systems that generate, shape and create culture' (emphasis in the original) and that this has a 'long history in anthropology and the social sciences, where people have ignored [these mechanisms] entirely'.

This criticism actually seems rather misplaced with respect to gene-culture co-evolution theory and cognitive anthropology, both of which claim to have identified a number of internal cognitive mechanisms by which cultural practices are propagated. Leaving this aside, it is also apparent that, if we think of cultural resources as either scaffolds or constituents of our cognitive processes, this criticism simply has no purchase; indeed, it simply dissolves. Swapping an internalist picture for an externalist picture provides a way for cultural patterns to be brought into the psychological fold and, far from ignoring mechanisms completely, anthropological and ethnographic studies provide a rich source of insight and data that can be used to inform our psychological theories precisely because cultural practices are, depending on one's theoretical proclivities, essential scaffolds or literal parts of the human mind. Moreover, this approach also dissolves the nature-nurture dichotomy: if minds extend and incorporate environmental resources and tools (or are scaffolded and dependent on them), it makes no sense to speak of ancestral cognitive architecture, ill-suited to modern environments, because culture and biology are no longer opposed. There is, then, much to be gained from this (literally) mind-expanding view; it would be narrow-minded indeed to remain clinging to a Cartesian conception of mind.

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