Cognitive History and Material Culture

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Cognitive Theory, History, and Material Culture

Historians of material culture rightly care not just about artifacts, but about their personal and collective uses, both routine and unique, and about 'the ways in which matter interrelates with the meanings humans ascribe to things' (Rublack 2013, 43). They ask, for example, whether print techniques 'helped to reorder the thought of *all* readers', or the spread of reading brought 'an emergence of fresh qualities of mindedness' (Eisenstein 1979, 105; Hart 2011, 125-6). Could early modern clothing come to *constitute* the wearer, or was it at most a form of disguise for an 'internal identity [that] was permanent and essential' (Jones & Stallybrass 2000; Vincent 2003, 162)? In domains such as religion and natural philosophy, were the changing and contested forms of embodied practice and material apparatus mere external products of or supports for the participants' real, inner beliefs, or did they in some way restructure religious or philosophical experience itself? These questions all implicate cognitive history. They cannot be addressed effectively without some views – whether explicit or tacit – on the mind and its history. What is it to have experience, or beliefs? When and in what ways *can* thought be reordered and restructured? How are mindedness and identity constructed, and how do they change? And, in particular, what are the relations between minds and media, artifacts, and institutions?

This chapter introduces cognitive history as one way to study material culture, or to reconsider what many historians of material culture already study. The version of cognitive history we develop here builds on recent discussions of 'distributed cognitive ecologies' (Hutchins 2010; Tribble & Sutton 2011; Tribble & Keene 2011). On this approach, objects, technologies, places and other people can in certain circumstances, in interaction of many kinds with embodied individuals, be full and complementary components in cognitive processes. The mind can spread beyond brain and body, into the social and physical world. To understand the mind, we thus have to understand its media and materials, for in certain circumstances, things can have a cognitive life (Sutton 2008); while to understand material culture in action, we must reciprocally understand the sensing, feeling, thinking agents who make it, use it, and are in turn transformed by and with it.

This perspective, we suggest, can throw light on a range of historical problems of independent interest. If relations between belief, memory, or experience and material culture are viewed in a dynamic, ecological light, of course changing technologies, practices, and norms can restructure mind and consciousness. But this is happening all the time, for cognitive artifacts are the medium or process of mental activity. It is not that a private, inner, subjective realm – the province of psychologists or novelists, perhaps – is suddenly transformed, freed, or constrained by novel external material resources. Rather, the history of the mind just is the array and trajectory of distributed, hybrid cognitive systems.

In many early modern contexts, the concept of soul was of greater moral and personal significance than any notion of 'mind'. The soul was invoked in at least two divergent contexts. In religion, on most views, the rational and immortal soul was unique to human beings, who have an eternal fate. Simultaneously, the vital soul grounded the organic functions of living animals (Park 1988). Operating in many theoretical and practical contexts from medicine to morals, from physiology to the passions, this latter framework offered richly integrated ways to think about the bodily and

worldly bases of perception and emotion, memory and movement, even thought and the will (James 1997; Sutton 2013). As Sullivan and Wear's chapter on materiality and the body (this volume) shows, pervasive early modern ideas about the bodily humours grounded not only conceptions of health and disease, but also dynamic understandings of temperament and character, and of what we would call psychological processes. In particular, the state of the quick and nimble animal spirits, subtle fluids derived from the blood and coursing through the brain and nerves, influenced the clarity and efficacy of reasoning, decision-making, and remembering. But because the animal spirits themselves were constantly changing, affected by places, bodily regimen, and the nature of one's passions, the mind in this ecological framework was porous, open to a variety of worldly influences (Paster 1997; Floyd-Wilson 2003; Sutton 2007). If personal identity later came, in Western cultures, to be seen and experienced as more impervious, that sense of the mind as an interior or autonomous realm was a contingent (and fragile) historical achievement with complex moral and ideological dimensions (Johnson, Sutton, & Tribble 2014; Reiss 2002; Sutton 1998; Tomaselli 1984).

So early modern Europeans, both individually and collectively, were fascinated by the processes, pleasures, and perils of our mental lives as embodied agents. They knew that conceiving, making, using and appreciating artifacts involved skill and intelligence: the world of early modern material culture was in no sense mindless. Designing, navigating, remembering, hearing, grieving, decision-making, imagining, communicating – the whole range of psychological activities were as central to early modern lives as they are to ours. This is so even though in many such cases their experiences may have been different, and though they had different understandings of their experiences – different from each other, as well as from us. One striking initial difficulty in thinking historically about memory, emotion, the senses, reasoning, or skilled movement is that there is no neutral general term for our topic. The terms 'mind', 'cognition', and 'psychology' and their equivalents in other European languages all have complex and contested histories, as do related words like 'consciousness', 'attention', or 'self' (Wierzbicka 1992). There is still no agreement in philosophy or science as to what, if anything, unifies all the various capacities and activities we tend to think of as mental. Indeed, historical and cross-cultural analysis is one way to assess any claim about the nature of the human mind, or about its historical construction (Rorty 1980). Sticking with the word 'cognitive', we follow standard modern usage in expanding the meaning of 'cognition' well beyond its narrower historical sense of explicit thought or reflective knowledge. While *ideas* about the mind of course influence and respond to cognitive practices, this chapter deals primarily not with early modern theories of mind, but with the history of mind in action. We survey existing approaches to cognitive history, before explaining why the idea of distributed cognitive ecologies is particularly promising for the historical study of material culture. Case studies and examples discussed include navigation, performance, and religious practice, before the final section addresses material culture in experiment, natural philosophy, and early modern technology. The chapter concludes with an explicit statement of the ways in which our recommended cognitive approach can encourage and promote effective historical work on material culture. We provide extensive references throughout, hoping to encourage historians actively to engage with and participate in these challenging cross-disciplinary conversations.

Cognitive History and the Cognitive Sciences

The cognitive sciences are the interdisciplinary sciences of mental life and of flexible, more or less intelligent behaviour. Like all major modern research institutions and practices, their history is itself complex and controversial, with links to a range of cultural and political movements (Boden 2006). In its earlier forms from the 1950s to 1970s, the focus of the 'cognitive revolution' was often on reasoning or calculation, mental processes closer to the primary historical sense of the term 'cognition': in such classical cognitivist work, the human mind was explicitly modelled on the kind of 'information processing' found in the digital computer, and also assumed to be located inside the

individual skull. But since the 1980s, as a result of both external critique and internal reform, dramatically different takes on both subject matter and theory have transformed the cognitive sciences (Varela, Thompson, & Rosch 1991; Clark 2001; Michaelian & Sutton 2013). For enabling a cognitive history of material culture, two related features of the new sciences of the embodied and extended mind are especially salient. Firstly, the full range of mental life is embraced: rather than a primary focus on 'rational' or explicit thought, the topics of emotion and action, communication and social interaction, sensory experience and bodily awareness are all firmly at the heart of current scientific work (Robbins & Aydede 2009). Secondly, in increasingly mainstream alternative traditions, cognitive processes are as we have already noted not 'internal' but are often 'distributed' across social and technological resources. In 'putting brain, body, and world together again', as the subtitle of Andy Clark's influential book had it (1997), cognitive scientists have developed 'anti-individualist' approaches: in certain contexts, particular artifacts (or places, or social interactions) are not merely external cues or triggers to the real process of sensing, remembering, or creating which occurs in the individual, but are themselves active constituents of the mental process.

In assessing the options available for cognitive history, we do not want to suggest that the distributed cognitive ecological framework is the only available or legitimate approach. Cognitive history takes many diverse forms, and now has its own *Journal of Cognitive Historiography* (Martin & Sørensen 2011; Eidinow & Martin 2014). In a number of relevant interdisciplinary fields, other approaches have been equally influential (Heintz 2011). Both the anthropology of religion and cognitive literary studies, for example, have seen significant work driven by firmly individualist alternatives such as evolutionary psychology, in which the human mind is a set of adaptive capacities of the brain shaped and more or less fixed far back in our species' past. In certain more universalizing forms, such approaches are less well suited to explaining specific historical variation; and because modular adaptations of shielded neural systems are taken to be the heart of the mind, material culture is at best an important but external system of cues or supports to the real cognitive processing in the head. Such views therefore also offer, in the extreme, a clear division of disciplinary labour: psychologists and neuroscientists study the true or essential nature of the mind, while historians and other humanities scholars attend to the contingent and changing play of technologies and artifacts which form the cultural froth overlaying the natural interior.

Our preferred approach, based on distributed cognitive ecologies, takes a dramatically different stance. In more thoroughly dissolving theoretical barriers between artifacts and users, structure and agency, and challenging residual divisions between the 'two cultures' of humanities and science, historians can draw on and contribute to the widespread recent rethinking of cognitive processes. Rather than giving 'psychology' up to reductionist, universalist, or individualist versions of science, historians can embrace it and flesh out the idea that cognitive activities are dynamic, social, and worldly, literally spread across distributed ecologies of brains, bodies, and physical and cultural settings (Hutchins 1995; Clark 1997).

In a flagship case study, Edwin Hutchins (1995) integrates historical and ethnographic studies of navigation in distinct cultural contexts as examples of 'naturally situated cognition'. Comparing celestial navigation among Micronesian islanders, the tools and techniques of early modern European navigators, and the massive technological and institutional system of a contemporary US Navy frigate, Hutchins shows in detail how the skilled cognitive activity of navigating the Pacific successfully is not executed by following a complete plan held in the mind or brain of any one individual. In contrast, in each distinct context, the cognitive processes of navigation are distributed across a number of people and a range of objects and instruments, where both the things and the practices in which they are engaged all have unique and complex histories. The Micronesian and Western traditions of navigation developed different solutions to the same problems of computing position and planning a course. Tracing the history of pre-modern Western navigation, Hutchins

argues that physical tools and mental skills were complementary elements in the computational ecology of navigation, emerging together in rich cognitive interdependence. The development of specific units of distance and speed, the increasing use of measurement in analog-to-digital conversion and the concomitant reliance on technologies of arithmetical computation, and the crystallization of knowledge and practice in the physical structure of durable artifacts – the astrolabe, the compass rose, the chip log, the chart – together formed a mutually dependent network of instruments and techniques (Hutchins 1995, 93-114).

In turn, Evelyn Tribble explicitly uses Hutchins' work on the coordinated roles of human agents, objects, and practices in distributed cognitive systems as a model for her account of the cognitive and mnemonic strategies of actors' companies in early modern English theatre. To meet the new demands of attention and memory in the Globe Theatre, for example, in which up to six different plays were performed every week without modern rehearsal periods or even scripts, actors on the Shakespearean stage were embedded among rich cues offered by the playhouses' physical architecture, a range of idiosyncratic artifacts such as partial plot documents, the company's established social structure in which apprentice actors learned performance on the job, an array of honed bodily skills, and the internal characteristics of the plays themselves. Where previous scholars saw the historical problem as one of the capacity and limits of individual actors' memories, Tribble's analysis reframes the issue of 'cognition in the Globe' at an ecological level, studying the material practices of the early modern stage as integrating memory, skill, embodied action, attentional devices, social hierarchy and group dynamics in a highly structured dramatic environment (Tribble 2011). This ground-breaking cognitive-historical study of distributed cognitive ecologies has in turn been taken up by and influenced theorists in philosophy and cognitive science (Clark 2008; Sutton 2010).

Some historians worry that such interaction with cognitive theory, seductive but insidious, will end in domineering takeover by reductionist science (Cooter 2014). This is not the case. First, as these two flagship examples demonstrate, cognitive history of this kind is not 'neurohistory'. Daniel Lord Smail rightly notes that many 'studies in the humanities have a psychological dimension', but goes on to equate this with the claim that they 'are laced with assumptions about how the brain works' (2010, 1). In practice, however, huge swathes of research in the cognitive sciences do not address the neural underpinnings of psychological processes. Further, as our sketch above already confirms, many cognitive scientists do not see psychological processes as restricted to the brain. Neural events may make vital and unique contributions to our intelligent interactions with the world, both constraining and enabling the ways we perceive, feel, and plan: but since they complement the diverse bodily, social, and environmental resources which also drive and form our experience, there is no reason to isolate or to privilege the brain alone in our analyses. Intriguing historical projects do focus on the brain, since cultural practices impinge so deeply on the operations of the human nervous system that our brains can be described as 'biosocial organs permeated by history' (Cowley 2002, 75; Smail 2008). There is no reason to think that such an integration of biology and culture in effect 'removes human agency from history' (Cooter 2014, 152). But cognitive history can paint on a broader canvas, in that it can address the practices, artifacts, and social processes of historically specific mental lives even where their effects on the brain cannot be directly identified.

Secondly, cognitive history based on the study of distributed cognitive ecologies is not imperialist: it rather draws directly on, and seeks to contribute to, existing historical projects of many kinds. It is not that settled frameworks from the cognitive sciences are to be applied to history as privileged truths, but that mutual benefits can arise from the careful meeting of these approaches on topics of independent interest. No firm line need be set between cognitive processes and cultural processes: mind and cognition are, we suggest, not hidden forces *behind* the public domain of artifacts, institutions, and social interaction, and do not have to be inferred *from* individual or collective

behaviour. In these and other respects, the kind of cognitive history we describe in this chapter has clear connections with other frameworks in history and social theory. This account of distributed cognitive ecologies could be compared in particular, despite the distinctive disciplinary sources, with the history of mentalities (Le Goff 1974; Gaskill 2000), with the historical study of everyday life and the turn to practice, and with Actor-Network theory in science studies (Latour 1993, 1996; Yates 2006). It can also be productively related to work in the histories of the senses and the emotions, to histories of the body and to historical phenomenology (Hillman & Mazzio 1997; Smith 2009, 2010). Rather than replacing these existing approaches, cognitive history can join them and aid in systematizing and extending them, offering theoretical tools and concepts to enrich the historical study of material culture.

Material Culture and Distributed Cognitive Ecologies

A cognitive ecology is a structured setting in which individuals or groups remember, create, imagine, or engage in other flexible intelligent action. Cognitive ecologies are often multidimensional, involving physical, technological, and social resources all at once (Hutchins 2010; Tribble & Sutton 2011). The ways in which embodied human agents interact with their environments in the course of these cognitive activities can be highly distributed, collaborative, and improvisatory (Preston 2012). Mental states and processes, to repeat, are not purely internal, located inside the individual skull and only expressed or communicated in the public domain. Rather, they can literally spread across heterogeneous elements including brains, bodies, artifacts, media, and other people (Clark 2003). The unit of analysis, then, is the whole shifting and dynamic system seen as an interacting whole, rather than a single individual. Because the human brain is unusually plastic and open to influence, our psychological nature is intrinsically cultural: we latch on to, adapt, and in turn are transformed by these tools, places, institutions, and people. Over the course of development, our mental life soaks in from the rich social and material world we inhabit, and then continues to participate and emerge in changing socio-technical networks.

Though this kind of cognitive theory is materialist, it does not identify mind with brain alone, for the brain is not the sole ground for or basis of our psychological capacities. The resources we deploy to think, remember, or play with individually and collectively are all material. But matter itself is volatile and unstable, even if often at timescales longer than the everyday: matter is also diverse in its characteristics and dynamics, ranging from the intricately flickering processes of the human brain and nervous system, to the functional or glittering properties of household artifacts or ornaments, to the larger-scale movements and transformations of institutions, buildings, and environments. If objects, routines, and the other public elements of a cognitive ecology are sometimes parts of a cognitive system, then variations in relevant features of the material and social resources in which individuals and groups are immersed can constitute variations in mind itself. The implications for both historical research and material culture studies are striking. If we are as Clark puts it 'natural-born cyborgs', in that as a species we have always thus incorporated artifacts and technologies into our distributed cognitive webs (while being ourselves constantly and reciprocally shaped and transformed in the process), then historical and cultural change is not just something that our best cognitive theories can in principle allow (Clark 2003). Rather, the idea of distributed cognitive ecologies actively predicts or requires significant historical and cultural diversity in our cognitive practices and activities as our social and material settings shift (Sutton 2010). As Matthew Day puts it in developing similar views for the study of religious belief and experience in particular, 'the broad spectrum of rituals, music, relics, scriptures, statues and buildings typically associated with religious traditions may be more than quaint ethnographic window dressing. Rather than thin cultural wrap arounds that decorate the *real* cognitive processes going on underneath, these elements could represent central components of the relevant machinery of religious thought' (Day 2004, 101). This case shows again that historical applications of the idea of distributed cognitive ecologies aim less at

revolutionary new methods than at recasting and especially integrating disparate aspects of current scholarship. The 'ecological' aspect of the framework urges us to treat features of material culture that are not always studied together as interconnected constituents of complex cognitive and socio-technical systems.

Any such list of the physical and cultural resources which form part of densely-coupled interactive networks in distinctive cultural contexts will be highly diverse, but will include artifacts and practices which historians already study in detail. These external artifacts complement our biological capacities as we learn – collectively and individually – to coordinate our internal and external resources so as best to meet our needs (Sutton 2010). Much work on external cognitive systems has focussed on the symbolic or representational systems we have created to anchor, stabilize, or reorient our thinking, creating, and planning. In influential work on the long-term development of human cognitive architecture, Merlin Donald attributed the dramatic and cumulative expansion of our cognitive and ecological capacities to external symbol systems: once we could use body markings, grave decorations, notations, paintings, and eventually writing systems, we became less dependent on our individual brains and bodies. Information could be stabilized and retained longer, transmitted further and more effectively, and opened up to collective scrutiny or renegotiated (Donald 1991, 308-333). Donald coined the term 'exograms' for the external traces which could thus store and carry information outside our brains, on the model of the neurobiological term 'engram' for our on-board memory traces. External symbol systems of course come to have active lives of their own in historical, cultural, and developmental timescales, and subsequent work has focussed on the complex and varied nature of the interfaces between embodied brains, social groups, and richly diverse artistic, economic, theoretic, and normative symbol systems. Though Donald has been criticized for treating external symbols as overly passive storage systems, he stressed that in use of course such artifacts are 'drawn into a maelstrom of shared cognitive activity in any culture' (Donald 1998, 184; Malafouris 2004; Sutton 2008).

But non-representational aspects of material culture also enter into cognitive relations and interactions, shaping the experience and emotions of historical actors at least as much as did symbolic or informational technologies. Non-symbolic material objects or behavioral routines drive and partly constitute our tactile or affective mental lives, for example, in experiences which may be hard to articulate but also actively involve brain, body, and artifact alike. Many cases discussed in this book are of this kind: aesthetic, functional, commercial, or spiritual aims, experiences, and practices are extended or distributed over physical objects which may have specific textures, values, and qualities independent of any explicit or intended representational or symbolic function.

Before discussing further early modern domains in which the idea of distributed cognitive ecologies may prove fruitful, we sum up the theoretical framework by underlining the methodological challenges and rewards it suggests. There are pitfalls for historians in selectively tapping into a controversial line of thought in cognitive theory, and it is helpful to engage carefully with the history and status of ongoing internal debates in the neighbouring disciplines. Equally, cognitive theorists with historical interests must develop the capacity to winnow through complex debates about evidence and methods in studying the lives and practices of historical actors and the trajectories and shifting meanings of material culture in the past. Critics of the idea of extended or distributed cognition have complained at the diversity of objects which it would take as incorporated into our mental lives: listing the range of representations and objects which theorists like Donald and Clark discuss, Adams and Aizawa worry that systems of brains coupled with such a diversity of cognitive tools, devices, or memory aids 'would seem to form such a motley collection that they will not form the basis for any significant scientific theorizing' (2001, 63). Historians may be more comfortable with motley collections. But it will still take novel forms of research training, collaboration and sharing of skills, and sustained openness to alien concepts, assumptions, and methods to forge the

insistently interdisciplinary teams needed for historiographical implementation of the idealistic vision of an integrated study of mind, action, and material culture articulated by Andy Clark:

> Much of what matters about human intelligence is hidden not in the brain, nor in the technology, but in the complex and iterated interactions and collaborations between the two .... The study of these interaction spaces is not easy, and depends both on new multidisciplinary alliances and new forms of modelling and analysis. The pay-off, however, could be spectacular: nothing less than a new kind of cognitive scientific collaboration involving neuroscience, physiology, and social, cultural, and technological studies in about equal measure. (Clark 2001, 154)

The utility of such an approach can only be assessed in practice, as we work through independently-motivated historical questions about early modern material culture, seeking new cognitive-historical angles on existing problems. Before addressing the history of skills in our final section, we can briefly underline how the distributed cognition framework offers a new lens through which to view familiar issues about Reformation religion.

As the chapters in this book by Suzanna Ivanič and Andrew Spicer show, emotion and cognition were inextricably linked with objects and practices in debates about material culture in the Reformation. This period of religious history is an apt test case for cognitive ecology, offering us different ways of looking at familiar material. In vigorous debates on the proper articulation or coordination between inner faith and external support, Reformers establishing a range of distinctive regimes for managing believers' senses, attention, and memory. New practices, new apparatus, new spaces and places, new words and sounds, new gestures and movements were developed for both individuals and groups. As Tribble and Keene (2011) argue, material culture was just as intrinsic to Protestant religion as to Catholic, though the systems of artifacts, surrounds, and rituals in play differed dramatically. New economies of attention were constructed, as Reformers clashed over the ways that set forms of prayer and posture might support or disrupt pious practice. Changes in the liturgy, architecture, and uses of sacred space directed new ways for worshippers to perceive, feel, remember, and reflect on the content of sermons and the Bible. New ideals of shared attention to the word required novel sensory signals to evoke the sacred, novel social processes, and novel forms of bodily discipline (Tribble & Keene 2011). No matter how strong the wish to be free of external scaffolding, there could in this life be no conclusive turn to purely interior devotion which entirely dispensed with material aids (Bynum 2013, 16-17). In placing cognitive ecologies at the heart of the Reformation, we can see certain kinds of material culture – from books to pulpits, from gestures to communion tables – as partly constituting the dynamic and shifting, unevenly distributed systems of attention, memory, and belief which formed the engine of religious practice and controversy. If the cognitive science of religion explores the possibility that humans have the religions we do because of the minds that we have, the theory of mind in question matters greatly (Day 2004). Debates continue between this picture of distributed cognitive practices as porous, intrinsically spread across brains, bodies, and world, and alternative accounts of universal cognitive capacities underlying the diversity of religious practice. Historians can engage with and directly contribute to the burgeoning interdisciplinary work in these fields (Whitehouse & Martin 2004).

Skill, Technology, and Apprentice Learning

Adopting this expanded understanding of mind as practice in social and material settings, cognitive history can also both draw on and contribute to studies of material culture in early modern technology and natural philosophy. In the social studies of science, historians have dismantled the conception of the 'Scientific Revolution' as a set of purely theoretical discoveries made by isolated thinkers (Henry 2008). Norms which later became codified as 'scientific method' were carefully constructed in institutional networks like that of the early Royal Society of London from the 1660s. Theories of matter were constantly in process: despite powerful new rhetoric about the mechanical

nature of the physical world and the passivity of matter (Merchant 1980), in practice a range of sympathies and active powers continued to be attributed to material substances, with nature still full of dynamic and agile spirits or forces which required firm containment and manipulation in safe laboratory spaces (Schaffer 1987). New forms of experimental apparatus had to be designed, maintained, and operated, often by 'invisible technicians' whose names and roles rarely appear in formal records; and to interpret experimental results, systems of trust among well-defined groups of accepted informants were established and policed to produce secure empirical knowledge about the natural world (Shapin 1994). The artifacts, raw materials, and products of the experimental life were a controversial and recalcitrant domain of material culture, engaging and creating ingenuity and frustration alike. Robert Boyle's air-pump experiments, for example, required not only supreme technical skill but also the laborious negotiation of collective assent among witnesses, and elaborately crafted written reports to establish the credibility of the matters of fact produced in the laboratory (Shapin & Schaffer 1985). Along with human observers and technicians, and the materials on which experiments were conducted such as minerals, chemicals, plants, and animals, instruments formed interactive heterogeneous assemblages by and through which the truths of the new natural philosophy were established (Latour 1993). The intended accurate representations of the natural world had to be mediated by active interventions in that world, on things and creatures with their own diverse qualities and powers. Historical studies of experiment and of the material culture of laboratories are thus central to the history of early modern science (Daston & Park 2006). The cognitive processes in play here, again, were not purely rational reflection and mathematical reasoning alone, as in some myths of scientific method: rather, the construction of scientific knowledge involved more interesting amalgams of sensory experience and social decorum, of technical know-how and intellectual clarity.

The practices of knowledge-making in the new elite institutions of natural philosophy in the seventeenth century drew on a range of established, socially and geographically diverse forms of enquiry into and engagement with the natural world. These encompassed Renaissance magical, medical, and artistic traditions as well as hybrid technical, commercial, military, and craft practices. In all these cases, the cognitive ecologies were highly distributed, spanning not only individuals' unique experience but also complex sociotechnical systems encompassing artifacts, organic or inorganic natural materials, and cooperating or competing groups of practitioners. These disparate forms of expertise involved rich interplays of embodied skills, tacit knowledge, and theoretical understanding. Because historians, philosophers, and cognitive theorists still disagree about the relations between skills and knowledge in distinct settings, these are fruitful topics for cognitive history. How did early modern actors and practitioners themselves understand the balance between practice and theory?

One point of view stresses cases and contexts in which hands-on experience was sharply divided from propositional knowledge, often when distinct and competitive professional interests were at stake. As elite medical education systems developed, for example, university-trained doctors were often at odds with surgeons or local practitioners: in 1673, the Antwerp apothecaries compared doctors to 'someone who would order a tower built … without being able to build the tower himself, as he has not learned masonry, nor is he acquainted with the raw material involved' (De Munck 2010, 351). On Steven Shapin's account of the new natural philosophy of Restoration England, certain scholars set manual skill 'at one end of an evaluative opposition at the other pole of which was some notion of *knowledge,* conceived not as work but as thought. So the knowledge-skill distinction is a particular version of such pervasive cultural divides as theory-practice, contemplation-action, and head-hand' (1994, 361). Manual labour and technical dexterity could be construed as merely rote or repetitive practice, rather than mindful action, and those who laid claim to social priority might also seek to distinguish their privileged and truly cognitive forms of articulable knowledge from the merely tacit bodily experience of artisans or craftspeople. It was

then tempting to efface the arduous processes by which theory had been generated, in the desire to codify rules or principles so that methods – for commercial production or experimental replication, for example – might be more easily transported. Instruction manuals and 'how-to' guides thus often appear incomplete, and perhaps played indirect roles other than that of direct transmission of practical recipes, for as Pamela Smith notes 'a book is not an optimal means for conveying technique' (2012, 10; Mylander 2009).

Although such rhetorical distinctions could have real effects, historians of technology have recently stressed how closely entangled in practice were all of these forms of knowledge and skill. In many domains, commercial production was combined with inquiry into nature: 'laboratories' were not all for gentlemen-scholars but were also workplaces, and expertise was hybrid, constantly 'putting useful knowledge into action' as the aims and interests of academics and artisans coincided around a shared material culture (Klein 2008, 782). Neither abstraction nor literate representational knowledge were always foreign to skilled practitioners, while in turn those laying out rules and theories often relied on experience, on bundles of practice. In re-evaluating the epistemology of artisans, sharp dichotomies between tacit and theoretical knowledge are queried. The knowledge of artisans working with material culture, argues Smith, 'was disciplined by years of practice, was precise, cumulative, experimental, investigative, demonstrated (visually and practically), collaborative and an example of distributed cognition' (2007, 44). She suggests that historical understanding of material culture is particularly apt for experiments in re-enactment or reconstruction. By working in historical practices, we can encounter the textures of objects afresh, engaging affectively with the collaborative processes and tribulations of skilled technique, we can potentially gain 'a firmer handhold on the past than would be the case for nonexternalized mental processes' (Smith 2012, 12). The products of cognitive activity must all be embodied: as Lissa Roberts notes, knowledge 'cannot exist or travel on its own in our material world. It needs a physical carrier, whether a human, a book, an illustration, a machine or an instrument' (2012, 51). Such artifacts and media, each with their own histories and qualities and their own alternative functions and meanings to different audiences, also form and transform the knowledge they transport.

Cognitive-historical approaches to skill and tacit knowledge might also offer new ways to think about early modern apprenticeship. Economic historians realize that the surviving evidence of apprenticeship contracts gives little sense of the reality of the situated process of learning in context, or of just what valuable work apprentices may have been able to contribute to their masters' trade practice (Epstein 2005; De Munck & Soly 2007). If technical skills are largely picked up implicitly and in practice, there are limits to explicit instruction as a means of transmitting tacit knowledge: so apprentices were likely to 'steal with their eyes', as the saying went, slowly coming to recognize patterns and anticipate problems in working with particular artifacts. Studies of skill and material culture in early modern history can here benefit directly from philosophical work on collaborative action and technology (Preston 2012), and ideas about material engagement and apprenticeship learning in cognitive archaeology (Malafouris 2013; Sterelny 2012).

As these examples suggest, many existing fields in the study of early modern material culture already include or rely on assumptions about mind and cognition. By engaging directly with cognitive theory, understood as the interdisciplinary study of all psychological processes, historians can render their own views more explicit, and find more subtle parallels with or differences from the ideas of early modern Europeans. In particular, by designing, conducting, and framing historical studies in light of the ideas about distributed cognitive ecologies which we have developed here, work on material culture can catch the interconnected nature of the historical subject-matter in the following ways. By stressing the ecologies of material culture, we remember to address the social and cognitive uses and meanings of sets of artifacts for historical actors in specific contexts, rather than studying each tool or object in isolation. By underlining the distributed nature of the cognitive

systems in question, we stress the heterogeneous nature of the arrays of disparate resources involved in navigation, performance, or devotion, in thinking, remembering, designing, or experimenting – resources which span and integrate bodily, psychological, emotional, environmental, material, interpersonal, technological, and institutional realms. And by analysing experiences involving material culture over time, in terms of the dynamic unfolding of such interconnected processes, we can probe ways that the balances between distinct parts of these cognitive systems shift across settings and contexts. If the best historical work already achieves these aims, and the cognitive theories we have described thus seem rather abstract and redundant, so be it: this kind of interdisciplinary project is in no way intended to revolutionize, overthrow, or eliminate effective existing scholarly practice. But even in that case, engaging with such cognitive theories allows historians to make direct contact with the rich resources of the best sciences of mind and culture. Integrating and reshaping scholarship in both humanities and sciences, rather than setting the two cultures against each other again, can potentially bring significant mutual benefit.

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