Extending material cognition to primate tool use

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ABSTRACT

The concept of extended or distributed cognition has been present in archaeology for some time, yet despite its inclusion of non-human hominin ancestors, it has remained distinctly anthropocentric in nature. Here, we suggest that the same concept may also be used to independently describe and interpret non-human animals within their own social and material networks. We illustrate this suggestion with examples from the tool use behaviour of wild monkeys and chimpanzees. Non-human primate social groups develop bodies of traditional knowledge, and we consider whether idiosyncratic expression of such knowledge may be viewed in terms of an individual's constructed social identity. At a micro-level, the performance of an individual tool use technique may be analogous to the idea of 'personhood' found in anthropological holistic or perspectivist theory; at a macro-level the physical and social distribution of primate technology is amenable to interpretation as an example of extended or distributed cognition. We conclude that combined consideration of extended cognition and niche construction offers a promising means for interpreting the material residues of non-human primate behaviour.

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1. Introduction

Humans are cognitively complex creatures. By this, we mean that humans engage in abstract analogical reasoning, understand multiple levels of intentionality in others, can perceive and devise solutions to difficult physical and social problems, and on occasion demonstrate novel behaviour appropriate to resolving difficulties. We also mean that they do these things in ways that involve many components at once. Yet even these broad descriptions do not cover all the ways that the term 'cognition' may be applied to various behavioural, neurological, cultural, social, and material patterns found in and created by humans and other animals (Shettleworth, 2010; Malafouris, 2013). The concept is even discussed for plants (Garzon and Keijzer, 2011). Because of this bewildering variety, we are reluctant to use 'cognition' as anything but a generic umbrella term for information processing (Rowlands, 2009), and consider it a term that always requires qualification to be of any use as a tractable scientific concept.

In this paper, therefore, we do not attempt to address cognition in its nebulous entirety. Instead, we explore the material dimensions of cognition through the specific and narrow lens of tool use. Even more specifically, we examine the ways that wild primate tool use may be usefully understood and examined as an example of extended or distributed cognition. We assess the extent to which tool use as extended cognition may inform our understanding of such phenomena as social traditions and the need to solve foraging problems. We thereby hope to identify ways that we can study the tools themselves (including archaeologically recovered material) in order to reconstruct the processes that underlay their selection, modification and use by non-human primates (NHP). Further, because concepts of agency and personhood are related to cognition in some of its human manifestations, we believe that they are worth considering in tool-using NHP. Our paper presents one way of bringing a cognitive element into the new field of primate archaeology (Carvalho et al., 2008; Haslam et al., 2009; Stewart et al., 2011; Haslam, 2012, 2014a, 2014b; McGrew et al., 2014).

2. Cognition and the distributed mind

All definitions of cognition have a common thread that identifies a reflexive, interactive process, rather than a static character state (Rowlands, 2009). These interactions may in theory occur anywhere from the neuronal level up to and beyond intergenerational transmission of social customs. An important outcome is that cognition is something that changes the physical world as it

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happens, which makes it amenable to scientific observation and, in some cases, archaeological preservation. In the following, we consider the observable, external physical manifestations of cognition in terms of either physical or social domains (Shettleworth, 2010). These do overlap, but their separation helps identify more clearly the specific links between tool use and distributed cognition.

For us, physical cognition involves reasoning about, and solving technical problems through interaction with, the material world. Social cognition involves reasoning about, and solving problems through interaction with, other individuals. In terms of tool use, physical cognition includes such activities as selecting and modifying materials, orienting tools, using appropriate force, identifying targets for tool use and perceiving and assessing their affordances. Tool use affects social cognition by structuring social relationships, by bringing individuals together in ways that would not otherwise occur, and by facilitating social learning. In turn, social learning is essential for creating traditions, and cultural behaviours.

Interactions between individuals and objects (including tools), or between different individuals, may be considered to involve cognition when either the gathering or use of information requires both components. These interactions, and the characteristics of the interacting components, are what we understand to constitute extended or distributed cognition. Since all interactions involving a living entity are inherently relational, and must involve at least two entities, they must all include some aspect of cognition.

We consider all cognition relating to Primate tool-use to be embodied on the grounds that all perception and physical problem-solving processes are constrained by real-world and bodily context (Barrett and Henzi, 2005). Embodiment breaks down the distinction between stimulus, thought and action (Merleau-Ponty, 2002; Costall, 2008).

The notions of extended and distributed mind possess subtle variations in the literature of embodied cognition (Barrett and Henzi, 2005; Ziemke and Frank, 2008). Extended mind theory has drawn from Donald's work on external memory storage (Donald, 1998), to argue that the cognition of an individual lies beyond the internalised 'mind' and in the holistic integration of external objects, or things, with the human organism (Gamble, 2010; Rowlands, 2010). The concept of distributed mind builds on a broad interdisciplinary base — considering cognition to be not just embodied, but also embedded in the external world, and emergent. For some, cognition is situated not just external to the internal mind, but also beyond the individual agent (Clark, 1997; Clark and Chalmers, 1998; Clark, 1999).

With the notion of external cognition, we can assess the abilities or actions of specific individuals, at the time of their acting, but we cannot assess the extent to which their actions were fundamentally dependent on information coming from outside their own body. This situation limits our ability to see how individuals affect others in their social network, and we may miss critical steps in how observed behaviour emerged within and is maintained by certain environmental cues. In this scheme, inanimate objects such as tools are not independent actors, but they do mediate the behaviour of individuals and groups, by constraining the range of options available in time and space — they enable certain activities and prevent others. We note that in this formulation, extended cognition has much in common with niche construction, and we suggest that the latter may actually be a more useful concept than the former in cases where the environment is sufficiently stable for adaptive responses to emerge and succeed (Sterelny, 2010).

In accordance with Actor-Network Theory (Latour, 2003), a system of actors and environment may be viewed as a set of nodes, and cognition is then comprised of a process of nodal interaction and restructuring. The cognitive system involves an active and constant process of engagement, such that 'material culture becomes a physical correlate of that system and part of the extended phenotype of the individual agents that comprise it' (Dunbar et al., 2010, p. 12). There is a clear temporal element involved, as material products resulting from earlier action can transform the nature of later events.

3. Recognising external cognition

To identify cases of primate external cognition (distributed or extended) requires a working definition of the phenomena. We follow Clark and Chalmers (1998) in their use of the Parity Principle. This states that any and all external activity is to be considered cognitive which, were it to take place within the mind, would be considered a part of the cognitive process of a task. For example, the use of a pencil and paper to write out a long division problem would qualify as external cognition. The same process could take place internally as mental arithmetic but as the cognitive load is shared by the environment, in this case by the pencil and paper, cognition can be described as external.

Distributed cognition is broadly defined as the flow of information through a system, with the actor being only part of the information matrix. Cognition is co-constructed, with the constraints of action/interpretation acting as a dynamic mediative process. Distributed cognition is manifest in the shared customs and traditions of a group, as well as in collective decision making. An example is found in the movement patterns of baboons (Strandburg-Pushkin et al., 2015), where no one individual guides or dictates movement initiation or direction. This process is a decision distributed across the band as a whole, with each member only needing to respond to local factors or triggers (Hutchins, 1995), and either following a specific initiator or compromising by taking an intermediate path. Eventually, the troop as a whole will move, because a 'decision' has been made by the group and not by any individual, no matter what their social ranking (Strandburg-Pushkin et al., 2015).

Extended cognition takes things a step further. In an extended model, information can be held in the environment independent of an individual's interaction. Not only can the environment mediate information but it can also retain cognition as an external 'memory store'. In an extended model, material culture acts to make what is conceptually intangible real through physical representation (e.g. Day, 2004). Examples of this are information written in a notebook for future reference (Clark, 1999) or mental time-travel using calendars (Donald, 1998).

Cognition may therefore be embodied, distributed and/or extended (Ziemke and Frank, 2008), moving from the least to most contentious views on external cognitive processes. These categories are not mutually exclusive, and to help distinguish between the three, we adapt the six criteria laid out by Wilson (2002), as follows:

(1) Cognition must be situated: it is grounded by the environment;
(2) Cognition is time sensitive: it is concurrent with stimulus and action;
(3) Cognition is body-based: it is grounded in physical action;
(4) Cognition guides action: it contributes to and underlies behavioural responses;
(5) Cognitive work is offloaded onto the environment: individuals derive and collect causal cues from the environment and others to reduce the cognitive workload;
(6) The environment is part of the cognitive system: information flow between individual and environment is such that the 'mind' is too restrictive a unit for understanding cognition.