Title of the target article

The cognitive bases of human tool use

Krist Vaesen

Title of the commentary

Can object affordances impact on human social learning of tool use?

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Abstract (word count: 57)

The author describes ‘high-level’ and ‘uniquely human’ socio-cognitive skills that he argues as being necessary for tool use. We propose that those skills could be based on simpler detection systems humans could share with other animal tool users. More specifically, we discuss the impact of object affordances on the understanding and the social learning of tool use.

Main text (word count: 896)

Krist Vaesen speculates that the humans’ capacity to learn novel tool use from observing goal-directed movements performed by others (Csibra & Gergely 2007) is a hallmark of our uniqueness, and is based on ‘higher’ socio-cognitive skills. It has been proposed that such skills were supported by the ability to i) decode kinematic information into causal relationships between a behavioural sequence and its result (Gergely 2007), ii) interpret others’ behaviors as rational (assuming that the most efficient observed action means are adopted to achieve a particular goal; Gergely & Csibra 2003) and iii) accumulate *a priori* knowledge from past observations about agents’ intentions and behaviours in order to predict future events (Chambon et al. 2011). We agree with the author that the sophistication of such socio-cognitive skills goes far beyond those of any other animals. Yet, we believe that this sophistication could also be the result of simpler systems allocated to the detection of low-level, local sources of information, such as the manipulative properties of objects called ‘affordances’.

Affordances define relational properties that emerge from matching the perceived physical features of objects and the agent’s biomechanical architecture, goals, plans, values, beliefs, and past experiences. We propose that affordances allow agents to delineate the number of candidate motor acts that could be performed on tools. We postulate that affordances constrain the number of possible solutions by generating biomechanical prior expectations in line with the bodily architecture of agents. These priors would bias individuals to act towards objects aiming at biomechanical optimization (Rosenbaum et al. 1996; Weiss et al. 2007). As the author rightly points out, compared to other animals, the many degrees of freedom characterizing human effectors and their striking motor control considerably enhances our ability to detect new affordances and new potential objects uses. All this contributes to increase the variety of the behavioural repertoire. Nonetheless, we are sceptical about the idea that the primary advantage such architectural properties brings for tool use acquisition is fine-grained social learning. Indeed, in many situations, detecting tools affordances allows learners to avoid such a high-level but costly strategy. Instead, this biomechanical uniqueness could increase the probability of individual innovation, particularly in situations where novel tools are physically unstructured and multi-purpose. For example, Acheulean stone tools are poorly structured and roughly symmetrical objects with a cutting edge. They do not offer affordances salient enough to constrain the number of candidate motor acts that could be perform on them. Sterelny (2003b) points out that the exact functions and uses of Acheulean stone tools, though they were the dominant element of human technology for over a million years, remain a matter of debate. It is more plausible that our ancestors – who were predisposed to behavioural innovation thanks to their high biomechanical flexibility – progressively discovered not one or two, but a multitude of tasks that Acheulean stone tools could carry out.

We argue that the evolution of the human technological environment favoured the utility of simpler systems such as affordances detection. This eases the negotiation of the highly demanding cognitive problems of tool use learning (Clark 1997; Dennett 1995; Sterelny 2003a, 2003b). Indeed, tools we interact with daily are designed for specific purposes.

Affordances that are available through their complex physical attributes offer the chance for naive users to extract their functions at low cost (Dennett 1982, 1995; Gregory 1981; Norman 1988). In our engineered environments, affordances play a crucial role in the acquisition of tool skills through individual trial-and-error as well as social learning. More specifically, we argue that perceiving affordances directly biases the understanding of tool behaviors performed by others, and consequently the extraction of related functional knowledge. The biomechanical priors that emerge from the perception of tools affordances constrain the number of candidate motor acts an individual could initiate. Similarly, they also tune the observer's prior expectations about which motor behaviors are most likely to be performed by others, enhancing their predictability and learnability. Learning about a novel tool from observing a demonstrator using it in a biomechanically 'rational' way would be less costly than learning from a demonstrator that violates our expectations. That is, the convergence of the demonstrator's and observer's biomechanical expectations facilitates an efficient learning strategy, based on prior knowledge and intentional inference.

Taken together, these observations question the exact role of high-level, fine-grained social learning in the acquisition of new tool skills. Relevant to this is work addressing animal behavioural 'traditions' – behavioural patterns which are relatively stable in groups and are at least partly maintained by some forms of social learning. These could result from constraints that limit the number of possible alternative behaviours, more than from the robustness of high-level social transmission mechanisms (Claidière & Sperber 2010; Tennie et al. 2008). Here, we posit that the crucial role affordances play in the acquisition of tool use strongly suggests that fine-grained social learning strategies, such as true imitation of observed action goals and means, is sometimes less important than previously assumed. In fact, affordances, together with ecological constraints and other products of epistemic engineering, could enhance the effectiveness of more frugal forms of socially-directed learning (Acerbi et al.

2011; Franz & Matthews 2010) like emulation learning (i.e. the observer copies action goals performed by a demonstrator without considering action means) or even stimulus enhancement (i.e. when an individual directs its behaviour towards an object or a part of an object with which it saw another individual interact).

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