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Title

Human tool cognition relies on teleology

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Abstract

Osiurak & Reynaud's account of human tool cognition misses key element: human capacity for functional representations and teleological inferences. I argue that teleofunctional approach accounts better for some features of human tool cognition and points to a viable candidate for the cognitive "difference-maker" behind human technological success.

Main text

Osiurak and Reynaud (O&R) characterize human tool cognition – i.e. cognitive skills underpinning human tool use and cumulative technological culture – solely in terms of technical reasoning defined as physical-problem solving on the bases of mechanical knowledge. Here I argue that O&R's account of human tool cognition is inadequate due to the omission of human propensity for functional representations.

Functional representations allow people to conceive of something (an object or an event) in relation to a future end-state, which they interpret both as *effect of* and *explanatory factor for* what they represent. This way actions and tools are interpreted as *means towards ends*, which are goals of actions. Such functional, or teleological, representations are present in the written record since antiquity (Aristotle), ubiquitous across cognitive domains in humans (Kelemen & Rosset, 2009; Rose & Nichols, 2009; Talanquer, 2007) and evident from early on in human infancy (Gergely & Csibra 2003; Hernik & Csibra, 2015; Liu, Brooks & Spelke, 2019).

Propensity for functional representations is not just a missing element in O&R's presentation of human tool cognition. Teleofunctional account (Casler & Kelemen, 2007; Hernik & Csibra 2009), which posits functional representations as the key element of human tool cognition, does overall a better job explaining some aspects of it, than O&R's account focusing on technical reasoning alone does.

First, the teleological account allows for a more accurate characterization of everyday instances of tool-use. Technical-reasoning account presents them as instances of physical-problem solving, which results in selection of a tool and a way to operate it. Teleofunctional account allows for characterizing them simply as instances of goal-directed action involving tools. Some instances of goal-directed tool use certainly involve solving physical problems and decision processes described by O&R (e.g. selecting the screwdriver with the tip small enough to fit the screw's aperture, or making do with a blade of a small knife instead). But remarkably, human tool use does *not* have to be always preceded by mental simulations and selection processes envisaged by O&R. This is because humans form enduring functional representations of tools, where they conceive of any tool as being *for* doing something, i.e. as a means to a certain type of goal. Humans indeed tend to use right tool for the job, but not because they go every time through the process of inferring the right means for the end. Rather, because they tend to use *the* tool for the job, i.e. the tool that they already represent as the means to the goal that they intend to achieve. Propensity to rely on functional representations underlying tool-kinds is present also in cases of genuine physical-problem solving, as evidenced by so-called functional fixedness. Solving physical problem takes more time if it requires using an object to achieve a goal that differs from its already represented function (e.g. German & Barrett, 2005).

Second, the teleofunctional account allows for a fuller characterization of inferences that humans can draw in the domains of tools and actions. We do engage in reverse engineering in the sense discussed by O&R, namely attempting to find out how does the tool do what it does. And we do engage in inferring means for the given ends, like in the tool-selection processes described by O&R. In both cases O&R are right in pointing to the role of naive mechanical principles in these processes. However, what O&R's account does not recognize is that causal-mechanical principles alone do not provide sufficient constraints on such inferences. And for a simple reason: any state is compatible with a myriad of hypothetical causes and a myriad of hypothetical effects. Human cognition obviously resolves such inferences. However it does so by relying on assumptions, which reach beyond the mere causal-mechanical principles, but are part and parcel of teleological representations, namely expectations of efficiency and optimality (Csibra & Gergely 2007; Dennett, 1990). Moreover, in addition to finding means for ends, humans engage also in the complementary inferential process and can find out the ends, when the means are given. A clear example of this in

the action domain is goal anticipation (Southgate & Csibra, 2009). In the tool domain, this inverse teleological inference allows humans to infer what goals the object at hand facilitates achieving and thus to form hypothesis about its function (Csibra & Gergely 2007).

Third, the teleofunctional account has better prospects of explaining development of tool knowledge, especially given the fundamental cognitive opacity (Gergely & Csibra, 2006) of tools and tool-use to the young observers. Rather than predicting that development of tool-knowledge has to track development of mechanical knowledge, teleological account predicts that it tracks capacity for teleological and functional representations. In other words, it predicts that even young human infants, despite poor capacity for tool-use and despite lack of detailed mechanical knowledge are nevertheless well equipped with the cognitive structures needed to learn about tool functions and tool kinds, because they are capable of representing means-end relations between actions and goals (Hernik & Csibra, 2015).

Recognition of the human capacity for functional representations and teleological inferences is missing from the O&R's proposal, or perhaps it is only tacit in it. This is a striking omission for two reasons. First, these cognitive capacities are arguably prerequisites of the human technological success. They enable constrained inferences of means from ends and ends from means. They can support learning from observed instances of tool-use by extracting the key means-end-relations with only cursory understanding of the underlying causal relations. They enable ascribing lasting value to unused tools by representing them as means for future goals. Second, even though non-human primates may engage in teleological inferences (Rochat, Serra, Fadiga & Gallese, 2008), there is only limited evidence that they may form end-from-means inferences, lasting functional representations of tools (Mulcahy & Call, 2006) and function-based tool categories (Gruber, Frick, Hirata, Adachi & Biro, 2019). Thus, the human teleo-functional representations are at least as good a candidate as the technical reasoning skills are for the cognitive "difference-maker" behind the human cumulative technological culture that O&R are after (Hernik & Csibra, 2009).

Conflict of interest declaration

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