Trends in
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Letter

Technical reasoning: neither cognitive instinct nor cognitive gadget

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In our target article in *TiCS* [1], we argued that technical reasoning is a cognitive capacity that supports cumulative technological culture. Heyes [2] rightly points out the ambiguity surrounding our use of the term 'technical reasoning' and sets a research agenda for the future: is technical reasoning general reasoning applied to the technological domain? Is it a form of reasoning that is specific to reasoning about technology? Has technical reasoning coevolved with human tool use? Does it vary across cultures? Before providing additional elaboration on the concept of technical reasoning that may help start answering these questions, we discuss Heyes' more general agenda, which seeks to determine whether cognitive capacities, such as technical reasoning, are instincts or gadgets, an issue Heyes raises in Box 1 in [2].

According to Heyes [3], a cognitive gadget is a cognitive mechanism that is shaped by our social interactions and cultural environment, without the guidance of a specialized innate cognitive mechanism. By contrast, cognitive instinct refers to such an innate cognitive mechanism. Bodily, particularly facial, imitation, mindreading, and language are, for Heyes [3], cognitive gadgets, because they develop ontogenetically from the interaction between domain-general processes (e.g., associative learning or executive control) and the sociocultural environment of the individual. Although useful in some respects, the distinction between cognitive instincts and cognitive gadgets may not carve nature at its joints. Picture a child learning to ride their bicycle for the first time. Protected by the watchful eyes of their parents and under loud encouragements, clumsy attempts quickly become successful. After a few hours, what was difficult has become easy and, after a few weeks, cycling has become irreversibly automatic and spontaneous. Is being able to cycle an instinct or a cognitive gadget? There is a sense in which being able to cycle comes from an innate disposition, both because motor learning and motor coordination have evolved to respond to environmental challenges such as this and because bicycles have been adapted to human physical and learning abilities. There is also a sense in which it is a cognitive gadget because cycling would not exist without the rich social and cultural environment that motivates its learning and provides bicycles to ride. What is true of our ability to cycle is also true of most of our cognitive abilities: our rich sociocultural environment shapes our cognitive abilities, from the most basic reflexes (e.g., stopping at a red light) to the most abstract form of thinking (e.g., mathematics). Cultural recycling [4], the notion of an adapted environment [5], and cognitive gadgets [3], to cite just a few, rightly point to the underappreciated importance of our cultural environment in shaping our cognition during development and in producing cumulative cultural evolution. However, the innate/acquired and newly added cognitive gadget distinction may cast the same processes under different lights, thus reflecting different scientific interests rather than different natural kinds [6].

With this in mind, we can start answering the fundamental questions raised by Heyes [2] about the cognitive reality of technical reasoning. The parietal F (PF) area within the left inferior parietal lobe has a central role in the technical-reasoning network [1]. Yet, similar to most of the parietal areas, it also supports the processing of spatial relationships between external objects. Its distinctive feature that justifies its key role in the technical-reasoning network is that it is recruited when the object–object relationships are not only spatial, but also imply nonspatial, material features (e.g., solidity or elasticity) as well as physical forces (e.g., support or gravity) or mechanical actions (e.g., cutting or hammering) [7]. This neural specialization resembles, to some extent, that of the visual word form area for print reading [8]. Hence, as for the visual word form area, the hypothesis that this neural specialization results from the interaction between cognitive processes and the sociocultural environment is legitimate. Nonetheless, evidence indicates that a brain network for tool processing, close to the technical-reasoning network, exists in the human brain before individual tool-use experiences [9] and that some elements of physical principles (e.g., object permanence), which do not need any specific social interaction, can be understood by infants during the first year of life [10]. In addition, if the neural specialization of the left area PF is mainly due to sociocultural interactions, then it should be sensitive to cultural variations. This remains difficult to envisage because technical reasoning is governed by 'physical, universal' and not 'social, arbitrary' rules [11]. This distinction is crucial because it implies that the ability to understand the physical world does not need social interactions to emerge, even if, of course, social interactions can considerably boost its development (i.e., social learning).

To conclude, Heyes [2] is absolutely right in emphasizing the importance of studying the impact of the sociocultural environment on the developmental origins of technical reasoning. She is also perfectly right in stressing that integrating the distinction between instrumental and ritual stances [12] with the technical-reasoning hypothesis can help us delineate its cognitive boundaries. Much still needs to be done in this respect, and we are extremely grateful to Heyes for her thoughtful and stimulating commentary on our article, which is a source of inspiration for our future research.

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References

1. Osiurak, F. *et al.* (2023) Bringing cumulative technological culture beyond copying versus reasoning. *Trends Cogn. Sci.* 27, 30–42
2. Heyes, C. (2023) The cognitive reality of causal understanding. *Trends Cogn. Sci.* 27, 337–338
3. Heyes, C. (2018) *Cognitive Gadgets: The Cultural Evolution of Thinking*, Harvard University Press
4. Dehaene, S. and Cohen, L. (2007) Cultural recycling of cortical maps. *Neuron* 56, 384–398
5. Sterelny, K. (2014) *The Evolved Apprentice: How Evolution Made Humans Unique*, MIT Press
6. Mameli, M. and Bateson, P. (2006) Innateness and the sciences. *Biol. Philos.* 21, 155–188
7. Federico, G. *et al.* (2022) The cortical thickness of the area PF of the left inferior parietal cortex mediates technical-reasoning skills. *Sci. Rep.* 12, 11840
8. Dehaene, S. and Cohen, L. (2011) The unique role of the visual word form area in reading. *Trends Cogn. Sci.* 15, 254–262
9. Wen, H. *et al.* (2022) Brain intrinsic connection patterns underlying tool processing in human adults are present in neonates and not in macaques. *NeuroImage* 258, 119339
10. Baillargeon, R. (2008) Innate ideas revisited: for a principle of persistence in infants' physical reasoning. *Perspect. Psychol. Sci.* 3, 2–1
11. Osiurak, F. and Reynaud, E. (2020) The elephant in the room: what matters cognitively in cumulative technological culture. *Behav. Brain Sci.* 43, e156
12. Jagiello, R. *et al.* (2022) Tradition and invention: the bifocal stance theory of cultural evolution. *Behav. Brain Sci.* 45, e249