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# Technical reasoning: Neither cognitive instinct nor cognitive gadget

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## **Main text**

In our target article [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 co-evolved with human tool use? Does it vary across cultures? Before providing additional elaboration of the concept of technical reasoning that may help start answering these questions, we discuss Heyes’ more general agenda that seeks to determine if cognitive capacities, such as technical reasoning, are instincts or gadgets, an issue Heyes raises in Box 1 of [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, executive control) and the socio-cultural environment of the individual. Though 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 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 socio-cultural 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 area PF (Parietal F) within the left inferior parietal lobe plays a central role in the technical-reasoning network [1]. Yet, like 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 non-spatial, material features (e.g., solidity, elasticity) as well as physical forces (e.g., support, gravity) or mechanical actions (e.g., cutting, 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 socio-cultural environment is legitimate. Nonetheless, evidence indicates that a brain network for tool processing – close to the technical-reasoning network – exists in the human brain prior to 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 in the first year of life [10]. In addition,

if the neural specialization of the left area PF is mainly due to socio-cultural 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 socio-cultural 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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