Technical reasoning alone does not take humans this far

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ABSTRACT
While we see much utility in Osiurak and Reynaud's in-depth discussion on the role of what they term technical reasoning in cumulative culture, we argue that they neglect the time and energy costs that individuals would have to face to acquire skills in absence of specific socio-cognitive abilities.

MAIN TEXT
We commend Osiurak and Reynaud's in-depth discussion of the role of what they call "technical reasoning" in cumulative culture (CC). There is no doubt that humans engage in complex forms of reasoning and a better appreciation of how this works is crucial for understanding what set humans apart from other animals. Contrary to what the authors suggest, Boyd et al. (2011) and Derex et al. (2019) never claimed that reasoning plays no role in CC. Rather they argued that the improvement of culturally evolving technology is not *necessarily* tied to individuals' level of understanding. Indeed, Derex et al.'s experiment shows that, over successive overlapping generations, participants produce increasingly efficient solutions despite exhibiting no improvement in causal understanding. This does not mean that causal reasoning cannot play a role in that process, but it shows that increases in efficiency are not necessarily accompanied (or even powered) by changes in individuals' understanding. These results illustrate the effects of the selective retention of beneficial modifications across generations and stress the roles of social learning and population-level processes in the emergence of adaptive cultural traits. That is not to say that the *ability* to reason has nothing to do with CC. Asking whether CC could occur in absence of specific reasoning abilities is an entirely different question. Osiurak and Reynaud's proposal that CC necessarily depends on species-specific ability to technically reason about phenomena is both timely and welcome. Unfortunately, the evidence and arguments that the authors bring to bear in support of their hypothesis are weak.

First, Osiurak and Reynaud overestimate the ability of individuals to extract relevant information by observing artefacts alone. They base their claims on a few experimental studies that showed that even minimal social learning mechanisms (such as reverse engineering) can result in cumulative improvements. According to them, "if signs of [CC] in reverse-engineering conditions are observed in humans, then this suggests that human non-social cognitive skills are sufficient for the emergence of [CC]". There are several problems with this argument. First, experimental investigations of CC rely on relatively simple tasks that participants can solve in a short period of time (Miton & Charbonneau, 2018). As a

result, the amount of information that individuals can typically extract from the observation of such simple experimental artefacts is unrealistically high and whether technical reasoning skills allow individuals to infer substantial amounts of missing information about more ecologically valid artefacts remains to be demonstrated. Moreover, Osiurak and Reynaud neglect the fact that experimental settings typically allow sustained and undisturbed observations maximizing the effectiveness of reverse engineering. Even if we assume that technical reasoning skills allow individuals to infer missing information, the usefulness of such capabilities in natural settings might be highly limited in absence of specific socio-cognitive abilities that give individuals appropriate access to cultural artefacts. Finally, we would like to point out that investigating information acquisition requires properly controlling for knowledge previously acquired by social learning. Indeed, Osiurak and Reynaud's argument that information extraction is mediated by individuals' level of expertise suggests that they conflate information that was acquired during a specific learning event with information that was acquired prior to this learning event. To take Osiurak and Reynaud's own example, showing that physics graduate students listening to Einstein retain more about the theory of relativity than individuals with no knowledge of physics might say less about what individuals actually learnt than what they previously knew.

Another problem with Osiurak and Reynaud's argument is their claim that much can be learned by reverse engineering if learners can alternate between periods of social and individual learning and that socio-cognitive skills only boost CC. The fact that people can learn much through trial-and-error learning does not imply that socio-cognitive skills are unnecessary to CC. Even if we assume that individual learners could build a traditional Inuit kayak from a pile of driftwood and seal skins without learning from others (which is unlikely to say the least) that does not mean that they will do so in absence of appropriate social support. More effective social learning strategies do more than just change the rate of CC. Individuals constantly face intense trade-offs and so must allocate their time and energy strategically. When learning costs are too high, individuals might not be able to afford to acquire complex skills by themselves. Experiments with children, for instance, show that they have difficulty innovating even simple tools even though they manufacture them easily after being exposed to social demonstrations (Beck et al. 2011). Moreover, being able to acquire a few skills through a combination of observational learning and individual leaning is not close to good enough. In the Arctic, kayaks are only useful if individuals can also develop warm clothes, harpoons and all other tools that their survival depends upon. Without appropriate socio-cognitive capabilities, the acquisition of these skills would require an investment in terms of time and energy that is way beyond what individuals can afford.

Finally, we would like to point out that experimental research has shown that toddlers are more likely to infer causal connections when sequences of events are the result of human actions rather than when they occur "naturally" without involving human interventions (Meltzoff et al. 2012). This means that reasoning skills are likely to at least partially result from socio-cognitive abilities that increase individuals' opportunities to witness valuable events. Furthermore, it suggests that hypotheses based on the role of reasoning skills should not be considered as alternative to those based on socio-cognitive

skills. A more fertile approach may be to study how both types of abilities reinforce each other.

CONFLICT OF INTEREST DECLARATION
Conflicts of interest: none

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