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Comment

Replication and individual-level emergence are not sufficient for understanding cultural transmission and the evolution of human culture
Comment on "Replication and emergence in cultural transmission" by Monica Tamariz

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Monica Tamariz [1] gives a comprehensive overview of the conceptual underpinnings of cultural evolution theory and provides a useful outline of the different understandings of cultural transmission found in the literature. In particular, she clearly distinguishes between 'mental' ('private'; not directly observable by others) and 'behavioural' ('public'; observable by others) expressions of culture, and she addresses debates around the transmission fidelity of private-mental traits. Tamariz deals with a core question in the field of cultural evolution: if private mental states are transmitted between individuals with low fidelity, how can we explain (cumulative) culture and its evolution? With the 'replication and emergence' model, she proposes that fidelity in cultural transmission is achieved through the replication of public-behavioural actions, while mental states emerge during usage and cannot be directly transmitted between individuals. We agree with Tamariz that mental states are emergent and are not directly copied among individuals, contrary to the views of Dawkins [2] and other proponents of the selfish 'meme' hypothesis. However, the 'replication and emergence' model still advances a 'replicator-centric' view of cultural evolution, where high fidelity in cultural transmission is achieved through the replication of motor-behavioural patterns. As outlined below, we consider this model much too restrictive since it neglects the social, interactive and communicative aspects of cultural transmission, which can strongly affect (and direct) the emergence of mental states.

1. Template-based replication is not crucial for inheritance

The influential work of Dawkins [2] places replicators at centre stage of Darwinian evolution. Even in biology, where DNA replication underlies inheritance, such a template-centred view of transmission processes is often misleading. Single genes, the replicators of biological evolution, only rarely determine a phenotypic trait on their own. Instead, genes act in concert, as members of large gene networks. In such a network, phenotypic differences can typi-

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cally not be traced back to differences between single genes [3]. The DNA sequences of the sets of interacting genes are not copied and transmitted together from parents to their offspring. Instead, the diploid parents only transmit haploid sets of genes, which, in addition, are reshuffled by recombination. It is for these reasons that replicators only play a marginal role in modern frameworks for the understanding of biological evolution (like evolutionary quantitative genetics [4], evo-devo theory [5], and evolutionary systems biology [6,7]). Similarly, template-based replication is not crucial for cultural evolution [8]. Tamariz herself reviews modelling studies (e.g. [9]) that illustrate how mental states can be transmitted with high fidelity without direct copying. Yet, Tamariz bases her theory on the replication of motor-behavioural patterns because the high-fidelity replication of a template would possibly allow individual learners to correctly guess the function of an action through repeated usage. We nonetheless think that the analogy with template-based replication is problematic since it downplays important aspects of cultural transmission. We develop this argument with respect to imitation-based learning in the following section. In the remaining sections, we further argue that the repeated usage of motor-behavioural patterns by individual learners cannot fully account for cultural transmission and for the emergence of mental states.

2. There is more to imitation than the replication of motor-behavioural patterns

Tamariz' model of cultural transmission relies on the assumption that the emergence of mental states associated with a motor-behavioural pattern is largely decoupled from the acquisition of this pattern. Naïve learners first replicate motor-behavioural patterns from others in a content-independent manner; mental states only emerge later during usage by the association of actions with their outcomes. Two-months old infants do indeed start to observe others and, a few months later, to match simple motor-behavioural patterns. At a later stage, reinforcement mechanisms might explain the emergence of mental states by the association of each action with its resulting outcome. While it is debated whether this simple picture characterizes social learning in early infancy, it is certainly not adequate at later stages of development. Already around the second year of infancy, the development of imitative capacities is based on the integration of motor skills with cognitive and social skills (reviewed in [10]). From this age onward, the imitation of actions seems to become supported by the higher cognition of others' intentions. In other words, mental states associated with imitated actions are not only shaped at a later stage (when these actions are used in practice) but already initiated in the earliest stages of the replication process. The care-takers of young children make use of this. For example, they guide the emergence of linguistic comprehension and production through joint attention and pointing behaviours [11]. The engagement of care-takers with infants also stimulates the emergence of social emotions, which provides the basis for later emotional and cognitive development [12]. In other words, the imitation of motor-behavioural patterns is, from an early age onward, embedded in communicative interactions that provide cues for linking the action with mental states, even before the action is later put into practice. This initial link may play a major role in the emergence of mental states, since these states do not need to emerge 'from scratch' but in a manner that is at least partly guided and canalized during the interaction of naïve learners with their models.

3. Human communication underlies all culture

In Tamariz' theory, all culture is ultimately rooted in imitable action patterns. In our opinion, this is a much too restricted view of culture. There are many aspects of 'mental culture' that cannot easily be derived from imitated actions. As a simple example, consider cultural precepts that prescribe *not* to execute a certain action. It is difficult to conceive how such precepts could emerge, at the individual level, from the imitation and usage of the prohibited action. Many, and perhaps most, mental cultural traits (from beliefs about the origin of the world to scientific theories like quantum mechanics), cannot easily be transmitted via imitable actions. Instead, language often plays a crucial role in the transmission of such traits. It is therefore strange that Tamariz does not discuss the role of language in cultural transmission in more depth and detail. We agree that verbal language may be viewed as a motor-behavioural pattern that, in principle, can be imitated. But with few exceptions (e.g. poems that are recited), verbal explanations or instructions are *not* imitated by the recipient. Instead, language vehiculates meanings that have no correspondence with imitable actions. While verbal instruction is certainly not equivalent to the replication of mental states, it can still be a powerful tool in directing and canalizing the emergence of mental states on the side of the receiver. If, for example, a naïve learner copies a complex action pattern (such as a hunting technique), the build-up of an associated mental state may be facilitated considerably if it does not have to emerge from scratch (based on the learner's own experiences

with the action pattern) but is guided by a verbal explanation by the model or an instructor. Verbal communication is often unreliable; it is perturbed by noise or misunderstandings and can be manipulative in various ways. Yet, we think that verbal communication plays a crucial role in cultural transmission and the evolution of cumulative culture. Perhaps most importantly, language-mediated communication allows to transmit (indirectly, via emergence) cultural information about imagined situations. This way, we can learn from the experiences of previous generations, even if we never tested the action patterns of these generations in practical situations.

4. The collective dimension is important for explaining (cumulative) culture

According to the theory of Tamariz, the mental representation of culture emerges in the brain of an individual, as the result of employing imitated action patterns (and modifications thereof) in practical situations. If the emergence of mental representations were an individual-level process, this process would be very inefficient, since everyone would have to 're-invent' the meaning of the replicated motor-sequences by herself. Moreover, such an individual-level emergence would most likely lead to the diversification of mental culture into individual lineages, each with their own private set of cultural meanings. The fact that we ascribe 'culture' to groups or societies, rather than to individuals, indicates that mental states are homogenized (to a certain extent). We suspect that the cultural transmission of mental states in social interactions is crucial for this, even if this transmission is of a more complicated nature than template-based replication followed by association during usage.

5. Conclusions

The replication and emergence theory of Tamariz may, at best, be an approximate description of the transmission and acquisition of culture in early infancy. But we doubt that the replication of motor-behavioural patterns and the subsequent individual-level emergence of mental representations are pivotal for cultural transmission later in life (even in case of subjects who find themselves in a cultural setting novel and unknown to them). In our opinion, the evolution of cumulative culture requires the transmission of 'cultural meanings,' in addition to the transmission of action patterns. Although such transmission is different from template-based replication, it can nevertheless be efficient if the emergence of mental states does not happen from scratch but is guided and canalized in interactions and via communication. However, a statement like this does not resolve the fundamental problem tackled by Tamariz: we lack a sound understanding of the processes and mechanisms governing the emergence of mental states in a cultural setting. Unravelling the principles governing the transmission of (mental) cultural information is a major foundational challenge for the field of cultural evolution. We firmly believe that progress will depend on the interdisciplinary collaboration of empirical and theoretical researchers, and that factors such as the various types of cultural interactions, the nature of communication in these interactions, the human ability to 'read the mind' of interaction partners [13], and the mechanisms governing the emergence of mental representations are crucial ingredients of any successful theory of cultural transmission.

References

[1] Tamariz M. Replication and emergence in cultural transmission. Phys Life Rev 2019;30:47–71. https://doi.org/10.1016/j.plrev.2019.04.004 [in this issue].
[2] Dawkins R. The selfish gene. Oxford University Press; 1976.
[3] Van Gestel J, Weissing FJ. Is plasticity caused by single genes? Nature 2018;555:E20.
[4] Walsh B, Lynch M. Evolution and selection of quantitative traits. Oxford Univ. Press; 2018.
[5] Carroll SB. Endless forms most beautiful – the new science of evo devo. Norton; 2005.
[6] Soyer OS, editor. Evolutionary systems biology. Springer; 2012.
[7] Wagner A. Robustness and evolvability of living systems. Princeton Univ. Press; 2007.
[8] Lewens T. Cultural evolution – conceptual challenges. Oxford Univ. Press; 2015.
[9] Henrich J, Boyd R. On modeling cognition and culture: why cultural evolution does not require replication of representations. J Cogn Cult 2002;2:87–112.
[10] Jones S. The development of imitation in infancy. Philos Trans R Soc B 2009;364:2325–35.
[11] Diessel H. Demonstratives, joint attention, and the emergence of grammar. Cogn Linguist 2006;17:463–89.
[12] Trevarthen C, Aitken KJ. Infant intersubjectivity: research, theory, and clinical applications. J Child Psychol Psychiatry Allied Discipl 2001;42:3–48.
[13] Apperly I. Mindreaders: the cognitive basis of 'theory of mind'. Hove; 2010.