A Cognitive Transition Underlying *Both* Technological and Social Aspects of Cumulative Culture

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Commentary on Target Paper by François Osiurak and Emanuelle Reynaud titled 'The elephant in the room: What matters cognitively in cumulative technological culture'.

Note: This is a pre-publication draft. There may be minor differences from the version accepted for publication in *Behavioral and Brain Sciences*.

60-WORD ABSTRACT
The argument that cumulative technological culture originates in technical-reasoning skills is not the only alternative to social accounts; another possibility is that accumulation of both technical-reasoning skills and enhanced social skills stemmed from the onset of a more basic cognitive ability such as recursive representational redescription. The paper confuses individual learning of pre-existing information with creative generation of new information.

1000-WORD MAIN TEXT

The target paper's main thesis—that cumulative technological culture originates not in social learning but in technical-reasoning skills—is consistent with results obtained with two computer models both of which show that cumulative cultural evolution *is* possible in the absence of social learning (albeit at a slower pace) but *not* in the absence of mental operations akin to reasoning or creative cognition (Gabora, 1995, 2008).

Variants of the target paper's argument have been proposed elsewhere (a sampling can be found in (Overmann & Coolidge, 2019)). We believe that a stronger case has been made for a competing argument which the authors do not address in this paper: that cumulative culture in technical-reasoning skills *and* enhanced social skills *both* stemmed from and relied upon the emergence of some more basic cognitive ability. Multiple versions of this have been proposed. Donald (1991) proposed that cumulative culture required a self-triggered recall and rehearsal loop, while Chomsky (2008) posits it was onset of what he called 'merge'. Hauser, Chomsky, and Fitch (2002) attribute it to the capacity for recursion, as does Corballis (2011), who also emphasizes mental time travel: the capacity to think about events not occurring in the present.

Penn et al (2008) suggest that cumulative culture required the capacity for relational reinterpretation. Our own two-step theory attributes it to the onset of representational redescription followed by the capacity to shift between convergent and divergent modes of thought, culminating in the capacity for an integrated internal model of the world (Gabora, 2018, 2019, 2020; Gabora & Smith, 2018, 2019; Smith, Gabora, & Gardner-O'Kearny, 2018). Thus, while Osiurak and Reynaud position their argument as the only serious contender to social accounts of cumulative technological culture, they omit theories involving more abstract cognitive abilities (some of which incorporate genetic evidence, e.g., Gabora & Smith, 2019). In short, many of the arguments Osiurak and Reynaud put forward in support of their technical-reasoning theory are also compatible with, and supportive of, theories that attribute cumulative culture to a more basic cognitive ability that paved the way for complex cognition in both the social and technical domains.

The authors highlight the distinction between sequential mechanical actions and combined mechanical actions, and between combined mechanical actions and genuine innovations (e.g., when they write "innovation in humans might primarily result from technical combinations rather than from novel inventions"). However, novelty does not depend on whether or not the elements are sequential (after all, notes of a song are sequential), nor on whether or not they are combined; the degree of novelty depends on the *structure* of the combination. The idea that nothing is truly new because innovation merely involves combining pre-existing elements was discredited decades ago with the discovery of emergent properties in concept (or word) combinations (Osherson & Smith, 1981), which have been shown to be not just present, but ubiquitous (Storms, De Boeck, Van Mechelen, & Ruts, 1998; Hampton, 1997). Indeed, there is a field dedicated to studying, empirically (e.g., Scotney, et al., 2020) and mathematically (e.g., Aerts & Gabora, 2005a,b; Aerts, & Sozzo, 2014; Bruza et al, 2012) the kinds of structure that emerge in combinations.

Throughout the paper the authors espouse a sharp distinction between social and asocial learning (e.g., they write, "social *versus* asocial learning"). However, consider the following scenarios for how a child learns to peel a banana: (1) by watching a sibling peel a banana, (2) by watching a monkey peel a banana, (3) by watching a cartoon monkey peel a banana, (4) by watching the petals of a cartoon tulip with a face unfold, (4) by watching the petals of a real tulip unfold. Where did we cross the line between social and asocial? One is forced to view social and asocial learning as ends on a continuum. The authors also assume that imitation and emulation are uniquely associated with social learning, but ask children in a theatre or dance class to imitate leaves blowing in the wind and they know exactly what to do. (Indeed, efforts to emulate nature have given rise to much of what constitutes human culture.)

Related to this is a confusion in the paper between individual learning and creative cognition. Individual learning involves obtaining *pre-existing* information from the environment through asocial means (e.g., learning by oneself the distinctions between different kinds of butterflies), whereas creative cognition involves generating ideas, behavior, or artifacts that *did not previously exist* (Gabora & Tseng, 2017). This distinction is vital to understanding cumulative cultural evolution because while the former (along with social learning) provides raw information about the world, the latter involves mental operations *on* this raw information. Thus, they contribute to cumulative culture in distinct yet complementary ways: the former providing new information *about* the world (e.g., discovery of electricity), and the latter bringing something new *into* the world (e.g., invention of flashlight). The distinction enables us to demarcate transition points in the evolution of complex cognition and in trajectories of actual

technological lineages (Gabora, Leijnen, Veloz, & Lipo, 2011; Gabora & Steel, 2017, under review; Veloz, Temkin, & Gabora, 2012).

The authors curiously state that "working memory is not a cognitive mechanism that is used to generate content," but if so then where is content generated? Although incubation, intuition, and subconscious processing play a role in creative cognition (e.g., Bowers, Farvolden, & Mermigis, 1995), the notion that generative capacities do not require working memory contradicts decades of research on the psychology of creativity. The authors also refer to "trial-and-error strategies that are not random but reasoned," but if the learning is "reasoned" then by definition it is not "trial and error".

It would be interesting to test some of the authors' ideas, such as the hypothesis that 'opaque' artifacts require more social learning for their transmission. Their notion of 'opacity' is reminiscent of Bateson's (1979) notion of affordances, except that affordances arise dynamically in the interaction between observer and observed. We believe this distinction is important; those who contribute most to culture may be those who see what others miss.

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