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The Role of Culture and Evolution for Human Cognition

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Abstract

Since the emergence of our species at least, natural selection based on genetic variation has been replaced by culture as the major driving force in human evolution. It has made us what we are today, by ratcheting up cultural innovations, promoting new cognitive skills, rewiring brain networks, and even shifting gene distributions. Adopting an evolutionary perspective can therefore be highly informative for cognitive science in several ways: It encourages us to ask grand questions about the origins and ramifications of our cognitive abilities; it equips us with the means to investigate, explain, and understand key dimensions of cognition; and it allows us to recognize the continued and ubiquitous workings of culture and evolution in everyday instances of cognitive behavior. Taking advantage of this reorientation presupposes a shift in focus, though, from human cognition as a general, homogenous phenomenon to the appreciation of cultural diversity in cognition as an invaluable source of data.

Keywords: Cognition; Culture; Evolution; Diversity; Language; Framework theories

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1. Introduction

The origin of our species in sub-Saharan Africa is commonly dated to roughly 200,000 years ago. When *Homo sapiens* began to spread around the globe, they were capable of making composite tools indicative of complex reasoning and problem-solving (Haidle, 2014), symbolic thinking (Henshilwood et al., 2018), and most likely language use (Fisher & Ridley, 2013). Although biological evolution, which provided the genetic endowment, brain anatomy, and physiology underpinning these skills, did not cease at the dawn of humanity, cultural evolution based on social learning and sharing (de Munck & Bennardo, 2019) came to play an increasingly important role (Colagè & d'Errico, 2018; Heyes, 2018; Laland et al., 2010; Thompson et al., 2016).

One way in which culture counteracts biological evolution is by buffering natural selection. For instance, people with psychological disorders have often adopted specific roles in a group rather than simply being excluded (Polimeni & Reiss, 2002). Heritable diseases can persist and spread if they occur in families that possess social and political power to begin with (McKusick, 1965). Selection pressures acting on humans may also be transformed by cultural practices that change the selective environment, a process called *niche construction* (Odling-Smee et al., 2003). Yet, beyond simply masking certain genetic features or shielding them from natural selection, culture can also take a much more active role in exerting evolutionary pressure of its own. The classic example for genetic evolution initiated by cultural practices is the selection of lactose tolerance in groups with dairy traditions (Holden & Mace, 2009).

As demonstrated by Colagè and d'Errico (2018), major innovations in human history are almost exclusively the result of processes which at least involved, if not entirely relied on, culture as the main driving force. Cultural evolutionary processes operate on several levels, with cultural practices impacting on (1) gene selection in a population, (2) the neural substrate and/or (3) the cognitive capabilities of individuals, and (4) culture itself (see Fig. 1 and examples in section 3).

1. The process through which a cultural innovation triggers changes in the genome is called *gene-culture co-evolution* (Boyd & Richerson, 1988; Durham, 1991). Positive selection of specific alleles induced by culture is faster than non-cultural selection, is very strong, and operates over a broad range of conditions, with lactose tolerance being the best known example (Laland et al., 2010).
2. Even in the absence of genetic modifications, a cultural innovation can trigger changes in the neural substrate of individuals due to neuroplasticity, the brain's response to intensive and enduring experiences, as involved in cultural practices. If this impact is so profound as to "rewire" the brain, we speak of *cultural recycling of cortical maps* (Dehaene & Cohen, 2007) or *cultural neural reuse* (d'Errico & Colagè, 2018). The prototypical example of this is the formation of a new brain network when learning to read and write (Dehaene et al., 2015).

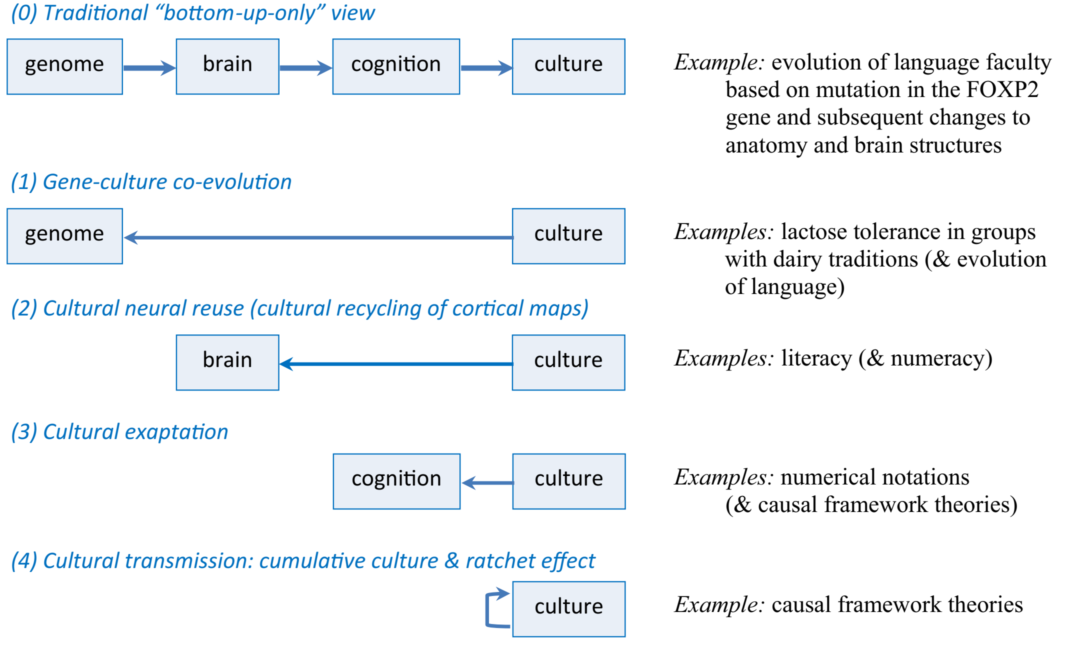

Fig. 1. Evolutionary processes involving culture on four levels (adapted from Colagè & d'Errico, 2018 [Fig. 2], and modified) with examples for each type of process; explanation in text.

3. A cultural innovation can also trigger changes in general cognitive capabilities by way of *cultural exaptation*. This process uses existing cultural traits for a new purpose, such as when the application of ochre for skin protection is co-opted for symbolic purposes (d'Errico & Colagè, 2018).
4. Finally, cultural transmission is the key mechanism by which cultural innovations lead to changes in culture itself. Active teaching, process-oriented learning, and conformity help to accumulate such innovations (*cumulative culture*), as do social interaction and communication in general, thereby providing later generations with a head-start (Heyes, 2012; Morin, 2016a; Tennie et al., 2009).

In all of these cases, the basis on which evolution operates is the variation created by cultural innovations. The goals of this paper are to outline the extent of cultural variation in human cognition and to illuminate the evolutionary processes linked to it—not only as interesting and important topics in their own right, but as a window into a more comprehensive investigation of cognition. In pursuit of the first goal, cultural innovations and their impact on human cognition will be illustrated for three cognitive domains. In pursuit of the second goal, the ensuing diversity will be accounted for as both outcome and motor of evolutionary processes. Finally, implications of such a perspective will be discussed, with specific emphasis on the explanatory power afforded by this perspective, and on how it can (and should) inform theorizing and research practices in cognitive science.

2. The cultural diversity of human cognition

Recent years have seen an increasing interest in the cultural diversity of cognition. Instigated by a renaissance of linguistic relativity (Gentner & Goldin-Meadow, 2003; Gumperz & Levinson, 1996; Lucy, 1992), by ground-breaking work on how culture shapes concepts, categories, and reasoning in the biological domain (Medin & Atran, 2004), or by fundamental critiques of prevailing research practices (Henrich et al., 2010), cross-cultural studies have become a vivid subfield in cognitive science. In the following, the extent of cognitive diversity is summarized for three domains: language and writing, number representations, and causal framework theories.

2.1. Language and writing

Communication is expedient for any social species, and the most powerful natural system of communication is human language. The use of language is one of our key abilities and has contributed essentially to what we are today. Language enables us to elaborate on ideas, gain new insights, and pass them on to others; it facilitates cooperation and allows us to agree on values and norms, thereby forming the foundation of our communities. The language faculty, understood here as the evolved capacities in humans for acquiring any human language (cf. Hauser et al., 2002), involves anatomic features and brain structures dedicated to language (Lim & Snyder, 2015) and a genetic basis distinct to and universal in humans (Enard et al., 2002). This is also attested by the drive in children to acquire language or, if linguistic input is insufficient, to create a linguistic system almost from scratch (Senghas et al., 2004). Still, both for the regular acquisition and the invention of language, humans are reliant on fellow humans. This renders culture a necessary prerequisite for developing the skills needed to learn and use language.

Culture is also the source of the specific language(s) which people acquire as their native tongue(s). Diversity begins with the modality in which language is expressed—spoken, whistled, signed, or written (including tactile forms like Braille)—and it extends to the shape and semantic scope of the symbols as well as to the rules for combining them. For instance, languages differ in where the verb is placed in a sentence (Dunn et al., 2011), in whether it is marked for tense and/or aspect (Binnick, 1991), and even in whether a word class like "verb" exists to begin with (Broschart, 1997). In fact, languages differ so profoundly that it has proved challenging to establish a single linguistic universal (Evans & Levinson, 2009). Nevertheless, diversity in languages is internally structured due to their descent from common ancestors, and the extent of the difference between languages is a function of their relatedness.

Writing systems reflect the diversity of the spoken languages they code, yet vary even more due to additional degrees of freedom, such as the unit of coding (vowels and consonants, syllables, or morphemes) or its transparency, with English being one of the less transparent systems.

Linguistic diversity is claimed to have implications for cognition, and although this claim has remained controversial within cognitive science (overviews in Lucy, 2016; Wolff & Holmes, 2011; and see Cibelli et al., 2016; Lupyan & Clark, 2015), evidence is accumulating in its favor across a range of phenomena, including linguistically encoded categories like labels for odors or colors (Majid & Burenhult, 2014; Roberson et al., 2005), conceptual systems like frames of reference (Majid et al., 2004), the extension of linguistic metaphors to abstract domains (Boroditsky & Gaby, 2010; Dolscheid et al., 2013), or grammatical features like number (Athanasopoulos, 2006; Lucy, 1996). In addition, proficiency in more than one language impacts on executive control (Bialystok et al., 2012), and the language of operation affects cognitive processing and may change the outcome of moral judgments and decision making (Athanasopoulos et al., 2015; Hayakawa et al., 2016).

Literacy also impacts on individual cognition: Being able to write and read increases the memory span for verbal input, enhances metalinguistic skills, and improves the ability to analyze details in complex configurations separately or to detect recurring patterns in sequences of symbols (Dehaene & Cohen, 2007; Dehaene et al., 2015). Structurally different writing systems have distinct effects, though, with the transparency of a system affecting ease of learning and access strategies (Seymour et al., 2003). And even a trivial variation like writing direction may distinctively affect attention, memory processes, and the representation of abstract concepts (Dehaene et al., 1993; Dobel et al., 2014; Tversky et al., 1991).

In view of these multifarious implications even for basic processes, linguistic diversity clearly should be acknowledged as an indispensable dimension in any account of cognition.

2.2. *Number representations*

Occurrence in different quantities is an impartial feature of objects, and indeed a feature whose recognition is potentially relevant for survival. But despite having a correspondent in the real world, the number representation on which these quantities are mapped for counting needs to be tediously learned (Núñez, 2017).

As cultural tools, number representations are diverse (Bender & Beller, 2012; Widom & Schlimm, 2012). They differ, for instance, in the modality in which they are implemented (e.g., by way of words, body parts, graphic codes, tally sticks, knotted cords, or abaci), in the shape of their symbols (e.g., “5” vs. “V”), and in structure (“8” vs. “VIII”).

The availability of exact number representations is a prerequisite for counting and calculation (Frank et al., 2012; Gordon, 2004). Differences in the structure of number systems affect the cognitive representation and processing of numerical information. For instance, a system that is internally structured by base and power allows for more compact representations of numbers than those which lack structure, and the greater the base, the more compact the representation; but greater bases also entail larger addition and multiplication tables to be memorized. If a system represents numerical information explicitly (as with “III” instead of “3”), it relieves working memory and reduces cognitive load. Such impacts of representational format on processing are called "representational effect" (Zhang & Norman, 1995; for examples, see Bender & Beller, 2014, 2017; Bender et al., 2015b; Schlimm & Neth, 2008).

As this effect has been a topic at the very heart of cognitive science (Hutchins, 1995; Larkin & Simon, 1987), diversity in number representation should be of genuine interest in this field and would be essential for updating our theoretical models of numerical cognition (Bender et al., 2015b).

2.3. *Causal framework theories*

Causal cognition serves a number of important functions: It enables us to diagnose causes, to predict future events, and to avoid or control their outcomes. Many abilities relevant to it, such as causal learning based on statistical regularities, appear to be available already in infancy. Infants also seem to possess domain-specific concepts linked to object motion and to agency, and they exhibit a drive to explore their environment and test causal assumptions (overview in Muentener & Bonawitz, 2017).

Causality is opaque, however (Waldmann et al., 2006), and even when our observations are largely accurate, they are frequently enriched by interpretation and complemented by cultural transmission. In fact, the overwhelming amount of what we believe we know about causal mechanisms, from simple facts to explanatory frameworks, is based on what we learned from others, and hence culturally shaped and diverse (Bender & Beller, in press; Bender et al., 2017). Moreover, a great deal of people's knowledge is embedded in larger models and culturally transmitted *framework theories* (Bang et al., 2007), which contain representations of causal structure and thereby help to organize concepts and categories, generate relations between them, and invite inferences. In the domain of folk biology, such theories guide the conceptualization of nature and humans' place in it. Here, the causal assumptions embedded in the framework theory affect how information on and associations between concepts of living kinds are organized in memory, whether or not typicality and diversity effects in reasoning emerge, or which decisions people make (Medin & Atran, 2004). Cultural framework theories even impact on how we partition the world in which we live. Cognitive domains such as (folk-) physics, biology, and psychology are assumed to be based on principles for agency ascription, in line with *properties* of the key entities that are emphasized in Western framework theories. Framework theories that emphasize interconnectedness instead conceptualize domains differently, with agency being grounded in *relations* between entities, in communication and exchange (Ojalehto et al., 2017a,2017b). One implication of holding such a relational framework theory is that it renders individuals less susceptible to asymmetric or anthropocentric inferences when reasoning about causal mechanisms in biology (Medin & Atran, 2004).

So, even for a comprehensive account of cognitive processes only, the diversity implied in what people know and how they interpret observations turns out to be decisive.

3. The evolution of human cognition

While the three examples mustered here—language and writing, number representations, and causal framework theories—are all central in most people's lives, they still differ in the scope of their impact on cultural evolution. In this section, the unfolding of such impacts on the four levels (summarized in Fig. 1) will be retraced in reverse order.

3.1. The evolution of causal framework theories as an instance of cumulative culture

The ability to come up with causal explanations of what's going on in the world around us is beneficial for survival, and both non-human animals and young children show evidence of core components of this ability, which indicates a broad evolutionary basis. But even though causal cognition is considered the driving force in human evolution (Stuart-Fox, 2015), the mechanisms involved in its development are likely confined to cultural and cognitive processes.

Compared with languages and number systems, causal framework theories are the least formalized and fixed of the cultural innovations considered here. They are not necessarily coherent; they vary across and within cultural groups (Atran et al., 2004), and conflicting causal beliefs can even co-exist within individuals (Astuti & Harris, 2008; Legare & Gelman, 2008; and see Shtulman & Legare, in press). Impacts are therefore rather unlikely for brain structures or gene pool, but they would be substantial on the two other levels. Framework theories are both cultural and cognitive tools: complex cognitive representations that are accrued and provided through cultural transmission ((Bender & Beller, in press). They build on knowledge that is gleaned from experience with one's environment and accumulates over time, and they are enriched with cultural values and epistemological orientations. Progress in causal understanding enabled our ancestors to adapt to ever new environments, to master incredible feats like traversing oceans in small boats, and to achieve spectacular advancements in technology, science, and medicine. In this sense, therefore, framework theories are a prime example of cumulative culture, and at the same time a prime example of how culture and cognition impact on one another (see Figs. 1.3 and 1.4).

3.2. The evolution of number representations as an instance of cultural exaptation

Some preconditions for our numerical abilities are biologically evolved and shared with other species. These include the ability to keep track of up to four distinct items by way of immediate perception (called *subitizing*) and to approximately estimate larger quantities (Feigenson et al., 2004). The ability for exact quantification, in contrast, is exclusively human. It does not easily follow from either of the above preconditions, but presupposes cultural tools (Núñez, 2017), which themselves took a long time to emerge and evolve (Coolidge & Overmann, 2012; d'Errico et al., 2017).

Number is an archetypal example of cumulative culture (Fig. 1.4) insofar as innovations tend to accumulate and afford new innovations (Miller & Paredes, 1996), subject to cultural needs (Beller & Bender, 2008). Like causal cognition, number comprehension has been claimed to be the main factor in human evolution (Everett, 2017). Cultural innovations in number representations are inextricably linked with cognitive concepts and skills, and their evolution passed through several cycles of cultural exaptation (Fig. 1.3), in which tools and techniques that had been developed to incise objects (e.g., for decorations) were co-opted for the production of an artificial memory system by associating signs with meaning (d'Errico et al., 2017).

Different modalities of number representation are subject to different evolutionary trajectories. Verbal systems are part of language and hence subject to language evolution (Calude & Verkerk, 2016; Xu & Regier, 2014). This is also true for written notations and other material representations (Chrisomalis, 2010; Menninger, 1969; Overmann, 2016), which, in addition, are more flexible to deliberate modification. As notational systems implicate writing and reading skills, they would even have initiated a process of cultural neural reuse (Fig. 1.2; d'Errico & Colagè, 2018).

3.3. The evolution of language and writing as an instance of cultural neural reuse (and likely gene-culture co-evolution)

Both the language faculty itself and the distinct languages spoken by people are subject to evolution, and at least for the former, there is no doubt that natural selection played a major role in its emergence. While most of its evolutionary precursors are shared with other species, the unique language skills in humans are closely linked to a genetic mutation. FOXP2, a highly conserved gene which is also important for the learning of vocalizations in songbirds, contains two modified amino acids in the human sequence; it experienced a recent selective sweep and is now functionally identical in all human populations (Enard et al., 2002; Vargha-Khadem et al., 2005).

The evolution of the language faculty thus seems to provide a prototypical instance of purely biological evolution (Fig. 1.0): Genetic mutations caused changes in the brain, which afforded the emergence of language, which then aided cultural innovations. However, since a mutation that promotes a yet to be invented skill is not highly likely to spread, and definitely not at the observed speed, a more plausible scenario is *gene-culture co-evolution* (Fig. 1.1). According to this view, the species was already using language when the mutations occurred. As improvement of language skills in such a context is highly desirable, it would have been culture exerting a strong selection pressure which favored the spread of the mutation (Fisher & Marcus, 2006; Fisher & Ridley, 2013).

Even with the language faculty being genetically fixed at some point, the individual language systems would still evolve and diversify. While today's variety of distinct languages is mostly a product of language variants drifting apart from one another over time, the gradual accumulation of minor changes resulting in major differences is not purely a matter of random variation. Some changes also arise from the fact that language adapts itself to cognitive constraints (Christiansen & Chater, 2008; Kirby et al., 2008) and to its environment (Lupyan & Dale, 2016). A major challenge to the comprehension of spoken language, for instance, is the *Now-or-Never bottleneck* (Christiansen & Chater, 2016): Since utterances are linear, rapid, and short-lived, incoming signals need to be processed and stored at high speed before they are overwritten by subsequent signals. Spoken language therefore evolves in the direction of increasing learnability and compositionality (Isbilen & Christiansen, 2018; Smith, 2018). A similar trend can be observed for writing, which adapts to requirements of asynchronous communication by combining the versatility characteristic for spoken language with sufficient productivity to remain learnable (Morin et al., 2018).

But linguistic systems do not only adapt themselves; they also cause modifications at various levels: by enhancing cognitive abilities, by "rewiring" the brain (Güntürkün et al., 2015), and by driving even genetic evolution (Dediu & Ladd, 2007). One case in point is writing. Writing was invented rather late in human history (Huettig & Mishra, 2014) and therefore lacks a genetic basis, but it reorganizes neural activities that link motor planning, vision, object recognition, and language in new ways (Dehaene & Cohen, 2007; Overmann, 2016). Different writing systems do so in distinct ways, with the reading of alphabetic scripts involving different brain areas than the reading of Chinese characters (Dehaene et al., 2015). This renders literacy the paradigmatic instance of cultural neural reuse (Fig 1.2). Insofar as artificial memory systems and particularly number notations are considered as a specific (and perhaps the primordial) case of writing, literacy also provides a paradigmatic instance of cultural exaptation (Fig. 1.3; d'Errico & Colagè, 2018). And finally, as literacy affords transmission of knowledge across space and time on a grand new scale (Huettig & Mishra, 2014; Morin et al., 2018), it is clearly one of the most powerful mechanisms in cumulative culture (Fig. 1.4).

4. Implications for cognitive science

Adopting an evolutionary perspective has implications for cognitive science in terms of the questions to be asked, the methodological approaches to be adopted, the explanatory power to be pursued, and ultimately the research practices to be revised. To this end, it does not really matter whether the perspective advocated is the one on which the current presentation is drawing or an alternative account (e.g., Claidière et al., 2014; Henrich et al., 2008; Mesoudi et al., 2006; Morin, 2016b; Scott-Phillips et al., 2018). These accounts may differ in conceptual details, but they share with this presentation an emphasis on human cognition as evolved and evolving (Sterelny, 2017).

4.1. Grand questions

Adopting an evolutionary perspective encourages us to ask grand questions: Where do our cognitive abilities come from? Which forces sparked them off and promoted, shaped, and constrained their evolution? How did the cognitive abilities become an active force in their own evolution, and how do they shape the environment in which they thrive? By conceiving of cognitive capacities as embedded in cultural practices and as a product of cultural evolution, we can thus begin to investigate the central role of culture in forming human cognition.

4.2. New methods

Evolution in humans operates on time scales that pose insurmountable challenges to controlled lab experiments. To compensate for this, several research strategies have been proposed. Those giving central stage to cultural rather than biological evolution—and hence to processes involved in diversification rather than convergence on single uniform solutions—include strategies from cognitive archaeology, comparative psychology, language evolution, and evolutionary anthropology.

Cognitive archaeology tries to reconstruct the cognitive abilities available to our ancestors by adopting a *chaîne opératoire* approach. It takes material remains as the starting point for identifying the steps required for producing them, the behavioral components implicated in these steps, and the necessary cognitive capacities underpinning them (Haidle, 2014; Sellet, 1993). Comparisons between species, across linguistic and cultural groups, and over the course of conceptual development have enabled comparative psychology to chart the social and cognitive skills in which humans differ from other species (Haun et al., 2010) and to identify cumulative culture as one of those evolutionary processes that made humans unique (Tennie et al., 2009; Tomasello, 1999). Cumulative culture is also at the center of a relatively young field in cognitive science that explores methods for investigating its key characteristics under controlled, experimental conditions. Such studies focus on specific changes in performance as the outcome of social transmission, and they are typically implemented as an iterated learning paradigm (Caldwell, 2018).

A research strategy adopted in evolutionary anthropology, finally, differs from the others in that it takes diversity, and not universal patterns, as a starting point for reconstructing the cultural and environmental factors that produced this diversity. Initially developed in biology (Harvey & Pagel, 1991), it has become a productive methodological toolkit for understanding sociocultural (Mace & Holden, 2005), linguistic (Dunn et al., 2011), and cognitive diversification (Haun et al., 2006). The method takes advantage of the evolution and diversification of languages which is captured by phylogenetic trees. By plotting linguistically coded concepts or categorical systems in today's languages onto these trees, phylogenetic comparative methods can be run to reconstruct how and (potentially) why these concepts have changed over time (Levinson & Gray, 2012).

4.3. Explanatory power

Adopting an evolutionary approach and its methodological toolkit yields findings on several tiers of explanatory power beyond simple descriptions. This might not seem obvious at first glance (Sterelny, 2019). The time spans involved in human evolution prevent direct observations of the involved processes (with the possible exceptions of emerging languages) and compromise the controlled testing of hypotheses. Furthermore, random changes are part and parcel of evolution: Selection chooses from what happens to be available, and its pressure is relative to the competing options, dependent on initial environmental conditions. Evolution will therefore promote, for instance, linguistic structures that can be effectively chunked, but it will not necessarily result in optimally learnable languages (Isbilen & Christiansen, 2018; Smith, 2018). On this account, evolutionary changes and the ensuing diversity are impossible to anticipate or reproduce in the laboratory and, to the extent that drift is involved, even hard to explain (cf. Billiard & Alvergne, 2017). Still, relevant components of evolution can be captured in empirical and systematic manners, and the insights to be gained from such studies are highly illuminating.

Thus, while *prediction* is largely out of reach for approaches that emphasize evolution and diversity, they can greatly improve *description*, *explanation*, and, crucially, *understanding*. Cross-cultural surveys provide comprehensive descriptions of diversity, and mapping it on a domain's design space reveals potential limits to variation (Kemp & Regier, 2012). As the diversity observed is a compromise of random drift and constraints to which systems adapt, it is not always meaningful on its own terms. Phylogenetic comparative methods allow us to identify the extent to which such limits are simply due to shared descent and the extent to which they would be due to environmental, cultural, or cognitive constraints (Levinson & Gray, 2012). For instance, categorization systems for kinship occupy only a tiny corner of the space of all possible systems. This clustering is largely due to shared history of the languages involved and the social practices linked to the kinship systems (Rácz, Passmore, & Jordan, 2019), but also reflects general communicative principles balancing informativeness and simplicity (Kemp & Regier, 2012). In modeling evolutionary trajectories of cognitive systems, finally, these approaches can also help us to establish the primordial values of certain parameters, to identify the factors that initiated subsequent changes, and to reconstruct the conditions under which such changes are likely (Jordan, 2011; Jordan et al., 2009; Levinson, 2012a).

4.4. Research practices

Investigating evolutionary changes is not just an interesting endeavor in its own right, but helps to shed light on characteristics and processes that are still active in shaping cognitive behavior. Cultural evolution did not cease sometime in the past, but is actually accelerating. A better grasp of its processes is therefore decisive for an understanding of contemporary developments also in cognitive activities. For instance, our communicative systems are changing due to new technologies, and a lot of what we know about cognitive processes involved in writing seem to no longer hold when applied to modern modes of text messaging (Lupyan & Dale, 2016).

Likewise, culture is not something that only others have, but is universal in humans, including our favored study samples as well as those who conduct the research (Henrich et al., 2010; Medin et al., 2017). Taking cultural diversity more seriously would thus equip us to identify blind spots and counter the "home-field disadvantages" in our research programs (Bender et al., 2015a; Medin et al., 2010). After all, scientists are like any other humans in that their assumptions and expectations are guided by framework theories and epistemological orientations (Ojalehto et al., 2017a,2017b; and see Aronowitz & Lombrozo, 2019). Even in mathematics, the “purest” of all sciences, scholars have come to acknowledge that taking different starting points will give rise to different sets of conceptualizations, and even different descriptions of the world (Kleiner & Avital, 1984). Increasing diversity in science in terms of framework theories—whether conveyed by cultural upbringing or by disciplinary training—would therefore be an important step forward.

Adopting an evolutionary approach, however, requires a shift in focus. One of the key goals in cognitive science has been to come up with an accurate model of the cognitive architecture and the cognitive processes operating in it, reflected in the attempts to generate computer-based models of the human mind. This entails an emphasis on the unity of this human mind, an interest in general mechanisms and processes, and a focus on idealized capacities. Taken to the extreme, it has enticed some researchers not only to ignore the possibility of variation in human cognition but even to deny it (for critical discussion, see Bender & Beller, 2011; Levinson, 2012b). Such a focus renders at least an incomplete, if not incorrect picture of cognition. Variation is not just noise, but the signal (Levinson & Gray, 2012). Variation within species is the raw material on which evolution is operating through selection, be it biological or cultural evolution. It is because of variation within species, also in terms of cognition, that our human cognitive skills are unique. In other words: There is no such thing as “the” human mind or one pure form of cognition; diversity is an inherent dimension of the very phenomenon that cognitive scientists seek to understand.

This has implications for our theoretical models as well as our research practices. Ignoring cultural diversity in human cognition and the evolution that gave rise to it would be a fatal mistake, not only because it renders an inaccurate impression of what human cognition is, but also because it blocks exciting and highly illuminating means of investigating and understanding it.

5. Conclusion

Contemporary human populations share the genetic endowment for cognition as a result of their joint evolutionary past. Yet, since the emergence of our species, if not longer, natural selection based on genetic variation has ceased to play a major role in human evolution. This is not to say that biology is irrelevant. After all, human cognition unfolds in organisms and brains that were shaped by biological evolution. Being aware of its precursors and evolved functions will therefore improve our understanding of its operation and constraints (see Bickle, in press). Nonetheless, while biology has equipped as with the “raw material” of body and brain, its emergent cognitive properties are shaped by cultural transmission and social interactions.

Cultural evolution made us what we are today, by ratcheting up cultural innovations, promoting new cognitive skills, rewiring brain networks, and even shifting gene distributions. Building on what it has endowed us with enables us to take yet another step further.[1] Its pivotal role in human evolution renders culture a constitutive feature of the specifically human brand of cognition and the prime source of its diversity (Bender & Beller, in press). Crucially, this implies that even in the absence of cultural differences, cognition remains a product of human culture—profoundly shaped by the very fact that humans are a cultural species.

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Note

1. An elegant example of cumulative culture in this sense is the transfer of phylogenetic comparative methods from biology to the social sciences: co-opting an established tool for new tasks.

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