

The cultural evolution of cognition

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As humans, we share most of our biological make-up with our closest primate relatives, yet we stand out not just from them but from all other species with respect to our cultural diversity, our capacity for language, and particularly our cognitive skills. While of prime interest for the field of cognitive science, the still-open question of which factors gave rise to human uniqueness has rarely surfaced at its conferences or in its journals. A hallmark of humankind, our propensity for engaging in social interactions and cultural transmission, is likely one of the most essential preconditions of cognitive evolution, accompanied by both language (Christiansen & Kirby, 2003) and material culture (Malafouris, 2013). Accounting for evolutionary change in human cognition thus requires new conceptual frameworks that view our psychological, behavioral, and material capabilities as interacting in complex manners in a continuous process of co-evolution (Richerson & Christiansen, 2013).

Our symposium highlights the relevance of culture as a driving force in the evolution of human cognition, with a special focus on material culture, language, and conceptual tools. Researchers from various sub-fields of cognitive science—including archaeology, anthropology, linguistics, cognitive psychology, and comparative psychology—will discuss cultural factors that may have triggered, constrained, or shaped the course of cognitive evolution:

Caldwell uses experimental methods to study cultural evolution in human participants, and carries out comparative research on social learning with nonhuman primates. Cognitive scientist **Christiansen** employs a variety of computational, behavioral, and neuroimaging experiments to unravel the interaction between biological and environmental constraints in the evolution, acquisition and processing of language. **Smith** develops experimental and computational models of cultural evolution and the co-evolution of language and language learning biases and strategies. Cogni-

tive archaeologist **Overmann** draws on insights from various subfields of cognitive science to investigate how mind, behavior, and material artifacts interact to change human cognition. **Bender & Beller**, finally, take an anthropological perspective on cultural diversity to account for how conceptual tools for cognition may have emerged and evolved.

Together, these participants have published several dozen papers related to the topic, including in high-quality journals such as *Science*, *PNAS*, *BBS*, *Proceedings of the Royal Society*, *TiCS*, *Current Anthropology*, or *Cognition*.

Prerequisites of Cumulative Culture in Laboratory Studies of Cultural Evolution

Christine A. Caldwell

In humans, cultural traditions often change in ways which increase efficiency and functionality (widely referred to as cumulative cultural evolution). However, directional change of this kind appears to distinguish human cultural traditions from behavioral traditions that have been documented in other animals. We (Caldwell et al., 2016) have reviewed experimental studies of cultural evolution to consider how the task is framed for the participants, and what kind of change is being measured by the researchers. Contrasting the broad approaches in the literature provides some enlightening insights into the conditions necessary for eliciting the ratcheting pattern of change regarded as the hallmark of cumulative culture. These insights may shed light on the apparent rarity of cumulative culture in nonhumans.

Language Evolution as Cultural Evolution

Morten H. Christiansen

Culture in its many manifestations—social organization, technology, science, language, religion—is responsible for the striking difference between humans and other organisms. Over the past few decades, a growing body of research has emerged from a variety of disciplines highlighting the importance of cultural evolution in understanding human

behavior (Richerson & Christiansen, 2013). Within the language sciences, this has resulted in a shift toward explaining language evolution in terms of cultural evolution rather than biological adaptation. This work has demonstrated how various nonlinguistic biases amplified by cultural transmission across generations and pressures from interactions within generations may help explain many facets of linguistic structure observable in today's languages (e.g., Christiansen & Chater, 2008). A key challenge for future research is to identify specific constraints on learning and use that shape the various aspects of the cultural evolution of language. Ongoing work will be discussed to shed light on specific constraints on the cultural evolution of linguistic structure (Christiansen & Chater, 2016).

The Cultural Evolution of Linguistic Structure

Kenny Smith

The expressive power of human language comes from its structure: Language provides a generative system for building complex utterances which convey complex meanings. How have humans developed this unique and powerful system of communication? One classic explanation is that language structure represents a biological adaptation to a uniquely socially-interdependent human ecology. Recent evidence (from computational and experimental models of cultural transmission) suggests an alternative: linguistic structure develops gradually through cumulative cultural evolution, as a consequence of language learning and language use (e.g., Kirby et al., 2015). This work predicts that structure should arise from cultural transmission under fairly general conditions, a prediction borne out by recent work on cultural evolution of structure in non-humans (Claidière et al., 2014). These various sources of evidence suggest that we have structured language because we are social, but rather than language being a biological adaptation to this social ecology, it is primarily a cultural adaptation arising from our propensity to learn socially.

Literacy as Cognitive Change Emerging from Material Engagement

Karenleigh A. Overmann

Seen through *Material Engagement Theory* (Malafouris, 2013), literacy is a cognitive change emerging from specific interactions with material forms (Overmann, 2016). Over multiple generations, the manuovisual stimulation inherent in handwriting influences brain functionality and form, and change in psychological processing facilitates the manipulation of writing and scripts into new, stimulating forms with subsequent impact on neurological functioning. Long-term sustainment of the behaviors required to develop the necessary psychological and material changes is culturally motivated. While each individual must acquire the cognitive change needed to participate in the literate system (to whatever degree it has been developed), multi-generational involvement ensures the cumulative change remains synchronized to average cognitive capabilities. What is ultimately

realized is beyond what any one individual could invent but something that most individuals can join. As a collective, cumulative process of cognitive change, literacy provides insight into the cultural evolution of human cognition through psychological-behavioral-material interactivity.

Puzzles in the Evolution of Numerical Cognition

Andrea Bender & Sieghard Beller

Counting is central to human cognition and cultural diversification, as it is one of the key activities that fostered abstraction and symbolic thinking at the dawn of humanity (Coolidge & Overmann, 2012). Then and now, however, the ability to count, and numeracy more generally, seems to presuppose a counting sequence, and this raises the question of how such a conceptual tool could be invented in the first place. And how would strikingly different conceptual tools or embodied experiences (Beller & Bender, 2008; Bender & Beller, 2012, 2014) stimulate the same decisive conceptual change believed to be required for eventually grasping the cardinality principle? Puzzles like these are presented, together with an overview of the attempts to tackle them.

References

- Beller, S., & Bender, A. (2008). The limits of counting: Numerical cognition between evolution and culture. *Science*, *319*, 213-215.
- Bender, A., & Beller, S. (2012). Nature and culture of finger counting: Diversity and representational effects of an embodied cognitive tool. *Cognition*, *124*, 156-182.
- Bender, A., & Beller, S. (2014). Mangarevan invention of binary steps for easier calculation. *PNAS*, *111*, 1322-1327.
- Caldwell, C. A., Cornish, H., & Kandler, A. (2016, forthcoming). Identifying innovation in laboratory studies of cultural evolution: Rates of retention and measures of adaptation. *Philosophical Transactions of the Royal Society of London B*.
- Caldwell, C. A., & Millen, A. (2009). Social learning mechanisms and cumulative cultural evolution: Is imitation necessary? *Psychological Science*, *20*, 1478-1483.
- Christiansen, M. H., & Chater, N. (2008). Language as shaped by the brain. *Behavioral & Brain Sciences*, *31*, 489-558.
- Christiansen, M. H., & Chater, N. (2016). *Creating language*. Cambridge, MA: MIT Press.
- Christiansen, M. H., & Kirby, S. (2003). Language evolution: Consensus and controversies. *Trends in Cognitive Sciences*, *7*, 300-307.
- Claidière, N., Smith, K., Kirby, S., & Fagot, J. (2014). Cultural evolution of a systematically structured behaviour in a non-human primate. *Proceedings of the Royal Society B*, *281*, 20141541.
- Coolidge, F. L., & Overmann, K. A. (2012). Numerosity, abstraction, and the emergence of symbolic thinking. *Current Anthropology*, *53*, 204-225.
- Kirby, S., Tamariz, M., Cornish, H., & Smith, K. (2015). Compression and communication in the cultural evolution of linguistic structure. *Cognition*, *141*, 87-102.
- Malafouris, L. (2013). *How things shape the mind*. Cambridge, MA: The MIT Press.
- Overmann, K. A. (2016). Beyond writing: The development of literacy in the Ancient Near East. *Cambridge Archaeological Journal*, *26*, 285-303.
- Richerson, P. J., & Christiansen, M. H. (Eds.) (2013). *Cultural evolution*. Cambridge, MA: MIT Press.