Unravelling Past Cognition: Approaches Across Disciplines

Organizers

Larissa Mendoza Straffon (Larissa.Straffon@uib.no) & Andrea Bender (andrea.bender@uib.no)
Department of Psychosocial Science, University of Bergen, Norway

Presenters

Claudio Tennie (claudio.tennie@uni-tuebingen.de)
Department for Early Prehistory and Quaternary Ecology, University of Tübingen, Germany

Dietrich Stout (dwstout@emory.edu)
Department of Anthropology, Emory University, USA

Simon Greenhill (greenhill@shh.mpg.de)
MPI for the Science of Human History, Jena, Germany

Francesco d'Errico (francesco.derrico@u-bordeaux.fr)
PACEA, Université Bordeaux, France

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Throughout its own history, cognitive science has paid little interest to the historical dimension of its key topic. Most cognitive scientists tended to treat cognition as if it always and everywhere were the same (Bender, 2019). But present-day cognition in humans (as well as in any other species for that matter) is a product of evolution – sometimes of different kinds of evolution – and has been subject to substantial change (Heyes, 2018).

About 6 million years ago, the human line dissociated from its closest relatives, setting off on a different evolutionary track. Several hundred thousand years ago, early *Homo sapiens* learned to control fire, invented complex compound tools such as bow and arrow, and began to use abstract symbols and language (Wadley, 2013). Even today, these achievements strike us as truly impressive, yet they also raise tantalizing questions: What made them possible? Did they emerge all of a sudden, subsequent to genetic mutations, or did they emerge gradually, through cultural cumulation? Which factors spurred them on, which role(s) did culture play in this, and how are these innovations linked to language?

For a more in-depth understanding of the forces that have shaped—and are still shaping—cognition, we need to combine insights across a range of disciplines that are not frequent contributors to cognitive science conferences: comparative research on cognition in humans and non-human species, archeological and other palaeoscientific research on prehistory, and anthropological research on human evolution and cognitive diversity. Bringing together leading scholars from these disciplines is what our symposium tries to achieve. In addressing some of the challenging questions mentioned above, they will also showcase why their contributions to cognitive science are invaluable. With publications in high-quality journals (such as *Science*, *Nature*, *PNAS*, *Philosophical Transactions of the Royal Society*, or *TiCS*), each of the presenters to this symposium is at the forefront of their respective fields:

Tennie, with his background in behavioral ecology and comparative psychology, has made key contributions to the evolution of culture and cognition in humans and great apes (Schmidt et al., 2019; Tennie et al., 2009). **Stout** has been pioneering the combination of anthropological research with brain-imaging for reconstructing past tool cognition (Stout & Chaminade, 2007; Stout et al., 2008). An outstanding expert on Bayesian phylogenetic methods, **Greenhill** harnesses present-day diversity to reconstruct the evolutionary dynamics of cognitive systems (Dunn et al., 2011; Greenhill et al., 2017). And **d'Errico**, in the past four years the "world's most cited researcher in the field of prehistory", has investigated the origins of human cognition across a wide range of domains (d'Errico et al., 2017; Henshilwood et al., 2018). Contingent disagreement notwithstanding, they will argue that – while attempts to investigate questions on past cognition are by necessity inferential and reliant on our understanding of present-day cognition – respective findings, in turn, have the potential to advance this understanding in fundamental ways.

Cultural evolution requires transmission of form – which evolved late in the human lineage

Claudio Tennie

Without transmission of form, the "cultural ratchet" slips – and behavioural form reverts back to baseline. *With* transmission of form, culture *necessarily* evolves – even without any selection – due to unavoidable *transmission error* (Eerkens & Lipo, 2005). Often, the literature conflates transmission of form (rare in the animal kingdom) with mere socially mediated – catalysed – *increases of form frequencies* (widespread in the animal kingdom). I will show that non-human great apes (a) do not spontaneously transmit form and (b) do not need to (empirically, mere socially mediated re-innovation suffices for apes). I will argue that this lack (and lack of need) of transmission of form is the most parsimonious model for early hominins. I will also briefly touch on the source of form transmission in humans: genetic, cultural, or both (see Heyes, 2018).

Neurocognitive foundations of stone tool-making skill learning: An individual differences approach

Dietrich Stout, Erin Hecht, & Justin Pargeter

Stone tools provide key evidence of human cognitive evolution but remain difficult to interpret. Toolmaking skill-learning in particular has been understudied even though (1) the most salient cognitive demands of toolmaking should occur during learning, and (2) variation in learning aptitude would have provided the raw material for any past selection acting on toolmaking ability. We thus investigated the effects of individual neuroanatomical and cognitive differences on toolmaking aptitude in naïve individuals. Study 1 employed *Diffusion Tensor Imaging* with participants learning to make Acheulean 'handaxes' (750,000-year-old technology) and found that aptitude correlated with the fractional anisotropy of white matter connections to anterior Broca's Region, supporting "action parsing" hypotheses of tool–language coevolution. Study 2 employed psychometrics with participants learning to make Oldowan flake-tools (2.5 million-year-old technology) and found aptitude to be associated with fluid intelligence in a verbally instructed group and with tendency to use social information in an observation-only group.

A cross-linguistic comparison of the evolved complexity of numeral systems

Simon Greenhill & Numeralbank Team

The ways in which languages keep track of quantities differ substantially (Bender & Beller, 2018), but the global diversity of these systems has barely been explored. Here we present some preliminary investigations into *Numeralbank*: a new global database of numeral systems containing ~186,000 number words from ~5300 languages. First, we show that there is a strong relationship between a number and the orthographic length of its lexeme, where the lexical forms for numbers below five are shortest, followed by the numbers below ten. Number words for multiples of base 10 (e.g. "twenty") also tend to be short. Second, we develop a novel method for characterizing the complexity of numeral systems in these languages, and quantify and model their evolution over time. Finally, we use these data to test some broad-scale generalizations (e.g., Pagel & Meade, 2018) that number words are shorter and less ambiguous than other words.

The complex and gradual origin of modern cognition

Francesco d'Errico

Paleoanthropological, genetic, and archaeological evidence is questioning a direct cause-and-effect relationship between the speciation event that would have given rise 200,000 years ago to *Homo sapiens* in Africa and the emergence of modern cognition (d'Errico & Colagè, 2018; Scerri et al., 2018). It is becoming increasingly clear that symbolic practices and other key cultural innovations emerged at different times, in different parts of the world, among different hominin taxa. These taxa appear more and more as phenotypic expressions of the same biological species sharing comparable plastic cognitions. Material culture–cognition coevolution, changes in modes of cultural transmission, and diffusion of cultural innovations, rather than inherited biological changes, appear the best candidate to account for the origin of modern human cognition.

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