

A Theme Issue of the [Philosophical Transactions of the Royal Society B](#) on 'New thinking: the evolution of human cognition' compiled and edited by Cecilia Heyes and Uta Frith, with contributions from, among others, Robin I. M. Dunbar, Chris D. Frith, Peter Godfrey-Smith, Alison Gopnik, Eva Jablonka, Kevin N. Laland, Nicholas Shea, Kim Sterelny, and Andrew Whiten. Some of it is polemical against evolutionary psychology.

Here is the abstract of Cecilia Heyes' Introduction to the issue: "Humans are animals that specialize in thinking and knowing, and our extraordinary cognitive abilities have transformed every aspect of our lives. In contrast to our chimpanzee cousins and Stone Age ancestors, we are complex political, economic, scientific and artistic creatures, living in a vast range of habitats, many of which are our own creation. Research on the evolution of human cognition asks what types of thinking make us such peculiar animals, and how they have been generated by evolutionary processes. New research in this field looks deeper into the evolutionary history of human cognition, and adopts a more multi-disciplinary approach than earlier 'Evolutionary Psychology'. It is informed by comparisons between humans and a range of primate and non-primate species, and integrates findings from anthropology, archaeology, economics, evolutionary biology, neuroscience, philosophy and psychology. Using these methods, recent research reveals profound commonalities, as well striking differences, between human and non-human minds, and suggests that the evolution of human cognition has been much more gradual and incremental than previously assumed. It accords crucial roles to cultural evolution, techno-social co-evolution and gene-culture co-evolution. These have produced domain-general developmental processes with extraordinary power—power that makes human cognition, and human lives, unique."

For the abstracts of the other articles,

Robert A. Barton: Embodied cognitive evolution and the cerebellum

Much attention has focused on the dramatic expansion of the forebrain, particularly the neocortex, as the neural substrate of cognitive evolution. However, though relatively small, the cerebellum contains about four times more neurons than the neocortex. I show that commonly used comparative measures such as neocortex ratio underestimate the contribution of the cerebellum to brain evolution. Once differences in the scaling of connectivity in neocortex and cerebellum are accounted for, a marked and general pattern of correlated evolution of the two structures is apparent. One deviation from this general pattern is a relative expansion of the cerebellum in apes and other extractive foragers. The confluence of these comparative patterns, studies of ape foraging skills and social learning, and recent evidence on the cognitive neuroscience of the cerebellum, suggest an important role for the cerebellum in the evolution of the capacity for planning, execution and understanding of complex behavioural sequences—including tool use and language. There is no clear separation between sensory-motor and cognitive specializations underpinning such skills, undermining the notion of executive control as a distinct process. Instead, I argue that cognitive evolution is most effectively understood as the elaboration of specialized systems for embodied adaptive control.

Louise Barrett, S. Peter Henzi, and David Lusseau : Taking sociality seriously: the structure of multi-dimensional social networks as a source of information for individuals

Understanding human cognitive evolution, and that of the other primates, means taking sociality very seriously. For humans, this requires the recognition of the sociocultural and historical means by which human minds and selves are constructed, and how this gives rise to the reflexivity and ability to respond to novelty that characterize our species. For other, non-linguistic, primates we can answer some interesting questions by viewing social life as a feedback process, drawing on cybernetics and systems approaches and using social network neo-theory to test these ideas.

Specifically, we show how social networks can be formalized as multi-dimensional objects, and use entropy measures to assess how networks respond to perturbation. We use simulations and natural 'knock-outs' in a free-ranging baboon troop to demonstrate that changes in interactions after social perturbations lead to a more certain social network, in which the outcomes of interactions are easier for members to predict. This new formalization of social networks provides a framework within which to predict network dynamics and evolution, helps us highlight how human and non-human social networks differ and has implications for theories of cognitive evolution.

Andrew Whiten and David Erdal: The human socio-cognitive niche and its evolutionary origins

Hominin evolution took a remarkable pathway, as the foraging strategy extended to large mammalian prey already hunted by a guild of specialist carnivores. How was this possible for a moderately sized ape lacking the formidable anatomical adaptations of these competing 'professional hunters'? The long-standing answer that this was achieved through the elaboration of a new 'cognitive niche' reliant on intelligence and technology is compelling, yet insufficient. Here we present evidence from a diversity of sources supporting the hypothesis that a fuller answer lies in the evolution of a new socio-cognitive niche, the principal components of which include forms of cooperation, egalitarianism, mindreading (also known as 'theory of mind'), language and cultural transmission, that go far beyond the most comparable phenomena in other primates. This cognitive and behavioural complex allows a human hunter-gatherer band to function as a unique and highly competitive predatory organism. Each of these core components of the socio-cognitive niche is distinctive to humans, but primate research has increasingly identified related capacities that permit inferences about significant ancestral cognitive foundations to the five pillars of the human social cognitive niche listed earlier. The principal focus of the present study was to review and integrate this range of recent comparative discoveries.

Susanne Shultz, Emma Nelson, and Robin I. M. Dunbar : Hominin cognitive evolution: identifying patterns and processes in the fossil and archaeological record

As only limited insight into behaviour is available from the archaeological record, much of our understanding of historical changes in human cognition is restricted to identifying changes in brain size and architecture. Using both absolute and residual brain size estimates, we show that hominin brain evolution was likely to be the result of a mix of processes; punctuated changes at approximately 100 kya, 1 Mya and 1.8 Mya are supplemented by gradual within-lineage changes in *Homo erectus* and *Homo sapiens sensu lato*. While brain size increase in *Homo* in Africa is a gradual process, migration of hominins into Eurasia is associated with step changes at approximately 400 kya and approximately 100 kya. We then demonstrate that periods of rapid change in hominin brain size are not temporally associated with changes in environmental unpredictability or with long-term palaeoclimate trends. Thus, we argue that commonly used global sea level or Indian Ocean dust palaeoclimate records provide little evidence for either the variability selection or aridity hypotheses explaining changes in hominin brain size. Brain size change at approximately 100 kya is coincident with demographic change and the appearance of fully modern language. However, gaps remain in our understanding of the external pressures driving encephalization, which will only be filled by novel applications of the fossil, palaeoclimatic and archaeological records.

Kim Sterelny : Language, gesture, skill: the co-evolutionary foundations of language

This paper defends a gestural origins hypothesis about the evolution of enhanced communication and language in the hominin lineage. The paper shows that we can develop an incremental model of language evolution on that hypothesis, but not if we suppose that language originated in an expansion of great ape vocalization. On the basis of the gestural origins hypothesis, the paper then

advances solutions to four classic problems about the evolution of language: (i) why did language evolve only in the hominin lineage? (ii) why is language use an evolutionarily stable form of informational cooperation, despite the fact that hominins have diverging evolutionary interests? (iii) how did stimulus independent symbols emerge? (iv) what were the origins of complex, syntactically organized symbols? The paper concludes by confronting two challenges: those of testability and of explaining the gesture-to-speech transition; crucial issues for any gestural origins hypothesis

Eva Jablonka, Simona Ginsburg, and Daniel Dor : The co-evolution of language and emotions

We argue that language evolution started like the evolution of reading and writing, through cultural evolutionary processes. Genuinely new behavioural patterns emerged from collective exploratory processes that individuals could learn because of their brain plasticity. Those cultural-linguistic innovative practices that were consistently socially and culturally selected drove a process of genetic accommodation of both general and language-specific aspects of cognition. We focus on the affective facet of this culture-driven cognitive evolution, and argue that the evolution of human emotions co-evolved with that of language. We suggest that complex tool manufacture and alloparenting played an important role in the evolution of emotions, by leading to increased executive control and inter-subjective sensitivity. This process, which can be interpreted as a special case of self-domestication, culminated in the construction of human-specific social emotions, which facilitated information-sharing. Once in place, language enhanced the inhibitory control of emotions, enabled the development of novel emotions and emotional capacities, and led to a human mentality that departs in fundamental ways from that of other apes. We end by suggesting experimental approaches that can help in evaluating some of these proposals and hence lead to better understanding of the evolutionary biology of language and emotions.

Peter Godfrey-Smith : Darwinism and cultural change

Evolutionary models of cultural change have acquired an important role in attempts to explain the course of human evolution, especially our specialization in knowledge-gathering and intelligent control of environments. In both biological and cultural change, different patterns of explanation become relevant at different 'grains' of analysis and in contexts associated with different explanatory targets. Existing treatments of the evolutionary approach to culture, both positive and negative, underestimate the importance of these distinctions. Close attention to grain of analysis motivates distinctions between three possible modes of cultural evolution, each associated with different empirical assumptions and explanatory roles.

Hannah M. Lewis and Kevin N. Laland: Transmission fidelity is the key to the build-up of cumulative culture

Many animals have socially transmitted behavioural traditions, but human culture appears unique in that it is cumulative, i.e. human cultural traits increase in diversity and complexity over time. It is often suggested that high-fidelity cultural transmission is necessary for cumulative culture to occur through refinement, a process known as 'ratcheting', but this hypothesis has never been formally evaluated. We discuss processes of information transmission and loss of traits from a cognitive viewpoint alongside other cultural processes of novel invention (generation of entirely new traits), modification (refinement of existing traits) and combination (bringing together two established traits to generate a new trait). We develop a simple cultural transmission model that does not assume major evolutionary changes (e.g. in brain architecture) and show that small changes in the fidelity with which information is passed between individuals can lead to cumulative culture. In comparison, modification and combination have a lesser influence on, and novel invention appears unimportant to, the ratcheting process. Our findings support the idea that high-fidelity transmission is the key driver of human cumulative culture, and that progress in cumulative culture depends more on trait

combination than novel invention or trait modification.

Cecilia Heyes : Grist and mills: on the cultural origins of cultural learning

Cumulative cultural evolution is what 'makes us odd'; our capacity to learn facts and techniques from others, and to refine them over generations, plays a major role in making human minds and lives radically different from those of other animals. In this article, I discuss cognitive processes that are known collectively as 'cultural learning' because they enable cumulative cultural evolution. These cognitive processes include reading, social learning, imitation, teaching, social motivation and theory of mind. Taking the first of these three types of cultural learning as examples, I ask whether and to what extent these cognitive processes have been adapted genetically or culturally to enable cumulative cultural evolution. I find that recent empirical work in comparative psychology, developmental psychology and cognitive neuroscience provides surprisingly little evidence of genetic adaptation, and ample evidence of cultural adaptation. This raises the possibility that it is not only 'grist' but also 'mills' that are culturally inherited; through social interaction in the course of development, we not only acquire facts about the world and how to deal with it (grist), we also build the cognitive processes that make 'fact inheritance' possible (mills).

R. I. M. Dunbar : Social cognition on the Internet: testing constraints on social network size

The social brain hypothesis (an explanation for the evolution of brain size in primates) predicts that humans typically cannot maintain more than 150 relationships at any one time. The constraint is partly cognitive (ultimately determined by some aspect of brain volume) and partly one of time. Friendships (but not necessarily kin relationships) are maintained by investing time in them, and failure to do so results in an inexorable deterioration in the quality of a relationship. The Internet, and in particular the rise of social networking sites (SNSs), raises the possibility that digital media might allow us to circumvent some or all of these constraints. This allows us to test the importance of these constraints in limiting human sociality. Although the recency of SNSs means that there have been relatively few studies, those that are available suggest that, in general, the ability to broadcast to many individuals at once, and the possibilities this provides in terms of continuously updating our understanding of network members' behaviour and thoughts, do not allow larger networks to be maintained. This may be because only relatively weak quality relationships can be maintained without face-to-face interaction.

Daphna Buchsbaum, Sophie Bridgers, Deena Skolnick Weisberg, and Alison Gopnik : The power of possibility: causal learning, counterfactual reasoning, and pretend play

We argue for a theoretical link between the development of an extended period of immaturity in human evolution and the emergence of powerful and wide-ranging causal learning mechanisms, specifically the use of causal models and Bayesian learning. We suggest that exploratory childhood learning, childhood play in particular, and causal cognition are closely connected. We report an empirical study demonstrating one such connection—a link between pretend play and counterfactual causal reasoning. Preschool children given new information about a causal system made very similar inferences both when they considered counterfactuals about the system and when they engaged in pretend play about it. Counterfactual cognition and causally coherent pretence were also significantly correlated even when age, general cognitive development and executive function were controlled for. These findings link a distinctive human form of childhood play and an equally distinctive human form of causal inference. We speculate that, during human evolution, computations that were initially reserved for solving particularly important ecological problems came to be used much more widely and extensively during the long period of protected immaturity.

Chris D. Frith : The role of metacognition in human social interactions

Metacognition concerns the processes by which we monitor and control our own cognitive processes. It can also be applied to others, in which case it is known as mentalizing. Both kinds of metacognition have implicit and explicit forms, where implicit means automatic and without awareness. Implicit metacognition enables us to adopt a we-mode, through which we automatically take account of the knowledge and intentions of others. Adoption of this mode enhances joint action. Explicit metacognition enables us to reflect on and justify our behaviour to others. However, access to the underlying processes is very limited for both self and others and our reports on our own and others' intentions can be very inaccurate. On the other hand, recent experiments have shown that, through discussions of our perceptual experiences with others, we can detect sensory signals more accurately, even in the absence of objective feedback. Through our willingness to discuss with others the reasons for our actions and perceptions, we overcome our lack of direct access to the underlying cognitive processes. This creates the potential for us to build more accurate accounts of the world and of ourselves. I suggest, therefore, that explicit metacognition is a uniquely human ability that has evolved through its enhancement of collaborative decision-making.

Nikolaus Robalino and Arthur Robson : The economic approach to 'theory of mind'

Theory of mind (ToM) is a great evolutionary achievement. It is a special intelligence that can assess not only one's own desires and beliefs, but also those of others. Whether it is uniquely human or not is controversial, but it is clear that humans are, at least, significantly better at ToM than any other animal. Economists and game theorists have developed sophisticated and powerful models of ToM and we provide a detailed summary of this here. This economic ToM entails a hierarchy of beliefs. I know my preferences, and I have beliefs (a probabilistic distribution) about your preferences, beliefs about your beliefs about my preferences, and so on. We then contrast this economic ToM with the theoretical approaches of neuroscience and with empirical data in general. Although this economic view provides a benchmark and makes useful suggestions about empirical tendencies, it does not always generate a close fit with the data. This provides an opportunity for a synergistic interdisciplinary production of a falsifiable theory of bounded rationality. In particular, a ToM that is founded on evolutionary biology might well be sufficiently structured to have predictive power, while remaining quite general. We sketch two papers that represent preliminary steps in this direction.

Nicholas Shea : New thinking, innateness and inherited representation

The New Thinking contained in this volume rejects an Evolutionary Psychology that is committed to innate domain-specific psychological mechanisms: gene-based adaptations that are unlearned, developmentally fixed and culturally universal. But the New Thinking does not simply deny the importance of innate psychological traits. The problem runs deeper: the concept of innateness is not suited to distinguishing between the New Thinking and Evolutionary Psychology. That points to a more serious problem with the concept of innateness as it is applied to human psychological phenotypes. This paper argues that the features of recent human evolution highlighted by the New Thinking imply that the concept of inherited representation, set out here, is a better tool for theorizing about human cognitive evolution.