

EAORC BULLETIN 1,200 – 14 June 2026

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NOTICES

FORMATTED VERSION OF THIS BULLETIN

A pdf formatted version of this Bulletin is available for download at martinedwardes.me.uk/eaorc/eaorc_bulletins.htm.

PUBLICATION ALERTS

If you have had a paper or book published, or you see something which would be of interest to the group, please send me a publication alert so that I can include it in the newsletter. Many thanks to those who have already sent in alerts.

If there is a journal you feel I should be tracking on a regular basis, let me know.

And if you have any other ideas for extending the “EAORC experience”, please contact me.

EDITORIAL INTERJECTIONS

Comments in curly brackets are editorial interjections. The Editor reserves the right to be wrong, and doesn't object to being called out on it.

NEWS

JOHN TEMPLETON FOUNDATION – Can Digital Computers Ever Achieve Consciousness?

The question of whether artificial intelligence could ever achieve consciousness is a common theme in science fiction. Could robots ever truly feel anything—like love, hate, or fear—or would they be all “dark inside,” experiencing nothing at all? It is more important than ever to answer this question correctly. Artificial intelligence (AI) is no longer merely a matter of science fiction. AI are increasingly capable of producing art and mastering the use of language, raising serious questions about whether AI are already capable of consciousness, or if not yet, then soon.

The idea that “digital consciousness” is possible is based on a philosophy known as functionalism. According to functionalism, our minds are just functions. For example, although you can add $2+2=4$ in your mind, a digital calculator can do the same thing. If we could program a digital computer to function exactly like your brain does, that computer would have a conscious mind just like you do. A ‘digital you’ would think and feel everything that you do. It would feel happiness, sadness, fear, and love.

But is functionalism correct?

<https://www.templeton.org/news/can-digital-computers-ever-achieve-consciousness>

JOHN TEMPLETON FOUNDATION – Consciousness at the Core of the Cosmos: Christof Koch interviewed

Christof Koch is a neuroscientist at the Allen Institute for Brain Science and the Chief Scientist of the Tiny Blue Dot Foundation. As a professor for 25 years at Cal Tech, he pioneered research on the neural basis of consciousness, and he has advanced one of the leading theories of consciousness called Integrated Information Theory. Among his many publications, Christof’s most recent book is entitled *Then I Am Myself the World: What Consciousness Is and How to Expand It*.

<https://www.templeton.org/news/consciousness-at-the-core-of-the-cosmos>

NATURE BRIEFING – Stonehenge ‘altar’ carried on glacier

A massive slab at the center of Stonehenge somehow travelled 700 kilometres from its origin in northeast Scotland to its current home in the south of England. A model of Neolithic ice flows suggests a glacier might have carried the six-tonne monolith as far as Doggerland — an area that is now beneath the North Sea. Then, roughly 3,000 years before it came to Stonehenge, people may have saved the rock from rising sea levels. “What is exciting about these findings is that they could imply that the people of Doggerland attached cultural significance to the Altar Stone long before it was incorporated into Stonehenge,” says glaciologist and study co-author Remy Veness.

<https://www.sciencefocus.com/news/we-may-have-just-cracked-one-of-stonehenges-greatest-mysteries>

NATURE BRIEFING – Why Europe is ditching US tech

“It is time for Europe to be in control of its data, of its supply chains and of its future,” said the European Commission’s Henna Virkkunen in a statement that accompanied the announcement of the European Technological Sovereignty Package. The plan expands on efforts by several countries and research institutions on the continent to move away from systems and services controlled by non-European countries — particularly the United States — because of concerns about data privacy and a decline in academic freedom.

<https://www.nature.com/articles/d41586-026-01610-9>

NATURE BRIEFING – People naturally wander widdershins

Humans have an innate tendency to turn left, and to drift anticlockwise when ambling around. In experiments in which individuals or small groups wandered around an enclosed space, researchers found that people almost always moved anticlockwise, a result that held true across genders and regardless of the person’s dominant leg. Why this happens is unclear, but by working it out, “we could better understand how we perceive the world,” says complex-systems researcher and study co-author Claudio Feliciani. “It can help us make other discoveries which may be more important than this one.”

<https://www.theguardian.com/science/2026/jun/10/humans-prefer-to-walk-anticlockwise-scientists-find-reason-unclear>

PUBLICATIONS

Academia Biology

PAPERS

MARC VERHAEGEN et al – A hypothesis of ape and human evolution based on comparative biology and plate tectonics

There is broad consensus among paleoanthropologists that extant African hominids (Pan and Gorilla) as well as hominins (our direct ancestors following the split from Pan, i.e., chimpanzee and bonobo) originated in Africa. The prevailing view, that hominins became upright bipeds after moving from tropical forests (the current habitat of Pan and Gorilla) to open savannas in East Africa—where they chased large mammals—is contradicted, however, by fossil, paleo-ecological, and comparative biological and physiological evidence. Here, we propose that hominoids (apes), hominids (great apes), and hominins (humans and fossil species more closely related to Homo than to Pan) instead evolved near water and mostly out of Africa. We

propose that Miocene (23.03–5.33 Ma) apes had already evolved an upright, tailless body as an adaptation to living in flooded forests, where they engaged in frequent bipedal wading and below-branch vertical climbing—a type of movement we term vertical aquarborealism. This largely Miocene aquarboreal style of locomotion can be seen as evolutionarily intermediate between the above-branch arboreality of Old World monkeys (Cercopithecoidea) and the various below-branch locomotive styles of extant apes (Hominoidea). Starting from vertical aquarborealism, *Homo*—at least by the Early Pleistocene (2.58 Ma)—had developed a lifestyle centred around shallow diving, primarily foraging for non-fleeing foods such as shellfish and aquatic plants. We also suggest that the timing of some major tectonic shifts in the African, Arabian, and Eurasian plates during the Miocene, Pliocene, and Pleistocene may help explain key aspects of this evolutionary scenario, including the splitting times of hominoids (apes), hominids, and hominins.

<https://www.academia.edu/2837-4010/4/2/10.20935/AcadBiol8310>

Biology Letters

PAPERS

SHOKO SUGASAWA et al – Nest building as a missing piece in biparental care

Many birds practise biparental care, providing useful systems to study its evolution. Although nest building has largely been ignored as biparental behaviour, parental conflict and cooperation could begin during nest building, before incubation and offspring provisioning. While there are ample data on biparental incubation and provisioning in model species like zebra finches (*Taeniopygia guttata*), nest-building data largely concern material collection and preference in the males, not building by the females. Here, we collected data on building by both female and male zebra finches to test whether building behaviour depends on the behaviour of their mate or on the material they used to build their nest. Males held nest material more frequently when their female was in the nest, while females held nest material longer when their male was away from the nest. But neither females nor males altered their building behaviour in response to changes in their partner holding nest material. Males that built with stiff material held the material more frequently than those that built with flexible material, while females manipulated stiff and flexible materials similarly. The next step will be to determine whether these building interactions affect later stages of parental care in the wild or in other species.

<https://royalsocietypublishing.org/rsbl/article/22/6/20250767/482032/Nest-building-as-a-missing-piece-in-biparental>

LUIGI BACIADONNA & VIVEK NITYANANDA – Temporal consistency of judgement biases in bumblebees

Judgement bias tasks are increasingly used to assess affective states in animals, yet the extent to which they might reflect transient states or stable traits remains unclear. Here, we tested bumblebees (*Bombus terrestris*) in an active choice task across three repeated sessions to assess individual consistency in the absence of any manipulation. Bees were trained to associate each of two colours with either a high or a low reward, presented in separate chambers. During testing, they were presented with ambiguous colours. Bees were more likely to choose the high-reward chamber and to choose more quickly in response to colours closer to the positive colour. The latency to choose the cues showed significant and moderate repeatability across sessions, suggesting a stable, trait-like underlying component. In contrast, the repeatability of the chamber choices was negligible, indicating that such responses might be largely state-dependent and influenced by situational factors. These findings suggest that judgement biases, particularly as assessed through an active choice task, reflect states affected by external factors. Active choice tasks may help disentangle stable behavioural traits from transient affective states in invertebrates.

<https://royalsocietypublishing.org/rsbl/article/22/6/20260011/482104/Temporal-consistency-of-judgement-biases-in>

Current Biology

PAPERS

WILLIAM KISTLER et al – Early skill learning is shaped by the offline emergence of expert synergies

Everyday skilled actions depend on the formation of coordinated motor synergies that integrate multiple digits into stable, low-dimensional control units. Although initial practice of a new skill leads to rapid performance improvements, it is unclear whether the underlying movement kinematics reorganize on a similar timescale or in a way that directly relates to these gains. It also remains uncertain whether such reorganization occurs mainly during active practice or instead during brief rest breaks. Here, we tracked the temporal evolution of multi-digit synergy formation during early learning of a naturalistic keypress skill. Initial practice rapidly sculpted the motor repertoire toward higher-order, temporally compressed, and overlapping multi-digit synergies. These synergies emerged after only minutes of practice and continued to be expressed throughout the full training session. Notably, they were primarily shaped across brief rest breaks and robustly predicted individual skill proficiency. Across learning, distinct synergy subtypes emerged that differed in their heuristic prevalence. Rarely expressed synergies reflected transient novice patterns, synergies expressed at intermediate levels could index exploratory and trial-initiation strategies, and highly expressed synergies emerged later to dominate performance, reflecting the consolidation and expansion of skilled motor control. Together, these findings indicate that skilled performance is supported by the early formation of a compact repertoire of expert multi-digit synergies that emerge preferentially across rest periods and predict subsequent skill gains. They further raise the hypothesis that explicitly training such expert synergies alongside task goals could enhance learning in domains such as the arts, sports, and neurorehabilitation.

eLife

PAPERS

RIDDHA MANNA et al – Learning is a fundamental source of individuality

Learning and memory are essential components of our individuality. While it is established that behaviour can vary across genetically identical individuals, it remains unknown how much of this variation stems from momentary experience during learning compared to genetics and its past interactions with the environment. To address this, we measured behaviour in thousands of flies from 90 genetic backgrounds while they performed tasks in conditions that either did or did not require learning. Flies that were genetically identical, raised under the same conditions and tested simultaneously in the same environment persistently modified the extent of expressed individuality when they could learn. This learning-induced residual expression of individuality and its dynamics were subdued or absent in innate, learning-independent behaviours. We could quantify and then recreate this phenomenon in computer simulations. The emergence of *in silico* behavioural individuality was most consistent with the individuality of real flies once we enabled reinforced learning in simulated agents. Moreover, we showed that minor differences in initial conditions of the experiment can exacerbate the expression of individuality within a genotype in a learning-dependent manner. Our results establish that besides the classical G x E interactions shared between individuals in the past, learning from individual momentary experience further extends the expression of individuality.

<https://elifesciences.org/reviewed-preprints/111235>

CHIARA BULGARELLI et al with THE BRIGHT STUDY TEAM – Growth in early infancy drives optimal brain functional connectivity which predicts cognitive flexibility in later childhood

Functional brain network organisation, measured by functional connectivity (FC), reflects key neurodevelopmental processes for healthy development. Early exposure to adversity, for example undernutrition, affects neurodevelopment, observable via disrupted FC, and leads to poorer outcomes from preschool age onwards. We assessed longitudinally the impact of early growth trajectories on developmental FC in a rural Gambian population from age 5–24 months. To investigate how these early trajectories relate to later childhood outcomes, we assessed cognitive flexibility at 3–5 years. We observed that early physical growth before the fifth month of life drove optimal developmental trajectories of FC that in turn predicted cognitive flexibility at pre-school age. In contrast to previously studied developmental populations, this Gambian sample exhibited long-range interhemispheric FC that decreased with age. Our results highlight the measurable effects that poor growth in early infancy has on brain development and the possible subsequent impact on pre-school age cognitive development, underscoring the need for early life interventions throughout global settings of adversity.

<https://elifesciences.org/articles/94194>

iScience

PAPERS

ANDREW HALLORAN et al with CRICKETTE SANZ – Freedom of choice supports social complexity in chimpanzees

Fission-fusion sociality offers almost infinite options for individuals to make self-determined choices about how to range across space, spend time in different activities, and associate with conspecifics. Yet, how such freedoms contribute to the construction of functional social groups has received little attention. In this investigation, we found that sanctuary-living chimpanzees residing within spacious outdoor habitats with choice among a variety of social partners formed integrated communities that showed emergent properties of the fission-fusion social systems. Social network topology varied across communities, indicating species-typical intraspecific variation in social complexity. This variation was positively associated with indicators of behavioral diversity and wellbeing. Our results offer newfound understanding of the factors that facilitate fission-fusion societies, which, in turn, foster agency, social belonging, and culture that enable apes to thrive.

[https://www.cell.com/iscience/fulltext/S2589-0042\(26\)01675-5](https://www.cell.com/iscience/fulltext/S2589-0042(26)01675-5)

Journal of the Royal Society Interface

PAPERS

YUAN LIU et al – Evolution of cooperation in psychological games with costly information

Cooperation is crucial for both biological and social systems. Yet it is not straightforward from the evolutionary perspective, since individuals are tempted to defect for personal interests. In traditional models, it is usually assumed that cooperation is determined only by external behaviours. Individuals, however, are likely to pay extra psychological costs if what they do differs from what they think, and are likely to pay to know what others think. Motivated by these observations, we extend donation games to psychological games by introducing value-behaviour inconsistency, which creates psychological costs such as guiltiness or regret, and information costs, which individuals pay to know the opponent's values. We find that the key for cooperation under weak rationality is the large guiltiness (the psychological cost for an individual with defective behaviour and cooperative internal value); the heterogeneity of information costs governs how cooperation is further enhanced under moderate rationality; and moderate information costs can effectively favour cooperation under strong rationality, which is

typically absent in classical donation games. These findings highlight how guiltiness, regret and information costs together shape cooperative behaviour across the rationality intensity. Our work can be insightful for a novel paradigm of cooperation beyond the classical prisoner's dilemma.

<https://royalsocietypublishing.org/rsif/article/23/239/20251172/482059/Evolution-of-cooperation-in-psychological-games>

MINGQUAN XU, SHUIA HUA & LINJIE LIU – Alleviating collective action failure through dynamic targets and adaptive punishment in collective-risk dilemmas

The question of how to mitigate collective action failure has persistently drawn significant attention from researchers. However, previous theoretical and experimental studies have predominantly assumed a static target, thereby overlooking its inherent dynamic variability. To address this gap, we propose a two-stage three-party collective-risk social dilemma model: in the first stage, punishers sanction defectors; if the first-stage target is achieved, then the collective target is elevated in the second stage to sustain cooperation and mitigate greater risks, whereas failure triggers increased punishment intensity. We find that even in low-risk scenarios, the dynamic target and punishment mechanism can facilitate the emergence of high-level cooperation. Furthermore, moderate target elevation promotes cooperation, while excessive increases trigger cooperation collapse. At high risk, cooperation correlates positively with collective target size. Increasing first-stage punishment intensity within a suitable range boosts cooperation, with the effect more pronounced in low-risk scenarios.

<https://royalsocietypublishing.org/rsif/article/23/239/20260153/482061/Alleviating-collective-action-failure-through>

ALEXANDER FEIGEL & ALEXANDRE V. MOROZOV – To clean or not to clean: the free-rider problem in sequentially shared resources

Shared resources enhance productivity, yet at the same time open pathways for biological and digital contamination, turning physical or digital hygiene into a cooperation dilemma prone to free-riding. Here, we introduce a game of sequential sharing of common resources, an empirically parameterized evolutionary model of population dynamics in sequential-use settings such as gyms or shared workspaces. The success of the strategies implemented in the model, which involve equipment cleaning before or after use, is based on the trade-offs between cleaning costs, contamination risks and social incentives to mitigate disease transmission. We find that cooperative hygiene can be achieved by lowering the effective costs of cleaning, strengthening pro-social incentives and monitoring population-level noncompliance. Remarkably, the stability of fully altruistic populations is primarily affected by the cleaning costs. In contrast, increasing effective infection costs, for example, through punishment, appears less important in this case. The model's evolutionary dynamics exhibit multi-stability, hysteresis and abrupt shifts in strategy composition, broadly consistent with empirical observations from shared-use facilities. Our framework offers testable predictions and is amenable to quantitative calibration with behavioural and environmental data. Our predictions can be used to inform the design of cost-effective public health and digital security policies.

<https://royalsocietypublishing.org/rsif/article/23/239/20251330/482062/To-clean-or-not-to-clean-the-free-rider-problem-in>

Language Sciences

PAPERS

VICTOR J. BOUCHER – Processing units of spoken language and the Mapping Problem: reassessing writing concepts in the study of neurobiological systems

It is a common practice in language neuroscience to describe speech stimuli as containing phonemes and words. But the ability to infer these units requires knowledge of a type of writing. That there are no acoustic markers in speech serving to divide phonemes and words underlies a long-standing Mapping Problem between units of linguistic description and units identified by neurophysiological methods. Yet research has shown that, in speech listening, low-frequency oscillations in sensory cortices entrain to syllable patterns and groups, indicating that temporal frames of neural processing align with identifiable units in speech sounds. These observations bring to light a basic mismatch between units of linguistic description that link to writing and units of speech processing linked to neurobiological systems. From this viewpoint, the present paper reviews a body of cross-disciplinary findings that provide converging support for a processing of speech in syllable patterns of motion units and sensorimotor chunks. The review focuses on 1) the defining attributes of these units in speech, 2) how they mismatch linguistic concepts, 3) their structural effects across languages, and 4) the behavioral and neurophysiological observations that support their function as processing units. The discussion highlights research on neural entrainment and how observations of auditory-motor coupling in entrained oscillations reveal syllable-related motion units and chunks as sensorimotor units of speech processing. The review also illustrates how these units can address basic issues in linking research on auditory perception and semantic memory to syllables and chunks in utterances as opposed to conceptual units of writing.

<https://www.sciencedirect.com/science/article/pii/S0388000126000471>

Mind & Language

PAPERS

RONALD J. PLANER – Gricean metacommunication

Three main approaches exist for finessing the cognitive demands of Grice's model of communication (a notorious problem): namely, deflationism, modularity, and interpretivism. Here, I consider each in light of human metacommunication, a phenomenon that has been neglected in foundational discussions of Gricean communication. This neglect is surprising, as metacommunication is central to human communication and is also something quite young children appear to engage in. I argue that metacommunication bears upon the plausibility of these three approaches very differently. More specifically, both deflationism and an intuitive version of the modularity approach are significantly challenged. Interpretivism, in contrast, is left unaffected.

<https://onlinelibrary.wiley.com/doi/full/10.1111/mila.70008>

ALEJANDRO VESGA et al – Explaining value: The principle of sufficient reason and the realm of value in ordinary cognition

Folk explanatory judgements seem to conform to the principle of sufficient reason (PSR), according to which if x is a fact, x must have an explanation. That is, children and adults judge that facts across a wide variety of descriptive domains must have an explanation. We test whether PSR-conforming judgements extend to the realm of value. Across four studies, we find that adults are less willing to judge that claims about moral and aesthetic value must have an explanation, compared to descriptive claims. Moreover, explanatory judgements about moral and aesthetic claims diverge from judgements about claims concerning affective responses.

<https://onlinelibrary.wiley.com/doi/abs/10.1111/mila.70006>

Nature Communications

PAPERS

GUANGYAO QI et al – Compositionality of social gaze in the prefrontal-amygdala circuits

We are providing an unedited version of this manuscript to give early access to its findings. Before final publication, the manuscript will undergo further editing. Please note there may be errors present which affect the content, and all legal disclaimers apply.

Social gaze underpins flexible primate communication and can be decomposed into three primitives: gaze content, social state, and gaze duration. To reduce dimensionality and facilitate generalization, the brain needs to represent these primitives in an abstract format. We show that social gaze is governed by a compositional code in the brain. During social gaze interactions in male and female macaques (neural recordings in two males), gaze exchanges were determined by how these primitives were combined, providing evidence for behavioral compositionality. The basolateral amygdala and the anterior cingulate gyrus represented content and state in abstract and orthogonal formats, whereas the dorsomedial prefrontal and orbitofrontal cortices exhibited limited generalization. Linear mixed-selective neurons facilitated this abstraction underlying generalization. Moreover, distinct channels routed content and state information through prefrontal-amygdala circuits, minimizing interference via linear mixed-selective neurons. These findings identify a neural grammar for social gaze, revealing compositional computations underlying flexible social communication.

<https://www.nature.com/articles/s41467-026-74347-8>

KLARA KOMZA, BENICE VIOLA & LAUREN SCHROEDER – Natural selection, genetic drift, and trait correlation shaped hominin midfoot evolution

We are providing an unedited version of this manuscript to give early access to its findings. Before final publication, the manuscript will undergo further editing. Please note there may be errors present which affect the content, and all legal disclaimers apply.

The foot has undergone significant morphological change throughout the hominin lineage as our extinct relatives evolved to walk upright. The midfoot displays key adaptations for terrestrial bipedal locomotion, and is therefore considered a target of natural selection. Prior work suggests that early selection for bipedalism targeted the lateral elements of the foot, but that later, among australopiths, these elements were less morphologically diverse, and less influenced by directional selection than medial elements. Here, we apply methods from quantitative genetics to test which evolutionary processes (directional vs. stabilizing selection) shaped hominin midfoot diversification under a null hypothesis of genetic drift. Results demonstrate that the lateral midfoot may have been the primary target of selection for bipedalism in *Ardipithecus ramidus*, but that later in the hominin lineage, there is no consistent evidence that the lateral elements were less influenced by directional selection. Instead, we find a complex interaction of evolutionary processes shaping midfoot diversification, characterized by genetic drift, directional selection, and indirect responses to selection based on correlation between different elements. In sum, we emphasize that narratives of the evolution of bipedalism should consider the role of genetic drift and correlation among skeletal elements, as both have been historically underestimated.

<https://www.nature.com/articles/s41467-026-74174-x>

Nature Reviews Psychology

PAPERS

PAUL A. M. VAN LANGE & PAUL K. BERGMANN – Human cooperation is strong among individuals but fragile between groups

Humans are often described as a cooperative species, and there is indeed a good deal of empirical support for this claim. However, there is also ample evidence of distrust, hostility and aggression. In this Perspective, we draw on the decades-long literature of human cooperation to reconcile this conflicting evidence. Specifically, we advance a theoretical model that suggests that individuals frequently engage cooperatively with other individuals, but that cooperation between groups is more fragile. We further outline that, compared to groups, cooperation in dyads is often more easily achieved through three complementary mechanisms: reciprocity, empathy and psychological safety. Conversely, cooperation is rare between groups because individuals often hold some intuition-based mistrust towards outgroup members that motivates ingroup favouritism, which can turn into evidence-based distrust following experiences of parochialism by outgroups. When groups are negatively interdependent and perceive outgroup threat, intergroup relations can further deteriorate into conflict characterized by hostility and sometimes even hate. We conclude by outlining the implications of this model for improving intergroup relations.

<https://www.nature.com/articles/s44159-026-00580-z>

Nature Scientific Reports

PAPERS

CRISTINA TOBIÁS FIGUEROLA et al – Visually challenging conditions on sign language intelligibility show behavioural analogies with spoken language

This study aimed to understand how visually degraded conditions affect the intelligibility of isolated signs in sign language, and how these conditions influence perceived difficulty. Twenty-nine fluent users of Swedish Sign Language viewed 100 isolated signs presented under two types of visual degradation: spectral degradation (pixelation) and background noise (salt-and-pepper noise), each across five levels of degradation. Participants identified each sign and rated the perceived difficulty. Generalized linear mixed models were used to evaluate the effect of level of degradation on intelligibility and perceived difficulty, separately and for each type of degradation. Psychometric functions were estimated, and generalized linear mixed models were used to analyse the relationship between intelligibility and perceived difficulty. Both types of degradation significantly reduced intelligibility and increased perceived difficulty. Psychometric curves showed that intelligibility plateaued around 70% accuracy, mirroring results from speech-in-noise research. Correct responses were consistently rated as easier to perceive, and an interaction between degradation level and response accuracy was observed only in the spectral degradation condition, suggesting distinct perceptual processing mechanisms. Visual degradations affect sign language intelligibility in ways comparable to auditory distortions in speech, with differences between degradation types suggesting distinct perceptual strategies. These findings have implications for theories about linguistic processing in perceptually challenging conditions and call for further investigation into cognitive and linguistic factors that influence sign perception in degraded conditions.

<https://www.nature.com/articles/s41598-026-57531-0>

ANNAHITA SARRÉ & LAURENT COHEN – Gaze dynamics of cued speech perception

For many deaf people, lip-reading plays a major role in verbal communication. However, lip reading is inherently ambiguous and does not allow for a complete understanding of speech. The consequences of these limitations are significant, potentially impeding language, cognitive, and social development. Cued speech (CS) was developed to eliminate this ambiguity by supplementing lip-reading with hand gestures, giving access to the entire phonological content of speech through the visual modality alone. Despite its documented efficacy in enhancing linguistic and communicative abilities, the mechanisms of CS perception remain largely unknown. The present study is the first to examine eye movements during CS perception, with a sample of deaf CS users, hearing CS users, and hearing naive controls. We presented silent videos of words, pseudowords, and sentences in their CS form, while recording the participants' eye movements. All groups fixated almost exclusively on the face, and predominantly on the lips of the speaker, despite the effective processing of CS gestures by CS users. Deaf and hearing participants differed strikingly in the way fixation was distributed between the left and right halves of the face. While both hearing groups mostly fixated the left side of the speaker's face, deaf participants showed a more symmetrical pattern. Finally, in CS users, stimuli that were phonologically, lexically or semantically more difficult tended to increase fixation in the inferior and left sector of the face. Apart from reading, CS stands as the sole system for visually conveying full phonological information of a spoken language. This study elucidates the fundamental behavioral tuning that facilitates the efficient recovery of phonology in this distinctive form.

<https://www.nature.com/articles/s41598-026-40719-9>

MINGYUE ZUO et al – Reinforcement-learning signals support dynamic adaptive control during language switching

We are providing an unedited version of this manuscript to give early access to its findings. Before final publication, the manuscript will undergo further editing. Please note there may be errors present which affect the content, and all legal disclaimers apply.

Language switching exemplifies a real-world model of adaptive control, as bilinguals select languages in response to continuously changing contextual demands. Although the Adaptive Control Hypothesis (ACH) highlights context-dependent language control in bilinguals, how these strategies are learned remains unclear. Drawing on reinforcement learning (RL) theory, we examined whether reward prediction error (RPE) drives adjustments in voluntary language switching. Chinese-English bilinguals performed a voluntary picture-naming task with probabilistic (i.e., high, medium, and low) reward feedback that generated RPE depending on the switch decisions. Computational modeling revealed that RPE dynamically updated an abstract, generalizable switch policy. Representational similarity analysis (RSA) suggested the learned value of the control policy was represented in the MTL, whereas RPE representations emerged in the dorsolateral prefrontal cortex (dlPFC). Furthermore, connectome-based predictive modeling (CPM) revealed a multi-stage network process. A distributed, cross-network pattern initially supported early exploratory learning, which then transitioned into a centralized, hub-centric network for policy exploitation. Finally, the network specialized into a localized circuit for policy automation, coupled with a globally distributed network for monitoring unexpected errors. Together, these findings establish adaptive language control as a value-based RL process. This provides a neurocomputational framework for strategy learning, extending RL principles from simple stimulus-response to high-level cognitive control.

<https://www.nature.com/articles/s42003-026-10448-w>

New Scientist**ARTICLES****JAMES WOODFORD – Stonehenge's altar stone probably wasn't transported by a glacier**

A glacier could have carried the giant sandstone at the centre of Stonehenge southwards from north-east Scotland, but this scenario appears unlikely

<https://www.newscientist.com/article/2529005-stonehenges-altar-stone-probably-wasnt-transported-by-a-glacier/>

Philosophical Transactions of the Royal Society B**PAPERS****MICHAEL J. SHEEHAN & MATTHEW N. ZIPPLE – Individual identity signatures: roles of negative frequency-dependent selection and cognition in shaping and maintaining individuality and trait diversity**

Recognition is critical for a wide range of biological interactions from the immune system at the cellular level to individual recognition mediating complex animal social structures. Identity signatures are common features of many animal traits and facilitate self/non-self and individual recognition across diverse taxa. Inherently, identity signatures show high levels of intra-population phenotypic diversity. While the existence of individually distinctive traits has attracted much attention, the developmental mechanisms and evolutionary pressures shaping identity signature diversity have been less well studied. Here, we review the evidence that selection shapes the phenotypic diversity of individual identity signals used in a range of social and sexual contexts. Evidence from comparative, developmental and behavioural studies shows that selection often shapes phenotypes to be signals rather than cues of identity. Population genomic evidence implicates negative frequency-dependent selection maintaining identity signalling diversity in humans and mice. Like the extreme diversity seen at allorecognition loci, such as major histocompatibility complex (MHC) in animals and self-incompatibility in plants, social processes in animals are drivers of phenotypic and genetic diversity. However, the quantitative traits contributing to identity signals in animals are more complex than allorecognition loci and thus the consequences of selection for individual identity signals probably differ in multiple ways in terms of the maintenance of allelic diversity. The role of cognition in shaping identity signalling traits and long-term patterns of phenotypic and allelic variation and divergence across populations and species is discussed.

<https://royalsocietypublishing.org/rstb/article/381/1952/20250190/482090/Individual-identity-signatures-roles-of-negative>

PLoS One**PAPERS****DANIEL PÉREZ-GARCÍA DE LOS SALMONES et al – Identity and mobility through personal ornaments in Upper Paleolithic cantabrian hunter-gatherer societies: Insights from Llonín cave (Asturias, Spain)**

The use of personal ornaments is considered a milestone in human cognitive evolution and the development of complex behavior. The Cantabrian region in the north of the Iberian Peninsula served as a hub of occupation and intergroup contact throughout the Upper Paleolithic, and acted as a climatic refugium during the Last Glacial Maximum (LGM – 25,000–19,000 years ago), constituting a key region for understanding the social and symbolic structures and interactions of hunter-gatherer groups. This study analyses personal ornaments recovered from the Upper Paleolithic stratigraphical sequence at Llonín Cave (Asturias, Spain), spanning from the Upper Solutrean to the Azilian (c. 21.8–11 kya cal BP), that comprises the regional largest and most diverse assemblage. The combination of taxonomic, biometric, taphonomic, and use-wear analyses reveals rarely

documented patterns, such as diachronic shifts in the site's role as an importer and producer of ornaments, the varying social significance of their use, and the strategies for raw material procurement. Furthermore, the study identifies evidence of coastal-inland interactions, allowing the reconstruction of the complete chaîne opératoire for ornament manufacture. These findings provide a framework for reinterpreting the use of personal ornaments among Paleolithic hunter-gatherer groups, facilitating critical discussions on key dimensions such as mobility and identity.

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0351170>

JEREMY GORDON, JOHN CHUANG & GIOVANNI PEZZULO – Gaze dynamics prior to navigation support hierarchical planning

The task of planning future actions in the context of an uncertain world results in massive state spaces that preclude exhaustive search and other strategies explored in the domains of both human decision-making and computational agents. One plausible solution to this dimensionality explosion is to decompose the task into subgoals that match the information geometry of the task at hand. However, how individuals identify a productive hierarchy, and perceive and select subgoals suitable to planning, is not well understood. To investigate this topic, we designed a virtual-reality based behavioral experiment which collected eye movements during a pre-navigation planning phase. By capturing gaze dynamics correlated with the simulative processes used in planning, we were able to identify the spatiotemporal evolution of visual search under uncertainty. Our results highlight gaze dynamics indicative of a search process that exhibits hierarchical structure. These include a decreasing trend seen in gaze distance from origin and a broad to narrow shift (with reducing saccade distances and longer fixation durations) as plans are established. In line with prior work, critical tiles to which landscape connectivity is most sensitive were the strongest predictors of visual attention. We also find that deeper planning was correlated with success only on the most complex maps (e.g., those with a larger number of information-nodes, higher branching factor, and more forks, according to an info-graphical map analysis). This study highlights the role of embodied visual search during planning, and the skill-dependence of the specific subgoals and hierarchical decomposition used which unlocked successful performance.

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0351056>

MARTA DÍAZ-GUARDAMINO et al – Boats on the rocks: Late prehistoric nautical iconography and landscape, from Northwest Iberia to Scandinavia

This paper offers a comparative analysis of prehistoric rock art boat depictions found across northwest Iberia and southern Scandinavia. We apply advanced digital documentation techniques, including high-resolution 3D recording and Geographic Information Systems (GIS)-based landscape analysis, to study the Iberian petroglyphs' iconography and geographic placement in detail. The study identifies significant typological and iconographic parallels between Northwest Iberia and Nordic images, which provides a comparative basis to propose a Late Bronze Age chronology (c. 1300–800 BCE) for the Iberian examples. This shared iconography supports existing hypotheses concerning extensive long-distance connectivity and maritime trade networks across Atlantic Europe, particularly regarding the movement of metals like copper and tin. Furthermore, the GIS analysis confirms that nearly all Iberian sites, whether coastal or far inland, maintain a crucial visual or physical relationship with navigable waters, such as the ocean or major river systems. Ultimately, the authors propose that this rock art reflects both advancements in boat technology and the ritual and cosmological beliefs of maritime communities engaged in transregional exchange.

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0349417>

Royal Society Open Science

PAPERS

MELISSA EMERY THOMPSON et al with RICHARD W. WRANGHAM & ELIZABETH LONSDORF – Contact aggression differently predicts risk of injury in wild male and female chimpanzees (*Pan troglodytes schweinfurthii*)

Injuries are a significant, recurring stressor across the lifespan. In species where injuries occur primarily from conspecific aggression, injury risk is expected to most affect those who are targeted for aggression or who are physically or socially disadvantaged. We test that assumption by examining patterns and predictors of injury in two longitudinal datasets comprising 955 injuries sustained by wild East African chimpanzees (*Pan troglodytes schweinfurthii*) in Gombe and Kibale National Parks. Most injuries were open wounds, and most such wounds were inflicted by conspecifics, particularly adult males. Female injury risk was strongly predicted by the rate of contact aggression received and increased for females with sexual swellings. Although socially dominant to females, adult males were injured more often. Receiving contact aggression did not predict male injury risk in either population. In Kibale, high-ranking males and those most aggressive to others received the most injuries, adding to evidence from this species that success in an intensely competitive mating market involves costly and persistent trade-offs with somatic health. Our results demonstrate that injury risk cannot be inferred from patterns of aggression alone. In particular, sexual selection on male physical traits and competitive behaviour escalates risks from male–male conflict.

<https://royalsocietypublishing.org/rsos/article/13/6/251960/482064/Contact-aggression-differently-predicts-risk-of>

Science

ARTICLES

LUCINDA M. SISK & THEODORE D. SATTERTHWAITE – Childhood environments shape the brain

Socioeconomic factors top the list of influences on children's brain structure and function

<https://www.science.org/doi/10.1126/science.aei3393>

PAPERS

SCOTT MAREK et al – Patterns of brain-wide associations reflect socioeconomics

Brain-wide association studies (BWAS) link individual differences in behavioral traits [e.g., intelligence quotient (IQ)] or living conditions (e.g., socioeconomic status) to variability in our brain function and structure. Widely used BWAS measures include magnetic resonance imaging (MRI)-derived resting-state functional connectivity, which successfully maps networks based on spontaneous neural fluctuations, and cortical thickness. Prior BWAS have associated brain imaging data with single traits, most commonly IQ or psychopathology, prioritizing association strength over spatial patterns. Although large samples improve BWAS replicability, the relative importance of different environmental and behavioral variables, their relationships to each other, and the interpretation of the underlying brain patterns remain unclear.

Datasets with many thousands of participants enable us to simultaneously map hundreds of nonimaging variables to the brain and to compare them both with each other and with well-established neurobiological reference patterns (non-BWAS). This framework leverages existing knowledge of brain biology for abductive pattern-based inference. For example, higher-order cognition relies on the frontal and parietal cortices, whereas the effects of sleep deprivation and stress manifest in primary motor and sensory regions. With such neurobiological patterns as a guiding light, we can robustly infer meaning from the BWAS patterns and identify which brain-wide associations may reflect confounding or are only valid for certain subsets of people.

Across 649 nonimaging variables, in a large sample of 9 to 10 year olds, socioeconomic measures had the strongest and most replicable brain-wide associations. The single strongest brain association was with the socioeconomic opportunities afforded by a child's zip code. This socioeconomic brain pattern was dominant and permeated many of the other BWAS maps.

Socioeconomic associations were concentrated in primary motor and sensory regions, with strong spatial similarity to arousal and stress patterns, including norepinephrine receptor density, sleep duration, and stimulant medication effects, while being negatively correlated with task functional MRI maps of higher-order cognition. Unexpectedly, the BWAS map of IQ closely matched the socioeconomic pattern. Adjusting for socioeconomics reduced brain-IQ associations and shifted them away from arousal and toward a pattern more similar to cognition, consistent with confounding by socioeconomics. Multivariate brain-IQ models failed when trained on samples from higher socioeconomic strata lacking a correlation between socioeconomics and IQ. Brain-IQ models could only detect associations when the training sample included children from neighborhoods with lower socioeconomic status. However, these were misleading, because the IQ-trained models still predicted socioeconomics better than IQ, consistent with shortcut learning.

Socioeconomic circumstances are more powerfully associated with brain function and structure than other variables. The dominant socioeconomic brain pattern matches the known effects of sleep deprivation and stress (primary motor and sensory) while sparing higher-order cognitive regions in the frontal and parietal cortices. Thus, it appears most likely that environmental factors indexed by neighborhood socioeconomic status, including sleep and stress, strongly shape childhood brain organization. This stands in contrast to brain-IQ associations that are confounded and reflect shortcut learning of socioeconomics rather than brain-based differences. Accounting for socioeconomics improves BWAS interpretation and generalizability. In summary, neighborhood socioeconomics represent the principal axis shaping brain organization during childhood and beyond, potentially through sleep and stress.

<https://www.science.org/doi/10.1126/science.aee6213>

Science Advances

PAPERS

DANIEL H. TEMPLE et al – Biomechanical evidence for occupational specialization in Mesolithic-Neolithic hunter-gatherers from Zvejnieki, Latvia

Mesolithic cemeteries have greater dimensionality and scale that reflect emerging social complexity following the Upper Paleolithic. The Zvejnieki cemetery dates between the Middle Mesolithic and Late Neolithic, is associated with a persistent hunter-fisher-gatherer economy, and includes burials with pendants fashioned from mammal teeth. Stable isotopic analyses indicate dietary differences between individuals with pendants and without pendants beginning early in life. This context provides an opportunity to explore questions relating to occupational specialization using long bone cross-sectional geometry. Femoral cross-sectional properties from Zvejnieki were compared to a European database from the Upper Paleolithic to Neolithic to explore mobility. Femoral and humeral cross-sectional properties were compared between individuals with and without pendants to understand differences in mobility and manual activity in relation to mortuary practices. Diminished femoral rigidity and circular femoral shape were found at Zvejnieki, but no differences were observed between burial groups. Expanded cortical area and diminished medullary area were observed in the right humeri of males with pendants. Right humeral shape was comparatively circular among males with pendants, while right and left humeral

shape was anteroposteriorly reinforced among males without pendants. Females with pendants had elevated right and left humeral shape ratios compared to females without pendants. Femoral morphology reflects reduced mobility, interaction with flat terrain, and exploitation of abundant, local resources at Zvejnieki. Differences in humeral cross-sectional properties between burial groups are consistent with specialized manual activity. These patterns reflect the economic and ideological components of independent specialization and point toward expanding social dimensions in Mesolithic-Neolithic hunter-gatherers.

<https://www.science.org/doi/10.1126/sciadv.aed3371>

Trends in Cognitive Sciences

PAPERS

BYUNG-DOH OH & TAL LINZEN – To model human linguistic prediction, make LLMs less superhuman

When we read, we make predictions about upcoming words; these predictions influence our reading behavior. The success of large language models (LLMs), which, like humans, make predictions about upcoming words, has motivated their use as models of human linguistic prediction. Surprisingly, in the last few years, as LLMs' ability to predict the next word has improved, their ability to explain reading behavior has declined. We argue this is because current LLMs can predict upcoming words much better than human readers can. This 'superhumanness' is driven by LLMs' extensive training data, stronger long-term memory of training examples, and stronger short-term memory. We advocate for LLMs with human-like memory and for new experiments to measure the alignment between humans and LLMs, and we outline directions toward achieving these goals.

{So, basically, they want LLMs to dumb down so they can be used for investigations into human linguistic prediction. Good luck with that plan.}

[https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613\(26\)00127-0](https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613(26)00127-0)

JÖRN DIEDRICHSEN et al – Online planning of sequential actions

Natural behavior unfolds as a continuous stream of actions. Because these actions often occur in rapid succession, the brain must prepare multiple future actions while the current action is being executed—a process we refer to as online planning. We review evidence for online planning in unpredictable movement sequences and consider neural implementations that could support parallel execution and multiple planning processes. We then show how this new framework could apply to the learning of specific sequences, improving performance while retaining the ability to modify sequences online. Online planning, therefore, provides a unifying account of how both unpredictable and well-learned sequences are produced, and how training leads to skillful and coordinated performance while retaining behavioral flexibility.

[https://www.cell.com/trends/cognitive-sciences/abstract/S1364-6613\(26\)00125-7](https://www.cell.com/trends/cognitive-sciences/abstract/S1364-6613(26)00125-7)

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