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## NOTICES

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### PUBLICATION ALERTS

If you have had a paper or book published, or you see something which would be of interest to the group, do 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, do let me know.

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

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### SCIENCE NEWS – Oldest Homo sapiens in Europe—and a cave bear pendant—suggest cultural link to Neanderthals

During a warm spell about 46,000 years ago, a small band of people took shelter in a cave on the northern slope of the Balkan Mountains in what is now Bulgaria. There, they butchered bison, wild horses, and cave bears, leaving the cave floor littered with bones and a wealth of artifacts—ivory beads, pendants made with cave bear teeth, and stone blades stained with red ochre.

[https://www.sciencemag.org/news/2020/05/oldest-homo-sapiens-europe-and-cave-bear-pendant-suggest-cultural-link-neanderthals?utm\\_campaign=news\\_daily\\_2020-05-11&et rid=17774313&et cid=3322703#](https://www.sciencemag.org/news/2020/05/oldest-homo-sapiens-europe-and-cave-bear-pendant-suggest-cultural-link-neanderthals?utm_campaign=news_daily_2020-05-11&et rid=17774313&et cid=3322703#)

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### SOCIETY FOR SCIENCE – The earliest known humans in Europe may have been found in a Bulgarian cave

New finds from Bulgaria point to a relatively rapid expansion of Homo sapiens into Eurasia starting as early as 46,000 years ago, two studies suggest.

<http://click.societyforscience->

[email.com/?qs=962f9a87ffdaabc70df54a14f8371a628814fd1538bac734c488dd93dce3b7b2558019b8d3616fc45453f9f3b3ca344015ae9bda8dfae3a](mailto:email.com/?qs=962f9a87ffdaabc70df54a14f8371a628814fd1538bac734c488dd93dce3b7b2558019b8d3616fc45453f9f3b3ca344015ae9bda8dfae3a)

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### BREAKING SCIENCE – Neanderthals Made Leather-Working Tools from Bison and Aurochs Ribs

Neanderthals selected rib bones from specific animals to make the lissoirs (French for ‘smoothers’), which are bone tools that have been intentionally shaped and used on animal hides to make them softer and more water resistant, according to new research led by paleoanthropologists from the University of California, Davis.

[http://feedproxy.google.com/~r/BreakingScienceNews/~3/zgYVXtkc2j8/neanderthal-lissoirs-bison-aurochs-ribs-08413.html?utm\\_source=feedburner&utm\\_medium=email](http://feedproxy.google.com/~r/BreakingScienceNews/~3/zgYVXtkc2j8/neanderthal-lissoirs-bison-aurochs-ribs-08413.html?utm_source=feedburner&utm_medium=email)

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### BREAKING SCIENCE – Humans Created Earliest Modern Artifacts in Europe, Research Shows

An international team of researchers has discovered and dated the remains of Homo sapiens and associated artifacts — including pendants manufactured from cave bear teeth that are reminiscent of those later produced by the last Neanderthals of western Europe — at the Initial Upper Paleolithic cave site of Bacho Kiro in Bulgaria.

[http://feedproxy.google.com/~r/BreakingScienceNews/~3/E9YR5uL7IZM/bacho-kiro-homo-sapiens-08420.html?utm\\_source=feedburner&utm\\_medium=email](http://feedproxy.google.com/~r/BreakingScienceNews/~3/E9YR5uL7IZM/bacho-kiro-homo-sapiens-08420.html?utm_source=feedburner&utm_medium=email)

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### BREAKING SCIENCE – Gobekli Tepe: Geometry Guided Construction of 11,500-yo Megalithic Complex

New research from Tel Aviv University sheds light on the building history of monumental structures in the main area of Göbekli Tepe, a Neolithic site in southeast Turkey known for its impressive megalithic architecture with characteristic T-shaped pillars, and the chronological relations between them.

[http://feedproxy.google.com/~r/BreakingScienceNews/~3/p\\_awjmGNT\\_l/gobekli-tepe-geometry-08424.html?utm\\_source=feedburner&utm\\_medium=email](http://feedproxy.google.com/~r/BreakingScienceNews/~3/p_awjmGNT_l/gobekli-tepe-geometry-08424.html?utm_source=feedburner&utm_medium=email)

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### SCIENCE DAILY – Our species created earliest modern artifacts in Europe

Blade-like tools and animal tooth pendants previously discovered in Europe, and once thought to possibly be the work of Neanderthals, are in fact the creation of Homo sapiens, or modern humans, who emigrated from Africa, finds a new analysis by an international team of researchers.

<https://www.sciencedaily.com/releases/2020/05/200511112604.htm>

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### SCIENCE DAILY – Tracing the evolution of self-control

Advances in the craftsmanship of stone hand axes around 500,000 years ago suggest individuals at this time possessed characteristics which demonstrate significant self-control, such as concentration and frustration tolerance.

<https://www.sciencedaily.com/releases/2020/05/200513121645.htm>

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## OTHER NEWS – BBC – Longer overlap for modern humans and Neanderthals

Modern humans began to edge out the Neanderthals in Europe earlier than previously thought, a new study shows. Tests on remains from a cave in northern Bulgaria suggest Homo sapiens was there as early as 46,000 years ago. This is up to 2,000 years older than evidence from Italy and the UK.

<https://www.bbc.co.uk/news/science-environment-52614870>

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## PUBLICATIONS

### Frontiers in Ecology and Evolution

#### PAPERS

#### **HAFIZ ISHFAQ AHMAD et al – The Domestication Makeup: Evolution, Survival, and Challenges**

Animal domestication is considered a complex and multistage process that altered behaviorally, morphologically, and physiologically the domesticates relative to their wild ancestors. Ever since Darwin, scientists have been concerned about the history of domestication. To determine the domestication origins of the species, it is crucial to discover their ancestors and identify the approximate local domestication. Domestication has been the focus of several studies from different specialties. Studying when, where, and how domestication happened is essential to understand the origins of civilizations and the evolution of domesticated species. The development of both humans and domestic animals is hard to justify, and the genetic variations that occurred during the early animal domestication process remain vague. The recent and potential applications of evolutionary biology may deliver answers for main social challenges. It is important to examine the relationship among the environment and the traits of organisms that have been influenced through the adaptation to modern environments and the patterns of selection triggered by their environments during domestication period. Once domestication occurred, several events such as gene flow and selective pressures occurred, leading to genomic and phenotypic alterations. In this review, we discuss the current knowledge about the spatiotemporal outlines of domestication and debates surrounding the intent, speed, and evolutionary landscapes of this event. We also focus on the core challenges for future research. In conclusion, we argue that although the current growth in domestication information has been remarkable, the next era will produce even more significant insights into not only how domestication occurred but also where and when it did so.

[https://www.frontiersin.org/articles/10.3389/fevo.2020.00103/full?utm\\_source=F-AAE&utm\\_medium=EMLF&utm\\_campaign=MRK\\_1326917\\_6\\_Ecolog\\_20200512\\_arts\\_A](https://www.frontiersin.org/articles/10.3389/fevo.2020.00103/full?utm_source=F-AAE&utm_medium=EMLF&utm_campaign=MRK_1326917_6_Ecolog_20200512_arts_A)

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### Nature

#### PAPERS

#### **JEAN-JACQUES HUBLIN et al with SVANTE PÄÄBO – Initial Upper Palaeolithic Homo sapiens from Bacho Kiro Cave, Bulgaria**

The Middle to Upper Palaeolithic transition in Europe witnessed the replacement and partial absorption of local Neanderthal populations by Homo sapiens populations of African origin. However, this process probably varied across regions and its details remain largely unknown. In particular, the duration of chronological overlap between the two groups is much debated, as are the implications of this overlap for the nature of the biological and cultural interactions between Neanderthals and H. sapiens. Here we report the discovery and direct dating of human remains found in association with Initial Upper Palaeolithic artefacts, from excavations at Bacho Kiro Cave (Bulgaria). Morphological analysis of a tooth and mitochondrial DNA from several hominin bone fragments, identified through proteomic screening, assign these finds to H. sapiens and link the expansion of Initial Upper Palaeolithic technologies with the spread of H. sapiens into the mid-latitudes of Eurasia before 45 thousand years ago. The excavations yielded a wealth of bone artefacts, including pendants manufactured from cave bear teeth that are reminiscent of those later produced by the last Neanderthals of western Europe. These finds are consistent with models based on the arrival of multiple waves of H. sapiens into Europe coming into contact with declining Neanderthal populations.

<https://www.nature.com/articles/s41586-020-2259-z>

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### Nature Communications

#### PAPERS

#### **CHRISTOPHER W. LYNN et al – Abstract representations of events arise from mental errors in learning and memory**

Humans are adept at uncovering abstract associations in the world around them, yet the underlying mechanisms remain poorly understood. Intuitively, learning the higher-order structure of statistical relationships should involve complex mental processes. Here we propose an alternative perspective: that higher-order associations instead arise from natural errors in learning and memory. Using the free energy principle, which bridges information theory and Bayesian inference, we derive a maximum entropy model of people's internal representations of the transitions between stimuli. Importantly, our model (i) affords a concise analytic form, (ii) qualitatively explains the effects of transition network structure on human expectations, and (iii) quantitatively predicts human reaction times in probabilistic sequential motor tasks. Together, these results suggest that mental errors influence our abstract representations of the world in significant and predictable ways, with direct implications for the study and design of optimally learnable information sources.

<https://www.nature.com/articles/s41467-020-15146-7>

### **AMING LI et al – Evolution of cooperation on temporal networks**

Population structure is a key determinant in fostering cooperation among naturally self-interested individuals in microbial populations, social insect groups, and human societies. Traditional research has focused on static structures, and yet most real interactions are finite in duration and changing in time, forming a temporal network. This raises the question of whether cooperation can emerge and persist despite an intrinsically fragmented population structure. Here we develop a framework to study the evolution of cooperation on temporal networks. Surprisingly, we find that network temporality actually enhances the evolution of cooperation relative to comparable static networks, despite the fact that bursty interaction patterns generally impede cooperation. We resolve this tension by proposing a measure to quantify the amount of temporality in a network, revealing an intermediate level that maximally boosts cooperation. Our results open a new avenue for investigating the evolution of cooperation and other emergent behaviours in more realistic structured populations.

<https://www.nature.com/articles/s41467-020-16088-w>

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## Nature Scientific Reports

### PAPERS

#### **LAURI KANGASSALO et al – Information gain modulates brain activity evoked by reading**

The human brain processes language to optimise efficient communication. Studies have shown extensive evidence that the brain's response to language is affected both by lower-level features, such as word-length and frequency, and syntactic and semantic violations within sentences. However, our understanding on cognitive processes at discourse level remains limited: How does the relationship between words and the wider topic one is reading about affect language processing? We propose an information theoretic model to explain cognitive resourcing. In a study in which participants read sentences from Wikipedia entries, we show information gain, an information theoretic measure that quantifies the specificity of a word given its topic context, modulates word-synchronised brain activity in the EEG. Words with high information gain amplified a slow positive shift in the event related potential. To show that the effect persists for individual and unseen brain responses, we furthermore show that a classifier trained on EEG data can successfully predict information gain from previously unseen EEG. The findings suggest that biological information processing seeks to maximise performance subject to constraints on information capacity.

<https://www.nature.com/articles/s41598-020-63828-5>

#### **MICHELLE KIKEL, RACHEL GECELTER & NATHAN E. THOMPSON – Is step width decoupled from pelvic motion in human evolution?**

Humans are the only primate that walk bipedally with adducted hips, valgus knees, and swing-side pelvic drop. These characteristic frontal-plane aspects of bipedalism likely play a role in balance and energy minimization during walking. Understanding when and why these aspects of bipedalism evolved also requires an understanding of how each of these features are interrelated during walking. Here we investigated the relationship between step width, hip adduction, and pelvic list during bipedalism by altering step widths and pelvic motions in humans in ways that both mimic chimpanzee gait as well as an exaggerated human gait. Our results show that altering either step width or pelvic list to mimic those of chimpanzees affects hip adduction, but neither of these gait parameters dramatically affects the other in ways that lead to a chimpanzee-like gait. These results suggest that the evolution of valgus knees and narrow steps in humans may be decoupled from the evolution of the human-like pattern of pelvic list. While the origin of narrow steps in hominins may be linked to minimizing energetic cost of locomotion, the origin of the human-like pattern of pelvic list remains unresolved.

<https://www.nature.com/articles/s41598-020-64799-3>

#### **NAOMI L. MARTISIUS et al – Non-destructive ZooMS identification reveals strategic bone tool raw material selection by Neandertals**

Five nearly identical fragments of specialized bone tools, interpreted as lissoirs (French for "smoothers"), have been found at two Middle Paleolithic sites in southwest France. The finds span three separate archaeological deposits, suggesting continuity in the behavior of late Neandertals. Using standard morphological assessments, we determined that the lissoirs were produced on ribs of medium-sized ungulates. However, since these bones are highly fragmented and anthropogenically modified, species determinations were challenging. Also, conservative curation policy recommends minimizing destructive sampling of rare, fragile, or small artifacts for molecular identification methods. To better understand raw material selection for these five lissoirs, we reassess their taxonomy using a non-destructive ZooMS methodology based on triboelectric capture of collagen. We sampled four storage containers and obtained identifiable MALDI-TOF MS collagen fingerprints, all indicative of the same taxonomic clade, which includes aurochs and bison (*Bos* sp. and *Bison* sp.). The fifth specimen, which was stored in a plastic bag, provided no useful MALDI-TOF MS spectra. We show that the choice of large bovid ribs in an archaeological layer dominated by reindeer (*Rangifer tarandus*) demonstrates strategic selection by these Neandertals. Furthermore, our results highlight the value of a promising technique for the non-destructive analysis of bone artifacts.

<https://www.nature.com/articles/s41598-020-64358-w>

## **HRAG PAILIAN et al with IRENE M. PEPPERBERG – Age and Species Comparisons of Visual Mental Manipulation Ability as Evidence for its Development and Evolution**

Intelligent behavior is shaped by the abilities to store and manipulate information in visual working memory. Although humans and various non-human animals demonstrate similar storage capacities, the evolution of manipulation ability remains relatively unspecified. To what extent are manipulation limits unique to humans versus shared across species? Here, we compare behavioral signatures of manipulation ability demonstrated by human adults and 6-to-8-year-old children with that of an animal separated from humans by over 300 million years of evolution: a Grey parrot (*Psittacus erithacus*). All groups of participants completed a variant of the “Shell Game”, which required mentally updating the locations of varying set sizes of occluded objects that swapped places a number of times. The parrot not only demonstrated above-chance performance, but also outperformed children across all conditions. Indeed, the parrot’s accuracy was comparable to (and slightly better than) human adults’ over 12/14 set-size/number-of-swaps combinations, until four items were manipulated with 3–4 swaps, where performance decreased toward that of 6- to 8-year-olds. These results suggest that manipulation of visual working memory representations is an evolutionarily ancient ability. An important next step in this research program is establishing variability across species, and identifying the evolutionary origins (analogous or homologous) of manipulation mechanisms.

<https://www.nature.com/articles/s41598-020-64666-1>

## **ATIQA AZHARI et al – Physical presence of spouse enhances brain-to-brain synchrony in co-parenting couples**

Co-parenting spouses who live together remain in close physical proximity to each other and regularly engage in reciprocal social interactions in joint endeavors to coordinate their caregiving. Although bi-parental rearing is a common occurrence in humans, the influence of the physical presence of a co-parenting spouse on parental brain responses remains largely unknown. Synchrony is conceptualized as the matching of behavioral and physiological signals between two individuals. In this study, we examined how the presence of a co-parenting spouse influences brain-to-brain synchrony when attending to salient infant and adult vocalizations. We hypothesized that brain-to-brain synchrony would be greater in the presence of a spousal partner. Functional Near-infrared Spectroscopy (fNIRS) was used on 24 mother-father dyads (N = 48) to measure prefrontal cortical (PFC) activities while they listened to infant and adult vocalizations in two conditions, together (in the same room at the same time) and separately (in different rooms at different times). Couples showed greater synchrony in the together condition; when comparing fNIRS data between true couples and randomly matched controls, this synchronous effect was only seen in true couples, indicating a unique effect of spousal co-regulation toward salient stimuli. Our results indicate that the physical presence of the spouse might establish synchrony in attentional regulation mechanisms toward socially relevant stimuli. This finding holds implications for the role of the co-parenting spouse in influencing social and parental brain mechanisms.

<https://www.nature.com/articles/s41598-020-63596-2>

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## **New Scientist**

### **NEWS**

#### **Neanderthals may have learned jewellery-making from us**

When modern humans first settled in Europe, they met Neanderthals – and possibly passed on jewellery-making tips. Jean-Jacques Hublin at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and his colleagues have confirmed for the first time that modern humans were in Europe at least 45,000 years ago. They also suggest that modern humans taught Neanderthals to make necklaces out of bear teeth.

<https://www.newscientist.com/article/2243134-neanderthals-may-have-learned-jewellery-making-from-us/#ixzz6MSEn1qfD>

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## **PeerJ**

### **PAPERS**

#### **SARAH GRIFFITHS et al – Early language competence, but not general cognitive ability, predicts children’s recognition of emotion from facial and vocal cues**

The ability to accurately identify and label emotions in the self and others is crucial for successful social interactions and good mental health. In the current study we tested the longitudinal relationship between early language skills and recognition of facial and vocal emotion cues in a representative UK population cohort with diverse language and cognitive skills (N = 369), including a large sample of children that met criteria for Developmental Language Disorder (DLD, N = 97). Language skills, but not non-verbal cognitive ability, at age 5–6 predicted emotion recognition at age 10–12. Children that met the criteria for DLD showed a large deficit in recognition of facial and vocal emotion cues. The results highlight the importance of language in supporting identification of emotions from non-verbal cues. Impairments in emotion identification may be one mechanism by which language disorder in early childhood predisposes children to later adverse social and mental health outcomes.

<https://peerj.com/articles/9118/>

**ZEJIE ZHOU, BOLESŁAW K. SZYMANSKI & JIANXI GAO – Modelling competitive evolution of multiple languages**

Increasing evidence demonstrates that in many places language coexistence has become ubiquitous and essential for supporting language and cultural diversity and associated with its financial and economic benefits. The competitive evolution among multiple languages determines the evolution outcome, either coexistence, or decline, or extinction. Here, we extend the Abrams-Strogatz model of language competition to multiple languages and then validate it by analyzing the behavioral transitions of language usage over the recent several decades in Singapore and Hong Kong. In each case, we estimate from data the model parameters that measure each language utility for its speakers and the strength of two biases, the majority preference for their language, and the minority aversion to it. The values of these two biases decide which language is the fastest growing in the competition and what would be the stable state of the system. We also study the system convergence time to stable states and discover the existence of tipping points with multiple attractors. Moreover, the critical slowdown of convergence to the stable fractions of language users appears near and peaks at the tipping points, signaling when the system approaches them. Our analysis furthers our understanding of evolution of various languages and the role of tipping points in behavioral transitions. These insights may help to protect languages from extinction and retain the language and cultural diversity.

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0232888>

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**WIM POUW et al – Acoustic information about upper limb movement in voicing**

We show that the human voice has complex acoustic qualities that are directly coupled to peripheral musculoskeletal tensioning of the body, such as subtle wrist movements. In this study, human vocalizers produced a steady-state vocalization while rhythmically moving the wrist or the arm at different tempos. Although listeners could only hear and not see the vocalizer, they were able to completely synchronize their own rhythmic wrist or arm movement with the movement of the vocalizer which they perceived in the voice acoustics. This study corroborates recent evidence suggesting that the human voice is constrained by bodily tensioning affecting the respiratory–vocal system. The current results show that the human voice contains a bodily imprint that is directly informative for the interpersonal perception of another’s dynamic physical states.

<https://www.pnas.org/content/early/2020/05/05/2004163117.abstract?etoc>

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**ABDULLAH ALMAATOUQ et al – Adaptive social networks promote the wisdom of crowds**

Social networks continuously change as new ties are created and existing ones fade. It is widely acknowledged that our social embedding has a substantial impact on what information we receive and how we form beliefs and make decisions. However, most empirical studies on the role of social networks in collective intelligence have overlooked the dynamic nature of social networks and its role in fostering adaptive collective intelligence. Therefore, little is known about how groups of individuals dynamically modify their local connections and, accordingly, the topology of the network of interactions to respond to changing environmental conditions. In this paper, we address this question through a series of behavioral experiments and supporting simulations. Our results reveal that, in the presence of plasticity and feedback, social networks can adapt to biased and changing information environments and produce collective estimates that are more accurate than their best-performing member. To explain these results, we explore two mechanisms: 1) a global-adaptation mechanism where the structural connectivity of the network itself changes such that it amplifies the estimates of high-performing members within the group (i.e., the network “edges” encode the computation); and 2) a local-adaptation mechanism where accurate individuals are more resistant to social influence (i.e., adjustments to the attributes of the “node” in the network); therefore, their initial belief is disproportionately weighted in the collective estimate. Our findings substantiate the role of social-network plasticity and feedback as key adaptive mechanisms for refining individual and collective judgments.

<https://www.pnas.org/content/early/2020/05/08/1917687117.abstract?etoc>

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**IAN J. WALLACE, M. LORING BURGESS & BIREN A. PATEL – Phalangeal curvature in a chimpanzee raised like a human: Implications for inferring arboreality in fossil hominins**

Arboreal primates such as chimpanzees exhibit pronounced curvature in their hand and foot phalanges, which is assumed to develop throughout life in response to mechanical loads produced by grasping and hanging from branches. Intriguingly, ancient fossil hominins also exhibit substantial phalangeal curvature, which, too, has been interpreted as a direct result of habitual arboreality during life. Here, we describe the phalangeal curvature of a chimpanzee who was raised during the 1930s in New York City to live much like a human, including by having very few opportunities to engage in arboreal activities. We show that the degree of hand and foot phalangeal curvature in this individual is indistinguishable from that of wild chimpanzees and distinct from humans. Thus, rather than being a direct effect of mechanical loads produced by lifetime arboreal activities, phalangeal curvature appears to be shaped largely by genetic factors. An important implication of this finding is that phalangeal curvature among fossil hominins is evidently best interpreted as a primitive trait inherited from an arboreal ancestral species rather than proof of engagement in arboreal activities during life.

## Science

### NEWS

#### **Oldest Homo sapiens bones found in Europe**

Europe has long been home to Neanderthals, who lived here from 400,000 to 40,000 years ago. But about 47,000 years ago, a new group of people took shelter in a cave in Bulgaria. There, they butchered bison, wild horses, and cave bears, leaving the cave floor littered with bones and a wealth of artifacts—ivory beads, pendants made with cave bear teeth, and stone blades stained with red ochre. Researchers used a cutting-edge toolkit of their own to identify a molar and five bone fragments as belonging to Homo sapiens, our own species. Precise new dates show these cave dwellers lived as early as 47,000 years ago, which makes them the earliest known members of our species in Europe. The work is also reigniting a long-standing debate about how Neanderthals and moderns may have influenced each other—because Neanderthals crafted similar artifacts a few thousand years later.

<https://science.sciencemag.org/content/368/6492/697>

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## Trends in Cognitive Sciences

### PAPERS

#### **ARIE W. KRUGLANSKI, KATARZYNA JASKO & KARL FRISTON – All Thinking is ‘Wishful’ Thinking**

People often seek new information and eagerly update their beliefs. Other times they avoid information or resist revising their beliefs. What explains those different reactions? Answers to this question often frame information processing as a competition between cognition and motivation. Here, we dissolve this dichotomy by bringing together two theoretical frameworks: epistemic motivation and active inference. Despite evolving from different intellectual traditions, both frameworks attest to the indispensability of motivational considerations to the epistemic process. The imperatives that guide model construction under the epistemic motivation framework can be mapped onto key constructs in active inference. Drawing these connections offers a way of articulating social psychological constructs in terms of Bayesian computations and provides a generative testing ground for future work.

[https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613\(20\)30079-6?dgcid=raven\\_jbs\\_etoc\\_email](https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613(20)30079-6?dgcid=raven_jbs_etoc_email)

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#### **RANDALL C. O'REILLY – Unraveling the Mysteries of Motivation**

Motivation plays a central role in human behavior and cognition but is not well captured by widely used artificial intelligence (AI) and computational modeling frameworks. This Opinion article addresses two central questions regarding the nature of motivation: what are the nature and dynamics of the internal goals that drive our motivational system and how can this system be sufficiently flexible to support our ability to rapidly adapt to novel situations, tasks, etc.? In reviewing existing systems and neuroscience research and theorizing on these questions, a wealth of insights to constrain the development of computational models of motivation can be found.

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