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## NOTICES

### 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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## EAORC NEWS – 1. New Website Preview Available

Since the creation of EAORC I have been using Webplus from Serif. Originally X4, I updated to X5, X6, X7 and X8, and I found it to be an outstanding product. Unfortunately, as is the way of anything outstanding in this World, Serif ceased to support the software in August 2018. Since then I have been using X8, despite its increasing unreliability, and trying out other web design solutions to find an alternative.

Eventually, out of desperation, I tried to redesign one of my websites (the EAORC site, because it's the simplest) in Microsoft products – mostly Word, with PowerPoint and Paint (good old Paint) to help gussy things up. It turns out that this is a quite good solution. I have now produced a reasonable version of the EAORC website, which is available for your inspection at [http://martinedwardes.me.uk/eaorc\\_test/](http://martinedwardes.me.uk/eaorc_test/). If people are content with this new site then I will replace the existing website in September.

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## EAORC NEWS – 2. Biennial Membership Check

2020 is a membership checking year; this normally begins in June, but I have delayed the check until September because of the 2020 plethora of crises. However, in September I will start asking for confirmation that you wish to continue receiving the bulletins. Anyone who has not indicated they wish to continue will be taken off the list at the end of October. This biennial membership check has been in operation since 2008, and GDPR has made it even more important that it is carried out regularly.

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## EAORC NEWS – 3. PDF bulletins? Your choice

It has been suggested that, as I produce a weekly pdf bulletin for the website, I could send that to the email group instead of the text email. The pdf has several advantages over the current email in terms of presentation, curation, and searching, but it has the disadvantage of being larger: the average EAORC pdf for the past few months has been about 350kb, the average bulletin email has been (I think) about 80kb. There are also issues to be considered of how your security system reacts to emails with a lot of links, or how it reacts to emails with attachments.

Let me know which option you prefer by sending me a two-word email: EAORC pdf or EAORC email. I will go with the majority choice. I will leave the voting open until end August to allow people otherwise out of contact to

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## SCIENCE NEWS – Long-lost relic may reveal origins of Stonehenge

As Robert Phillips neared his 90th birthday, the former diamond cutter decided to return a priceless piece of history to the United Kingdom: a 91-centimeter-long cylinder of rock from the heart of Stonehenge. Now, archaeologists working with the so-called Phillips core have all but conclusively shown that the famed monument's largest building blocks came from a forest about 25 kilometers away, confirming a long-standing hypothesis.

[https://www.sciencemag.org/news/2020/07/long-lost-relic-may-reveal-origins-stonehenge?utm\\_campaign=news\\_daily\\_2020-07-29&et rid=17774313&et cid=3428350](https://www.sciencemag.org/news/2020/07/long-lost-relic-may-reveal-origins-stonehenge?utm_campaign=news_daily_2020-07-29&et rid=17774313&et cid=3428350)

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## SCIENCE NEWS – man who can read letters—but not numbers—exposes roots of consciousness

In the video, the man sounds creeped out. "This is too strange for words," he mutters. He's holding a plate-size, green foam 8. When upright, it looks to him like an incoherent jumble. But when he rotates it 90°, the shape snaps into focus; it looks like "a mask." He begins to rotate the numeral back and forth, watching it melt and cohere over and over. He finally hands it to a nearby scientist, saying, "You gotta take that away."

[https://www.sciencemag.org/news/2020/07/mysterious-case-man-who-can-read-letters-not-numbers-exposes-complex-roots?utm\\_campaign=news\\_daily\\_2020-07-29](https://www.sciencemag.org/news/2020/07/mysterious-case-man-who-can-read-letters-not-numbers-exposes-complex-roots?utm_campaign=news_daily_2020-07-29)

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## BREAKING SCIENCE – Neanderthals May Have Had Heightened Sensitivity to Pain

Neanderthals may have experienced more pain than average modern humans do, according to new research led by scientists from the Max Planck Institute for Evolutionary Anthropology, Karolinska Institutet and Okinawa Institute of Science and Technology. Neanderthals and their Asian relatives, Denisovans, evolved separately from the ancestors of present-day humans for about 500,000 years.

[http://feedproxy.google.com/~r/BreakingScienceNews/~3/AKVzNLMFgPk/neanderthal-pain-sensitivity-08680.html?utm\\_source=feedburner&utm\\_medium=email](http://feedproxy.google.com/~r/BreakingScienceNews/~3/AKVzNLMFgPk/neanderthal-pain-sensitivity-08680.html?utm_source=feedburner&utm_medium=email)

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## BREAKING SCIENCE – Archaeologists Pinpoint Source of Stonehenge's Sarsen Megaliths

A team of researchers from the UK and South Africa has discovered that most of the hulking sandstone boulders — called sarsens — that make up the famous Stonehenge monument appear to share a common origin 25 km (15.5 miles) away in West Woods on the edge of the Marlborough Downs, Wiltshire.

[http://feedproxy.google.com/~r/BreakingScienceNews/~3/QRwc7Klp-pw/source-stonehenges-sarsen-megaliths-08699.html?utm\\_source=feedburner&utm\\_medium=email](http://feedproxy.google.com/~r/BreakingScienceNews/~3/QRwc7Klp-pw/source-stonehenges-sarsen-megaliths-08699.html?utm_source=feedburner&utm_medium=email)

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## SCIENCE DAILY – Big brains and dexterous hands

Primates with large brains can master more complex hand movements than those with smaller brains. However, fine motor skills such as using tools can take time to learn, and humans take the longest of all. Large-brained species such as humans and great apes do not actually learn more slowly than other primates but instead start later, researchers have shown.

<https://www.sciencedaily.com/releases/2020/07/200724141034.htm>

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## SCIENCE DAILY – Remote islands: Stepping stones to understanding evolution

Researchers have investigated evolutionary and ecological changes in ants in the South Pacific archipelago of Fiji to examine a controversial theory for how evolution occurs on islands.

<https://www.sciencedaily.com/releases/2020/07/200730110124.htm>

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## SCIENCE DAILY – To distinguish contexts, animals think probabilistically, study suggests

A new statistical model may help scientists understand how animals make inferences about whether their surroundings are novel or haven't changed enough to be regarded a new context.

<https://www.sciencedaily.com/releases/2020/07/200731152732.htm>

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## SCIENCE DAILY – 'Little brain' or cerebellum not so little after all

When we say someone has a quick mind, it may be in part thanks to our expanded cerebellum that distinguishes human brains from those of macaque monkeys, for example. High-res imaging shows the cerebellum is 80% of the area of the cortex, indicating it has grown as human behavior and cognition evolved.

<https://www.sciencedaily.com/releases/2020/07/200731135558.htm>

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## NATURE BRIEFING – How did language evolve?

A popular theory about the origin of language is that it began with gestures, rather than speech. Before children can talk, they learn to point, nod and wave. Could the development of language in our ancestors have followed the same sequence? Cognitive scientist Kensy Cooperrider explores the gesture-first and speech-first origins of language, and explains why the 'hardest problem in science' could be one of the most tantalizing.

<https://nature.us17.list-manage.com/track/click?u=2c6057c528fdc6f73fa196d9d&id=0c5e23ed8c&e=1db4b9a19b>

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## NATURE BRIEFING – Stonehenge origin mystery solved

Researchers have pinpointed the origin of Stonehenge's giant sarsen stones after a sample that was taken from the site more than 60 years ago was finally returned. A detailed geochemical analysis of the sample, a tube-shaped core that was drilled from one of the stones in 1958, compared its trace-element levels with those of rock samples from sites across southern England, and researchers concluded that it came from an area near Marlborough, 25 kilometres away from Stonehenge. "What it really brings home for me is the Herculean effort that went into making this structure in a reasonably short time window," says physical geographer David Nash. Other mysteries remain, including how Neolithic architects were able to transport the 20-tonne stones.

<https://nature.us17.list-manage.com/track/click?u=2c6057c528fdc6f73fa196d9d&id=e9c2cd4128&e=1db4b9a19b>

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## ACADEMIA.EDU – The archeology of cognitive evolution

*In E. Bruner (ed.), Human Paleoneurology. Springer International Publishing: Switzerland (2015).*

### NATALIE T. UOMINI – Paleoneurology and Behaviour

The discipline of Paleoneurology goes beyond the determination of biological characteristics and morphologies; it can also be used to infer behaviour in extinct species. In Paleocognition, the cognitive capacities of extinct humans can be examined through their fossil remains and the tools they left behind. This chapter examines some inferences that can be made about the origins of language based on paleoneurological and archaeological evidence. It focuses on laterality as a case study for the many behaviours that can be inferred from archaeology, and which are relevant to the origins and evolution of language. First is a review of the ontogeny of human hand preference, handedness in humans, and the hand preferences of nonhuman apes. Human handedness begins before birth, and develops into adulthood. All human populations have a majority of right-handers; explanations for the maintenance of a minority of left-handers are discussed. Next, the data for hand preferences and asymmetries in extinct fossil hominins are summarised. These show that species-level right-handedness has existed since *Homo heidelbergensis*, but there is only evidence for left-handed minorities in Neanderthals and *Homo sapiens*. Finally, links between language, hand skill, ancient stone tool-making, and other cultural behaviours are discussed to propose a tentative date for the origins of language.

[https://www.academia.edu/31389907/Paleoneurology\\_and\\_behaviour?email\\_work\\_card=minimal-title](https://www.academia.edu/31389907/Paleoneurology_and_behaviour?email_work_card=minimal-title)

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## ACADEMIA.EDU – Human Paleontology and Prehistory

**Assaf Marom & Erella Hovers (eds.) (2014). Human Paleontology and Prehistory: Contributions in Honor of Yoel Rak. Springer: Cham, Switzerland.**

This volume presents a collection of original papers contributed by many of Yoel's friends and colleagues from all over the globe, many of whom have collaborated with their students, thus keeping the flame burning, so to speak. The papers in this volume touch upon diverse ways of thinking about human evolution. Many of these approaches are among the topics that Yoel has been studying during his productive career.

The papers fall roughly into three broad categories: Reflections on some of the broad theoretical questions of evolution, and especially about human evolution; the early hominins, with special emphasis on *Australopithecus afarensis* and *Paranthropus*; and the Neanderthals, that contentious group of our closest extinct relatives. Within and across these categories, nearly every paper addresses combinations of methodological, analytical and theoretical questions that are pertinent to the whole human evolutionary time span.

[https://www.academia.edu/6959022/Sharon G. E. Hovers and Y. Zaidner eds. . 2014. Opportunities Problems and Future Directions in the Study of Open-air Middle Paleolithic Sites. Quaternary International 331?email\\_work\\_card=minimal-title](https://www.academia.edu/6959022/Sharon_G._E._Hovers_and_Y._Zaidner_eds._.2014._Opportunities_Problems_and_Future_Directions_in_the_Study_of_Open-air_Middle_Paleolithic_Sites._Quaternary_International_331?email_work_card=minimal-title)

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## ACADEMIA.EDU – Behavioural and technological reversal after 60 ka in Southern Africa

*South African Archaeological Bulletin 65 (192): 221–228, 2010*

**MARLIZE LOMBARD & ISABELLE PARSONS – Fact or fiction? Behavioural and technological reversal after 60 ka in Southern Africa**

Southern Africa features prominently in current debate regarding the evolution of cultural modernity and cognitive complexity. Human behaviour in southern Africa associated with the Still Bay and Howieson's Poort stone tool industries between ~75–60 ka is now widely accepted as modern, and some argue for even earlier origins of such behaviour (Deacon 1995; Henshilwood & Marean 2003; Wurz 2008). Yet, stone tool assemblages immediately post-dating the Howieson's Poort are often ignored in discussions concerning modern or symbolic behaviour. They have been described as "reverting to type" (Deacon 1989: 560), "less sophisticated" (Jacobs & Roberts 2009:191), and "returning to earlier technological strategies" (McCall 2007: 1749), reminiscent of assemblages pre-dating the Still Bay Industry. This perception is mostly based on early observations regarding Middle Stone Age (MSA) stone tool assemblages from Klasies River (Singer & Wymer 1982), and the seeming lack of unambiguous symbolic objects during the ~20 ka following the Howieson's Poort (e.g. Mitchell 2008: 59). These factors have brought to the fore potential explanations of significant episodes of simplification or devolution (Mellars 2007: 7), technological and/or behavioural reversal (McCall 2007: 1749; Clark 2009: 18), a material culture cul-de-sac (Henshilwood 2007: 130) or cultural regression (Henshilwood 2005: 455), a demise of regional information networks (Ambrose 2002: 21) and territorial population displacement (Mellars 2007: 7).

[https://www.academia.edu/4561889/Fact or fiction Behavioural and technological reversal after 60 ka in southern Africa?email\\_work\\_card=title](https://www.academia.edu/4561889/Fact_or_fiction_Behavioural_and_technological_reversal_after_60_ka_in_southern_Africa?email_work_card=title)

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## ACADEMIA.EDU – The Pre-Clovis Occupation of the Topper Site

*In Albert C. Goodyear and Christopher R. Moore (eds.), Early Human Life on the Southeastern Coastal Plain. University Press Scholarship Online: Oxford, UK, ch2.*

**ALBERT C. GOODYEAR & DOUGLAS A. SAIN – The Pre-Clovis Occupation of the Topper Site, Allendale County, South Carolina**

The Topper site is a multicomponent prehistoric site located on the east bank of the Savannah River in Allendale County, South Carolina. The site is composed of an alluvial terrace bordered on the west by a chute channel of the Savannah River and the upland of the Coastal Plain (Figure 2.1). The upland, which slopes down to the terrace, has also been referred to as the Hillside or Hilltop by the various investigators. A bed of high-quality chert known as Allendale Coastal Plain chert is exposed at the base of the uplands, which was extensively quarried during pre-Clovis, Clovis, and later Holocene times. This chert, in its terrestrial exposure and in the bottom of the adjacent Savannah River (Goodyear and Charles 1984), was the primary resource that drew people to the site for several millennia.

[https://www.academia.edu/39776169/The Pre-Clovis Occupation of the Topper Site Allendale County South Carolina?email\\_work\\_card=view-paper](https://www.academia.edu/39776169/The_Pre-Clovis_Occupation_of_the_Topper_Site_Allendale_County_South_Carolina?email_work_card=view-paper)

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## THE CONVERSATION – Chimpanzees once helped African rainforests recover from a major collapse

But with chimps now endangered, we risk losing their forest-rebuilding abilities.

<https://theconversationuk.cmail19.com/t/r-l-jkhljde-khhilalah-e/>

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## THE CONVERSATION – Stonehenge: how we revealed the original source of the biggest stones

How we traced the origin of the sarsen stones.

<https://theconversationuk.cmail19.com/t/r-l-jkhljde-khhilalah-yd/>



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## THE CONVERSATION – New Stonehenge discovery: how we found a prehistoric monument hidden in data

Archaeologists reveal two-kilometre ring of pits around the Neolithic Durrington Walls by studying old geophysical surveys.

<https://theconversationuk.cmail20.com/t/r-l-jkhyez-khhilillah-x/>

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## OTHER NEWS – BBC – Mystery of origin of Stonehenge megaliths solved

The origin of the giant sarsen stones at Stonehenge has finally been discovered with the help of a missing piece of the site which was returned after 60 years.

<https://www.bbc.co.uk/news/uk-england-wiltshire-53580339>

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## PUBLICATIONS

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### American Journal of Human Genetics

#### PAPERS

#### **DUNCAN N. E. STIBBARD-HAWKES et al with IBRAHIM A. MABULLA – To the hunter go the spoils? No evidence of nutritional benefit to being or marrying a well-reputed Hadza hunter**

The incentives underlying men's hunting acquisition patterns among foragers are much debated. Some argue that hunters preferentially channel foods to their households, others maintain that foods are widely redistributed. Debates have focused on the redistribution of foods brought to camp, though the proper interpretation of results is contested. Here we instead address this question using two nutritional variables, employed as proxies for longer-term food access. We also report on broader patterns in nutritional status.

We measured male hunting success, hemoglobin concentration and body fatness among bush-living Hadza. Hunting success was measured using an aggregated reputation score. Hemoglobin concentration, a proxy for dietary red meat, was measured from fingerprick capillary blood. Body fatness, a proxy for energy balance, was measured using BMI and bioelectrical impedance.

We find no statistically significant relationship between a hunter's success and any measure of his nutritional status or that of his spouse. We further find that: women are, as elsewhere, at greater risk of iron-deficiency anemia than men; men had slightly lower BMIs than women; men but not women had significantly lower hemoglobin levels than in the 1960s.

The absence of an association between hunting reputation and nutritional status is consistent with generalized food sharing. Null results are difficult to interpret and findings could potentially be a consequence of insufficient signal in the study measures or some confounding effect. In any event, our results add to a substantial corpus of existing research that identifies few nutritional advantages to being or marrying a well-reputed Hadza hunter.

<https://onlinelibrary.wiley.com/doi/abs/10.1002/ajpa.24027?campaign=woletoc>

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### Biology Letters

#### PAPERS

#### **LAURA BUSIA & MATTEO GRIGGIO – The dawn of social bonds: what is the role of shared experiences in non-human animals?**

Group-living animals can develop social bonds. Social bonds can be considered a type of social relationship characterized by frequent and consistent affiliative (non-reproductive) interactions. Social bonds with conspecifics bring many advantages, also in terms of direct fitness. A characteristic of social bonds is that they need time to develop. Several studies on humans have emphasized the fact that sharing experiences can affect the strength of social bonds. A similar trend can be spotted in non-human species. For example, a recent experiment showed that if chimpanzees watched a video together with a conspecific, they spent more time in proximity compared to conspecifics with whom they did not actively watch a video. Another experiment on fish showed that individuals who experienced a situation of high predation risk together, showed preference for each other compared to those who did not. As the link between shared experiences and social bonds is not explicitly recognized in non-human animals, the main goal of this work is to propose the exploration of this novel research path. This exploration would contribute to shed light on the evolutionary mechanisms of social bond (or friendship) development and maintenance between individuals in different vertebrate species, from fish to non-human primates.

<https://royalsocietypublishing.org/doi/full/10.1098/rsbl.2020.0201>

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#### **MAXIME GARCIA & ANDREA RAVIGNANI – Acoustic allometry and vocal learning in mammals**

Acoustic allometry is the study of how animal vocalizations reflect their body size. A key aim of this research is to identify outliers to acoustic allometry principles and pinpoint the evolutionary origins of such outliers. A parallel strand of research investigates species capable of vocal learning, the experience-driven ability to produce novel vocal signals through imitation or modification of existing vocalizations. Modification of vocalizations is a common feature found when studying both acoustic allometry and vocal learning. Yet, these two fields have only been investigated separately to date. Here, we review and connect acoustic allometry and vocal learning across mammalian clades, combining perspectives from bioacoustics, anatomy and evolutionary biology. Based on this, we hypothesize that, as a precursor to vocal learning, some species might have evolved the capacity for volitional vocal modulation via sexual selection for 'dishonest' signalling. We provide preliminary support for our hypothesis by showing significant associations between allometric deviation and vocal learning in

a dataset of 164 mammals. Our work offers a testable framework for future empirical research linking allometric principles with the evolution of vocal learning.

<https://royalsocietypublishing.org/doi/full/10.1098/rsbl.2020.0081>

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## Frontiers in Psychology

### PAPERS

#### **GERALD MATTHEWS – A Grand Challenge for Personality and Social Psychology: Competition, Cooperation, or Co-existence?**

Like two rival siblings, the disciplines of personality and social psychology have common roots but an evolving and sometimes difficult relationship (Pettigrew and Cherry, 2012; Lanning, 2017). Both are diverse and have their own internal controversies, but, historically, the field has been divided according to two worldviews (Cloninger, 2020). Personality trait researchers favor a natural sciences approach, characterized by a search for general, nomothetic principles for understanding relationships between quantitative individual-difference variables (Boyle et al., 2008). They are sympathetic to biological explanations for trait variation, expressed in studies of evolutionary bases, behavior and molecular genetics, and neuroscience. By contrast, social constructivists are attuned to qualitative, idiographic studies of the ways in which people interact within a specific sociocultural milieu, with personality negotiated dynamically “between” as much as “within” people (Hampson, 1988). They also favor a humanistic over a natural-sciences orientation, which values efforts by psychologists to support individual flourishing and social justice (Cloninger, 2020).

Neither worldview is monolithic. For example, on the trait side, variation in traits associated with the self has been attributed to motivational and cognitive factors rather than direct neurological influences (Ryan and Deci, 2017). Experimental social psychology lends itself to nomothetic theories, such as those focused on social cognition. Nevertheless, the tension between natural-science and humanistic perspectives (Cloninger, 2020) threatens the unity and integrity of the field.

[https://www.frontiersin.org/articles/10.3389/fpsyg.2020.01570/full?utm\\_source=F-AAE&utm\\_medium=EMLF&utm\\_campaign=MRK\\_1391749\\_69\\_Psycho\\_20200730\\_arts\\_A](https://www.frontiersin.org/articles/10.3389/fpsyg.2020.01570/full?utm_source=F-AAE&utm_medium=EMLF&utm_campaign=MRK_1391749_69_Psycho_20200730_arts_A)

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## Journal of Language Evolution

### IMPACT-MAKING ARTICLES

#### **CARMEN SALDANA, SIMON KIRBY, ROBERT TRUSWELL & KENNY SMITH – Compositional Hierarchical Structure Evolves through Cultural Transmission: An Experimental Study**

Compositional hierarchical structure is a prerequisite for productive languages; it allows language learners to express and understand an infinity of meanings from finite sources (i.e., a lexicon and a grammar). Understanding how such structure evolved is central to evolutionary linguistics. Previous work combining artificial language learning and iterated learning techniques has shown how basic compositional structure can evolve from the trade-off between learnability and expressivity pressures at play in language transmission. In the present study we show, across two experiments, how the same mechanisms involved in the evolution of basic compositionality can also lead to the evolution of compositional hierarchical structure. We thus provide experimental evidence showing that cultural transmission allows advantages of compositional hierarchical structure in language learning and use to permeate language as a system of behaviour.

<https://academic.oup.com/jole/article/4/2/83/5499169>

#### **VERA KEMPE et al – Adults are more efficient in creating and transmitting novel signalling systems than children**

Iterated language learning experiments have shown that meaningful and structured signalling systems emerge when there is pressure for signals to be both learnable and expressive. Yet, such experiments have mainly been conducted with adults using language-like signals. Here we explore whether structured signalling systems can also emerge when signalling domains are unfamiliar and when the learners are children with their well-attested cognitive and pragmatic limitations. In Experiment 1, we compared iterated learning of binary auditory sequences denoting small sets of meanings in chains of adults and 5- to 7-year-old children. Signalling systems became more learnable even though iconicity and structure did not emerge despite applying a homonymy filter designed to keep the systems expressive. When the same types of signals were used in referential communication by adult and child dyads in Experiment 2, only the adults, but not the children, were able to negotiate shared iconic and structured signals. Referential communication using their native language by 4- to 5-year-old children in Experiment 3 showed that only interaction with adults, but not with peers resulted in informative expressions. These findings suggest that emergence and transmission of communication systems are unlikely to be driven by children, and point to the importance of cognitive maturity and pragmatic expertise of learners as well as feedback-based scaffolding of communicative effectiveness by experts during language evolution.

<https://academic.oup.com/jole/article/4/1/44/5321155>

#### **MARK ATKINSON, GREGORY J MILLS & KENNY SMITH – Social Group Effects on the Emergence of Communicative Conventions and Language Complexity**

Languages differ in their complexity. One possible explanation for this observation is that differences in social factors influence linguistic complexity: languages that are used for communication in small-scale ‘societies of intimates’ exhibit greater complexity as a result of the communicative contexts in which they are typically employed. We used the techniques

from referential communication studies across three experiments to assess the effects of two social group factors—group size and amount of communally shared knowledge—on the brevity and transparency of linguistic conventions. In Experiment 1, we explored the effects of a manipulation of group size, comparing the conventions which develop from the interaction of two speakers, with those which develop between three speakers. In Experiment 2, we manipulated the extent to which groups of three speakers share talk-relevant contextual information. While we found the conditions that involve larger groups and less shared background information initially resulted in longer labels and a greater reliance on more literal descriptive terms, there was no effect of either factor in the longer term. In Experiment 3, we investigated the transparency of the conventions of Experiments 1 and 2 by assessing how well they could be matched to their intended referents by naive individuals. We found no evidence to support the claims that communicative contexts involving communicating with more individuals, or individuals with whom less relevant information is shared, produce more transparent conventions. Our experiments ultimately provide no support for the idea that the structure of linguistic conventions is shaped by the groups in which they develop.

<https://academic.oup.com/jole/article/4/1/1/5146761>

### **PEDRO TIAGO MARTINS, MATIES MARÍ & CEDRIC BOECKX – SRGAP2 and the gradual evolution of the modern human language faculty**

In this article, we examine a new source of evidence that draws on data from archaic human genomes to support the hypothesis that vocal learning in Homo preceded the emergence of anatomically modern humans. We build our claim on the evolutionary history of the SLIT-ROBO GTPase 2 gene (SRGAP2). The SLIT-ROBO molecular pathway has been shown to have an important role in the context of vocal learning. Though the relevance of the SRGAP2 gene duplication in the emergence of some aspect of language has not gone completely unnoticed, recent results now allow us to articulate a mechanistic hypothesis of its role in the context of axon guidance. Specifically, SRGAP2C, a duplication of SRGAP2 crucially also found in Neanderthals and Denisovans, but not in extant mammals, inhibits the ancestral SRGAP2A, which in turn modulates the axon guidance function of the SLIT-ROBO molecular pathway. This, we claim, could have contributed to the establishment of the critical cortico-laryngeal connection of the vocal learning circuit. Our conclusions support the idea that complex vocal learning could already have been part of the arsenal of some of our extinct ancestors.

<https://academic.oup.com/jole/article/3/1/67/4797564>

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## Journal of Linguistics

### PAPERS

#### **TIM NISBET – Meaning, metaphor, and argument structure<sup>1</sup>**

This paper challenges what it calls the SEMANTIC DETERMINIST HYPOTHESIS (SDH) of argument licensing, according to which the syntactic realisation of a verb's arguments is a function of its semantic properties. Specifically, it takes issue with 'event schema' versions of the SDH applied to the English ditransitive alternation (give/send {Jesse the gun/the gun to Jesse}), which claim a systematic, syntactically predictive distinction between 'caused possession' and 'caused motion'. It is first shown that semantic and syntactic irregularities among the alternating verbs disconfirm such a mapping. More crucially, however, it is argued that 'non-prototypical' (metaphorical and idiomatic) usage (The news report gave Walt an idea, Walt's actions gave the lie to his promises, The discovery sent Jesse into a fury) is fatal to the SDH, since the hypothesis entails the existence of SEMANTIC CONSTRAINTS on argument realisation which these expressions violate.

Based on an analysis of the semantically-related verbs give, send, and put, it is claimed that prototypical, metaphorical and idiomatic expressions of a verb can all be licensed straightforwardly, but only if theory maintains separate syntactic and semantic representation of arguments in lexical entries, observing the 'parallel architecture' of Jackendoff (1997, 2002), and only if argument tokens are licensed by the syntactic representation alone. A type of structure called a LEXICAL ARGUMENT CONSTRUCTION is proposed, which can describe all the relevant properties of verbs and verbal idioms.

*{I think Nisbet successfully dismisses what he calls the strong version of SDH – but that always was a bit of an Aunt Sally. However, the weak version seems more resilient. Weak SDH seems, to me, to explain the semantic difference between “they put the cat out” and “they put out the cat” better than LAC (a difference missing from “they put the fire out/put out the fire”). I would also like to see LAC on “they simply did it/did it simply” (a problem he inadvertently illustrates on p646 with “... must be simply a stipulated form in the lexical entry”). And, of course, there is always “They saw a house with chimneys/binoculars/Snow White/surprise”. Fixing language systemics to form inevitably runs up against the elephant in the room: forms change in unpredictable ways; or, to put it another way, people adopt new forms because they can; or “forms so totally are regulated ... not!”}*

<https://www.cambridge.org/core/journals/journal-of-linguistics/article/meaning-metaphor-and-argument-structure/370553D7209AA986F0407D944DB5DBA4>

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## Nature Scientific Reports

### PAPERS

#### **KATARZYNA BOBROWICZ, MIKAEL JOHANSSON & MATHIAS OSVATH – Great apes selectively retrieve relevant memories to guide action**

Memory allows us to draw on past experiences to inform behaviour in the present. However, memories rarely match the situation at hand exactly, and new situations regularly trigger multiple related memories where only some are relevant to act



upon. The flexibility of human memory systems is largely attributed to the ability to disregard irrelevant, but salient, memories in favour of relevant ones. This is considered an expression of an executive function responsible for suppressing irrelevant memories, associated with the prefrontal cortex. It is unclear to what extent animals have access to this ability. Here, we demonstrate, in a series of tool-use tasks designed to evoke conflicting memories, that chimpanzees and an orangutan suffer from this conflict but overcome it in favour of a more relevant memory. Such mnemonic flexibility is among the most advanced expressions of executive function shown in animals to date and might explain several behaviours related to tool-use, innovation, planning and more.

<https://www.nature.com/articles/s41598-020-69607-6>

#### **T. JONATHAN DAVIES et al – Savanna tree evolutionary ages inform the reconstruction of the paleoenvironment of our hominin ancestors**

Ideas on hominin evolution have long invoked the emergence from forests into open habitats as generating selection for traits such as bipedalism and dietary shifts. Though controversial, the savanna hypothesis continues to motivate research into the palaeo-environments of Africa. Reconstruction of these ancient environments has depended heavily on carbon isotopic analysis of fossil bones and palaeosols. The sparsity of the fossil record, however, imposes a limit to the strength of inference that can be drawn from such data. Time-calibrated phylogenies offer an additional tool for dating the spread of savanna habitat. Here, using the evolutionary ages of African savanna trees, we suggest an initial tropical or subtropical expansion of savanna between 10 and 15 Ma, which then extended to higher latitudes, reaching southern Africa ca. 3 Ma. Our phylogenetic estimates of the origin and latitudinal spread of savannas broadly correspond with isotopic age estimates and encompass the entire hominin fossil record. Our results are consistent with the savanna hypothesis of early hominin evolution and reignite the debate on the drivers of savanna expansion. Our analysis demonstrates the utility of phylogenetic proxies for dating major ecological transitions in geological time, especially in regions where fossils are rare or absent or occur in discontinuous sediments.

<https://www.nature.com/articles/s41598-020-69378-0>

#### **ALAIN GOVAERT & MING CAO – Strategically influencing an uncertain future**

Many of today's most pressing societal concerns require decisions which take into account a distant and uncertain future. Recent developments in strategic decision-making suggest that individuals, or a small group of individuals, can unilaterally influence the collective outcome of such complex social dilemmas. However, these results do not account for the extent to which decisions are moderated by uncertainty in the probability or timing of future outcomes that characterise the valuation of a (distant) uncertain future. Here we develop a general framework that captures interactions among uncertainty, the resulting time-inconsistent discounting, and their consequences for decision-making processes. In deterministic limits, existing theories can be recovered. More importantly, new insights are obtained into the possibilities for strategic influence when the valuation of the future is uncertain. We show that in order to unilaterally promote and sustain cooperation in social dilemmas, decisions of generous and extortionate strategies should be adjusted to the level of uncertainty. In particular, generous payoff relations cannot be enforced during periods of greater risk (which we term the "generosity gap"), unless the strategic enforcer orients their strategy towards a more distant future by consistently choosing "selfless" cooperative decisions; likewise, the possibilities for extortion are directly limited by the level of uncertainty. Our results have implications for policies that aim to solve societal concerns with consequences for a distant future and provides a theoretical starting point for investigating how collaborative decision-making can help solve long-standing societal dilemmas.

<https://www.nature.com/articles/s41598-020-69006-x>

#### **AYAKA SUGIURA et al – Neural dynamics during the vocalization of 'uh' or 'um'**

People occasionally use filler phrases or pauses, such as "uh", "um", or "y'know," that interrupt the flow of a sentence and fill silent moments between ordinary (non-filler) phrases. It remains unknown which brain networks are engaged during the utterance of fillers. We addressed this question by quantifying event-related cortical high gamma activity at 70–110 Hz. During extraoperative electrocorticography recordings performed as part of the presurgical evaluation, patients with drug-resistant focal epilepsy were instructed to overtly explain, in a sentence, 'what is in the image (subject)', 'doing what (verb)', 'where (location)', and 'when (time)'. Time–frequency analysis revealed that the utterance of fillers, compared to that of ordinary words, was associated with a greater magnitude of high gamma augmentation in association and visual cortex of either hemisphere. Our preliminary results raise the hypothesis that filler utterance would often occur when large-scale networks across the association and visual cortex are engaged in cognitive processing, including lexical retrieval as well as verbal working memory and visual scene scanning.

<https://www.nature.com/articles/s41598-020-68606-x>

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## PLoS Biology

### PAPERS

#### **LEA ROUMAZEILLES et al – Longitudinal connections and the organization of the temporal cortex in macaques, great apes, and humans**

*This is an uncorrected proof.*

The temporal association cortex is considered a primate specialization and is involved in complex behaviors, with some, such as language, particularly characteristic of humans. The emergence of these behaviors has been linked to major differences in temporal lobe white matter in humans compared with monkeys. It is unknown, however, how the organization of the temporal lobe differs across several anthropoid primates. Therefore, we systematically compared the organization of the major temporal lobe white matter tracts in the human, gorilla, and chimpanzee great apes and in the macaque monkey. We show that humans and great apes, in particular the chimpanzee, exhibit an expanded and more complex occipital–temporal white matter system; additionally, in humans, the invasion of dorsal tracts into the temporal lobe provides a further specialization. We demonstrate the reorganization of different tracts along the primate evolutionary tree, including distinctive connectivity of human temporal gray matter.

<https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3000810>

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## PLoS One

### PAPERS

#### **OLGA A. FILATOVA – Independent acoustic variation of the higher- and lower-frequency components of biphonic calls can facilitate call recognition and social affiliation in killer whales**

Each resident-type (R-type) killer whale pod has a set of stereotyped calls that are culturally transmitted from mother to offspring. The functions of particular call types are not yet clearly understood, but it is believed that calls with two independently modulated frequency components (biphonic calls) play an important role in pod communication and cohesion at long ranges. In this study we examined the possible functions of biphonic calls in R-type killer whales. First, we tested the hypothesis that the additional component enhances the potential of a call to identify the family affiliation. We found that the similarity patterns of the lower- and higher frequency components across the families were largely unrelated. Calls were classified more accurately to their respective family when both lower- and higher-frequency components were considered. Second, we tested the long-range detectability of the lower- and higher-frequency components. After adjusting the received levels by the killer whale hearing sensitivity to different frequency ranges, the sensation level of the higher-frequency component was higher than the amplitude of the lower-frequency component. Our results suggest that the higher-frequency component of killer whale biphonic calls varies independently of the lower-frequency component, which enhances the efficiency of these calls as family markers. The acoustic variation of the higher-frequency component allows the recognition of family identity of a caller even if the shape of the lower-frequency component accidentally becomes similar in unrelated families. The higher-frequency component can also facilitate family recognition when the lower-frequency component is masked by low-frequency noise.

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0236749>

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## PNAS

### PAPERS

#### **MARTIN I. SERENO et al – The human cerebellum has almost 80% of the surface area of the neocortex**

The surface of the human cerebellar cortex is much more tightly folded than the cerebral cortex. It was computationally reconstructed for the first time to the level of all individual folia from multicontrast high-resolution postmortem MRI scans. Its total shrinkage-corrected surface area (1,590 cm<sup>2</sup>) was larger than expected or previously reported, equal to 78% of the total surface area of the human neocortex. The unfolded and flattened surface comprised a narrow strip 10 cm wide but almost 1 m long. By applying the same methods to the neocortex and cerebellum of the macaque monkey, we found that its cerebellum was relatively much smaller, approximately 33% of the total surface area of its neocortex. This suggests a prominent role for the cerebellum in the evolution of distinctively human behaviors and cognition.

<https://www.pnas.org/content/early/2020/07/27/2002896117.abstract?etoc>

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## Proceedings of the Royal Society B

### PAPERS

#### **ROBIN E. MORRISON et al – Comparing measures of social complexity: larger mountain gorilla groups do not have a greater diversity of relationships**

Social complexity reflects the intricate patterns of social interactions in societies. Understanding social complexity is fundamental for studying the evolution of diverse social systems and the cognitive innovations used to cope with the demands of social life. Social complexity has been predominantly quantified by social unit size, but newer measures of social complexity reflect the diversity of relationships. However, the association between these two sets of measures remains unclear. We used 12 years of data on 13 gorilla groups to investigate how measures of social complexity relate to each other. We found that group size was a poor proxy for relationship diversity and that the social complexity individuals experienced within the same group varied greatly. Our findings demonstrate two fundamental takeaways: first, that the number of

relationships and the diversity of those relationships represent separate components of social complexity, both of which should be accounted for; and second, that social complexity measured at the group level may not represent the social complexity experienced by individuals in those groups. These findings suggest that comprehensive studies of social complexity, particularly those relating to the social demands faced by individuals, may require fine-scale social data to allow accurate comparisons across populations and species.

<https://royalsocietypublishing.org/doi/full/10.1098/rspb.2020.1026>

### **NICCOLÒ PESCELELLI & NICK YEUNG – The effects of recursive communication dynamics on belief updating**

Many social interactions are characterized by dynamic interplay, such that individuals exert reciprocal influence over each other's behaviours and beliefs. The present study investigated how the dynamics of reciprocal influence affect individual beliefs in a social context, over and above the information communicated in an interaction. To this end, we developed a simple social decision-making paradigm in which two people are asked to make perceptual judgments while receiving information about each other's decisions. In a Static condition, information about the partner only conveyed their initial, independent judgment. However, in a Dynamic condition, each individual saw the evolving belief of their partner as they learnt about and responded to the individual's own judgment. The results indicated that in both conditions, the majority of confidence adjustments were characterized by an abrupt change followed by smaller adjustments around an equilibrium, and that participants' confidence was used to arbitrate conflict (although deviating from Bayesian norm). Crucially, recursive interaction had systematic effects on belief change relative to the static baseline, magnifying confidence change when partners agreed and reducing confidence change when they disagreed. These findings indicate that during dynamic interactions—often a characteristic of real-life and online social contexts—information is collectively transformed rather than acted upon by individuals in isolation. Consequently, the output of social events is not only influenced by what the dyad knows but also by predictable recursive and self-reinforcing dynamics.

<https://royalsocietypublishing.org/doi/10.1098/rspb.2020.0025>

### **YIN WU et al – Exogenous testosterone increases the audience effect in healthy males: evidence for the social status hypothesis**

Several studies have implicated testosterone in the modulation of altruistic behaviours instrumental to advancing social status. Independent studies have also shown that people tend to behave more altruistically when being watched (i.e. audience effect). To date, little is known about whether testosterone could modulate the audience effect. In the current study, we tested the effect of testosterone on altruistic behaviour using a donation task, wherein participants were asked to either accept or reject a monetary transfer to a charity organization accompanying a personal cost either in the presence or absence of an observer. We administered testosterone gel or placebo to healthy young men ( $n = 140$ ) in a double-blind, placebo-controlled, mixed design. Our results showed that participants were more likely to accept the monetary transfer to the charity when being observed compared to when they completed the task alone. More importantly, this audience effect was amplified among people receiving testosterone versus placebo. Our findings suggest that testosterone administration increases the audience effect and further buttress the social status hypothesis, according to which testosterone promotes status-seeking behaviour in a context-dependent manner.

<https://royalsocietypublishing.org/doi/full/10.1098/rspb.2020.0976>

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## Royal Society Open Science

### PAPERS

#### **M. JUSUP et al – Behavioural patterns behind the demise of the commons across different cultures**

Common-pool resources require a dose of self-restraint to ensure sustainable exploitation, but this has often proven elusive in practice. To understand why, and characterize behaviours towards ecological systems in general, we devised a social dilemma experiment in which participants gain profit from harvesting a virtual forest vulnerable to overexploitation. Out of 16 Chinese and 15 Spanish player groups, only one group from each country converged to the forest's maximum sustainable yield. All other groups were overzealous, with about half of them surpassing or on the way to surpass a no-recovery threshold. Computational–statistical analyses attribute such outcomes to an interplay between three prominent player behaviours, two of which are subject to decision-making 'inertia' that causes near blindness to the resource state. These behaviours, being equally pervasive among players from both nations, imply that the commons fall victim to behavioural patterns robust to confounding factors such as age, education and culture.

<https://royalsocietypublishing.org/doi/full/10.1098/rsos.201026>

#### **WILLIAM AMOS – Signals interpreted as archaic introgression appear to be driven primarily by faster evolution in Africa**

Non-African humans appear to carry a few per cent archaic DNA due to ancient inter-breeding. This modest legacy and its likely recent timing imply that most introgressed fragments will be rare and hence will occur mainly in the heterozygous state. I tested this prediction by calculating D statistics, a measure of legacy size, for pairs of humans where one of the pair was conditioned always to be either homozygous or heterozygous. Using coalescent simulations, I confirmed that conditioning the non-African to be heterozygous increased D, while conditioning the non-African to be homozygous reduced D to zero. Repeating with real data reveals the exact opposite pattern. In African–non-African comparisons, D is near-zero if the African individual is held homozygous. Conditioning one of two Africans to be either homozygous or heterozygous

invariably generates large values of D, even when both individuals are drawn from the same population. Invariably, the African with more heterozygous sites (conditioned heterozygous > unconditioned > conditioned homozygous) appears less related to the archaic. By contrast, the same analysis applied to pairs of non-Africans always yields near-zero D, showing that conditioning does not create large D without an underlying signal to expose. Large D values in humans are therefore driven almost entirely by heterozygous sites in Africans acting to increase divergence from related taxa such as Neanderthals. In comparison with heterozygous Africans, individuals that lack African heterozygous sites, whether non-African or conditioned homozygous African, always appear more similar to archaic outgroups, a signal previously interpreted as evidence for introgression. I hope these analyses will encourage others to consider increased divergence as well as increased similarity to archaics as mechanisms capable of driving asymmetrical base-sharing.

<https://royalsocietypublishing.org/doi/full/10.1098/rsos.191900>

### **ELIZABETH V. LONSDORF et al – Why chimpanzees carry dead infants: an empirical assessment of existing hypotheses**

The study of non-human primate thanatology has expanded dramatically in recent years as scientists seek to understand the evolutionary roots of human death concepts and practices. However, observations of how conspecifics respond to dead individuals are rare and highly variable. Mothers of several species of primate have been reported to carry and continue to interact with dead infants. Such interactions have been proposed to be related to maternal condition, attachment, environmental conditions or reflect a lack of awareness that the infant has died. Here, we tested these hypotheses using a dataset of cases of infant corpse carrying by chimpanzees in Gombe National Park, Tanzania (n = 33), the largest dataset of such cases in chimpanzees. We found that mothers carried infant corpses at high rates, despite behavioural evidence that they recognize that death has occurred. Median duration of carriage was 1.83 days (interquartile range = 1.03–3.59). Using an information theoretic approach, we found no support for any of the leading hypotheses for duration of continued carriage. We interpret these data in the context of recent discussions regarding what non-human primates understand about death.

<https://royalsocietypublishing.org/doi/full/10.1098/rsos.200931>

### **JELENA GRUJIĆ & TOM LENAERTS – Do people imitate when making decisions? Evidence from a spatial Prisoner's Dilemma experiment**

How do people decide which action to take? This question is best answered using Game Theory, which has proposed a series of decision-making mechanisms that people potentially use. In network simulations, wherein games are repeated and pay-off differences can be observed, those mechanisms often rely on imitation of successful behaviour. Surprisingly, little to no evidence has been provided about whether people actually imitate more successful opponents when altering their actions in that context. By comparing two experimental treatments wherein participants play the iterated Prisoner's Dilemma game in a lattice, we aim to answer whether more successful actions are imitated. While in the first treatment, participants have the possibility to use pay-off differences in making their decision, the second treatment hinders such imitation as no information about the gains is provided. If imitation of the more successful plays a role then there should be a difference in how players switch from cooperation to defection between both treatments. Although, cooperation and pay-off levels do not appear to be significantly different between both treatments, detailed analysis shows that there are behavioural differences: when confronted with a more successful co-player, the focal player will imitate her behaviour as the switching is related to the experienced pay-off inequality.

<https://royalsocietypublishing.org/doi/full/10.1098/rsos.200618>

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## Science

### ARTICLES

#### **SAM KEAN – This man can read letters but numbers are a blank**

In the video, the man sounds creeped out. "This is too strange for words," he mutters. He's holding a plate-size, green foam 8. When upright, it looks to him like an incoherent jumble. But when he rotates it 90°, the shape snaps into focus; it looks like "a mask." He begins to rotate the numeral back and forth, watching it melt and cohere over and over. He finally hands it to a nearby scientist, saying, "You gotta take that away."

<https://science.sciencemag.org/content/369/6503/494>

#### **COLETTE DEHAY & HENRY KENNEDY – Evolution of the human brain**

Since early hominids emerged 5 million years ago, humans have evolved sizable brains to support higher cognitive functions. In particular, the human cerebral cortex is greatly expanded, allowing accommodation of the evolutionary increases in the number of cortical areas, the functional modules that subserve perception, attention, motor control, cognition, memory, and learning. Duplicated genes specific to the Homo lineage have played key roles in human speciation, particularly in the development of the highly complex human brain and the circuits of the cerebral cortex. On page 546 of this issue, Heide et al. identify ARHGAP11B [Rho guanosine triphosphatase (GTPase) activating protein 11B], a human-specific duplicated gene, as a regulator of human cerebral cortex development. By expressing ARHGAP11B in marmosets, a smooth-brained primate, this study explores the influence of the gene on expansion of the primate cortex.

<https://science.sciencemag.org/content/369/6503/506>

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## Science Advances

### PAPERS

#### **DAVID J. NASH et al – Origins of the sarsen megaliths at Stonehenge**

The sources of the stone used to construct Stonehenge around 2500 BCE have been debated for over four centuries. The smaller “bluestones” near the center of the monument have been traced to Wales, but the origins of the sarsen (silcrete) megaliths that form the primary architecture of Stonehenge remain unknown. Here, we use geochemical data to show that 50 of the 52 sarsens at the monument share a consistent chemistry and, by inference, originated from a common source area. We then compare the geochemical signature of a core extracted from stone 58 at Stonehenge with equivalent data for sarsens from across southern Britain. From this, we identify West Woods, Wiltshire, 25 km north of Stonehenge, as the most probable source area for the majority of sarsens at the monument.

[https://advances.sciencemag.org/content/6/31/eabc0133?utm\\_campaign=toc\\_advances\\_2020-07-31&et rid=17774313&et cid=3430735](https://advances.sciencemag.org/content/6/31/eabc0133?utm_campaign=toc_advances_2020-07-31&et rid=17774313&et cid=3430735)

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## Trends in Cognitive Sciences

### PAPERS

#### **PATRICIA L. LOCKWOOD, MATTHEW A.J. APPS & STEVE W.C. CHANG – Is There a ‘Social’ Brain? Implementations and Algorithms**

A fundamental question in psychology and neuroscience is the extent to which cognitive and neural processes are specialised for social behaviour, or are shared with other ‘non-social’ cognitive, perceptual, and motor faculties. Here we apply the influential framework of Marr (1982) across research in humans, monkeys, and rodents to propose that information processing can be understood as ‘social’ or ‘non-social’ at different levels. We argue that processes can be socially specialised at the implementational and/or the algorithmic level, and that changing the goal of social behaviour can also change social specificity. This framework could provide important new insights into the nature of social behaviour across species, facilitate greater integration, and inspire novel theoretical and empirical approaches.

[https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613\(20\)30168-6?dgcid=raven\\_jbs\\_aip\\_email](https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613(20)30168-6?dgcid=raven_jbs_aip_email)

#### **FRIEDEMANN PULVERMÜLLER & LUIGI GRISONI – Semantic Prediction in Brain and Mind**

We highlight a novel brain correlate of prediction, the prediction potential (or PP), a slow negative-going potential shift preceding visual, acoustic, and spoken or written verbal stimuli that can be predicted from their context. The cortical sources underlying the prediction potential reflect perceptual and semantic features of anticipated stimuli before these appear.

[https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613\(20\)30171-6?dgcid=raven\\_jbs\\_aip\\_email](https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613(20)30171-6?dgcid=raven_jbs_aip_email)

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## Trends in Ecology and Evolution

### PAPERS

#### **VALÉRIA ROMANO, ANDREW J.J. MACINTOSH & CÉDRIC SUEUR – Stemming the Flow: Information, Infection, and Social Evolution**

Social information and socially transmitted pathogens are governed by social structure, and also shape social interactions. However, information and infection are rarely investigated as interactive factors driving social evolution. We propose exactly such an integrative framework, drawing attention to mechanisms of social phenotypic plasticity for information spread and pathogen control.

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## Trends in Neurosciences

### PAPERS

#### **ILYA E. MONOSOV – How Outcome Uncertainty Mediates Attention, Learning, and Decision-Making**

Animals and humans evolved sophisticated nervous systems that endowed them with the ability to form internal-models or beliefs and make predictions about the future to survive and flourish in a world in which future outcomes are often uncertain. Crucial to this capacity is the ability to adjust behavioral and learning policies in response to the level of uncertainty. Until recently, the neuronal mechanisms that could underlie such uncertainty-guided control have been largely unknown. In this review, I discuss newly discovered neuronal circuits in primates that represent uncertainty about future rewards and propose how they guide information-seeking, attention, decision-making, and learning to help us survive in an uncertain world. Lastly, I discuss the possible relevance of these findings to learning in artificial systems.

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