anthropogeny tracks
a CARTA newsletter
Volume 3, Issue 1 - February 2015

Next CARTA Symposium Addresses Language Evolution

On February 20, 2015, international and local San Diego language experts will explore **How Language Evolves** as part of CARTA's continuing human origins symposium series.

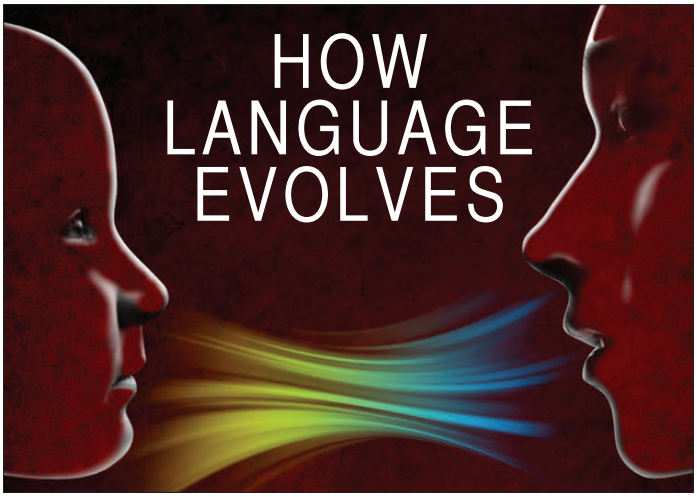
Free and open to the public, **How Language Evolves** will address the question of how human language came to have the kind of structure it has, focusing on three sources of evidence:

- Ways languages get new structure not present in the language of the previous generation(s) of speakers or signers;
- What contrasts between new and mature languages reveal about how language evolves;
- Neuroscientific investigations of functional specialization for language in the human brain and its dependence on the linguistic input the language learner gets during cognitive development.

This CARTA symposium is made possible by **The G. Harold and Leila Y. Mathers Charitable Foundation.**

Symposium Details

- Friday, February 20, 1:00 - 5:30 p.m., Pacific
- Hojel Auditorium, Institute of the Americas, UC San Diego
- Free and open to the public, however registration is required
- Live webcast
- For more information or to register, visit: http://carta.anthropogeny.org/events/how-language-evolves



The fantastic lineup of speakers includes:

HOW LANGUAGES GET NEW STRUCTURE

Language Evolution in the Lab: The Emergence of Design Features
Simon Kirby, University of Edinburgh

Contact Languages and Light Warlpiri
Carmel O'Shannessy, University of Michigan

Rethinking Recapitulation: Sources of Structure in Nicaraguan Sign Language
Ann Senghas, Barnard College

CONTRASTS BETWEEN NEW AND MATURE LANGUAGES

Co-Emergence of Meaning and Structure in a New Language
Mark Aronoff, Stony Brook University

Combinatoriality within the Word: Sign Language Evidence
David Perlmutter, UC San Diego

What Can You Say without Syntax?
Ray Jackendoff, Tufts University

LANGUAGE IN THE BRAIN

Specialization for Language in the Human Brain
Evelina Fedorenko, Massachusetts General Hospital

How the Environment Shapes Language in the Brain
Rachel Mayberry, UC San Diego

Neuroscience of Speech Perception and Speech Production
Edward Chang, UC San Francisco

Center for Academic Research and Training in Anthropogeny
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Reflections From Tanzania: 2014 Anthropogeny Field Course

2014 Anthropogeny Field Course participants, left to right: Kiri Hagerman, Andrew Schork, Corinna Most, Stephen Johnston, Caroline Horton, Sequoyah Reynoso.

For three weeks spanning late August to early September, six Anthropogeny Specialization students embarked on a once-in-a-lifetime learning experience in Ethiopia and Tanzania as participants in the 2014 Anthropogeny Field Course (only available to Specialization students). Led by Dr. Pascal Gagneux (Associate Director, CARTA) and Dr. Fiona Stewart (president, Anthropogeny Research Group), the students travelled to East Africa to explore human origins research in person, in the field, and with experts on human evolution.

The field tour began at the National Museum in Addis Ababa, Ethiopia where CARTA member Dr. Berhane Asfaw (director, Rift Valley Research Service) presented important Ethiopian hominin fossils spanning over 4 million years, including the original Ardi (*A. ramidus*), Lucy (*A. afarensis*), Bodo skull (*H. heidelbergensis*), and the oldest complete modern human cranium (Herto man). CARTA member Dr. Gen Suwa and his team showed the group a collection of stone tools, including some over a million years old.

In Tanzania, students visited Ngorongoro Crater and the nearby Serengeti, ecosystems with wildlife densities early man would have encountered daily. This was followed by a session in Olduvai Gorge, Tanzania, where many hominin fossils and artifacts are found yearly.

From there, the group drove to the shore of Lake Eyasi to visit the Hadza, one of the rare traditional foraging societies. Students interacted with tribe members and followed their daily activities to learn about their way of life through gathering and hunting alone in a harsh landscape.

Lastly, the students visited two chimpanzee field sites: the forested Gombe Stream National Park, Jane Goodall's research center, and Issah Valley at Ugalla, where chimpanzees live in wooded savannah not unlike the ecosystem in which Ardi had lived over 4 million years ago.

The following brief reflections, written by the students, capture different aspects of the field course.

The field course made stops at Olduvai, Ngorongoro, Hadza Land, Gombe, and Ugalla. Image: www.imagineafrica.com

Hominid Exploitation of Resource Zones

Kiri Hagerman, Anthropology

When we talk of early hominid evolution or early human behavior, we tend to speak in monolithic terms, no doubt for the sake of simplicity. An excellent example of this happening is in discussions of the origins of bipedalism in hominins, where the environment in general, and climatic changes in particular, are often pointed to as catalysts for the origin of this form of locomotion. The anthropogeny field course made me realize that to continue thinking in such simplified terms is probably incorrect and definitely over simplistic. It seems likely that different groups of contemporaneous hominids were simultaneously occupying and exploiting a wide range of different environmental zones on the African landscape, just as modern chimpanzees are taking advantage of multiple resource zones within their territory and cohabitating with other primate species. If the environment of the Miocene and Pliocene—despite the climatic changes that were occurring—exhibited even a modest degree of the variation present today, then I believe it is reasonable to expect that our ancestors were probably exploiting many different resource zones at a time.

Above: Students examined the original 4.4 million year old Ardipithecus ramidus fossils at the National Museum in Addis Ababa, Ethiopia.

Left: Kiri listens intently as Dr. Berhane Asfaw describes a hand axe in the archives of the National Museum.

Models of Social Structure and Warfare

Corinna Most, Anthropology

The second part of the trip dealt with living models of human evolution: the Hadza, modern hunter-gatherers whose lifestyle is probably the closest modern approximation of our species' predominant way of life for most of its evolutionary history, and chimpanzees, our closest living relatives (together with bonobos). Both represent models of social structure that are more fluid than we are used to in our own cultures, although our lifestyles are also marked by flexible associations with other people (our families, our friends, our coworkers) that shift both in the short- and the long-term. Chimpanzees display 'fission-fusion' social dynamics whereby the larger community splits off into smaller groups, which tend to aggregate at night and then separate when foraging during the day. This apparent lack of a strict social structure doesn't translate when it comes to inter-community relationships. On the contrary, chimpanzees display the behaviors that come closest to what can be considered human-like warfare and, in fact, these were first witnessed at Gombe, one of the sites we visited. Here, Kasekela, the primary study community of chimpanzees, systematically exterminated a splinter group over the course of 4 years. The 'war-like' behavior – since witnessed at other chimpanzee sites and recently officially confirmed as part of the natural suite of chimpanzee behaviors rather than a pathological response to human presence – included not just brutal killings of foreign males, but also border patrols, kidnapping of females, and infanticide.

Corinna (left) and Andrew (right) shoot arrows.

Corinna examines a Hadza dwelling.

Fanny, a chimpanzee, and her day-old infant.

The Ecology of Human Evolution

Andrew Schork,
Cognitive Science

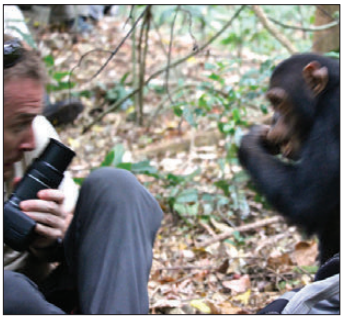
In our three weeks, we saw at least five different landscapes that varied with respect to topology, elevation, vegetation, density and diversity of animals and plants, access to water, richness of resources, etc.

Having spent hours crawling, twisting, clawing and climbing through the forests of Gombe and the gallery forests in Ugalla, I feel comfortable stating that modern humans are not well adapted to forest life. It was impossible to move with the efficiency and speed of the chimpanzees. Our upright posture makes for awkward contorting through underbrush, our hairless fragile skin catches and tears, and our limbs are not well suited to take advantage of the vertical dimension.

The last common ancestor between humans and chimpanzees is thought to be morphologically more chimpanzee-like than human-like, suggesting a continuity of this forest niche for the chimpanzees but not the first hominins.

As such, I like the idea that early hominins were the losers in a competition for shrinking Gombe-like forests sparked by increasing desiccation.

Faced with the choice to fight or flee, these first hominins fled to the margins, into the harsher and sparser woodland savannahs best represented in Ugalla.



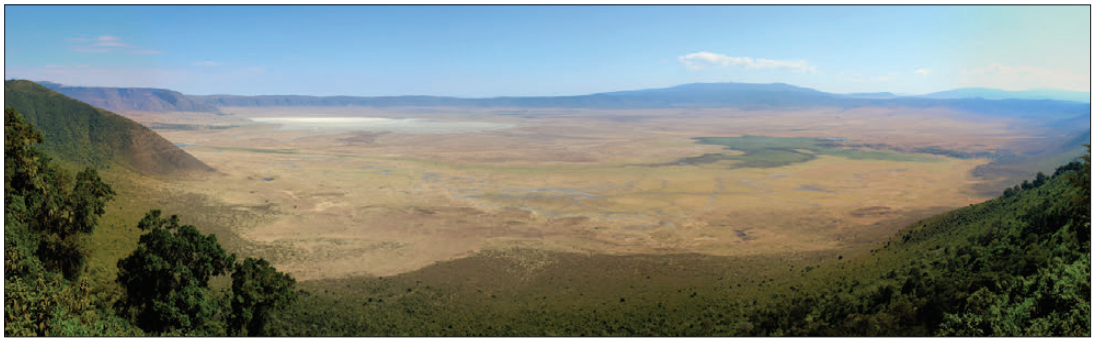
Andrew gets an unexpected visit from a curious chimpanzee in Gombe, perhaps reenacting the hominin/chimpanzee "fight or flee" scenario as described above.

Issa Valley in Ugalla Area of Southeastern Tanzania. *Images courtesy of A. Schork.*

Gombe Stream National Park on eastern shore of Lake Tanganika.

Yaeda, overlooking Lake Eyasi to the west.

Olduvai Gorge with Serengeti plain in the background.



Ngorongoro Crater, encompassing 10 to 12 square miles (16 to 19 sq km) across, is home to thousands of large mammals.

Niche Construction

Stephen Johnston, Neuroscience

Humans evolved in ecosystems of environmental fluctuation rather than a particular geographic niche. We adapted to variability itself and excel regardless of niche. This impact often goes unnoticed: roads across the Serengeti, farms tiling any swath of fertile land, and cleared forests starkly demark artificial geographic boundaries and human developments. Humans have a profound capacity to mold their environment to match their needs, and in doing so construct their own niches. When in our family tree this capacity developed, however, remains unclear.

Technology and tool use were key in the transition from a chimpanzee-like lifestyle in forests, such as Gombe and Ugalla, to modern human societies. However, it's easy to see how a lifestyle of hunting and gathering, adapted to highly variable ecosystems, even without the use of tools, served as a seminal event in human evolution. Early hominins began cooking their food, which in turn allowed for a reduction in tooth and gut size in favor of an over-embellished brain. However, the adaptation of early humans to highly variable ecosystems is still a far cry from the profound niche construction of industrialized man.

The Hadza, as pre-pastoralist peoples, lie on the border of active niche construction and passive participation in the ecosystem. Dietary needs are primarily met through seasonally available foods with little planning for times of scarcity. Minor intentional niche modifications are present to ease resource collection—beehives and tuber sites are sustainably harvested, baobab act as water cisterns—however, other passively sewn foodstuffs along footpaths or popular encampments hardly represent intentional niche construction. Chimpanzees, birds, and other animals similarly benefit from passive niche construction. The difference is intent. Sedentary agriculture is an obvious demonstration that humans long ago mastered. Humans utilize this capacity to relax evolutionary pressure and fuel our own expansion with massive impact on global ecosystems. We externalize adaptive structures outside our own biology, instead of speciating into local niches. By adapting the niche to us, we exert some control over our own evolution.

Examples of increasing niche construction (clockwise from top):

Passive seed dispersal by a red-tailed monkey.

Active alteration by chimpanzees leads to incidental future nest use (Steven posing next to the nest).

A primitive bee hive (with a rock to limit access by animals) as a food store.

Full niche development.

Global niche constructions (Image: Earth at Night, Nasa, http://apod.nasa.gov/apod/ap001127.html).

Left: After a lesson on hunter-gather technology, Caroline whittles an arrow shaft stabilized with her toes.

Below: On the way to Gombe Stream National Park via boat, human impact, especially deforestation of the surrounding hills, is readily apparent.

Environmental Influence on the Evolution of Human Cognition

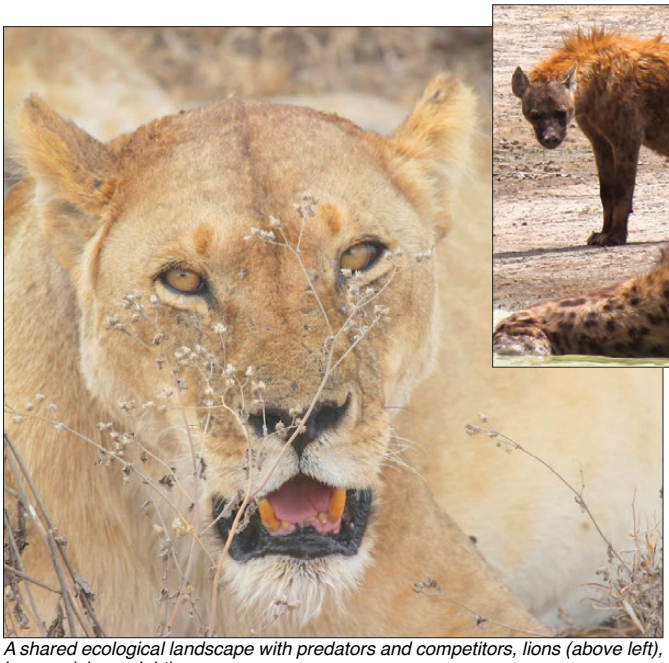
Caroline Horton, Anthropology

The CARTA Anthropogeny Field Course was an amazing experience that has greatly impacted my understanding of human origins. As a biological anthropologist, my primary research interests are focused on the relationship between evolutionary shifts in the human brain and the emergence of human cognition. However, it was not until our experiences in Tanzania that I truly appreciated the importance of adaptation to the environment in the evolution of human cognition and the brain. The value of cognitive ability was made apparent by observing the creativity and innovation the Hadza employ to meet basic needs in their harsh environment. And in the extreme, the effects of human intrusion and deforestation of the regions surrounding Gombe National Park are bringing rapid changes to the environment, which are influencing the survival strategies of affected chimpanzee and even human communities. I will continue to reflect on my experiences from the trip as I ponder the evolutionary implications of my research findings, and the possible forces behind important shifts in human neuroanatomy and cognition.

Inter-Species Competition

Sequoyah Reynoso, Neuroscience

In the past, hominins would share landscapes like Ngorongoro Crater with formidable predators like lions and hyenas. I could see how the presence of these stronger, faster competitors would pressure hominins into a cognitive niche in order to survive. Without technology, hominins would have little chance to defend against the savage might of a lion. The chimpanzees at Gombe had taken an intermediate route, possessing both strength and intelligence. Despite their diminutive stature, the chimps could let loose sudden, disorienting screams that left you feeling tiny and inconsequential. One moment the troop would sit serenely while an infant nursed; the next, a piloerect alpha would transform the tranquility into chaos.

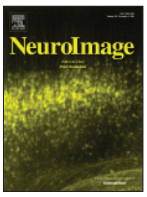


A shared ecological landscape with predators and competitors, lions (above left), hyenas (above right).

Finding elusive savannah chimpanzees in Ugalla: Sequoyah (foreground and left) and Pascal examine footage from a camera trap. Interestingly, the footage was recorded less than ten minutes before the team arrived.

CARTA-Inspired Publications

Transdisciplinary interaction is at the core of CARTA's mission to advance human origins research. CARTA symposia provide a forum for experts from vastly different fields to share knowledge and work together to spark new research. The following is a selection of publications inspired by interactions amongst CARTA members (**in bold**) and facilitated by CARTA. (Complete list at the CARTA website.)



Autrey, M.M., Reamer, L.A., Mareno, M.C., **Sherwood, C.C.**, Herndon, J.G., **Preuss, T.**, Schapiro, S.J., **Hopkins, W.D**. Age-related effects in the neocortical organization of chimpanzees: Gray and white matter volume, cortical thickness, and gyrification. *Neuroimage*. 2014; 101C:59–67.

Humans exhibit more marked declines in brain structure beginning in middle age than do other primates that have been studied, although data for old chimpanzees have been limited. The present study included 38 old chimpanzees (≥40 years), and indicates they experience only modest age-related decline. This highlights the unusual life history of humans, with an extended period of late adulthood.

Ayala, F.J. Human evolution. Whence and whither? In: Thompson, R.P., Walsh, D., eds. *Evolutionary Biology: Conceptual, Ethical, and Religious Issues*. Cambridge: Cambridge University Press; 2014:13–28.

Mankind has evolved from species that were not human. Our closest living relatives are the chimpanzees. Erect posture and a large brain are two distinctive human anatomical traits. But, humans are notably different in their behavioral traits, which include exalted intelligence; self-awareness and death awareness, symbolic language, technology, science, literature and art, ethics and

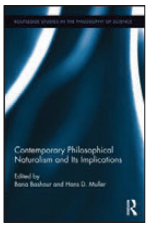
Cela-Conde, C.J., **Ayala, F.J.** Brain keys in the appreciation of beauty: a tale of two worlds. *Rendiconti Lincei.* 2014; 25(3):277–284.

Two worlds: a metaphor for the barriers between the subjective appreciation of beauty and the objective analysis of brain activity. Aesthetic perception may not have evolved because of its adaptive advantage, but benefits from evolved cognitive characteristics. Once evolved, the capacity for beauty appreciation adds adaptive advantages. Aesthetic perception activates brain regions linked to executive functions.

Davidson, I. Marks on an ancient shell lead to a re-think of human history. *The Conversation*. 2014; Dec. 3. Retrieved from: https://theconversation.com

Scratch marks were recently discovered on a mussel shell from Java found more than a hundred years ago. The shell had three groups of scratches, one of them in the form of a carefully made zig-zag. If it was really contemporary with the *Homo erectus* remains from the site, it may indicate the hominin was making patterned, conventional marks. There may be more such finds hidden in old collections.

CARTA-Inspired Publications, Continued

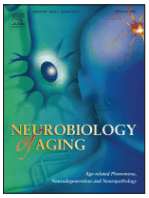


Dennett, D.C. The Evolution of Reasons. In: Bashour, B., Muller, H.D., eds. *Contemporary Philosophical Naturalism and Its Implications*. London: Routledge; 2014:47–62.

Natural selection brings purpose to life, without itself having a purpose. The transition from "why" in the sense of "how come?" to "why" in the sense of "what for?" is, like all things Darwinian, gradual. We can no more identify a first moment when something had a purpose than we can identify the first mammal. But, reasons do exist, and existed long before there were reasoners (in much the way the atomic number of gold was 79 long before anybody did arithmetic).

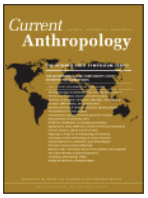
Erwin, J.A., Marchetto, M.C., **Gage, F.H.** Mobile DNA elements in the generation of diversity and complexity in the brain. *Nat Rev Neurosci*. 2014; 15(8):497–506.

Mobile elements are DNA sequences that change their position within the genome and shape genome evolution. Their rates of movement differ in human and non-human primates, which may have resulted in less human diversity. Also, mobile elements move during brain development, thereby creating genomic diversity between neurons. Misregulated mobile elements may contribute to neurological disorders.



Finch, C.E., Austad, S.N. Commentary: is Alzheimer's disease uniquely human? *Neurobiol Aging*. 2014; In-Press.

Alzheimer's disease may be unique to humans. Careful studies of brains from aging great apes show that none of the oldest brains examined show the devastating loss of neurons or other changes of Alzheimer's disease. While humans evolved the longest lifespan of any primate, this benefit travels with the bad baggage of a new disease of aging that may afflict 50% of us who chance to reach age 90.



Gintis, H., **van Schaik, C.**, and **Boehm, C**. Zoon Politikon: The Evolutionary Origins of Human Political Systems. *Current Anthropology*. 2014; In-Press.

The development of lethal weapons by early humans undermined authority based on physical prowess and gave an evolutionary advantage to individuals with expert communicative and persuasive skills, adding to the human genome a unique political dimension. *Homo sapiens* became, in the words Aristotle's Nicomachean Ethics, a *zoon politikon*.

Harris, C.R., Prouvost, C. Jealousy in dogs. *PLoS One*. 2014; 9(7):e94597.

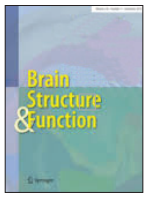
What is the origin of human jealousy? Some have argued it is a social construction that depends upon cognitions about the self. Contrary to this view, we found that dogs displayed jealous behaviors when they experienced a threat to an important social bond. This suggests that jealousy may be an emotion that evolved in more than one species in order to protect relationships from interlopers.

Hinde, K., Skibiel, A.L., Foster, A.B., Del Rosso, L., Mendoza, S.P., Capitanio, J.P. Cortisol in mother's milk across lactation reflects maternal life history and predicts infant temperament. *Behav Ecol*. 2014; In-Press.

Mother's milk is an important physiological pathway for nutrient transfer and hormonal signaling. Milk cortisol, independent of milk energy, predicted more Nervous, less Confident temperament in monkeys, although sons and daughters differed in their windows of sensitivity to maternal-origin cortisol. Mothers may be hormonally "programming" behaviorally cautious offspring that prioritize growth.

Hublin, J.J., Neubauer, S., Gunz, P. Brain ontogeny and life history in Pleistocene hominins. *Philos Trans R Soc Lond B Biol Sci*. 2015; 370(1663).

The evolution of a very large brain is critical to the human adaptive niche. Over the past 2 million years, it has required important adjustments, in particular concerning our diet and the way we grow up. Modern humans are characterized by an extended growth period and delayed brain maturation. However, Pleistocene hominins displayed varied developmental patterns and one cannot simply contrast an ape-model to a human-model.

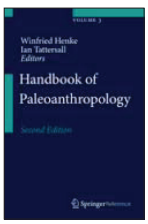


Keeney, J.G., Davis, J.M., Siegenthaler, J., Post, M.D., Nielsen, B.S., **Hopkins, W.D.**, **Sikela, J.M.** DUF1220 protein domains drive proliferation in human neural stem cells and are associated with increased cortical volume in anthropoid primates. *Brain Struct Funct*. 2014; In-Press.

Genome sequences encoding DUF1220 protein domains have undergone the greatest human lineage-specific copy number expansion of any protein coding sequence in the genome. Using multiple complementary approaches to gain insight into DUF1220 function, we provide the strongest evidence so far reported implicating DUF1220 dosage in anthropoid and human brain expansion through mechanisms involving increasing neural stem cell proliferation.

Kim, P.S., McQueen, J.S., Coxworth, J.E., **Hawkes, K.** Grandmothering drives the evolution of longevity in a probabilistic model. *J Theor Biol*. 2014; 353:84–94.

Humans can live much longer than great apes can, although female fertility ends near the same age in us and them, our closest living cousins. The Grandmother Hypothesis proposes the human difference resulted from grandmother effects. Here we simulate that hypothesis mathematically. As proposed, an ancestral great ape-like life history evolves to become human-like due only to helpful grandmothering.



Lieberman, P., McCarthy, R.C. The Evolution of Speech and Language. In: Henke, W., **Tattersall, I.**, eds. *Handbook of Paleoanthropology*, 2nd ed. Berlin: Springer-Verlag; 2015.

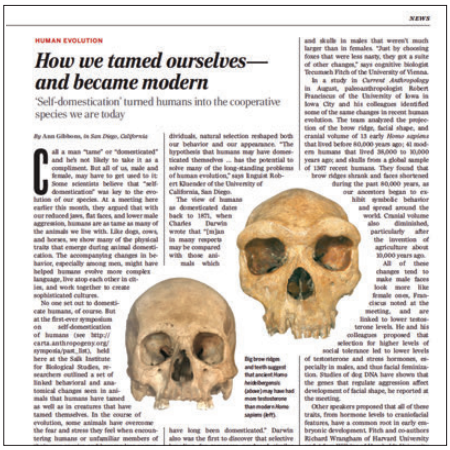
Speech makes complex language possible. The unique human tongue allows us to produce sounds that enhance the intelligibility of speech at the cost of increasing the risk of choking on food. New analyses of fossil remains show that the human tongue evolved well after brains capable of language, cognition and fine motor control. Neanderthals talked, though not as clearly as fully modern humans.

anthropogeny tracks

CARTA

CARTA in the News

A nice summary of CARTA's symposium, *Domestication and Human Evolution*, was published in the October 24, 2014 issue of *Science* magazine. "How we tamed ourselves – and became modern," by science writer Ann Gibbons, provides an overview of the over-arching theme of the event, namely the self-domestication of humans. The full article can be found here: http://www.sciencemag.org/content/346/6208/405.full.pdf



HUMAN EVOLUTION

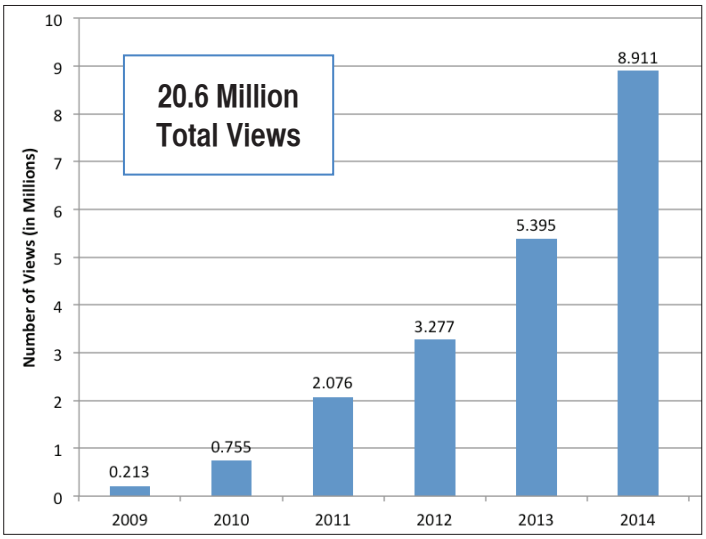
How we tamed ourselves—and became modern

'Self-domestication' turned humans into the cooperative species we are today

By Ann Gibbons, in San Diego, California

CARTA Video Statistics

CARTA videos have exceeded 20 million views! All CARTA symposia are video recorded by UCSD-TV, broadcast on the UCSD-TV channel, and then archived on CARTA, UCSD-TV, iTunes, and YouTube websites.



* Stats collected through December 2014

CARTA Symposia Schedule

How Language Evolves
February 20, 2015, UC San Diego

Human-Climate Interactions and Evolution: Past and Future
May 15, 2015, Salk Institute

Unique Features of Human Skin
October 16, 2015, Salk Institute

Origin of Genus *Homo*
Winter 2016

CARTA on the Web

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Want to re-watch a CARTA symposium? All symposia, including **"Domestication and Human Evolution"** (October 2014), are available at these websites.

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What is CARTA?

The UC San Diego/Salk Institute Center for Academic Research and Training in Anthropogeny (CARTA) is dedicated to answering the age old questions "where did we come from?" and "how did we get here?" As CARTA explores the origins of humanity, we are not only answering philosophical and existential questions, but also addressing very practical issues such as human nutrition, medicine, mental disease, the organization of society, the upbringing of our young, and the interactions of humans with one another and with our environment. Transdisciplinary interaction is at the core of CARTA's mission to advance human origins research.

For more information, please visit
http://carta.anthropogeny.org

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Your donation helps to ensure that CARTA's symposia remain free and available to all. There are three ways to donate to CARTA:

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