anthropogeny tracks
a CARTA newsletter
Volume 2, Issue 3 - October 2014

Did Domestication Make Us Human?

The domestication of animals has, in large part, been a primary factor in the planetary dominance and success of modern humans. Recently, a convergence of views has led to the notion that the study of animal domestication may tell us something, not only about our relationship with domesticated species, but also about our own evolution as a species in the more distant past.

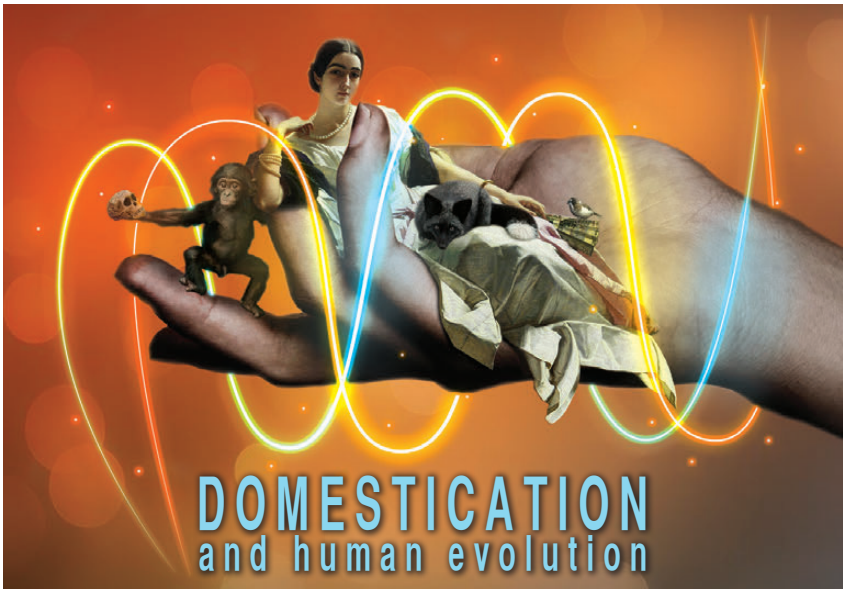
Specifically, it has been suggested that a number of the unique anatomical, neural, developmental, social, cognitive and communicative traits that define our species may be attributable to selection for lack of aggression and to a process of self-domestication.

CARTA's free public symposium, **Domestication and Human Evolution** (October 10, 2014), will bring together researchers from a variety of backgrounds to examine these concepts, and to elucidate further the possible role of domestication in human evolution.

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

Symposium Details

- Friday, October 10, 1:00 - 5:30 p.m., Pacific
- Salk Institute, Conrad T. Prebys Auditorium
- Free and open to the public, however registration is required
- Live webcast
- For more information or to register, visit: http://carta.anthropogeny.org/events/domestication-and-human-evolution



Presentations and Speakers

The Transformation of Wolf to Dog: History, Traits, and Genetics
Robert Wayne, UCLA

Fox Domestication and Genetics of Complex Behaviors
Anna Kukekova, University of Illinois at Urbana-Champaign

Craniofacial Feminization in Canine and Human Evolution
Robert Franciscus, University of Iowa

The Domesticated Brain
Terrence Deacon, UC Berkeley

Neotenous Gene Expression in the Developing Human Brain
Philipp Khaitovich, PICB, Shanghai

The Domestication Syndrome and Neural Crest Cells: A Unifying Hypothesis
Tecumseh Fitch, The University of Vienna

Domestication and Vocal Behavior in Finches
Kazuo Okanoya, University of Tokyo

Did Homo sapiens Self-Domesticate?
Richard Wrangham, Harvard University

Center for Academic Research and Training in Anthropogeny
"to explore and explain the origins of the human phenomenon"
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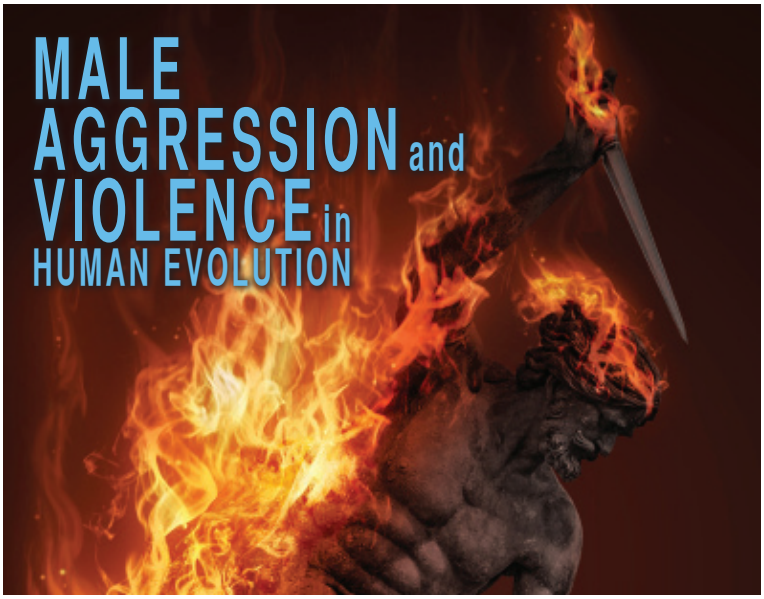
Excerpts from Student Essays

At each CARTA symposium, graduate students enrolled in the Anthropogeny Specialization Track have the unique opportunity to "host" internationally renowned speakers. Students are provided with an unparalleled opportunity to learn from and network with scientists who are on the forefront of human origins research. As part of the curriculum requirement, each participating student summarizes their assigned speaker's presentation and ensuing discussions in a written essay, which is vetted by the speaker and Faculty of Anthropogeny. Below are excerpts from select student essays resulting from talks delivered at the May 2014 symposium, **Male Aggression and Violence in Human Evolution**.



Emily Bovino, Visual Arts
Speaker: Donald Pfaff, Professor of Neurobiology, Rockefeller University
Talk: *Neuroendocrine Mechanisms Underlying Male Aggression*

In response to biological anthropologist Richard Wrangham's question on how androgen receptor density might inform research on uniquely human characteristics, neuroendocrinologist Donald Pfaff provided a physical analogy: "If you want to study Newton's laws of motion and you have a puck on ice with perfectly smooth walls (at an air level so that friction is low), you can measure angles and velocities and so forth. With an American football covered in Vaseline bouncing down the side of a quarry, the same laws are followed, but it is impossible to discover them." In other words, in seeking to understand correlations between hormones historically used to sex the brain, and behaviors that anthropologists and biologists have agreed to define as "aggressive," reading backwards will always be "an exercise in frustration" if the ecological semantics are ignored.

It is for this reason, Pfaff asserts, that most neuroendocrinology has traditionally looked to develop "simple lab models (…) to uncover lawfulness [otherwise] (…) obscured in more complicated circumstances." The familiar "simple lab model" cited by Pfaff is nothing new: it is the daily practice of animal experiments in control environments, or more specifically the often-featured transgenic mice as protagonist variables in the staging of "differential equations." Pfaff's CARTA talk entitled "Neuroendocrine mechanisms underlying male aggression," followed the basic premises of this method: it reviewed the various lab models Pfaff has worked with to begin mapping the neuroendocrinological apparatus behind reported correlations of murder rates and testosterone levels in young human males.

Whitney Friedman, Cognitive Science
Speaker: Richard Wrangham, Professor of Anthropology, Harvard University
Talk: *The Parallel Evolution of Humanity and Savagery*

Richard Wrangham's talk at the recent CARTA symposium drew evidence from chimpanzees as well as small- and large-scale human societies to culminate in a theory of human aggression and warfare.

The first critical distinction in Wrangham's argument is between reactive and proactive aggression, which the speaker contends are sufficiently distinct that different kinds of selection could act on them. Reactive aggression is the kind of "hot-headed," impulsive, fear- or contest-driven, unplanned aggression that occurs in bar fights, and is the main cause of homicide in the US and Europe. Proactive aggression is protracted, planned aggression in which impulse is suppressed and violence exacted over time, with benefits delayed as well.

Wild chimpanzee males (*Pan troglodytes*) demonstrate proactive aggression when, while patrolling the boundary of their range, a group encounters and kills a solitary male from a neighboring group. The simple fact of an encounter with an outsider is not enough to incite aggression: patrolling chimps will only attack the outsider if there is significant asymmetry in the number of individuals involved. Pooling evidence across nine study sites, the speaker (Wrangham, 1999; Wrangham and Glowacki, 2012) found that lethal attacks were most common when they had a minimum of a 4-5:1 advantage. Furthermore, as food surplus allows for the formation of larger patrols, lethal attacks are predicted when food is more abundant. Wrangham formalized these observations as the "Imbalance of Power Hypothesis" (Wrangham, 1999), in which the probability of attacking a neighboring group increases when there is an increase in resources and significant asymmetry in group size.

Caroline Horton, Anthropology
Speaker: Anne Pusey, Professor of Evolutionary Anthropology, Duke University
Talk: *Intergroup Violence: Chimpanzees and Lions*

In the CARTA symposium, "Male Aggression and Violence in Human Evolution," Dr. Anne Pusey discussed her work on aggression in female chimpanzees at her field site in Gombe in Tanzania. Violence and aggression is prevalent amongst male chimpanzees, both in terms of intergroup violence during boundary patrols and raiding and intragroup aggression in the establishment and maintenance of dominance hierarchies. However, Pusey noted that while male dominance hierarchies are relatively easy to establish after a short period of observation, female dominance hierarchies are difficult to discern because female aggression is far less common. The instances in which females do display aggression appear to be linked to competition for food resources.

Female chimpanzees are much less social than males, spending around 40% of their time alone or with offspring only. Furthermore, females maintain distinct ranges from other females, and feed in distinct core areas, although overlap is common in regions that are resource rich. Such patterns of female dispersion avoid the necessity for frequent aggressive encounters, and are thought to be an ecological strategy to maximize feeding efficiency and minimize food competition. Despite such infrequent encounters, there is increasing evidence of competition and aggression in female chimpanzees, which can be grouped into three major categories: dominance rank, aggression to immigrant females, and infanticide.

Heidi Sharipov, Neuroscience
Speaker: Christopher Boehm, Professor of Anthropology, University of Southern California
Talk: *Warfare and Feuding in Pleistocene Societies*

Understanding warfare and feuding in our early ancestors can help offer a better understanding of modern tendencies toward organized aggressive acts. There is much debate about whether humans are innately aggressive, with a tendency to start or participate in wars, or whether this may be a more modern behavior characterized by increased population densities and access to safer, long-distance projectile weapons. It is clear that aggression, at least at some level, would be beneficial for survival but the extent of organized, human aggressive acts seems to separate us from most other animals, including the great apes. Dr. Christopher Boehm is one of the scientists trying to determine how much these violent acts may be attributed to evolution, rather than societal changes, by studying the aggressive behaviors of modern hunter-gatherer societies.

Although some information can be gained from the fossil record, there are very few reliable indicators of warfare-type aggressive acts, and limited sampling may lead to a poor estimate of actual levels of warfare. Boehm believes that better measures can be obtained from modern hunter-gatherer societies, but the selection of societies needs to be specific to ensure that their current living conditions would be most similar to that of the late Pleistocene. The requirements for inclusion in this study are that the societies must not be foragers with horticulture, trade or rich resources. The two biggest criticisms to the study of modern hunter gatherer groups as a comparison to hunter gatherers in the late Pleistocene is that they are more marginalized now (pushed into smaller and smaller regions from the forces of developing areas) and that the Pleistocene environment would have been too different to serve as a fair comparison. However, Boehm argues that Pleistocene hunter gatherers would have had just as many pressures from other groups and from the environment that would have led to marginalization. Additionally, the mosaic environment would have allowed less distant ranges, so there are probably very few differences between Pleistocene and modern environments for hunter gatherers.

Rachel Zarndt, Biomedical Sciences
Speaker: Robert Kelly, Professor of Anthropology, University of Wyoming
Talk: *Do Hunter-Gatherers Tell Us About Human Nature?*

If acts of violence assume some sort of benefit of resource protection, when is the cost of violence not worth the benefit? The nomadic foragers of Inuit of the North West Territories "vote with their feet" when faced with warfare, and often move away from aggression. In fact, while various acts of aggression are not absent in any ethnographic group, rates of violence tend to be higher in sedentary groups. Population pressure seems to apply pressure on homicide levels. The general trend is higher population pressure equals higher homicide rates. In the May CARTA Symposium, Dr Kelly shared a figure of ethnographic groups with varying population pressures, revealing this significant trend (with the outlier violent Hiwi tribe included, this trend is R = -.51, p=0.06).

How high can this rate go? 1,000 cases of violence in a population of 100,000 is the observed maximum across populations with varying population pressure. Dr. Kelly's proposed rates cannot go higher than this, since at this level, every person in a population knows someone who is dying or killed. This then may turn the social pressure to stopping warfare and initiating peace-making. Further, amongst a warring community, a losing population (or one with trends toward high levels of intra-tribe violence) could become subsumed into a victor's population and no longer be a population with which to contend.

Digital Anthropogeny in Action

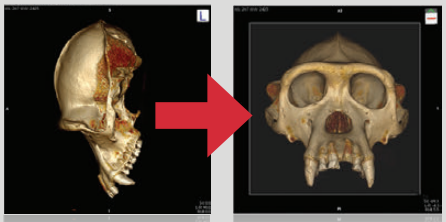
Over the summer, three San Diego high school students, Sankaran Ramanarayanan, Grant Summers, and Ashwin Muthukumarasamy, got to the digital "bare bones" of a complete chimpanzee skeleton*. As part of San Diego Supercomputer Center's fifth annual Research Experience for High School Students (REHS) summer program (funded by the NSF), the students joined CARTA programmer and San Diego Super Computer Center (SDSC) staff member, John Moreland, to produce software, images, and animations from the existing 3D medical CT scans of the chimpanzee's skeleton. The effort entailed four related projects, described in the following boxes adapted from the final poster project created by the students, which not only gives the students valuable training, but also benefits CARTA's digital anthropogeny and research goals.

**The skeleton is part of a collection of chimpanzee skeletons generously donated to CARTA by the Primate Foundation of Arizona (PFA). The PFA collection represents a major portion of CARTA's Museum of Primatology (MOP). Cataloging, scanning and 3D digitization of these skeletons is underway thanks to support from the Mathers Foundation and long-time CARTA supporter, Annette C. Merle-Smith.*

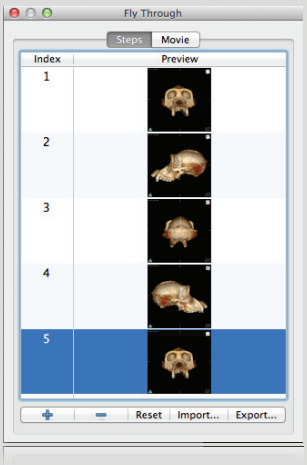
Image and Animation Rendering

- **Render images in anatomical orientations.**
- **Render movies using key-frame animations.**

Each zip file (each scan) contains a series of up to 3800 cross-sections. Osirix stitches those slices together in a volume rendering.



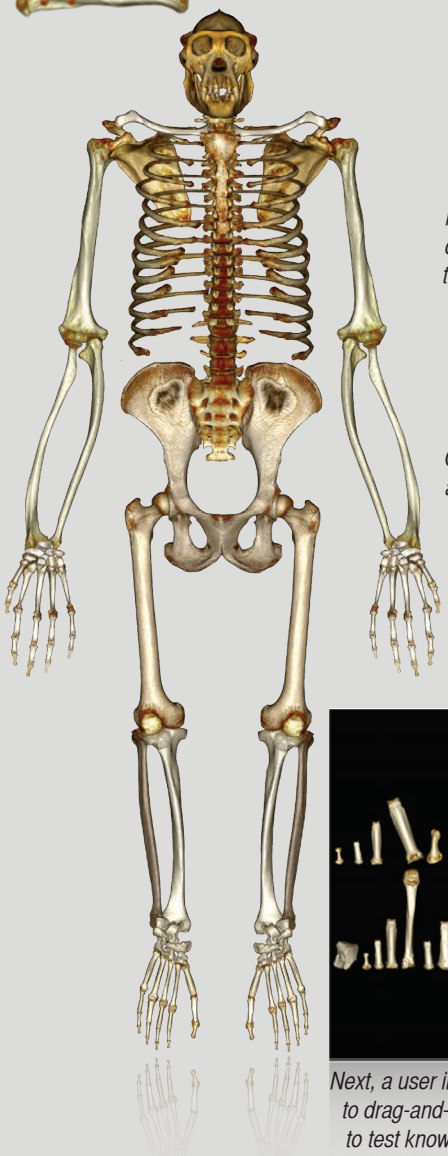
Bones were rendered in the same orientation they had been laid out on the scanner bed. This was not necessarily the correct anatomical orientation, therefore, CARTA and internet resources were utilized to properly orient each bone.



To create the video-tours of each bone, specific "key-frames" were produced to instruct the computer to calculate the video animation using the key-frames as landmarks.

2D Skeleton Reconstruction

- **Combine each bone image into a single .png file with each bone in the correct anatomical orientation.**
- **Create an educational application for students to drag-and-drop each bone into its correct position on the skeleton.**



The bone snapshots had different image sizes, so a scaling system was developed to compensate and re-size the bones to their original size-factors.

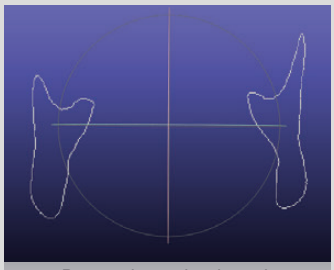
Once properly scaled, the complete skeleton could be re-assmbled in proper anatomical orientation. Complex portions, such as the hands and feet, were assembled separately and later incorporated into the base file.

Next, a user interface was created to allow students to drag-and-drop each bone into a "skeleton-key" to test knowledge of osteology. In this example, users select a hand bone and drag it to the proper position in the corresponding bone chart.

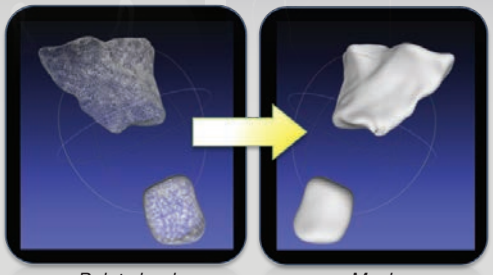
3D Surface Extraction

- Use Perl code to find bone edge points in each CT slice.
- Combine bone edge points into 3D point clouds and then into mesh (polygonal surfaces).

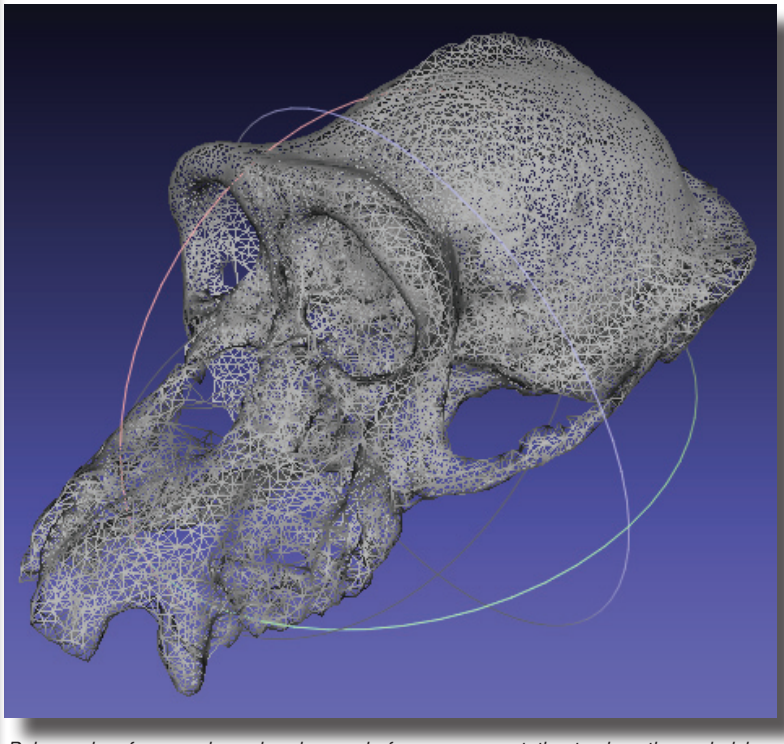
CT scan cross-section



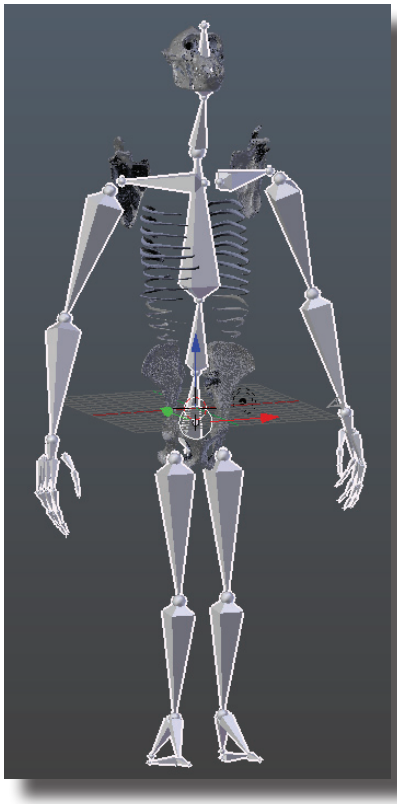
Bone edge point detection



Point cloud *Mesh*

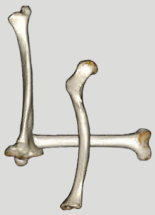


Polygonal surface mesh rendered as a wireframe representation to show the underlying Perl-generated points and polygons.

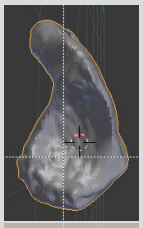


Keyframe poses were created using armatures, which are simplified skeletons to which individual bones can be attached, so when the armature is moved, the bones move and rotate with it.

3D Skeletal Reconstruction

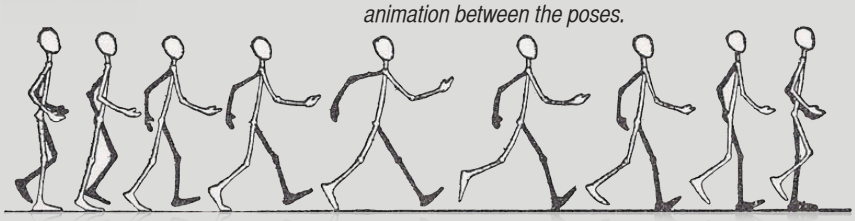


- Combine each bone into a single Blender file with each bone in the correct anatomical orientation.
- Create walking and movement algorithms for the chimpanzee skeleton.



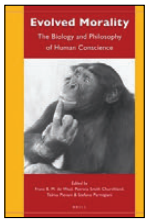
Bone sets like the foot tarsals (shown below) had to be separated into individual Blender objects. Additionally, each bone's curvature was studied to identify its articular structures and how it would interact physically with other bones.

Existing models of each bone, created in the third project, were fitted together and walking simulations and other animations were made using keyframes. Certain skeletal poses were marked as keyframes, and Blender computed a smooth animation between the poses.



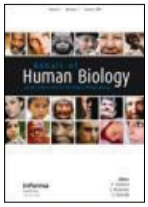
CARTA-Inspired Publications

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.)



Boehm, C. The Moral Consequences of Social Selection. In: **De Waal, F.**, **Churchland, P.S.**, Pievani, T., and Parmigiani, S., eds. *Evolved Morality: The Biology and Philosophy of Human Conscience.* Leiden: Brill; 2014:31–48.

This article looks statistically at the role of moralistic capital punishment in today's hunter-gatherers in keeping their political bands egalitarian, meaning that no hunter can self-aggrandize or try to give orders to other hunters. Because the foragers involved have been carefully chosen to correspond with prehistoric human foragers in Africa who were behaviorally modern, this political pattern goes back at least 45,000 years and possibly three times that.



Bogin, B., Bragg, J., and Kuzawa, C. Humans are not cooperative breeders but practice biocultural reproduction. *Ann Hum Biol*. 2014; 41(4):368–380.

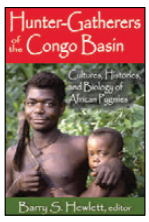
Human care of children is distinct from other species because helpers are defined culturally rather than by genetic kinship alone. Human bicultural reproduction allows for flexibility and ensures that care and resources flow efficiently, lowering the costs of child rearing by 20% compared to other mammals. This efficiency could help explain why women may live for decades beyond menopause.

Clarke, E.M., et al. including **Finch, C.E.** Is atherosclerosis fundamental to human aging? Lessons from ancient mummies. *J Cardiol*. 2014; 63(5):329–334.

Evidence from mummies suggests that arterial disease is not modern and existed at least 4,000 years ago. The multi-disciplinary team of cardiologists and anthropologists conclude that arterial disease is a general condition of human aging in diverse cultures from the ancient Egyptians to Aleutian Islanders, and is not linked to specific lifestyle and diet.

Davidson, I. Hunter-gatherers in Australia: deep histories of continuity and change. In: Cummings, V., Jordan, P., Zvelebil, M., eds. *The Oxford Handbook of the Archaeology and Anthropology of Hunter-Gatherers*. Oxford: Oxford University Press; 2014: 368–404.

This handbook entry sets the narrative of Australian archaeology in the context of environment and environmental change, and the behavioral variation observed in the earliest post-contact accounts. The narrative is one of how that variation came about during the last 50 thousand years from first colonization. Topics include demography, megafaunal extinction, fire use, subsistence and symbolism.

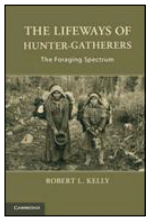


Hewlett, B.S., ed. *Hunter-Gatherers of the Congo Basin*. Piscataway: Transaction; 2014.

The forest foragers of the Congo Basin, known collectively as "Pygmies," are the largest and most diverse group of active hunter-gatherers remaining in the world. At least 15 different ethno-linguistic groups exist with a total population of 250,000-350,000 individuals. Leading academic authorities from around the world summarize and synthesize recent research on topics ranging from genetics to music and childhood.

Keeney, J.G., Dumas, L., and **Sikela, J.M.** The case for DUF1220 domain dosage as a primary contributor to anthropoid brain expansion. *Front Hum Neurosci*. 2014; 8:427.

Sequences encoding DUF1220 protein domains show the largest human lineage-specific increase in copy number of any coding region in the genome. This article provides a compilation of the available data supporting the view that increasing copy number DUF1220 sequences is a major contributor to the evolutionary increase in brain size associated with anthropoid primates (monkeys, apes and humans).



Kelly, R.L. *The Lifeways of Hunter-Gatherers: The Foraging Spectrum***.** New York: Cambridge University Press; 2013.

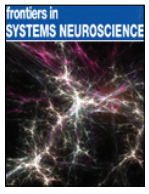
Kelly challenges the preconception that hunter-gatherers conform to a single type or that they provide a model of early human society. Using human behavioral ecology, he examines diversity in foraging behavior, such as diet, mobility, and sharing. He argues that archaeologists should use archaeological data to test theories rather than ethnographic analogy to reconstruct the past.

Kuzawa, C.W., et al. including **Grossman, L.I., Hof, P.R., and Sherwood, C.C.** Metabolic costs and evolutionary implications of human brain development. *Proc Natl Acad Sci U S A*. 2014; 111(36):13010-5.

Metabolic costs of brain development have been thought to explain distinctly human traits like exceptionally slow and protracted childhood growth. Using existing data to calculate birth to adulthood brain glucose use, we find the brain's metabolic requirements peak in childhood (at 66% of the body's resting metabolism), and that brain glucose demand relates inversely to body growth from infancy to puberty.

Ng, R., Jarvinen, A., and **Bellugi, U.** Toward a deeper characterization of the social phenotype of Williams syndrome: The association between personality and social drive. *Res Dev Disabil*. 2014; 35(8):1838–1849.

Elucidating the paradoxical social phenotype of Williams syndrome (WS) characterized by hypersocial yet anxious personality, this study showed that social affiliation was motivated by social closeness and desire for affectionate relations in WS, contrasted with social dominance in controls. The study is part of a multidisciplinary program focusing on neurogenetic underpinnings of human sociality.



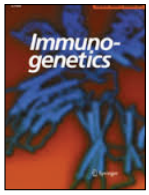
Patel, A.D. and Iversen, J.R. The evolutionary neuroscience of musical beat perception: the Action Simulation for Auditory Prediction (ASAP) hypothesis. *Front Syst Neurosci*. 2014; 8(57).

When we perceive a beat in music, we don't just passively register temporal patterns, we actively predict the timing of upcoming beats. How does our brain accomplish this? We hypothesize that prediction of beats relies on temporally-precise two-way communication between hearing and motor planning regions of the brain, and on brain circuits which distinguish us from all other primates.

CARTA-Inspired Publications, Continued

Skyrms, B., **Avise, J.C.**, and **Ayala, F.J.** In the light of evolution VIII: Darwinian thinking in the social sciences. *Proc Natl Acad Sci U S A*. 2014;111(S3):10781–10784.

Darwinian thinking in the social sciences was inaugurated by Darwin himself in *The Descent of Man and Selection in Relation to Sex*. Despite various misappropriations of the Darwinian label, true Darwinian thinking continued in the social sciences. But with the advent of evolutionary game theory, there has been an explosion of Darwinian analysis in the social sciences.

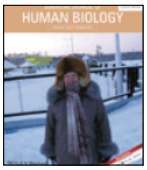


Springer, S.A., Diaz, S.L., and **Gagneux, P.** Parallel evolution of a self-signal: humans and new world monkeys independently lost the cell surface sugar Neu5Gc. *Immunogenetics*. 2014; In-Press.

Humans are not like other animals. Cultural to cellular, each detail reveals differences. We lost a key mammalian sugar, a self signal, changing our biochemistry and immunity. New World monkeys also lost this sugar. Now, comparisons can reveal how this tiny change has such broad effects. We marvel at human uniqueness, but the details also speak of similarity. There is much to learn by comparison.

Striedter, G.F., et al. including **Hof, P.R.**, **Preuss, T.M.**, **Sherwood, C.C.**, and **Stevens, C.F.** NSF workshop report: discovering general principles of nervous system organization by comparing brain maps across species. Published jointly by *Brain Behavior and Evolution* and *The Journal of Comparative Neurology*. *Brain Behav Evol*. 2014;83(1):1-8. *J Comp Neurol*. 2014; 522(7):1445-53.

This paper, which developed out of a 2013 NSF-sponsored conference, is a call for increased emphasis for comparative research in the neurosciences, arguing that comparative studies provide the best route for discovering general principles of brain organization and the only means for identifying features of brain organization that distinguish different groups of animals. The authors argue in favor of developing research programs in a number of "reference species" that cover a broad phylogenetic range.



Tackney, J., Cawthon, R.M., Coxworth, J.E., and **Hawkes, K.** Blood cell telomere lengths and shortening rates of chimpanzee and human females. *Am J Hum Biol*. 2014; 26(4):452–460.

Humans live much longer than our closest living cousins chimpanzees do. We hypothesized that slower attrition of the telomere caps on chromosomes that shorten at each cell replication might help explain how. Instead, we found little difference in attrition rates between the species, and, surprisingly, chimpanzee telomeres are twice as long, underlining the importance of this close phylogenetic comparison for understanding the mechanisms of human longevity.

CARTA Master Class

As part of its community outreach, CARTA is offering a second Master Class this fall on human origins at UCSD's Osher Lifelong Learning Institute, an educational and cultural organization for retirees, directed by its members under the administrative auspices of UCSD Extension. The Master Class consists of a series of five talks by prominent CARTA Members (listed below), who will focus on uniquely human aspects of the brain. CARTA talks have been uniformly well-received by the Osher community both at CARTA's Symposia and Master Classes.

What Makes the Human Brain Human?
Dr. Terrence J. Sejnowski, Salk Institute

Progress made in elucidating the structure, function, and connectivity of cellular circuits in the nervous system is revolutionizing our capacity to understand brain function and behavior.

Where Do Morals Come From?
Dr. Patricia S. Churchland, UC San Diego

The concept of morality as it relates to human behavior is explored. What are the social and neurobiological roots of moral behavior?

The Tangle of Space and Time in Human Origins
Dr. Rafael Núñez, UC San Diego

The origin of spatial construals of duration, sequence, past, present, and future take many different forms in diverse populations.

Emergence of Grammatical Structure in a New Language
Dr. Carol Padden, UC San Diego

How the study of new sign languages, which emerge under certain conditions, can shed light on fundamental properties of human languages.

How Can We Hope to Understand the Brain?
Dr. Ralph J. Greenspan, UC San Diego

New directions in technology have the potential to show us much more of what is going on in our brains.

All classes held at UCSD's Osher Lifelong Learning Institute

Osher Coordinator: Dick Dahlberg

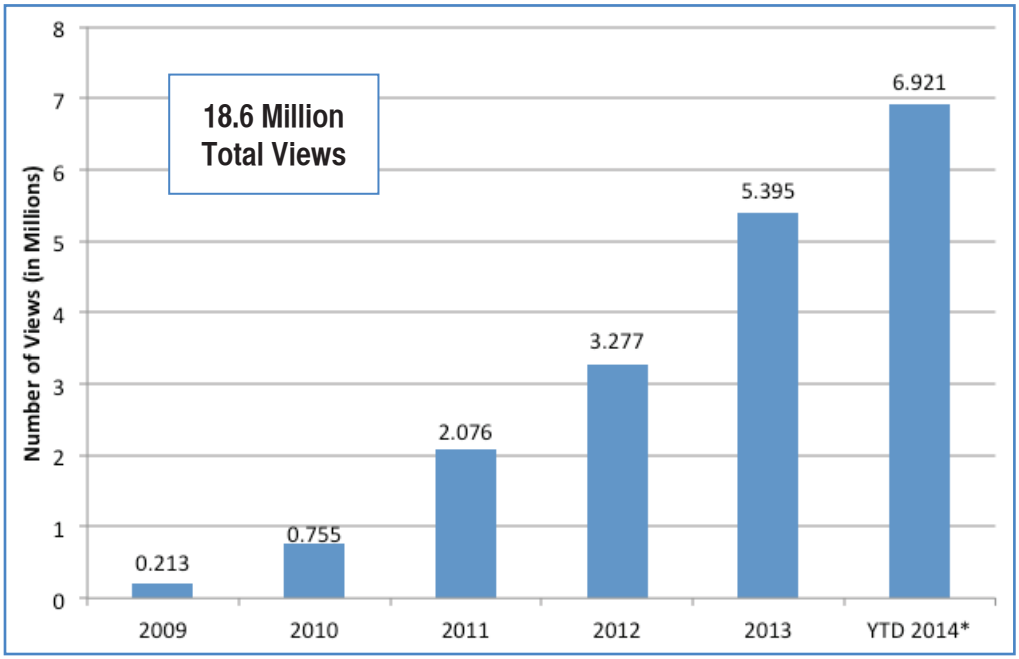
For more details, visit http://olli.ucsd.edu

anthropogeny tracks

CARTA

CARTA Video Statistics

CARTA videos have exceeded 18 million views! At the current rate, the number of downloads of CARTA videos and audio podcasts will top 20 million by the end of 2014, with recent "hits" exceeding 1 million per month. 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 August 2014

CARTA Symposia Schedule

Domestication and Human Evolution
October 10, 2014 • Salk Institute

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

CARTA on the Web

UC SD TV iTunes YouTube

Want to re-watch a CARTA symposium? All symposia, including **"Male Aggression and Violence in Human Evolution"** (May 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 in advancing human origins research.

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

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