Comparative Anthropogeny: Exploring the Human-Ape Paradox

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ABSTRACTS

The Foundations of Cooperative Breeding

Alyssa Crittenden, University of Nevada, Las Vegas

Alloparenting, or the investment in young by individuals other than the biological parents, occurs among a wide array of insects, birds, and mammals – including humans. Human reproduction is characterized by notable features that distinguish it from the general mammalian pattern and that of the extant great apes, our closest living relatives. Comparatively, we wean our infants early, before they are nutritionally independent. Despite this practice of early weaning, we maintain relatively short inter-birth intervals (IBI), or the space between births. This association between short IBI and early weaning is hypothesized to have evolutionary roots, allowing hominid mothers to resume ovarian cycling more rapidly, facilitating the birth of new infants while maintaining care for older (and still highly dependent) children. Given the high estimates of the nutritional input required for a hominid mother to successfully feed herself and only one of her offspring, it is unlikely that she would have been able to do it alone - she likely relied on assistance from others. This practice of allomothering unfolded in the larger social context of cooperative breeding and includes nurturing, caregiving, and/or provisioning. It likely allowed our Pleistocene ancestors to successfully rear energetically expensive, large brained offspring in an unpredictable ecological environment. Allomothering, while considered to be one of the hallmarks of human evolutionary history, also has a strong contemporary resonance. It is currently the most widespread cross-cultural practice of child rearing, not only normative among small-scale non-industrial populations such as foraging communities, but also commonplace in the post-industrialized cultural west. Despite changes in demography and residence patterns throughout the world, allomothers continue to provide for and nurture children, underscoring not only how central this practice is to the anthropology of reproduction, but also to what makes us (and our reproductive lives) human.

Childhood

Barry Bogin, Loughborough University, UK

In this presentation we try to understand why people grow-up in such a strange way, taking over twenty years to reach fully productive and reproductive adulthood, but even as adults remain connected and interdependent with so many other people. As part of CARTA I focus on one human-ape paradox – the uniquely human stage of childhood development. Human childhood takes place between the ages of about 3 to 7 years. The evolution of childhood was good for the mother as it freed her from breast-feeding her current infant, allowing her to shift energy and care to another pregnancy and a new infant. In contrast to people, most apes nurse their current infant for 4, 5, even 7 years and this means that those apes reproduce more slowly than do people. A problem with childhood is that the child needs care and feeding from other people. Our ancestors addressed this problem with new biocultural systems to foster and define roles for childcare responsibilities. Eventually these new social systems evolved into the human capacities for language, kinship, and marriage – these are the cultural traits that set us apart from all the other apes.

Nutrition and Diet

Margaret Schoeninger, University of California, San Diego

Over the last 10 years, the fascination for identifying the 'Natural Human Diet' has expanded beyond anything imagined by Eaton and Konner who authored the first paper on Paleolithic Nutrition. The publication of Paleodiet and Paleonutrition cookbooks has exploded, almost exponentially although the science underlying these diets is not always very convincing. Over the same period, we have seen another explosion in the scientific literature on the diets of some fossil members of our lineage based on dental microwear analyses, stable isotope analyses, and microfossils and DNA in dental calculus. Around 2 million years ago some of our fossil relatives consumed diets unlike anything observed in living primates (e.g., sedges), others began to eat meat, and still others maintained the more general primate diet of leafy plants, fruits, seeds, nuts, and insects. Based on our knowledge of the diets of living nonhuman primates, of extant non-agriculturist humans, and of prehistoric humans, we know that living humans can eat virtually everything and that what cannot be eaten, we often feed to animals that we subsequently consume or we co-opt these animals to provide us with blood or milk for consumption. Yet, these sources show that the highly processed and heavily starch-based diet ingested most commonly across living humans today has existed for only 15,000 years at the very most. The extraordinary dietary flexibility of humans must be considered in order to understand the evolution and appearance of our species, *Homo sapiens.*

Symbolic Play

Linda Marchant, Miami University, Ohio

Symbolic (also labeled fantasy, imaginative or pretend) play is a human universal. Its role in ontogeny, especially childhood, is essential to cognitive and social development. A child's capacity to utilize objects, actions or ideas in symbolic play scaffolds cognitive flexibility/ creativity, tempers emotional regulation, and may impact language development.

This presentation explores whether our nearest living relatives, the great apes (chimpanzee, bonobo, gorilla, and orangutan) evince a capacity for symbolic play. Before examining such evidence, an overview of play is presented. Suggested functions of play include practice, coping with extremes, and extending the period of learning. Behavioral cues to play include: open-mouth play face, exaggeration, repetition, and restraint but context is crucial and these cues are not always present. Köhler's "serious play" is characterized by deliberate movements, compressed mouth and other facial signals. Thus, rather than viewing play as frivolous or lacking practical purpose, an evolutionary perspective argues that play is critical to the "rehearsal" of adult behavior and underpins behavioral flexibility.

Evidence in this presentation for symbolic play in great apes (Genera *Pan*, *Gorilla* and *Pongo*) ranges from extended anecdote to empirical reports from field studies with the latter coming from Genus *Pan*. Individuals from the three great ape genera who have participated in language acquisition research, whether arguably failed attempts to produce speech (chimpanzee Vicki from the 1950s) or more successful efforts with American Sign Language (ASL) that capitalized on the natural repertoire of great apes to use gesture, show evidence of symbolic play. These apes use ASL to "talk" to themselves in private, to their toys, make requests of toys, or care-givers, and dissimulate about the presence or absence of feared creatures. They engage in pretend object play which suggests the symbolic capacity to treat objects representationally.

The most persuasive evidence for symbolic play in wild apes comes from the Kanyawara community of chimpanzee in Kibale National Park, Uganda. In a 2010 *Current Biology* publication, Kahlenberg and Wrangham reported juvenile chimpanzees carrying sticks and rocks as a form of "object play/doll play." The pattern was female-biased and included lengthy periods of object transport, carrying objects into trees, nesting with, or making nests for the objects. Reports of possible symbolic play when chimpanzees and bonobos explore still or moving water may indicate the use of water to self-explore or manipulate the properties of water.

That there is some evidence for symbolic play in great apes is, perhaps, not surprising given what we have learned about ape cultures in the last decades. Evidence of ape abilities for innovation, imitation, social transmission of knowledge, and Theory of Mind (ToM) argue for their impressive cognitive attributes. Nonetheless, the human aptitude for symbolic play is universally observed in childhood and continues through-out the life course. Symbolic play is embedded in the fabric of human cultures and is likely tied to symbolic systems including language.

Language

Robert Kluender, University of California, San Diego

In the language evolution literature there is a well-known paradox: human language appears very different from animal communication, but has to have come from somewhere evolutionarily. Since previously existing hominin species have all gone extinct, it's nearly impossible to use them as a basis of comparison. Aside from fossilized bones, all that's left to us are currently existing animal species. And at first blush their communication abilities – and those of other great apes – seem quite paltry relative to our own. Over the past 40 years, scholarly discussions of language evolution have become respectable again, after over a century of taboo, and so a fair amount of progress has been made in studying animal communication, both in the wild and in the laboratory. Here we compare it to human language on the basis of four characteristics. While animals exposed to human environments can be trained to understand basic symbolic representation, defined here as an arbitrary mapping between sign and referent, they never produce it on their own. Humans also have an extensive ability to refer to entities, properties and events well beyond the confines of the here and now, known as "displaced reference." While isolated rudimentary examples of displaced reference can be found in both wild and trained animals, its occurrence is exceedingly rare. Human language also affords us the ability to combine meaningless elements – the sounds of spoken language and the manual features of sign language – into meaningful units, namely words or signs. These can in turn be combined into higher-level units – phrases and sentences – that retain and integrate the meanings of their individual parts in predictable ways. While such combinatorics were previously thought to be beyond the reach of other animals, recent research has revealed some surprising examples, especially in bird calls. There is also evidence that apes may be capable of simple combinations of this type in their gestural communication. In the end, a huge cleft remains between humans and other animals in their capacity for language, but we can identify isolated primitive building blocks of language-like behavior in their communicative repertoires.

Teaching

Tetsuro Matsuzawa, Kyoto University, Japan

I have been studying chimpanzees in the wild (Bosou-Nimba, Guinea, West Africa) and also in the laboratory (the Primate Research Institute of Kyoto University). In short, "Teaching" in chimpanzees is called "Education by master-apprenticeship." In my talk, I will introduce the three topics: 1) the mother-infant relationship in chimpanzees, 2) tool-use in the wild, and 3) the laboratory simulation of "Education by master-apprenticeship." At the last point, I want to introduce 4) the extra-ordinary working memory of young chimpanzees. That is, in a sense, beyond teaching: it is beyond what I have taught to the chimpanzees. In this CARTA conference, I want to share my knowledge and experience that I had through study of chimpanzees. I also want to take this opportunity to learn various topics related to human-ape paradox. Please take a look at the following sites:

Fieldwork in Bossou-Nimba chimpanzees: https://www.greencorridor.info/
Laboratory work in Ai project: http://langint.pri.kyoto-u.ac.jp/ai/
Tetsuro Matsuzawa: https://www.matsuzawa.kyoto/cv/en/

Ancient Grandmothers, African Savannas

Kristen Hawkes, University of Utah

Human life history evolved from an ancestral condition shared with the other great apes whose infants begin to feed themselves on the fruits and leaves their mothers are eating while still nursing, then feed on their own at weaning so mothers can commit to their next offspring. The savannas that spread in ancient Africa would have presented foraging opportunities with novel tradeoffs. Lessons come from modern people foraging in African savannas now. Hadza women earn predictable returns from plants that flourish in savanna seasonality, but youngsters are too small to be effective at exploiting the deeply buried tubers that are year 'round staples, so they depend on their moms. Yet mothers have next babies long before the one can feed itself as weaned dependents are subsidized by the daily productivity of grandmothers.

Those lessons contributed to a grandmother hypothesis to explain the evolution of our distinctive life history, which modeling and evidence now link to other features that distinguish us from our great ape cousins. Postmenopausal longevity brought along all those old men, biasing mating sex ratios toward males - a likely basis for our distinctive pair bonding habits. Greater longevity delays development, slowing neural maturation and expanding brain size. So ancestral infants and toddlers immature brains wired to a world without the full maternal commitment enjoyed by other ape infants. Survival depended on actively engaging relationships from babyhood onward, which could make our distinctive life-long social appetites a legacy of our grandmothering life history.

Brains

Todd Preuss, Emory University School of Medicine, Yerkes Primate Research Center

Advances in noninvasive neuroimaging and comparative genomics over the past two decades have yielded a remarkable body of new knowledge about the differences in brain organization between humans, apes, and other primates. Although human specializations have been identified in many different brain systems, modifications of the classical association cortical regions—the prefrontal cortex, posterior parietal cortex, and the middle and inferior temporal cortex—are especially pertinent to the evolution of human cognitive capacities. Recent studies support the traditional view that the evolutionary enlargement of the human brain, which is more than 3X as large as those of African apes of similar body size, reflects primarily the expansion of association cortex. While it is currently unclear whether humans possess cortical areas that apes lack, it is clear that evolution repurposed certain areas shared by humans and nonhuman primates to serve new, human-specific functions. The best studied example of this is the inferior frontal gyrus (Broca's area), modified for language in the left hemisphere and for complex, hierarchically organized action planning and execution (as for example in making tools) in the right hemisphere. These functional changes were accompanied by, and presumably supported by, changes in the connections between the inferior temporal and parietal association areas, as demonstrated by diffusion-weighted MRI studies.

Human association areas also appear to be hotspots for changes in gene expression. Comparative genomic research has identified non-coding DNA regions that regulate gene expression and underwent rapid changes in human evolution ("human accelerated regions," or HARs). Genes associated with HARs show more expression changes in human association cortex than do the homologous genes of chimpanzees and macaque monkeys. Many of these genes regulate synaptic formation and could thus shape the intrinsic information-processing architecture of association areas, and mutations of HAR-associated genes are known to disrupt cognition and social behavior.

Like gray matter, the white matter, which carries fibers traveling between cortical areas, is known to undergo plastic modifications in response to learning and experience. Compared to the chimpanzee lineage, the human lineage underwent many more changes in gene expression by oligodendrocytes, the cells that make the myelin sheaths that invest fibers in white matter. What's more, a subset of these expression-modified genes has alleles associated with schizophrenia and other neurocognitive disorders. One of the truly exciting aspects of this new era of discovery is the accessibility of the data. MRI scans are publicly available for chimpanzees through the National Chimpanzee Brain Resource and for humans from a variety of sources. Gene-expression data for chimpanzees are available online through PsychENCODE and for humans from the *Allen Human Brain Atlas*. We can expect these datasets to provide new insights into human brain specializations and human disease. Go for it.

Skin

Nina Jablonski, Pennsylvania State University

Mostly naked, potentially sweaty, and variably colored skin is a hallmark of modern human beings. Skin is often overlooked in discussions of human evolution because it is rarely preserved in the fossil record. But because of its central role as an interface between the outside world and the body, it is essential that we study the evolution of skin and, specifically, how our skin differs from that of our ape relatives. We evolved mostly naked skin early in the evolution of the genus *Homo* for reasons of temperature regulation. Naked skin with lots of sweat glands makes it possible for people to stay cool while they are physically active in hot environments. The loss of hair meant that we lost important protection against the environment, especially strong sunlight. This is when our ancestors evolved permanently dark skin, rich in the natural sunscreen, eumelanin. Eumelanin absorbs much of the harmful ultraviolet radiation that falls on the Earth's surface, and is widely used in nature because of its protective properties and its color. Our ancestors living in equatorial Africa had dark skin and little body hair. This was the universal human condition for a long time for all ancient people living in Africa, including the earliest members of our own species, *Homo sapiens*. When some people left equatorial Africa and moved to less intensely sunny places, like southern Africa, northern and eastern Asia, and Europe, changes occurred in their skin color. This is because people actually needed to have less eumelanin sunscreen in the skin in order to make it possible for some UV rays to penetrate the skin and make vitamin D. As people moved around early in prehistory, their skin color changed according to the intensity of the sunlight under which they lived. Many aspects of our skin are different from those in apes, and have come to be of great interest and social importance. We pay a lot of attention to skin, we show important emotions through our skin, and we spend a lot of time and effort caring for and decorating our skin. So, it's high time we celebrate its remarkable evolution!

Fire and Early Homo Sapiens Innovations

Lyn Wadley, University of the Witwatersrand

Fire, more than any other technology, separates human from non-human primate behavior. Fire was used expediently by pre-*Homo sapiens* hominins more than a million years ago. Rare, ephemeral traces of early fire use have been recovered from archaeological sites in Africa, Israel and Europe. Perhaps the ability to cook food occasionally, thereby extracting nutrients easily, played some role in hominin evolution, allowing the development of smaller teeth and gut, and larger, more nutrient-costly brains. This suggestion is controversial because an increased meat diet could have the same effect, but there is less controversy about the control that *Homo sapiens* wielded over fire. Archaeological evidence for fire use increased dramatically from about 300,000 years ago, close to the origin of our species, and at the dawn of the Middle Stone Age in Africa. Thick stacks of ash, suggesting repeated fire use, and therefore probably the ability to produce fire at will, have been found in some Middle Stone Age sites like Border Cave in South Africa. In this presentation, the newly published data from Border Cave will be described. Ash was deliberately used as an under-blanket for Border Cave grass bedding at 227,000 years ago. Ash deters crawling parasites as well as providing a clean, insulating surface. Furthermore, people here were collecting rhizomes and bringing them back to the cave to cook and share. We therefore see that they practiced delayed gratification and had social mores that involved sharing. Once people learned to control and reproduce fire instead of using it only from natural sources, its usefulness broadened. In addition to using fire for light, warmth, cooking, social comfort, and protection from predators, people began to use pyrotechnology to create a variety of useful products. Sophisticated fire technology was known to *Homo sapiens*; this included creating medicinal smoke, heat treating rocks to improve their knapping quality, and the use of low temperature heat to dehydrate adhesives for hafting tools and weapons.

Music

Aniruddh Patel, Tufts University

Have humans evolved neural specializations for music processing, or is music a purely cultural invention based on brain circuits that evolved for other reasons, like literacy? This debate, which goes back to Darwin's writings on music in *The Descent of Man*, is far from resolved. While the debate is often framed as a dichotomy between biological vs. cultural views of music's origins, a new line of thinking is emerging which considers musicality in the framework of gene-culture coevolution. In this talk, I introduce this framework and present relevant findings from neuroscience, cross-species studies, and genetics.

Art, Story, Mind

Iain Davidson, University of New England, Australia

The role of art in anthropogeny cannot be understood by using concepts from modern students of art, since art theory and art philosophy have moved a long way from anything that led to them. Our goal is to understand how those modern concepts arose in hominin and human evolution. To investigate this, first, we need a definition of art which will encompass early examples and yet lead us to a definition we can recognize. Art is about a material intervention in relationships between people and the stories that define those relationships. Second, what are the claims for art among modern apes, and indeed other modern animals, in the wild and in captivity. There is fascinatingly little evidence of the use of material in relationships among free-living apes, but, of course, we cannot engage in story telling with apes. When we explore the archaeological record in search of such relationships, we uncover similarities and differences between what might be early art (which I call Art 3) and art now (which I call Art 1). Third, we will look at some examples of early art (Art 3) from the archaeological record. Fourth, what are the implications of the first part of the talk for our understandings of what Art (Art 1) is and how it came to be? The point is that in all cases, art is embedded in culture and story-telling. Finally, why do scenes make a difference to the way humans see the world? Once people started to represent scenes, the art could stand alone without the artist—it tells its own story—and observers could infer their own understanding. The art seems to have implicational meaning of its own.