THE GREAT APE NEUROSCIENCE PROJECT
PROGRESS REPORT – FEBRUARY 2011

Introduction. As our closest living relatives, great apes share similarities with humans in terms of cognition, emotion, sociality, and susceptibility to some diseases of aging. Yet despite these striking similarities, important differences exist that set humans apart with regard to brain structure and function. The overarching goal of the Great Ape Neuroscience Project is to investigate the neurobiological basis of variation that distinguishes great apes from other primates, defines each great ape species as unique, and helps us to better understand humans' place in nature. The Great Ape Neuroscience Project has been active for just over a decade and continues to be at the forefront of comparative research in primate neuroscience. Our research publications have garnered thousands of citations in diverse journals spanning biology, psychology, veterinary medicine, primatology, and anthropology. Our accomplishments are the result of a community of collaborators from zoos, academic institutions, and governmental organizations. The contribution of each member in this network is essential to advancing the science of great ape neurobiology. This report was prepared to provide an update on the outcomes of the Great Ape Neuroscience Project. We look forward to working together in the future.

Background. The Great Ape Neuroscience Project originated as an extension of the Great Ape Aging Project (funded by the National Institute on Aging of the National Institutes of Health). The Great Ape Aging Project was conceived of as a means of adding scientific value to elderly apes in captivity. The need was seen by members of the Association of Zoos and Aquariums Ape Taxon Advisory Group (Ape-TAG) to increase the quantity and quality of humane scientific studies of apes in zoological collections. It also became clear that many chimpanzees in research facilities were regarded as "surplus to research needs," and were thought to be unsupportable with research funds. Medical scientists studying the causes of neurodegenerative diseases such as Alzheimer's and Parkinson's diseases expressed interest in studies of brain and behavior in great apes to determine whether or not the same neurodegenerative processes occurred in them as in afflicted humans. The convergence of these interests and needs led to the development of the Great Ape Aging Project in 1997.

Progress. Soon after the first brain specimens were received, it became clear that much remained to be learned about the basic similarities and differences in the neuroanatomy of great apes and humans, as well as other primates and mammals. One of the first achievements was discovery that a neuronal type dramatically affected in advanced Alzheimer's disease (and thought to exist exclusively in humans), called the von Economo neuron, is present in the brains of all the great apes. Since its inception, the project has acquired more than 100 great ape brains that have been involved in detailed comparisons with human and other primate and mammalian brains, using advanced imaging, immunohistochemical, and stereological techniques.

Highlights of major findings include:

- The overt shrinkage of the frontal lobe and hippocampus that is characteristic of human brain aging is not observed in aged chimpanzees.

- Comparisons of gene expression in the cerebral cortex of humans, chimpanzees, and gorillas indicate that there has been upregulation of genes involved in metabolism and synaptic function

in humans. Consistent with this idea, the neurons of the frontal cortex become progressively more metabolically costly with brain enlargement in primates, as indicated by counts of surrounding glial cells. This greater requirement for energy uptake may be associated with vulnerability to oxidative damage, which characterizes diseases of aging, such as Alzheimer's disease.

- The anatomical supply of the neurotransmitters dopamine, serotonin, and acetylcholine to the prefrontal cortex of humans and chimpanzees are similar, but differ from macaque monkeys. This indicates that some aspects of the neuromodulation of cognitive processing are evolutionarily derived in the ape-human lineage.

- Compared to great apes, only humans show a leftward asymmetry of Broca's area of the cerebral cortex, a region that is important for the production of speech and language. In contrast, humans and great apes are similar in displaying asymmetry of Wernicke's area, a region that is important for decoding complex sounds used in language.

Funding. The initial phases of this project were supported by grants from the National Institute on Aging of the National Institutes of Health (AG14308). Later phases have received grant support from the National Science Foundation, National Institutes of Health, Wenner-Gren Foundation, and James S. McDonnell Foundation. We are well supported by external funds, postdoctoral scientists, and graduate students to continue pursuing the most cutting-edge research on great ape neurobiology.

Moving Forward. We hope to develop a strong communications network that will enable information to flow between ourselves and the staff who provide care, clinical, and curatorial expertise at the home institution of each participating ape. People who had a special interest or affinity with a specific ape will be able to find out exactly what was learned from that individual. **To sustain progress in our studies of the comparative neurobiology of great apes and other primates, we renew our request for collaboration**. We continue to seek intact brains from great apes, as well as other primates and mammals. Whole fixed brains are best suited for MRI scanning prior to histological sectioning for research and pathology diagnosis. If the postmortem interval before brain collection is less than 12 hours, we request the left hemisphere fixed and the right hemisphere snap frozen or placed in RNAlater. **When brain tissue specimens are provided, we will make every effort to secure a collaborating neuropathologist to provide a detailed neurological report to the institutional veterinarian. Alternatively, we will coordinate dissection and sampling directly with the originating institutions in case they desire performing their own neuropathologic examination and we will return sufficient materials for the diagnostic procedures. We will also provide a high-quality 3 T MRI (and as of spring 2011, 7 T) with DTI of each brain, if intact.** All our research on postmortem brains is conducted in coordination with Dr. William Hopkins (Division of Psychobiology, Yerkes National Primate Research Center and Department of Psychology, Agnes Scott College), a comparative psychologist with decades of experience collecting behavioral data in captive populations of great apes. We will continue to work together with Dr. Hopkins to correlate studies of brain structure with the behavioral measures he has obtained from these apes during their lifetime.

We will present progress reports to all participating institutions on an annual basis to apprise them of the general scientific findings arising from the project and to make them aware of the contributions made by specific animals that were housed under their care.

Contacts. Please contact us if you have any questions about the contents of this report, or if additional agreements and applications are required to renew our collaboration. Upon request, we can provide shipping account information for billing, as well as other supplies for brain specimen collection.

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Conference Abstracts

Our research has been presented regularly at annual meetings of the Society for Neuroscience, the American Association of Primatologists, the International Primatological Society, the American Association of Physical Anthropologists, as well as others.

Trainees (2000-2011)

Undergraduates	*Graduate students*	*Postdoctoral fellows*
Paula Lee	Esther Nimchinsky	Emmanuel Gilissen
Roxana Flagg	Chet Sherwood	Daniela Vogt Weisenhorn
Monica Rubin	Tanya Page	Yong He
Tony Flores	Huiling Duan	Claire Rivara
Tom Rein	Daniil Rohlshud	Atiya Hakeem
Rebecca Chanis	Michael Einstein	Anne Rocher
Cheryl Stimpson	Alisha Macedo	Estelle Van der Gucht
Elizabeth Wahl	Harlan Bruner	Monica Uddin
Amy Garrison	Mary Ann Raghanti	Muhammad Spocter
Virginie Goubert	Alexandra de Sousa	Yukti Sharma
Bridget Wicinski	Camilla Butti	T Xu
Michael Carey	Amy Bauernfeind	Natalie Schenker
Adrienne Zigo	Nicole Tetreault	Tanya Duka
Greg Carr	S Watson	Steven Chance
Clay Long	Eric Lewitus	
Brittany von Derau	Chad Lennon	
Jackie Hill	James Taylor	
Jackie Gesumaria	Nicolaas Fourie	
Susan DeMartino	Tanvi Avasthi	
Kanika Gupta	Daniel Miller	
Shanyn Ronis	Kate Teffer	
Sarah Anderson	Nicole Barger	
Abigail Hehmeyer		
Zach Collins		
Abby Knop		
Sophia Reji		