

Psychology W3470  
***Brain Evolution: Becoming Human***  
 Spring 2011  
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**I. Bulletin description**

PSYC W3470 Brain Evolution: Becoming Human (seminar)  
 4 pts J Curley W 12:10-2:00 PM 200C Schermerhorn Hall

Prerequisite: At least two other psychology courses and the instructor's permission.

Investigation of the uniqueness of the human brain and human behavior from an evolutionary perspective, approached from many levels of inquiry--from mechanistic changes to the human genome and neurobiology, to evolutionary shifts in emotional and cognitive capacities, to the evolution of higher-order processes such as language, beliefs, morals and consciousness. The course will draw upon research from many disciplines, including animal behavior, biological anthropology, psychology, neuroscience, genetics and social anthropology.

**II. A full description of the content of the course**

One of the fundamental questions throughout scientific history has been *What makes the human species unique?* In particular, for psychologists, the critical question is *Which aspects of our brain and behavior are those that define us as human?* If we can identify such human traits, is it then possible to trace their evolutionary history in the human lineage and to determine when they evolved, for what reasons and under which selective pressures? Furthermore, can we trace those changes that have occurred in our genomes and neurobiology that have led to these behavioral adaptations? Throughout this course, we shall examine the evolution of the human brain and behavior, bringing together evidence from a variety of disciplines including animal behavior, psychology, neuroscience, genetics and biological anthropology to try and delineate what it is about our brains that makes us uniquely human.

This course will address the evolution of the human brain and behavior from a number of different perspectives including: 1) the fossil evidence for human brain evolution, 2) evolutionary hypotheses for the remodeling of brain structures in humans 3) neural specializations in the human lineage, 4) genetic specializations in the human lineage, 5) the interaction of genetic and cultural processes in human evolution, 5) the evolution of emotions, 6) the evolution of cognitive capacities and 7) the evolution of language.

### III. The rationale for giving the course

PSYC W3470 is an advanced seminar, most fitting for undergraduates who are majoring in Psychology or in Neuroscience and Behavior, and for students participating in the Postbac Psychology Program. This course covers both genetic and neurobiological aspects of behavior and brain development and thus provides an integrated perspective on topics of current interest in the fields of psychology, organismal biology and neuroscience. This course is intended to explore the topic with a comparative approach and would therefore be appropriate for biology and anthropology students in addition to psychology students.

It fulfills the following degree requirements:

- PSYC W3470 will meet the Group II (Psychobiology and Neuroscience) distribution requirement of the Psychology major or concentration in the College and in G. S., the Psychology minor in Engineering, and the Psychology Post-bac certificate.
- For the Neuroscience and Behavior joint major, W3470 will fulfill the 5<sup>th</sup> Psychology requirement: “one advanced psychology seminar from a list approved by the Psychology Department advisor to the program.”
- W3470 will meet the seminar requirement of the Psychology Post-bac certificate.
- For the science requirements of the College and GS, W3470 will satisfy one term of the requirement, provided that students obtain the necessary permission and have taken the prerequisite two psychology courses. Students who are majoring in Psychology or in Neuroscience and Behavior will have priority over Biology and E3B students, or students who are taking the course for the science requirement.

### IV. The reading list and weekly syllabus

Representative reading assignments are provided but may change.

#### Weekly overview

#### **Week 1 – Weds Jan 19<sup>th</sup> 2011 :- Introduction**

#### **Week 2 – Weds Jan 26<sup>th</sup> 2011 :- Evidence for Human Brain & Behavioral Evolution**

*What does the fossil record tell us about the evolution of the human lineage and the human brain? How can and when do we observe changes in the behavioral abilities and capacities of our ancestors? What can we learn about the behavioral abilities of our closest extinct relatives the Neanderthals? What can we discover about the evolution of our own behavior from observations of our closest living relatives, other primates?*

#### READINGS:

Holloway RL, 2008, The human brain evolving: a personal retrospective, *Ann Rev Anth* 37: 1-19.

Park MS et al., 2007, Evolution of the Human Brain: Changing Brain Size and the Fossil Record, *Neurosurgery* 60: 555-62.

Ponce de Leon MS et al., 2008, Neanderthal brain size at birth provides insights into the evolution of human life history, *PNAS* 105: 13764-8.

**Week 3 – Weds Feb 2<sup>nd</sup> 2011 - : Evolutionary explanations for the evolution of human brain size**

*Which selective pressures have been greatest in driving the evolution of the large primate and human brain? Are social, ecological or cognitive pressures more important? How have humans managed to account for this metabolically expensive brain? Have other species with large brains for their body sizes solved this evolutionary puzzle in the same manner?*

READINGS:

Aiello LC & Wheeler P, 1995, The Expensive-Tissue Hypothesis: The Brain and the Digestive System in Human and Primate Evolution, *Curr. Anth.* 36: 199-221.

Byrne RW & Bates LA, 2007, Sociality, Evolution & Cognition, *Curr. Biol.* 17: R714-23.

Dunbar RIM, 2009, The social brain hypothesis and its implication for social evolution, *Ann. Hum Biol* 36: 562-72.

Healy S & Rowe C, 2007, A critique of comparative studies of brain size, *Proc Roy Soc* 274: 453-64.

**Week 4 – Weds Feb 9<sup>th</sup> 2011 - : Remodeling of brain development & structure during evolution**

*Why have all areas of the human brain not increased in size at the same rate? What does the differential evolution of each sensory and cognitive area tell us about the course of human evolution? What are the genetic underpinnings of this differential evolution? Is the human brain continuing to evolve?*

READINGS:

Barton RA, 2007, Evolutionary specialization in mammalian cortex structure, *J Evol Biol* 20: 1504-11.

Curley JP & Keverne EB, 2005, Genes, brains and mammalian social bonds, *TREE* 20: 561-7.

Herculano-Houzel S, 2009, The human brain in numbers: a linearly scaled-up primate brain, *Front. Hum. Neuro* 3: 1-11.

Schoenemann PT, 2006, Evolution of the size and functional areas of the human brain, *Ann Rev Anth* 35: 379-406.

**Week 5 – Weds Feb 16<sup>th</sup> 2011 - : Journal presentation week**

6 students will critically evaluate a research journal article about a topic from the first half of the semester.

**Week 6 – Weds Feb 23<sup>rd</sup> 2011 - : Neuronal specializations in the human lineage**

*What brain areas and neural components are unique to humans? What are the functional consequences of such uniqueness? Can such evolutionary specializations be responsible for the extraordinary behavioral and cognitive capacities of humans?*

READINGS:

Raghanti MA et al., 2009, Species-specific distributions of tyrosine hydroxylase-immunoreactive neurons in the prefrontal cortex of anthropoid primates, *Neuroscience* 158: 1551-9.

Sherwood CC et al., 2008, A natural history of the human mind: Tracing evolutionary changes in brain and cognition, *J. Anat* 212: 426-54.

Sherwood CC et al., 2006, Evolution of increased glia-neuron ratios in the human frontal cortex, *PNAS* 103: 13606-11.

### **Week 7 – Weds Mar 2<sup>nd</sup> 2011 - : Genetic specializations in the human lineage**

*Given the 99% genomic similarity between humans and chimpanzees, how can we identify relevant genetic changes that relate to the modifications in neurobiology and behavior in humans? Which genes have been identified as being positively selected for in the human lineage? Is the human genome still evolving?*

#### READINGS:

Evans PD et al., 2006, Evidence that the adaptive allele of the brain size gene *microcephalin* introgressed into *Homo sapiens* from an archaic *Homo* lineage, *PNAS* 103: 18178-83.

Mekel-Bobrov N et al., 2005, Ongoing Adaptive Evolution of *ASPM*, a Brain Size Determinant in *Homo sapiens*, *Science* 309: 1720-2.

Pollen AA & Hofmann HA, 2008, Beyond neuroanatomy: novel approaches to studying brain evolution, *Brain Behavior & Evolution* 72:

Vallender EJ et al., 2008, Genetic basis of human brain evolution, *TINS* 31: 637-44.

### **Week 8 – Weds Mar 9<sup>th</sup> 2011 - : Midterm exam**

### **Week 9 – Weds Mar 23<sup>rd</sup> 2011 - : Gene-culture co-evolution**

*It is increasingly acknowledged that human evolution has been characterized by gene-culture interactions. How have cultural processes modified genetic selection and shaped the natural selection of human behavior? How have humans shaped their own evolutionary history?*

#### READINGS:

Bell AV et al., 2009, Culture rather than genes provides greater scope for the evolution of large-scale human prosociality, *PNAS* 106: 17671-4.

Laland KN et al., 2010, How culture shaped the human genome: bringing genetics and the human sciences together, *Nat Rev Genet* 11: 137-48

Varki A et al., 2008, Explaining human uniqueness: genome interactions with environment, behaviour and culture, *Nat Rev Genet* 9: 749-63.

### **Week 10 – Weds Mar 30<sup>th</sup> 2011 - : The expression of the emotions in man and animals**

*Charles Darwin's book of this name was published in 1872 and addressed his view about the evolution*

*of human emotional capacities. Darwin was particularly concerned with describing the common descent and cross-cultural universality of human expression of emotion – how have modern approaches to the study of the evolution of human emotion expanded upon this? Is it possible to determine the common descent of emotions and ascribe adaptive explanations to their selection? Can we identify emotions that are unique to humans? How do human emotions influence other behavioral domains specialized in humans such as attention, cognition, memory and motivation and can these be interpreted from an adaptationist perspective? Finally, what is the relationship between the evolution of human emotions, culture and social behavior, and how might this have led to unique human traits such as beliefs and morals?*

#### READINGS:

Adolphs R, 2009, The Social Brain: Neural Basis of Social Knowledge, *Ann Rev Psych* 60: 693-716.  
Ekman P, 2009, Darwin's contribution to our understanding of emotional expressions, *Phil Trans Roy Soc* 1535: 3449-51.

Huebner, B., Dwyer, S., Hauser, M.D. 2008. The role of emotion in moral psychology. *Trends in Cognitive Science* 12: 1-6

Nesse R & Ellsworth PC, 2009, Evolution, emotion and emotional disorders, *American Psychologist* 64: 129-39.

#### **Week 11 – Weds Mar 6<sup>th</sup> 2011 - : Journal presentation week**

6 students will critically evaluate a research journal article about a topic from the second half of the semester.

#### **Week 12 – Weds Mar 13<sup>th</sup> 2011 - : The evolution of cognition & evolutionary psychology**

*The evolution of unique human cognitive capacities has attracted numerous adaptive explanations. Which of these various approaches provides the most appropriate framework for studying the evolution of human cognition? What can animal behavior tell us about the evolution of human cognition and do some animals have similar higher-level cognitive abilities? Did particular cognitive abilities (learning, memory, attention, etc.) evolve as separate modules in response to specific environmental challenges or was there a general gradual change in cognition? What selective pressures led to the evolution of a “theory of mind”? How does understanding of this evolution inform our ideas about consciousness and whether that is a unique human ability?*

#### READINGS:

Barbey AK et al., 2009, An evolutionarily adaptive neural architecture for social reasoning, *TINS* 32: 603-10.

Brune M & Brune-Cohrs U, 2005, Theory of mind—evolution, ontogeny, brain mechanisms and psychopathology, *Neurosci. Biobehav. Rev.* 30: 437-55.

Butler AB, 2008, Evolution of brains, cognition and consciousness, *Br. Res. Bull.* 75: 442-9.

Tattersall, I. 2007. How did modern human cognition evolve? *In* H. Cohen and B. Stemmer (eds), *Consciousness and Cognition: Fragments of Mind and Brain*: 3-17. San Diego CA, Elsevier.

**Week 13 – Weds Mar 20<sup>th</sup> 2011 - : The evolution of language**

*Is human language unique? What can we determine about the linguistic capabilities of our closest ancestors such as Neanderthals? Is language necessary for conceptual representation? How do non-human animals represent social and vocal information and did language evolve from such systems? What are the neural and genetic changes that have occurred during human evolution to facilitate language acquisition?*

READINGS:

Charter N et al., 2008, Restrictions on biological adaptation in language evolution, PNAS 106: 1015-20.

Fogassi L & Ferrari PF, 2007, Mirror Neurons and the Evolution of Embodied Language, Current Directions in Psychological Science 16: 136-41.

Hauser, M. 2009. The possibility of impossible cultures. *Nature* 460: 190-196.

**Week 14 – Weds Mar 27<sup>th</sup> 2011 - : Final exam****V. Course requirements**

Each week, students will attend a two-hour seminar. Class time will be devoted to the presentation and discussion of journal articles. The reading is intended to provide background knowledge on the relevant topics, to cover current research on those topics, and to serve as a stimulus for discussion. Classes will either consist of overview lectures by the instructor followed by class discussion or of student seminars.

The students take a written midterm exam with short answer questions covering the material in the papers and the class discussions. The final exam (during the last day of class) will also consist of short answer questions.

Grading is allocated as follows:

Class participation & attendance	20%
Journal presentations	30%
Midterm Exam	25%
Final Exam	25%