James Madison University
Honors Program

Department of Geology/Environmental Studies
Department of Sociology & Anthropology

SYLLABUS - HONORS 200B

EVOLUTION OF THE BRAIN AND INTELLIGENCE

FALL, 1998

Index Number: 3172
Credit hours: 03

Building/Room: Room 209 Miller Hall
Time TT 12:30 - 2:30

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Office hours:	MW 10:00-11:00; TT 8-10, and by appointment	By appointment; or just drop by; in the office most of the time.

Final Exam: Tuesday, December 15, 10:30-12:30

Purchased Texts: See page 3 for details and discussion

- ☺ Ornstein and Thompson, 1984, The Amazing Brain
- ☺ Notebook of Lecture Illustrations; purchased from Dukes Duplicates
- ☺ Jaynes, Julian, The Origin of Consciousness in the Breakdown of the Bicameral Mind
- ☺ Sack, Oliver, 1985, The Man Who Mistook His Wife for a Hat
- ☺ Ackerman, Diane, A Natural History of the Senses
- ☺ Cytowic, Richard E.,1993, The Man Who Tasted Shapes:

INTRODUCTION

The human brain is the most complex entity we know in the universe. Its immediate history goes back nearly 600 million years to the origin of the vertebrates and has resulted from a complex chain of random events and systematic structure guided by natural selection. In the larger sense the history of the human brain goes back to the origins of the universe. It is possible, based on current theories of evolutionary processes in the universe, that the origin of a higher intelligence in our universe is inevitable given enough time. The universe, in a sense, has evolved a part of itself to study the rest of it; we are the universe looking at itself and wondering how and why. And that part is now looking at itself too, and wondering how and why. [The evolution of our brain was not, however, inevitable from a naturalistic perspective.] Until recently human beings, whether philosophers, theologians, humanists, or scientists, have treated the brain as a black box - observing what goes in, and what comes out, but having little insight or understanding of how what happens in between constructs and influences our sense of reality and its interpretations. Frequently people have made untested and unverified assumptions about how the brain works, oftentimes in attempts to support world views they espouse for other reasons. Research is beginning to tell us that many of these assumptions are not true. Every thought, every feeling, every belief, every action is the direct result of immensely complex processes in the brain, some of which are innate and over which individuals have little or no control. Furthermore, how the brain constructs reality, i.e. what people experience to be real, is influenced by the food they eat, the substances they ingest, their experiences, and the trauma and deprivation they are subject to. One of the most significant conclusions of brain research is that there is no one model of reality.

The fully developed human brain is so complex, and it works so well at creating a model of reality that it is hard to appreciate just how well it works. Two traditional tactics exist to find answers. The first is to study the effects of brain injuries resulting from strokes, war injuries, brain surgery, etc. The second tactic is to study simple nervous systems and to put the human brain into historical context.

Recently, however, advances in technology have allowed direct experimentation on the brain with such techniques as CAT scanning, probing with electrodes, etc. Extensive recent research in computer generation of Artificial Intelligence and Artificial Life has given insight into how an animal brain does and does not work. A vast amount of research has been done on the brain by neurophysiologists, psychologists, paleontologists, anthropologists, mathematicians and many others, and recently grand syntheses have been done constructing theoretical models of the environmental and evolutionary history which, by putting the human brain in context, demonstrates its marvelous complexity.

Despite all this study, it is still fair to say that we do not yet understand the brain, or how it in fact operates. And although our approach in this course is to look at the origin of the brain historically, and some of the principles behind its evolution, we also examine some contemporary ideas about the functioning of the human brain.

The professors for this course each approach it from a long interest in the brain and its evolution. Their perspectives, however, are different, but complementary. Bill Boyer is an anthropologist with primary interests in human origins and evolution, and naturally has interests in the evolution of the human brain and its influence on the development of language, culture, social structures, behavior, etc. Lynn Fichter is a vertebrate paleontologist by training whose interest stems from the larger picture of vertebrate history and attempts to construct the perceptual world of extinct animals. This interest grew

into interest in human perception and intelligence, especially questions about how the brain constructs models of reality and their influence on religious experience and science. It is these two world views which lie behind the course.

TEXTS AND OTHER READINGS

No textbooks (that is, a compact description and summary of everything known and professionally accepted) exist for this subject. But, seminal other works about the brain and intelligence are staggeringly abundant, diverse, and scattered, and exist at all levels of technical sophistication. We used to try and keep a list of representative books dealing with the brain and mind, but books on these subjects are now published by the dozens each year. It is practically impossible to keep up with the barrage of words and ideas. This reflects not only the great interest in the brain, but also how rapidly ideas are growing and changing.

The textbook by Ornstein and Thompson is, however, a good introduction to the current state of scientific knowledge about the human brain. We want you to read this book within the first three weeks of the semester. It prepares you to think about this subject in a scientific manner.

The Notebook of Lecture Illustrations, purchased from Dukes Duplicates, contains most of the "handouts" used in the course of the semester.

A variety of other readings are assigned throughout the semester. As the course progresses we select the best currently available readings at the appropriate level and make them available among the reading materials stored in the class room. It is a cardinal rule THAT NO READINGS MAY BE REMOVED FROM THE CLASS ROOM UNDER ANY CIRCUMSTANCES FOR ANY PERIOD OF TIME. . . There are two exceptions to the rule:

(1) IF there is a class in the room while you want to read you may take it into another room, BUT you must leave a note on the board--name, time, title of reading and return the reading immediately after use.

(2) If you want to photocopy something you may remove it for the period of time to do that; BUT leave a note on the board, and return it immediately! Since many people require the use of these readings, and some of the information necessary for test preparation may be contained therein, the inconsiderate removal of any readings is considered cheating, and prosecuted as such.

BOOKS FOR THE SEMINAR PORTION of the course must be purchased. They are not necessary until the last part of the semester (see schedule), but should be purchased earlier since the bookstore sends unpurchased copies back by mid semester. A list of some of the works to be discussed are listed below. We may add some other works at seminar time. Some of the works for seminar discussion are journal articles. The Zygon journal with the d'Aquili article is in the class room on the reading shelf and we request that each of you make a photocopy to bring to the seminar.

READING LIST - INTRODUCTION TO THE BRAIN

☺ Ornstein, Robert, and Richard F. Thompson, 1984, The Amazing Brain: Houghton Mifflin Company: ISBN 0-395-40800-8, 182 p.

READING LIST - SEMINARS

- ☺ d'Aquili, Eugene G., 1978, The Neurobiological Bases of Myth and Concepts of Deity: Zygon, v. 13 (4), p. 257-273. (to be photocopied from master copy on reading shelf)
- ☺ Jaynes, Julian, 1976, The Origin of Consciousness in the Breakdown of the Bicameral Mind: Houghton Mifflin Company, Boston, 467 p.
- ☺ Sack, Oliver, 1985 , The Man Who Mistook His Wife for a Hat:
- ☺ Ackerman, Diane, 1990, A Natural History of the Senses: Random House
- ☺ Cytowic, Richard E.,1993, The Man Who Tasted Shapes: Tarcher/Putnam ISBN 0-87477-738-0

COURSE METHODOLOGY

The course is divided into two stages, although they are not separated by a distinct and sharp break. Rather the emphasis shifts steadily from a *"what do we know"* stage to a *"what are the implications"* stage as the semester progresses.

The first stage is primarily lecture format covering the assumptions and working principles behind the study of the brain and mind, i.e. the scientific world view, principles of evolution, anatomy and function of the brain, and the evolutionary history leading to the development of the human brain. You cannot plan to just sit back and passively absorb this knowledge, however. This knowledge is repeatedly accompanied by the exploration of ideas, concepts to discuss, and questions to explore. Accompanying this is a diverse reading list.

Accompanying this will be a variety of computer demonstrations, some done in class, some homework experiments you run in the Geology Computer Lab (Miller 230). There is a long history of research into AI (Artificial Intelligence), much of the early work misguided for understanding how real brains work. More recently advances in chaos and complexity theory (non-linear dynamics), as well as the study of neural networks, have made important contributions to understanding how brains work.

The second stage of the course shifts toward seminar format where more theoretical and controversial topics are discussed. The seminar is conducted like a Socratic Seminar (details later). These discussions focus on books or articles in such areas as the origin of consciousness, origins of ethics and morality, nature vs. nurture (is behavior hardwired into the brain or not), the universality of mystical/religious experiences and what that means in terms of brain function, etc. There are many potential seminar readings. The ones we have chosen have worked well in the past, and explore subjects discussed during the early part of the semester. It is quite likely we will run out of time before exploring all of them, and there is an outside possibility alternative reading may be substituted.

TESTING AND GRADING

The grade for this class is based on the following:

30% Quizzes and minor tests
20% Writing assignments, contributions to seminar, and any other assignments made during the semester.
25% Take Home Portion of Final
25% Seminar Portion of Final

100%

- ☺ All grading is done on a 12 point scale (A+ = 11-12, A = 10-11, A- = 9-10, B+ = 8-9, etc.).
- ☺ Final grades are calculated by averaging the grades for each category above, and then multiplying them by their percentage value.
- ☺ The quizzes and minor tests deal with specific, narrowly focused factual matter and interpretations.
- ☺ The final exam consists of two parts. First part is a series of questions handed out ahead of time you prepare for. You prepare for all the questions, but during the exam you answer only selected questions. These questions deal with broad, synthetic topics. The second part of the final consists of the analysis and interpretation of the seminar books and articles we discuss. You will not know which article(s) you will have to write on until the time of the exam. Details later.
- ☺ The writing assignments are relatively numerous but not that long. There will not be term papers.
- ☺ Contributions to the seminars are another matter, however. Your contributions to the seminars are critical since the goal of a seminar is NOT for the professors to tell you anything. Our job is only to ask you question after question about the work before the seminar until you begin to sustain the discussion among yourselves. Then we become moderators. What questions do we ask?
  1. We must first be sure we all clearly understand what the author is saying, not what we think they are saying, or want then to say, but what they are saying. We will, thus, begin the seminar by asking you questions of the work in front of us to insure you have read carefully and clearly, and understand what the author is saying.
  2. We usually assign specific questions and problems ahead of time to think about as you read the work (see Notebook of Lecture Illustrations).
  3. We then ask questions which probe the meaning and implications of the author's ideas.

Details will follow later.

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PHILOSOPHICAL OVERVIEW OF OUR STRATEGIES AND GOALS

One difficulty with trying to study the evolution of the brain is the intricacy, diversity, and complexity of the subject matter. In our attempts to unravel the evolution of the brain it is necessary to seek evidence and arguments from a wide diversity of disciplines; and to genuinely appreciate the problems, and attempts to understand and solve them, this evidence and these arguments need to be explored in some detail. So at various points we need to discuss classification, evolutionary relationships and phylogeny, comparative anatomy, physiology, evolutionary theory, structure of the brain, philosophy, anthropology, and many others.

On the other hand, every subject we explore is a rich topic on its own. Each of these subjects could take weeks to explore, even in survey, and we typically devote only a few hours to them.

This is often difficult for us, to give a short-changed and inadequate presentation of subjects which fascinate us. But in this course we do have another goal, and so will just have to live with the dissatisfaction of exploring a subject inadequately. That goal is to understand the brain.

To be tested in detail on all this material would be overwhelming, and actually defeat the purposes of this class. Our goals are not so much to force you into detailed knowledge of everything but rather to explore with you the diversity of this fascinating subject matter, the kinds of problems encountered, and the ways they are solved.

Still, there are things which you must come to know and understand before you can move on to more encompassing subjects. If you were just to try to absorb the knowledge by listening in class but not engaging the material, it would not be long before you became confused, and then lost. Thus, the quizzes, tests, and writing assignments are not really there because we have a strong desire to make you do a lot of busy work. Instead they give you a reason to grapple with, come to know and make your own a body of knowledge necessary to understand later topics. What we are really after is preparing you to write erudite essays analyzing the deeper questions dealt with in the seminar and on the final exam. If you can do that then you have begun an understanding of this subject, and will be able to pursue it on your own in the future.

It is our intent, therefore, that as the semester progresses the emphasis of the course will shift from the concrete to the abstract. The abstract which is our real goal since in one semester we cannot adequately deal with all of the individual topics which support and inform the abstract. Where we want to end up by the end of the semester is attempting a holistic understanding of this very complicated brain we have, and all that it took to create it, and all that it is taking to understand it, and grappling with what it means to be human.

COURSE OUTLINE

The times given for each topic are estimates. Each of these subjects is more involved than outlined here and could take considerably longer. Because new advances or insights continuously require reevaluation of the course subject matter we have to play the schedule "by ear".

Topics	Instructor	Estim. Time
I Epistemology and Understanding the Brain ☺ Mythology and the human brain ☺ Naturalistic strategies for understanding the brain's function and evolution	Fichter	4 hours
II The Evolution of Hierarchial Systems ☺ Systems ☺ Dissipative Structures and Self Organization ☺ Chaos and Emergent Properties	Boyer	5 hours
III Artificial Intelligence (AI), Artificial Life (ALife), Chaos/Complexity Theories, and Neural Networks ☺ The origin of complexity from simplicity, emergent properties, and modern evolutionary theory ☺ Why AI is not like animal intelligence and ALife is ☺ Neural networks-strategies for how real brains work	Fichter	7 hours
IV Survey of vertebrate evolution ☺ Origin of the vertebrate brain ☺ Organization and function of a basic vertebrate brain ☺ Survey of Vertebrate Evolution	Fichter	5 hours
V Anthropology and the evolution of Homo sapiens ☺ Origins of the human species ☺ Evolutionary pedigree of the human brain ☺ Coevolution of culture and intelligence	Boyer	5 hours
VI Perceptual Worlds of the Vertebrates ☺ Just what do other vertebrates experience about the world. ☺ Evolutionary principles of the brain and intelligence ☺ Stages in the evolution of the brain and intelligence, and why and how they came about	Fichter	6 hours
VII Consciousness in Other Species	Boyer	4 hours
VIII Seminar Discussions ☺ What it means to be conscious and the historical origins of consciousness ☺ A return to mythology; where is God in the brain ☺ What abnormal brain functioning can tell us about being human ☺ How much of being human comes from our senses?	Boyer /Fichter	Remaining Time (but still not enough time!)