1 What is Biopsychology? (aka psychobiology, behavioral neuroscience, etc)
   • The scientific study of the biology of behavior
     - How can complex psychological processes, such as perception, emotion, thought and memory be produced by brain activity?

2 Why is it Interesting?
"From nothing else but the brain come joy, delights, laughter and sports, and sorrows, griefs, despondency, and lamentations...madness and delirium... the fears and frights which assail us... thoughts that will not come, forgotten duties, and eccentricities... All these things we endure from the brain...”
- Hippocrates, On the Sacred Disease, 4th Century B.C.

3 Can the study of brain activity really tell us about complex mental processes?
   • Some skepticism is understandable
   • Some complex mental processes are not particularly amenable to biological investigation - but this may be changing

4 Can the study of brain activity really tell us about complex mental processes?

5 Are there changes in brain structure associated with mental activity?
   • from Proceedings of the National Academy of Sciences, 2000
     • Hypothesis: relatively normal mental activity can change volume of the brain
       ▪ Subjects: 16 male, right-handed London taxi drivers
         50 matched controls (matched for??)
     • Method: Used MRI to measure hippocampus size
       Why hippocampus? Constructs and stores maps of the external world from the sensory input that it receives

6 Can the study of brain activity really tell us about complex mental processes?

7 Can the study of brain activity really tell us about complex mental processes?
   • fMRI: functional magnetic resonance imaging
     • detects the regional changes in blood oxygenation due to activity-related changes in blood flow:
       More active neurons (shown in hot colors)
       --> more blood flow
       --> more $O_2$

8 fMRI Taken During Picture Naming Task
fMRI Taken During Picture Naming Task

Why Else is Biopsychology Interesting?
- Disorders of the brain and nervous system result in more hospitalizations than any other disease group, including heart disease and cancer.
- Neurological illnesses affect more than 50 million Americans annually (total US population is about 300 million) at costs exceeding $400 billion.
- In addition, mental disorders, excluding drug and alcohol problems, strike 44 million adults a year at a cost of some $148 billion.

Why Else is Biopsychology Important?
- We are bombarded by biopsychological information. How can we evaluate it?

Course Goals:
- Introduce the principles of experimental biopsychology
- Survey the structure and function of the nervous system
- Examine the relationships between brain function and behavior
- Educate consumers of biopsychological information (encourage critical thinking)

Biopsychology applies information from several branches of neuroscience to the study of behavior
- Neuroanatomy - structure of the nervous system
- Neurochemistry - chemical basis of neural activity
- Neuroendocrinology - interactions between nervous system and endocrine system
- Neuropathology - nervous system disorders
- Neuropharmacology - effects of drugs on neural activity
- Neurophysiology - functions and activity of the nervous system

The Traditional Divisions of Biopsychology
- Physiological Psychology
  - Studies neural mechanism of behavior through direct manipulation of the brain in controlled experiments
- Psychopharmacology
  - Focuses on manipulation of neural activity and behavior with drugs
The Traditional Divisions of Biopsychology

- Physiological Psychology
- Psychopharmacology
- Neuropsychology
  - Study of psychological effects of brain damage in human patients

The Traditional Divisions of Biopsychology

- Physiological Psychology
- Psychopharmacology
- Neuropsychology
- Psychophysiology
  - Studies the relationship between physiological activity and psychological processes in human subjects

The Traditional Divisions of Biopsychology

- Physiological Psychology
- Psychopharmacology
- Neuropsychology
- Psychophysiology
- Cognitive Neuroscience
  - Studies the neural bases of cognition

The Traditional Divisions of Biopsychology

- Physiological Psychology
- Psychopharmacology
- Neuropsychology
- Psychophysiology
- Cognitive Neuroscience
- Comparative Psychology
  - Compares the behavior of different species to understand the evolution and adaptiveness of behavior

Biopsychology Uses Several Types of Research

- Experimental
  - Subjects tested under two or more conditions

Biopsychology Uses Several Types of Research

- Experimental
Subjects tested under two or more conditions
- Between - Subjects Design
  - A different group of subjects is tested under each condition

24  Biopsychology Uses Several Types of Research
• Experimental
  - Independent Variable(s) - these are set or manipulated by the experimenter to produce the different treatment conditions

25  Biopsychology Uses Several Types of Research
• Experimental
  - Independent Variable(s) - set or manipulated by the experimenter to produce the different treatment conditions
  - Dependent Variable - the variable that is measured by the experimenter to assess the effect of the independent variable(s)

26  Biopsychology Uses Several Types of Research
• Experimental
  - Independent Variable(s) - set or manipulated by the experimenter to produce the different treatment conditions
  - Dependent Variable - the variable that is measured by the experimenter to assess the effect of the independent variable(s)
  - Confounding Variable(s) - other unintended differences among conditions that can influence the dependent variable
Biopsychology Uses Several Types of Research

- Experimental
- Quasiexperimental
  - Studies of groups of subjects who have been exposed to the condition of interest in the real world (e.g. smoking)
  - Can not control for confounding variables

Biopsychology Uses Several Types of Research

- Experimental
- Quasiexperimental
- Case Studies
  - Studies that focus on a single case or subject

Generalizability? (The extent to which the result tells us something about the general population)
31 Theory and Uncertainty in Science:

Why is so much scientific information presented as theory instead of fact?

• Complexity of research and results
• Terms like “fact” and “proof” suggest final answers – which are rare in research
  – As knowledge bases expand, ideas no longer supported by the available evidence may need to be discarded or modified

32 Theory and Uncertainty in Science:

Why is so much scientific information presented as theory instead of fact?

• A *theory* integrates and interprets diverse observations in an attempt to explain some phenomenon
  – Good scientific theories generate new (and testable) *hypotheses*
• A *hypothesis* is a statement about the expected relationship between two or more variables

33 An Example: The Dopamine Theory of Schizophrenia

• *Observations:*
  – Amphetamines can produce schizophrenia-like behaviors
  – Amphetamines increase activity in brain cells that use dopamine for transmitting messages.
• *Theory:* Schizophrenia is produced by excessive activity of the brain chemical dopamine
• A Testable Hypothesis based on the theory: Drugs that decrease dopamine activity should improve functioning in schizophrenics
  – Confirmed in some, but not all cases
  – Dopamine Theory is incomplete

34 Critical thinking about biophysiological claims?

• The 1949 Nobel Prize in Medicine went to Egas Moniz

35 Critical thinking about biophysiological claims?

• The 1949 Nobel Prize in Medicine went to Egas Moniz
  – For the development of the prefrontal lobotomy

36 The Prefrontal Lobotomy
• A procedure in which the connections between the prefrontal lobes and the rest of the brain were cut as a treatment for mental illness

37 The Prefrontal Lobotomy
• Little therapeutic benefit
• Many undesirable side effects
• Over 40,000 patients were lobotomized in the US alone
  – Rosemary Kennedy was one of them

38 Lobotomies: What went wrong?
A failure of critical thinking
• Program was largely based on observation of a single chimpanzee in a single situation
• Failure to carefully evaluate the consequences of lobotomy in early patients

39 Lobotomies: What went wrong?
A Drive for “Great and Desperate Cures?”
• The first effective psycho-therapeutic drugs were not introduced until 1954

40 Thinking About the Biology of Behavior
• Is behavior physiological or psychological (nature vs. nurture)?

41 Thinking About the Biology of Behavior
• Is behavior physiological or psychological (nature vs. nurture)?
  – In the 16th century Descartes proposed that humans have two aspects:
Thinking About the Biology of Behavior

• Is behavior physiological or psychological (nature vs. nurture)?
  – In the 16th century Descartes proposed that humans have two aspects:
    • Physical - can be studied scientifically
    • Mental - lacks physical substance, obeys no natural laws, controls human behavior, and is thus the concern of the Church

Thinking About the Biology of Behavior

• Is behavior physiological or psychological (nature vs. nurture)?
  – In the 16th century Descartes proposed that humans have two aspects:
    • Physical - can be studied scientifically
    • Mental - lacks physical substance, obeys no natural laws, controls human behavior, and is thus the concern of the Church
  – This view is known as Cartesian dualism

Is There a Purely Psychological Category of Human Existence?

• Even the most complex psychological processes (e.g. self-awareness, memory, or emotion) can be affected by damage to / stimulation of the brain

• Some non-human species possess abilities once assumed to be purely psychological, and thus purely human
  – (e.g. Gallup’s studies in chimpanzees)

Chimpanzees Show Self-awareness

• An organism is to some degree self-aware if it is capable of becoming the object of it’s own attention

Evolving Ideas About the Development of Behavior
• nature vs. nurture
• genes or learning
  • (but factors other than genes and learning influence development -e.g. diet, stress)
• genes or experience
• interaction of genetic factors and experience

The Interaction of Genetic Factors and Experience

• Tryon selectively breed “maze-bright and maze-dull rats
  – However, maze-bright did better than maze-dull only if they were both raised in impoverished environments
  – Maze-bright not generally more intelligent - apparently do better because they are less “emotional”