

Lecture 8: Early Developments in Physiology and the Rise of Experimental Psychology

I. INTRODUCTION

A. Introduction

- Next few weeks we focus on the beginnings of scientific psychology and its early growth
- Wundt's founding of a psychological laboratory is often cited as the formal beginning of scientific psychology.
 - Wundt's *Institute for Experimental Psychology* was founded 1879 at University of Leipzig.
 - However, the term *Psychology* first used in print by Phillip Melanchthon (associate of Martin Luther) in 16th century Germany.
- This seems consistent with the view that Psychology has a long past and short history!

I. INTRODUCTION

A. Introduction

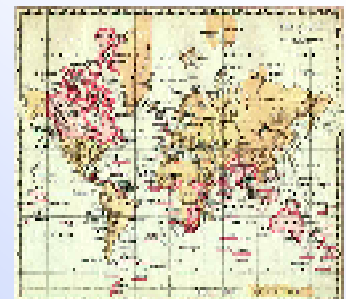
- Today's lecture presents the 19th C context for Wundt's founding the laboratory
 - The lab is significant in that it marks scientific psychology becoming *separate from* speculative philosophy.
 - We focus on social and intellectual currents of the 19th C which gives rise to the separation.
 - These social and intellectual currents have to do with the rise of science and the realization that traditionally philosophical questions can now be answered scientifically.

II. INTRODUCTION

A. The 19th C

Politics

- British Empire is the world's leading power after the Napoleonic wars (1803 to 1815).
- Empire controls one quarter of the world's population and one third of the land area.



I. INTRODUCTION

B. The 19th C

- Industrial Revolution
 - Three stages
 - First Industrial Revolution, which began in the 18th C transformed economy from manual- into machine-based labor.
 - Second Industrial Revolution around 1850, when technological and economic progress rested on the development of steam-powered ships and railways,
 - Third Industrial Revolution of 19th century involved more technological innovation with the internal combustion engine and electrical power generation.
 - Spread from Great Britain to Europe, to North America, and eventually the world.

I. INTRODUCTION

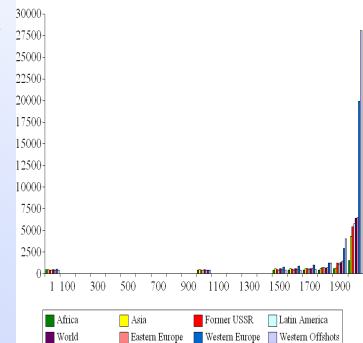
B. The 19th C

Industrial Revolution results in increases in the middle class.

Ordinary people employed in the new mills and factories.

But strict working conditions with long hours of labor dominated by a pace set by machines.

World GDP/capita 1-2003 A.D.



II. INTRODUCTION

B. The 19th C

- 19th C Education
 - Early 19thC churches schooled for poor children.
 - From 1833 the government provided them with grants.
 - The state took responsibility for education in 1870.
 - In 1880 school made compulsory for 5 to 10 year olds
 - From 1899 school required for children until they were 12
 - Gender differences in schooling
 - Middle class boys went to grammar schools whereas girls went to private schools where they were taught 'accomplishments' such as music and sewing.
 - Discipline in Victorian schools was savage.

II. INTRODUCTION

B. The 19th C

- 19th C Science
 - Era of widespread invention and discovery.
 - Significant developments in the understanding or manipulation of mathematics, physics, chemistry, biology, electricity, and metallurgy largely
 - setting the groundwork for the comparably rapid technological innovations which would take place the following century
 - Modest advances in medicine and the understanding of human anatomy and disease prevention
 - Partly responsible for rapidly accelerating population growth in the western world.

I. INTRODUCTION

C. History of Sciences

- The Scientific Revolution (16th - 17th) resulted in important new ideas
- The replacement of...
 - the Earth by the Sun as the center of the solar system
 - *basic elements* view of matter by an atomistic or corpuscular view.
 - the idea that objects behave by their *nature* by the idea that all bodies move according to the same physical laws
 - the concept that all motions require the continued action of a cause by the inertial concept of motion
 - the idea that two separate systems account of blood circulation to a single "recycling" circulatory systems.

I. INTRODUCTION

C. History of Sciences

- 16th -17th C science had successfully addresses the nature of the physical world.
 - Galileo Galilei invents telescope and discovers heliocentric theory.
 - Issac Newton discovers mechanics, universal gravitation. Calculus, Optics
 - Jacob Priestley discovers "dephlogisticated air" or Oxygen
 - Stephen Gray demonstrated that electricity could be "transmitted" through metal filaments.
 - Robert Boyle (1627–1691) was credited with the discovery of Boyle's Law and the development of the atomic theory of matter.
 - Antoine Lavoisier discovers the law of Conservation of mass.

I. INTRODUCTION

C. History of Sciences

- But medical and biological sciences just emerging in 18th C
- Biological Sciences
 - The micro-world of biology newly discovered
 - 200x single lens microscope invented by Antony van Leeuwenhoek (father of microbiology) in the 1670s
 - Naming and classifying dominated natural history throughout much of the 17th and 18th C.
 - Biological classification is systematized in 1735
 - Linnaeus divides nature into three kingdoms: mineral, vegetable and animal and uses five ranks: class, order, genus, species, and variety.

I. INTRODUCTION

C. History of Sciences

- Medical Science
 - The Germ theory of Disease only begins to gain wide acceptance by 1875.
 - Robert Koch was the first scientist to devise a series of proofs used to verify the germ theory.
 - 1847 Semmelweis reduces new mothers' death rate by making physicians wash hands before attending to childbirth.
 - Louis Pasteur's work on pasteurization (1862) confirms germ theory.
 - Medicine revolutionized only in 19th C.
 - Advances in chemistry, laboratory techniques, equipment, growth of bacteriology and virology.

I. INTRODUCTION

D. Setting the Stage

- Early 19th C. basic questions about perception arise.
 - The relation between the objective world of physical stimuli and subjective world of the experiences were being explored.
 - Scientific advances helped to address the question: By what mechanisms do empirical events come to be represented in consciousness
 - Physical nature of light and color were discovered and physiology studies of sensory processing was beginning

I. INTRODUCTION

D. Setting the Stage

- Bessel (1784 – 1846) *an astronomer* performs the first reaction-time experiment.
 - Such studies demonstrate individual differences in perception.
 - Also highlights the discrepancy between objective and subjective reality.
 - No point to point correspondence between physical reality and the psychological experience of that reality.
 - Researchers became interested in physiology of the nervous system, brain processing, and perceptual processes.
 - These studies gave birth to experimental psychology.

II. PHYSIOLOGY OF THE NERVOUS SYSTEM

A. Charles Bell and Francois Magendie

- Charles Bell (1774-1842) and Francois Magendie (1783-1855) were 19th scientific competitors.
- Ironically the results of the competition resulted in the Bell-Magendie law.
 - The law demonstrates that sensory nerves enter the dorsal roots of the spinal cord and motor nerves emerge from the ventral roots.
 - Separated nerve physiology into sensory and motor functions.



II. PHYSIOLOGY OF THE NERVOUS SYSTEM

A. Charles Bell and Francois Magendie

- Bell and Magendie
 - Specific mental functions are mediated by different anatomical structures.
 - No longer possible to think of nerves as general conveyers of vibrations or spirits.
 - Sensory nerves carried impulses from sense receptors to the brain
 - Motor nerves carried impulses from brain to muscles and glands.
 - This suggested separate sensory and motor regions in the brain.



II. PHYSIOLOGY OF THE NERVOUS SYSTEM

B. Johannes Muller

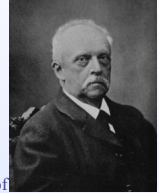
- Johannes Muller (1801-1858)
- Demonstrated that each of the 5 types of sensory nerves results in a characteristic sensation.
 - In other words, each nerve responds in its own way regardless of the stimulation which activated it.
- Each sensory system is maximally sensitive to a specific type of stimulation but may be stimulated by other forms of energy.



II. PHYSIOLOGY OF THE NERVOUS SYSTEM

C. Hermann von Helmholtz

- von Helmholtz (1821-1894)
 - He as a student of Muller and made contributions to several areas of science and philosophy.
 - Physiology and Psychology
 - The analysis of sensory processes.
 - Physics:
 - Theories of conservation of energy, work and the mechanical foundation of thermodynamics.
 - Philosopher:
 - Work on philosophy of science and aesthetics.



II. PHYSIOLOGY OF THE NERVOUS SYSTEM

C. Hermann von Helmholtz

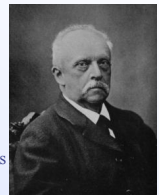
- von Helmholtz (1821-1894)
 - Dismissed Muller's *vitalism* (life force) as unscientific.
 - He was a materialist and applied the principle of conservation of energy to living organisms.
 - He measured speed of nerve conduction to find proof of physical-chemical processes are involved in our interactions with the environment
 - Found that nerve conduction in humans to be between 165 - 330 ft/sec.



II. PHYSIOLOGY OF THE NERVOUS SYSTEM

C. Hermann von Helmholtz

- von Helmholtz (1821-1894)
 - Active mind makes sense of *signs* received from sensory system
 - Sensation and perception
 - Perceptions are sensations (raw element of experience) which have meaning given by past experience
 - Trichromatic theory of color vision
 - Proposed three types of color receptors reflecting the primary additive colors (R G B).
 - Place theory of auditory perception.
 - Pitch determined by where on basilar membrane the most vibrations occur to an auditory input.



II. PHYSIOLOGY OF THE NERVOUS SYSTEM

D. Ewald Hering

- Ewald Hering (1834-1918)
 - Challenged Helmholtz.
 - Theory suggested receptors in the eye which respond in an opponent process manner, red- green, blue-yellow, and black-white.
 - Helmholtz's theory is correct at the retina level but that neural processes farther up in the system work in opponent process as Hering's proposed.
 - Held an innate theory of depth perception (receptors in the eye)



II. PHYSIOLOGY OF THE NERVOUS SYSTEM

E. Christine Ladd-Franklin

- Christine Ladd-Franklin (1847-1930)
 - Also challenged Helmholtz.
 - Proposed a theory of color vision that was based on evolutionary theory and evolution of the physiology of the system.
 - Concluded that achromatic vision came first, then blue-yellow sensitivity, and finally red-green sensitivity.



II. PHYSIOLOGY OF THE NERVOUS SYSTEM

E. Christine Ladd-Franklin

Her *Science* obituary read:

The career of Dr. Christine Ladd-Franklin... was remarkable in several ways. It was remarkable for brilliancy of achievement. Her theory of color vision, whether or not it shall be the final word on the subject, has certainly done excellent service by holding together the most important facts, and by relating psychology, physiology and photochemistry, along with an evolutionary conception of the development of the color sense. This theory arose out of her study of the theories of Helmholtz and Hering during her work in Germany in 1891-92. She pointed out defects in each of these rival theories and showed how the merits of each could be combined into a single theory...



III. EARLY WORK ON BRAIN FUNCTIONING

A. Localization of Function

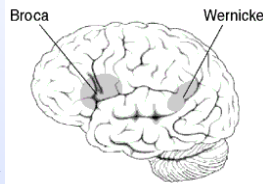
- Phrenology (yet again!)
 - Franz Gall (1758 – 1828)
 - Developed the first cohesive ideas about phrenology – the magnitude of one's mental faculties could be determined by examining the bumps and depressions on one's skull.
 - Johann Spurzheim (1776-1832)
 - Popularized phrenology with books and demonstrations.
 - Phrenologists claimed faculties become stronger with practice.



III. EARLY WORK ON BRAIN FUNCTIONING

A. Localization of Function

- Case studies of aphasia by Paul Broca and Carl Wernicke
- The pair were able to localize language and communication functions in the left hemisphere of the brain.
- Broca engaged in craniometry to relate brain size and intelligence



III. EARLY WORK ON BRAIN FUNCTIONING

C. Mass Action

- Pierre Flourens (1794-1867)
- Used ablation method
 - Destroying part of the brain and noting consequences
 - Investigated localization of function in the brain.
 - Findings were contrary to the phrenologists
 - Observed that in some cases the function that was lost to an ablation was regained later.



III. EARLY WORK ON BRAIN FUNCTIONING

C. Electrical Stimulation

- Electrical stimulations of the brain
 - Gustav Fritsch (1838-1927), Eduard Hitzig (1837-1907), and later David Ferrier (1843-1928) found that the cortex is not insensitive as previously thought.
 - When a certain area of the cortex is stimulated, muscular movements on the opposite side of the body are elicited, thus discovering the motor cortex. What would turn out later to be the sensory cortex was also discovered.
- These findings extended the Bell-Magendie law to the brain.



III. RISE OF EXPERIMENTAL PSYCHOLOGY

A. Ernst Weber

- Ernst Weber (1795 –1878)
- German physician who is considered a founder of experimental psychology.
 - In 1818 he was appointed Associate Professor of comparative anatomy at Leipzig University
- Investigated the sense of touch.
 - Mapped out the sensitivity of touch for the entire body using the two-point threshold.
 - Sensitivity found to be most sensitive on the tongue and least sensitive on back.



III. RISE OF EXPERIMENTAL PSYCHOLOGY

A. Ernst Weber

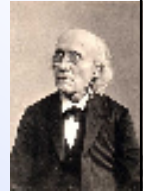
- Ernst Weber (1795 –1878)
 - Work in kinesthesia led to identification of the just noticeable difference (jnd)
 - The least amount of change necessary to notice a difference along a particular dimension between two stimuli.
 - Articulated Weber's Law: The first quantitative law in psychology.
 - The finding that the amount of change necessary to notice a difference (jnd), is a constant fraction relating the stimuli.



III. RISE OF EXPERIMENTAL PSYCHOLOGY

B. Gustav Fechner

- Gustav Fechner (1801 - 1887)
 - A pioneer in experimental psychology and founder of psychophysics.
 - Interested in the psychophysical relationship between the body and mind.
 - For sensations to change arithmetically, the physical stimulus must change geometrically.
 - Research and further mathematical analysis
Fechner found a formula describing the relationship between the mental and physical.



III. RISE OF EXPERIMENTAL PSYCHOLOGY

B. Gustav Fechner

- Gustav Fechner
 - Other research included studies on the absolute and difference thresholds.
 - Absolute Threshold : Lowest intensity at which a stimulus can be detected
 - Difference threshold: The stimulus magnitude that needs to be changed before a person detects a difference.
 - Developed various methods of research including the method of limits, the method of constant stimuli, and method of adjustment.

