Term paper – Grading rubric

1. Originality - uniqueness of the idea; clear separation between original ideas and those of others.
2. Depth - scope of the paper; how well ideas are developed.
3. Theme - how well the ideas in the book are addressed and extended to outside information sources.
4. Coherence of arguments - how well the point of view adopted is supported by evidence and argument.
5. Clarity and style of writing - quality of writing, careful proofreading (spelling, grammar).

Term paper

- **Introduction**
  - introduce ideas and concepts
  - define terms
  - provide rationale
  - overview of the paper
- **Main body of the paper**
  - use headers where appropriate
- **Summary and Conclusions**
  - main take-home message
  - summarize what the paper has shown
  - why it is important
- **References**
  - any consistent format that will allow readers to find the materials you’ve cited

Charles Darwin
(1809-1882)

- The origin of species
- Evolution
- Natural selection

"Nothing in biology makes sense except in the light of evolution."
Th. Dobzhansky, 1973

Important Dates

- Thursday, July 18 – Term paper due
- Thursday, August 1 – Last class
- Tuesday August 6 – Final exam 8:00–10:45 PM

Voyage of the Beagle (1831-1836)
Voyage of the Beagle (1831-1836)

Developments in geology

- Lyell’s theory of uniformitarianism
- Fossil evidence of extinct species
- Radioactivity and carbon dating (20th century)

Darwin’s Finches

Galapagos Islands (600 miles from mainland Ecuador)

Natural selection is an observable, interpretable, and repeatable process in a natural environment. It oscillates in direction. It happens when the environment changes. It has evolutionary consequences (adaptive change).

Industrial Melanism

Dark and light forms of the peppered moth (*Biston betularia*). Dark forms were more prevalent in cities during the Industrial Revolution. Industrial melanism: more effective camouflage for the dark moths provided by soot-covered tree limbs and buildings.
Darwin’s Finches

Adaptive radiation
Reproductive isolation
Endemic species

Excerpt from Darwin’s journal
"The most curious fact is the perfect gradation in the size of the beaks in the different species of Geospiza, from one as large as that of a hawfinch to that of a chaffinch, and ... even to that of a warbler... Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends."

Darwin’s return to England

Journal of Researches into the Geology and Natural History of the Various Countries Visited during the Voyages of the H.M.S. Beagle, under the Command of Captain Fitzroy, R.N., from 1832 to 1836

Problem of the origin of species

William Paley (1743-1805)
Argument from design: adaptations in plants and animals are complex. Only an intelligent Designer could have created them, just as only an intelligent watchmaker can make a watch.

Jean-Baptiste Lamarck (1744-1829)
Theory of evolution by acquired characteristics
“exercise of a structure enhances its appearance in future generations; absence of use causes it to disappear”
E.g. giraffe’s neck
all-important role of environment
Problem: lacked mechanism for change (genetic inheritance)

Thomas Malthus
An essay on the principle of population (1798)
Human populations can grow exponentially
Hence, they inevitably outgrow their means of subsistence
Population increase ultimately must be checked by war, famine or disease.
There is potential for exponential population growth in plant and animal communities but actual population growth is fairly constant.
Darwin’s theory of natural selection

1. **Variation** exists in behavior and structure
2. Some of that variation is **heritable**
3. More individuals are born than leave offspring for future generations.
4. Certain inherited traits make individuals better able to cope with environmental conditions and compete for limited resources such as food and shelter. These individuals survive longer and leave more offspring than those with less successful traits (**survival of the fittest**).
5. Changes in an entire population can lead to the formation of new species (**speciation**).

“As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.”

*Darwin, C. On the Origin of Species. (John Murray, 1859).*
Convergent evolution

Convergent evolution is the tendency for unrelated groups of organisms to evolve similar traits as a result of adaptation to similar environments or ecological niches.

- Example: wings of birds and bats

Divergent evolution is the opposite: related species evolve different traits.

- Example: Darwin’s finches

Natural selection and artificial selection

Domestication of animals (selective breeding) as a model for natural selection:

- Variability in traits
- Inherited
- Selection of desired characteristics
- Modification of structure or behavior over generations

Natural selection and artificial selection

Unlike artificial selection, natural selection is not guided or purposeful, but instead is a "self-generated outcome of interactions between organisms and their environments."

(Dobzhansky, Evolution, 1977, p 97)

Natural selection in progress

“The affinities of all the beings of the same class have sometimes been represented by a great tree. I believe this simile largely speaks the truth. The green and budding twigs may represent existing species; and those produced during each former year may represent the long succession of extinct species ... As buds give rise by growth to fresh buds, and these, if vigorous, branch out … so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever branching and beautiful ramifications” (Darwin, 1859).
Natural selection

Indivdiuals vary in size, strength, fertility, longevity, behavior, …

Reproductive potential exceeds the rate needed to maintain constant population size. Natural selection operates on individuals, but alters entire populations.

Fitness requires both genetic stability and genetic variability.

Darwin’s contribution to psychology

Emphasis on variation and individual differences

Focus on the adaptive value of behavior and mental processes (functionalism)

Spawned the new fields of ethology and comparative psychology

Blind trial and error

Darwin’s Influence

- Differential survival and population genetics
- Theory of sexual selection
- The expression of the emotions in man and animals (1872)
- “Social Darwinism”
- Infant development
- Individual differences

Darwin’s later work

Human evolution

The Descent of Man, and Selection in Relation to Sex (1871)

Anatomical, morphological, embryological, and behavioral similarities between humans and other primates

- Theory of sexual selection
  - Mating preferences
  - Sexual dimorphism

Figure 6.4 Alfred Russel Wallace (1823–1913)
Communication and emotion

Communication and emotion in humans and animals
- *The expression of the emotions in man and animals* (1872)
- Universals of expression (gestures, facial expressions, laughter, grief and rage)

Social Darwinism

“the struggle for existence”
“nature red in tooth and claw”

*Herbert Spencer* (1820-1903)

“Survival of the fittest”
Theory of social progress based on competition

Infant development

*Bibliographical sketch of an infant* (1877)

*Diary study* of Darwin’s infant son, William
cognitive and linguistic development, behavioral milestones
analysis of variation and individual differences

Theories of inheritance

*Genotype vs phenotype*
Aristotle and the “blood” theory
Inheritance as blending
Gregor Mendel showed that heredity is transmitted through factors (now called *genes*) that do not blend, but segregate

Johann Gregor Mendel (1822-1888)
- Born in Czech Republic
- Friar at Augustinian monastery
- Experiments on garden peas
- Mendelian traits
Johann Gregor Mendel (1822-1888)

- dominant/recessive traits
  - $R$ = gene for purple flowers
  - $r$ = gene for white flowers
- $R$ is dominant, $r$ recessive
- Each plant has two genes for flower color
  - homozygote – $rr$ or $RR$
  - heterozygote – $Rr$

Genetics

- DNA (Friedrich Miescher, 1871)
- gametes (sex cells)
- zygote (fertilized egg cell)
- human genome
- chromosomes (23 pairs)
- DNA replication
- mitosis and meiosis

Sir Francis Galton (1822-1911)

- Charles Darwin’s cousin
- Explorer, statistician, meteorologist, and psychologist
- Measurement of intelligence
- Individual differences
- Implications of natural selection
- Statistical methods
- Studies of hereditary genius
- Twin studies
- Eugenics

Galton and the Measurement of Intelligence

- Anthropometry
- London International Health Exhibition (1884)
- Measurement of intelligence
  - Head size
  - Sensory acuity
  - Reaction time

Sir Francis Galton (1822-1911)

- born in a family of 7 children
- father was a wealthy banker
- an early genius, could write at age 3, read advanced books at age 7 (Shakespeare)
- studied medicine in Birmingham and London then studied at Cambridge
- traveled extensively as a gentleman explorer
- received the medal of the Royal Geographic Society for exploration and mapping out remote regions in Africa
Sir Francis Galton (1822-1911)

- Wrote “how-to” books on various subjects
- Invented the weather map and coined the terms: highs, lows, fronts
- First to suggest the use of fingerprints as a means of identification, later adopted by Scotland Yard
- Life mission: to investigate and understand the basis for hereditary differences in intelligence

Galton: Nature Vs. Nurture Debate

- Individual differences
- Normal distributions
- Scatterplots
- Twin studies
- Correlation & regression
- Regression to the mean
- Eugenics

Nature-Nurture Controversy

- Normal distribution of intellectual abilities
- Correlation in patterns of creativity and genius among the family members
- Questionnaire study
- Twin studies: dizygotic (fraternal) vs monozygotic (identical) twins

Nature 2017 doi:10.1038/nature22999

Normal Distribution
Galton and the Efficacy of Prayer

It is asserted by some, that men possess the faculty of obtaining results over which they have little or no direct personal control, by means of devout and earnest prayer, while others doubt the truth of this assertion. The question regards a matter of fact, that has to be determined by observation and not by authority: And it is one that appears to be a very suitable topic for statistical inquiry.


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**Origins of American psychology**

**Focus on individual differences**
- emphasis on individual experience
- the adaptive nature of behavior and mind
- study of adaptation to the environment

**Structuralism versus functionalism**
- two opposing approaches to psychology

**Structuralism**

Wilhelm Wundt (1832-1920)

Goal: to understand the structure of the mind and the contents of consciousness.

Students and followers of Wundt included:
- **Edward Bradford Titchener (1867-1927)**
  - psychology program at Cornell University
- **G. Stanley Hall**
  - first professor of psychology at Johns Hopkins
  - Founder of American Psychological Association

**Ebbinghaus on memory**

Hermann Ebbinghaus (1850-1909)

Experimental and mathematical study of memory

Variability in memorization: role of past associations

Solution: use **nonsense syllables** (2,300 possible combinations of CVC syllables (e.g., “bip”, “waf”, etc.))

Forgetting curves (exponentially decreasing function)

Wundt questioned the validity of Ebbinghaus’ findings: nonsense syllables are unnatural and artificial.
Functionalism

- Goal: to understand how the mind and behavior help the organism to adjust to the environment
  - Focus on function rather than structure
  - Charles Sanders Peirce (1839-1914)
  - William James (1849-1910)
  - John Dewey (1859-1952)

- Influenced by evolutionary theory
- Biological (e.g. Darwin) rather than physiological (e.g. Helmholtz) tradition
- Research methods
  - reliance on introspection and experiment
  - the study of animal behavior
  - mechanisms of learning and development
  - the study of mental illness

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Functionalism

- Goal: understanding the function of the mind rather than in describing its contents
- Never formulated as a formal theory
- Emphasis on applications of theory: improving the human condition, educational practice, industry, and personal life

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Midterm grade distribution

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