

Human Responses to the Environment

I. Levels of Response to Environmental Change

- A. Genetic Responses
 1. Occur at the population level through natural selection
 2. Genetic responses take a long time to institute (generations) and are difficult to reverse
 3. Examples: the evolution of bipedalism and larger brains in our early ancestors through natural selection
- B. Developmental Responses (Developmental Plasticity)
 1. Developmental responses occur in individuals during the childhood period of rapid growth
 2. Developmental responses usually require a number of years to institute and are difficult or impossible to reverse.
 3. Example: Reduced body size adults who had inadequate childhood nutrition
- C. Acclimatization
 1. Short-term, reversible, physiological responses to changes in environmental conditions.
 2. Example: tanning in response to exposure to sunlight
- D. Cultural Responses
 1. Responses to the environment based on learning new patterns of behavior or technology
 2. Cultural responses can be instituted rapidly and are also comparatively easy to reverse
 3. Example: The development of clothing by our ancestors

II. Responses to Cold Environments

- A. **Immediate responses**
 1. Vasoconstriction to reduce heat loss
 2. Increased heat production through shivering and activity
- B. **Developmental Responses: increased non-shivering thermogenesis**
- C. **Population Differences**
 1. Responses to Moderate Cold : Australian aborigines- Reduced blood flow to extremities and reduced metabolic heat production to conserve energy
 2. Responses to Extreme Cold: Eskimos- Increased metabolic rate and blood flow to the extremities to prevent frostbite

III. Responses to Heat Stress

- A. **Responses to High Temperatures**
- B. **Mechanisms of heat transfer**
 1. Radiation, conduction, convection and evaporation
 2. Sweating: 560 calories lost per gram of sweat
- C. **Immediate responses to increase heat loss**

1. Low vasodilation
2. Inefficient sweating

D. Long-term responses

1. Increased vasodilation
2. Better distribution of sweat
3. Decreased concentration of salt in sweat

E. Developmental Responses :Children who develop in conditions of heat stress tend to have smaller trunk size and longer limbs of smaller girth than controls.

F. Population Differences

1. Most difference can be explained in terms of developmental plasticity
2. The long limbs of some people who live under heat stress may be explained as genetic adaptations for more efficient heat loss (ie. Allen's rule)

G. Evolution of Human Heat Regulation

1. Why are humans such hairless, sweaty, thirsty animals
2. We thermoregulate through sweating
3. Sweating is efficient only in environments with a low relative humidity so that evaporation occurs
4. Humans have comparatively little capacity to store up water
5. These facts suggest that we evolved our hairlessness in a warm environment with a low relative humidity and plenty of water
6. This is consistent with paleoenvironmental evidence concerning the African environments our early ancestors evolved in
- 7.

IV. Responses to High Altitudes

A. Immediate Responses

1. Increased rate and depth of pulmonary ventilation
2. Mountain sickness in response to hypoxia

B. Acclimatization Responses

1. Increase in hemoglobin content of blood
2. Increase in capillarization of the lungs

C. Developmental Responses found in Native Highlanders

1. Increased lung volume: "barrel chests"
2. Increased pulmonary diffusion capacity

D. Reproductive Consequence of Life at High Altitudes

1. Reduced sperm production
2. Increased placenta weight

V. Human Responses to Variation in Nutrition

A. Responses to malnutrition

1. Stunted growth
2. Reduced metabolic rate

3. Minimum daily requirements and developmental plasticity in nutritional requirements
4. Milk dependence and the geographical distribution of lactase deficiency:

Variation in Body Form

I. Why Study Body Form?

- A. **Knowledge of variation in body form is essential for the design of automobiles, clothing etc.**
- B. **People have long been interested in the possibility of predicting disease susceptibility, behavior, etc. based on the analysis of body form**

II. Early Attempts to Correlate Body Form With Behavior

A. Phrenology

- 1. A Pseudoscience popular in the 19th century
- 2. Based on the idea that skull shape reflected brain function
- 3. Dolichocephalic (long headed) people were believed by some to be superior to brachycephalic (round headed) people

B. Cesare Lombroso (1836-1909)

- 1. Believed that criminals exhibited degenerate physical features as asymmetrical skulls, which allowed them to be identified.
- 2. Considered non-criminals who exhibited these features to be "cryptocriminals"

C. Frans Boas

- 1. Showed that the shape of the skulls of parents born in Europe were different from those of their children who were born in the United states
- 2. He attributed this to cultural practices such as swaddling

III. Somatology: Classification of the human physique

A. Sheldon's system for the classification of body shape

- 1. **Endomorphs**- fat, broad from front to back
- 2. **Mesomorphs**- muscle and bone predominate, thin from front to back
- 3. **Ectomorphs**- thin people

B. Problems with Sheldon's work: Subjectivity and the "halo" effect

C. Correlations between physique, behavior and disease

- 1. Pulmonary tuberculosis higher in ectomorphy
- 2. Coronary thrombosis higher in endomorphs
- 3. Schizophrenia higher in ectomorphy
- 4. Paranoids higher in mesomorphy

IV. Natural Selection Explanations for Variation in Body Form

A. Bergmann's rule: **The members of widely distributed species tend to have a larger body size in the colder areas of their range**

- 1. Heat conductance depends on the surface area of the body
- 2. With increase in body size, volume increases at a faster rate (x3) than surface area (x2)

Variation in Human Skin Color and Hair Form

I. Anatomy of the Skin

- A. Epidermis: stratum corneum, stratum lucidum, stratum granulosum (carries melanin), stratum germinativum (produces melanin)
- B. Dermis: Contains sweat glands (apocrine and eccrine), sebaceous glands hair follicles, capillaries

II. Sources of skin color

- A. Stratum corneum: buildup of dead keratin, interspersed in some cases with broken-down hemoglobin and melanin
- B. Blood in capillaries of the dermis
- C. Melanin in the stratum granulosum
- D. Genetic studies suggest that a small number of genes determine skin color

III. Developmental Plasticity and Acclimatization

- A. Girls have lighter skin than boys
- B. Skin color darkens with age
- C. Effects of diet: certain foods can influence skin color
- D. Tanning as an adaptive response to ultraviolet light

IV. Geographical variation in skin color

- A. Skin color is usually measured through color matching and reflectivity
- B. Although there are many exceptions, throughout the world darker skinned people tend to inhabit areas nearer the equator

V. Possible explanations of geographical variation in skin color

- A. Skin Color and heat exchange
 - 1. Dark skin absorbs more radiant energy than light skin
 - 2. Heat absorbed by dark skin may be an adaptation for replacing body heat lost during the night
 - 3. This has the disadvantage of increasing heat load
- B. Skin Color and Frostbite Susceptibility
 - 1. Dark skin may be more susceptible to cold injury than light skin
 - 2. In areas where frostbite is a problem, light skin would have a selective advantage
- C. Radiation protection
 - 1. Ultraviolet light is known to be harmful if it penetrates the skin. It causes sunburn and may induce cancer
 - 2. Darker skinned people have an advantage when exposed to high levels of ultraviolet light
 - 3. The late onset of skin cancer may reduce its significance as a selective pressure
- D. Skin Color and Vitamin D Synthesis
 - 1. Vitamin D is synthesized in the epidermis through the action of ultraviolet light on a steroid precursor
 - 2. Low levels of vitamin D produce rickets and skeletal malformations that can result in death during childbirth
 - 3. Too much vitamin D results in kidney stones and calcification of soft tissues

4. As people moved from the tropics to temperate areas, reduced sunlight and the necessity of wearing clothes would select for depigmentation to regulate vitamin D synthesis

VI. Cultural Modification of Skin Color

- A. Tattooing, Scarification, Branding, Body Painting
- B. Functions: tribal identification, beautification, stigmatization

VII. Hair

- A. Does natural selection explain population differences? Head hair as protection?
- B. Sexual Selection: Darwin believed that sexual selection explained the relative hairlessness of humans as well as population differences. Is hair a signal of health status?
- C. Social Function of Hair
 1. Pubic hair, axillary hair, apocrine glands and body odor: Why are we so concerned about our smell?
 2. Hair styles as tribal marks

Human Sexual Dimorphism

I. The difference between gender and sex

- A. A person's sex is their biological identity
- B. A person's gender is their socio-cultural identity

II. The genetic and hormonal basis of human sexual dimorphism

- A. The genetic basis of sex differences: xx and xy are typical genotypes but there are many variations (xyy, xxy, xxx, xo, etc.)
- B. Androgens (testosterone): responsible for differentiation of sex phenotype during fetal development. Later causes for muscular development, laryngeal development, balding, acne
- C. Estrogens (estrogen, progesterone, relaxin): estrogen stimulates development of female secondary sexual characteristics at puberty, progesterone is important in regulating ovulation and the menstruation, relaxin is important at the time of birth
- D. Overlapping distributions of sex hormones in men and women

III. Sex differences in human morphology and physiology

- A. Men are about 10% larger than women and have longer legs relative to the trunk.
- B. Men have a higher proportions of bone and muscle and women more fat
- C. Men have higher concentrations of hemoglobin than women
- D. Women have a lower basal metabolic rate than men
- E. Women have a more "active" immune response than men.
- F. Some sex differences (hip width, shoulder width) are a result of androgen and estrogen stimulation of specific cartilage cells.

IV. The evolution of sex

- A. Advantages of Asexual Reproduction: Allows rapid reproduction, no energy expended in finding a mate, offspring receive all of parents genes
- B. Sexual reproduction: Considerable time and energy expended in finding a mate, offspring receive 1/2 of parents genetic complement.
- C. Advantages of Sexual Reproduction: Allows increased genetic variability through crossing-over. John Tooby's theory: the variability that results provides a moving target for pathogens.

V. Natural selection as a cause of human sexual dimorphism

- A. Hip Width and reproductive success: Why do men have such narrow hips?
- B. Sub-cutaneous fat and Energy Storage: Did the capacity for energy storage increase the reproductive success of early human females?

VI. Sexual selection as a cause of sexual dimorphism

- A. Are the breasts and buttocks of women an advertisement of reproductive potential?
- B. The spearman and the archer: Wide shoulders and weapons technology --Is there a feedback between technology, natural selection, and sexual selection
- C. Balding, Beards and Bluff
- D. Are population differences in face form simply a reflection of differences in sexual preferences?

VII. Sexual dimorphism and mating systems

- A. Polygamy tends to be associated with a great deal of sexual dimorphism. Examples: elephant seals and baboons

- B. Monogamy and a lack sexual dimorphism (eg. Gibbons)
- C. Female/male weight ratios of apes: Gibbons (103-93%) Orangutan (49%) Gorilla (48%) Chimpanzee (88%) Human (89%)
- D. Analogies with early human mating systems

VIII. Developmental explanations of sex differences

- A. The magnitude of adult sexual dimorphism is influenced by the conditions a person is exposed to during development
- B. Genetic males can become phenotypically female (and vice versa) if exposed to certain chemicals at critical times during their development.
- C. Sensitive Males: the development of males is more sensitive to environmental variation than is that of females. This can result in a reduction in sexual dimorphism during unfavorable periods.

IX. Acclimatization, hormone levels, and reproduction

- A. Malnutrition, stress and lowered testosterone levels
- B. Malnutrition, low body fat and infertility in women

X. Culture as an explanation of sex differences

- A. sex refers to a person's biological identity, gender refers to a person's cultural identity
- B. Cultural influences can increase or decrease sex differences
- C. Cultural practices that accentuate sex differences in morphology: Fashions, foot binding, lip stretching, weight lifting and plastic surgery
- D. Reinforcement of gender roles during socialization

XI. Sex Differences in Behavior

- A. Non-human examples: progesterone stimulates nest building behavior in rodents and parental behavior of both male and female birds
- B. Primate experiments: sex differences in "rough and tumble play" and grooming in surrogate raised androgenized monkeys
- C. The prenatal hormonal environment influences later behavior

XII. Sex differences in cognition?

- A. There is much overlap in male and female performance on tests of cognitive ability.
- B. Women tend to perform better than men on tests of verbal ability, perceptual speed, tasks that require fine motor coordination, mathematical calculation tests.
- C. Men tend to perform better than women on tests of certain spatial abilities, target directed motor skills, and tests of mathematical reasoning
- D. Before puberty few consistent sex difference are apparent
- E. Testosterone levels are know to affect performance on certain tests
- F. There is disagreement over the extent to which these differences are a result of differences in biology or differences in socialization, lifestyle etc.

XIII. Gender Differences

- A. Similarities have been found in the anterior hypothalamus of some homosexual men and women
- B. Some tests show homosexual men to be similar to women in their performance on certain tests

- C. There is disagreement over the extent to which these differences are a result of differences in biology or differences in socialization, lifestyle etc.

Intelligence and Intelligence Testing

I. What is intelligence

- A. One intelligence? Several types of intelligence? Intelligence is what intelligence tests measure
- B. Intelligence as a species specific way of adapting: each organisms nervous system has been designed by natural selection to solve specific problems relevant to its survival
- C. An adaptive definition human intelligence: intellectual capacities valuable to our early ancestors include memory, as well as the capacity to symbolize and generalize

II. Cultural differences in sensory processing and patterning

- A. Perception as a focusing of sensory input so that there is selective awareness of the surroundings
- B. Children learn to perceive the patterns and configurations in their surroundings according positive and negative reinforcements provided other members of their culture

III. Population differences in susceptibility to visual illusions and skill at solving embedded figure problems

- A. The effects of living in a "carpentered" world
- B. "Linear" and "non-linear" thinking
- C. Differences in "field dependence"
- D. Effects of the environment on development of the nervous system and cognitive abilities

IV. Sensory enrichment and sensory deprivation

- A. The malnourished mind
- B. Industrial pollutants: the effects of lead as an example

V. Intelligence Tests

- A. Cultural biases in I.Q. tests
- B. Heritability of I.Q.: studies of heritability are based on the idea that variation in phenotype (V_p) = variation in genotype (V_g) + variation in environment (V_e)
- C. Studies designed to measure the heritability of I.Q. involve either attempting to control for the environmental or genetic variable
- D. Measures of heritability describe the degree of variance in a population which is due to genes under a specific set of environmental conditions
- E. What do S.A.T.'s predict?
- F. Intelligence tests: an autonomous force of cultural selection
- G. Intelligence tests as tools

Human Variation In the Future

I. Genetic Engineering

II. We know that we will be a lot better at identifying genes associated with diseases

- A. Example: Women with the BRCA1 gene have 85% increased risk of developing breast cancer and a 45% risk of ovarian cancer. Preventative surgery

III. What will we do with genetic information

- A. It will be used to make money: Hundred of millions are at stake.
- B. Should genetic sequences be private property?
- C. Information on genetic disorders that cannot be treated poses psychological problems: Should children at risk be tested? I

D. Should people be tested if their is no treatment?

IV. What effect will this knowledge have on the human gene pool

- A. It seems clear that in the near future these techniques will only be available to the wealthy.
- B. 12.2 million children <5 died in the developing world in 1993. 95% of these deaths were from preventable diseases. Gene therapies are certainly not the best way to deal with the health problems of most of humanity.
- C. The Rurla Advancement Foundation opposes patents on living things. A patent was granted to NIH on a sequ3nce from a Papua New Guinea man.

V. Genetic discrimination

- A. 455 of 917 with genetic diseases repo4rted having been discriminated against by insurance companies.
- B. 22% of the members of a family some of whose members have a genetic disease report being discriminated against by insurance companies

Final Study Questions

Marks Chapter 9

1. What is the significance of geographical gradients and cultural boundaries in defining human races? Can we use them to represent fundamental biological divisions among different peoples?
2. What are the two major forms of genetic polymorphic variants found in the human species?
3. Discuss some of the problems of trying to genetically test in order to classify them into groups on the basis of a phenotype like skin color.
4. Explain what the "Out of Africa" hypothesis is and how mtDNA studies have been used to support this theory.
5. What is the Human Genome Project, and what are its objectives? Be able to discuss the strengths and weaknesses of the project.

Marks Chapter 10

1. How do differences (or gradients) arise in human populations?
2. Why is adaptation a troublesome concept in evolution?
3. What are the four different processes that can be defined as adaptation?
4. In what two ways can structures arise that are not necessarily adaptive?
5. What is the "pathology paradigm" ?
6. What was T. Dobzhansky's "balance" model ?
7. Explain Allen's rule, Bergmann's rule and Gloger's rule.
8. What is the "thrifty genotype" hypothesis?
9. Explain how cultural adaptation can result in behavior that does not maximize reproduction.

Marks Chapter 11

1. What are the two major demographic transitions that Marks identifies? Explain their consequences for social structure, population, etc.
2. In America are differences in fertility due to issues of race or economics? Explain.
3. What consequences does an agrarian life have on disease, nutrition and labor?
4. What are some of the problems of cultural solutions to health problems?

Marks Chapter 12

1. Why is it dangerous to correlate some of our behaviors such as warfare and rape to animals who also exhibit them? To what extent can we say these behaviors are homologous across species ?
2. What does A.J. Bateman have to say about male and female reproductive variance?
3. What is the difference between proximate and ultimate causes in biology?
4. Discuss the four fallacies in F. Goodwin's argument on promoting violence from an evolutionary, scientific perspective.
5. Explain "heritage" (plesiomorphies) and "habitus" (apomorphies). Include W.K. Gregory's discussion of these terms.

Marks Chapter 13

1. What are the three types of population comparisons that Marks discusses?
2. How do social and historical factors influence an individual's performance (i.e. sports, behavior).
3. Discuss the role of genetics and environment on intelligence, aggression and sexuality.

