

Protection for the Brain

- Skull -> Dura Matter -> cerebral-spinal fluid

Protection in the Spinal Column

- Vertebrae -> Dura Matter -> spinal fluid

The Hierarchical Brain

- The human brain has been evolving for ~500 million years
- Brainstem is similar to lower-order animals
 - ✓ Associated with basic survival processes (breathing, heart rate, etc)
- More evolved structures (cerebrum) built atop structures from more distant evolutionary past
 - ✓ Involved in thinking, reasoning
- Embryonic development: Brain progresses in same order
 - ✓ “Neural tube” (spinal cord and brain stem) develops first

The Hindbrain

- Medulla: Nerve relay between spine and brain
 - ✓ Contralateral control (left side of brain controls right side of body, vice versa)
- Pons (“Bridge”): Nerve relay allowing respiration
- Cerebellum: wrapped around Pons, center for motor control (esp. involuntary/reflex control)
 - ✓ Also important for learning and memory

The Midbrain

- Reticular system: Awareness of incoming stimuli
 - ✓ Modulates alertness/wakefulness and sleep for sustained periods
- Basal Forebrain: Thalamus, the ‘sensory switchboard’
 - ✓ Relays sensory information to higher brain
 - ✓ Thalamic abnormalities: schizophrenia & disordered sensory information
- Basal Ganglion: Voluntary movement
 - ✓ Parkinson’s patients have problems in BG: leads to tremors & rigidity
- Hypothalamus: automatic nervous system, hormones & drives
- Limbic system
 - ✓ *Amygdala*: emotion in memory
 - ✓ *Hippocampus*: memory formation

Forebrain

- Cerebrum: 2 hemispheres joined by the Corpus Collosum, 4 lobes in each hemisphere
- Remember: no two brains are exactly alike; each person has a slightly different organization
- Cerebral cortex: 2/3 of a cm thick
 - ✓ Sheet of cells forming outer layer of brain (80% of human brain tissue)
 - ✓ Thought, memory, perception (associated with quality of life)
 - ✓ Anencephaly: no cortex = no awareness

The Lobes of the Forebrain

- Frontal Lobe: movement, impulse control, personality
 - ✓ Broca's area: speech formation
- Temporal Lobe: auditory functioning
 - ✓ Wernicke's area: speech comprehension
- Parietal Lobe: bodily senses (touch, sensitivity, pain)
- Occipital Lobe: vision

- Primary Motor Cortex: rear of the frontal lobe: >600 muscles in voluntary movement
 - ✓ More sensitive areas (face, fingers) have more space allotted
- Primary Sensory Cortex: front of the parietal lobe: senses and balance
- Why do we have facial expressions for emotion?
 - ✓ Brain areas for emotion and facial muscle control are very close together

Prefrontal cortex – behind the eyes/face, 29% of cortex

- Functions: judgment, planning, sense of self, impulse control (“executive control”)
- Functions of prefrontal cortex demonstrated from case of Phineas Gage, he lost this area of the brain, lost impulse control and many aspects of his personality changed
- These symptoms are similar to patients who have had prefrontal lobotomies
- PET Scans on homicidal individuals show less prefrontal activity (...less impulse control?)

Hemispheric Lateralization

- Each brain differs across each individual, even identical twins have different brain structures
- Right and left hemispheres have different functions
- Language – centralized in the left hemisphere
 - ✓ Greater lateralization in right handers and males
- Pattern recognition and spatial organization – centralized in the right hemisphere
- Emotion – positive emotions centralized in left hemisphere, negative emotions in right hemisphere

Split brain research

- Patients with severe epilepsy typically have their corpus collosum surgically severed, which cuts the only communications mechanism by which hemispheres communicate
- Research paradigm consists of presenting them with objects in the left or right focal area
 - If you place objects in the right visual area, they do not see object but can pick it up with their left hand; this shows that patients are aware of the object
- Brain damage – aphasia – total or partial loss of ability to communicate
 - Broca's area
 - Wernicke's area

Nature-Nurture Controversy (Reciprocal Relationship between the two)

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Chapter 4 - Genetics
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- *Nature*: development of the brain and neurons is affected by genetics and “natural” maturation process regardless of experience
- Evidence: genetic passage of Trisomy 21 (Down’s Syndrome), Holoprocencephaly (incomplete lateralization)
- Some aspects of the human nervous system seem predetermined; an infant born without limbs still experience sensations and pain where the limb should have developed
- *Nurture*: our experiences shape the development of our brain and nervous system
- Neural networks are affected by experience → neural priming—less used areas become devoted to other functions
- Some patients who suffer strokes can recover some of their function

Healing and the Nervous System

- It was previously believed that neurons were incapable of regenerating/repairing themselves, recent research on monkeys shows migration and regeneration of neurons
- Axon repair & Neurogenesis
- Surviving neurons can restore function by altering their physical or chemical structure; they can change the neurotransmitter they respond to
- Brain grafts-grafting embryonic tissue
- Transplantation of neural stem cells hold promise

Cortical Plasticity

- “Plasticity” video features 9yr old Jodie Miller, who was suffering epileptic seizures soon after her 3rd birthday, she was losing control of the left side of her body
- She had a hemispherectomy – removal of her right hemisphere, which was source of seizures
- Plasticity – ability for brains to change in structure and function
 - ✓ Decreases markedly with age
- She demonstrated remarkable plasticity, she was walking 10 days after her surgery, though she still has some paralysis in her left side

The Endocrine System

- Pituitary gland (controlled by hypothalamus)
 - ✓ ‘master gland’, regulates growth to glands
- Adrenal glands – secrete stress hormones
- Pancreas – regulates sugar metabolism (insulin)
- Gonads – physical development, sexual behaviour
- Thyroid – controls metabolic rate, weight, activity level

Immune System

- Functions: body’s defensive response to foreign substances (antigens) such as bacteria, viruses, chemicals, and abnormal cells
- Produces antibodies to kill foreign substances, and has memory for the foreign substances it kills
- Receives, interprets, and responds to certain forms of stimulation
 - ✓ Also ‘remembers’: concept behind vaccines

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Chapter 4 - Genetics
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- It can be misguided, overactive (e.g. autoimmune diseases) or underactive (e.g. cancer)

Body-Mind interactions

- Stimulation or destruction of certain brain areas result in increases or decreases in immune response
- Injection of antigens will result in increased electrical activity in the brain
- Immune system cells are keyed to neurotransmitter substances and can produce hormones and neurotransmitters

Disorders related to Brain Atrophy

- Dementia – marked by symptoms of multiple cognitive deficits including memory impairment and 1 or more of aphasia (language), apraxia (motor control), agnosia (recognition), and/or disturbance in executive functioning
- Most common disorders with dementia onset are Alzheimer's and Huntington's
- Exact causes unknown, some signs include unusual proteins around neurons, breakdown of interneural connectors, unused neurons then die
- Possible environmental factors: impoverished environment in childhood, dietary/lifestyle factors, drinking from aluminum cans
- Alzheimer's patients also show atrophy of brain tissue and enlarged ventricles
- Pick's disease: Y-linked (occurs in males), genetic disease that appears in mid-30s
 - ✓ Atrophy and low metabolism in frontal & temporal lobes
 - ✓ First sign: abrupt change in personality
 - ✓ Abnormal neurons, called "pick bodies", between neurons, interrupt communication
 - ✓

CHAPTER 4: GENETIC INFLUENCES

- Our genetic blueprint, inherited from our parents affects all aspects of our development & behavior.
- Dominant Genes – if the gene received by both parents is *dominant*, the trait will be expressed.
- Recessive Genes – if the gene is recessive, the trait will not be expressed unless the paired gene from the other parent is also recessive.
E.g. Brown eyes & dark hair are dominant over blue eyes & blonde hair.

EXAMPLE:

EYE COLOR - Mother (**BROWN** gene) + Father (blue gene) – child has brown eyes.
- Mother (blue gene) + Father (blue gene) – child has blue eyes.

- Polygenic effects – numerous genes combine to determine a trait.

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Genetic Counseling – identify whether a person has the specific genes that will result in certain diseases.

E.g. Huntington's Disease, breast cancer.

- provide medical counseling & support

Genetic Engineering:

- Recombinant DNA procedures
 - Splice & combine DNA from 2 different organisms.E.g. Production of human growth hormone
- Gene Knockout Techniques
 - Destroy certain genes to determine the effects on development & behaviorBUT, most behaviors effected by numerous genes.

Cloning is the production of one or more individual plants or animals that are genetically identical to another plant or animal.

3 DISTINCT TYPES:

- Embryo Cloning (a.k.a. Artificial Twinning)
 - technique which produces monozygotic (identical) twins or triplets
- Adult DNA Cloning (a.k.a. Reproductive cloning)
 - DNA from an ovum is removed
 - & replaced by the DNA of an adult
 - implanted in surrogate mother
- Therapeutic Cloning (a.k.a. Biomedical cloning)
 - process same as adult cloning but *stem cells are harvested to produce new tissue or organs.*
 - * *The “pre embryo” dies in the process.*

ISSUES WITH CLONING

Scientific:

- *Unknown factors: future illness? deformity? premature death of clones?*
- *No current answers*

Psychological:

- *If Cloned: effect on individual and*
- *society's perceptions of that individual*

Ethical/Moral: Criticisms & concerns include:

- *Definition of life? (at conception? or some time later?)*
- *Breeding clones to harvest organs & then disposing of the clones.*
- *Religious groups criticize scientists for “playing God”*

Legal:

- *Who owns DNA? And genetic information?*
- *If a cloned child is born who are the legitimate parents? Parents of the DNA donor? The DNA donor?*
- *Judicial system: DNA evidence. Impossible to establish guilt “beyond reasonable doubt” if 2 individuals share the same DNA*

**BEHAVIORAL GENETIC TECHNIQUES:
STUDYING GENETIC INFLUENCES ON BEHAVIOR**

TWIN STUDIES

*- Compare identical twins (100 % identical genes)
to Fraternal twins (50% shared genes).*

BUT, identical twins may be treated differently from fraternal twins

ADOPTION STUDIES- *Compare children to adopted parents (nurture) & biological parents (nature).*

*- Best controlled studies compare identical twins separated at birth
& raised in 2 different environments.*

Heritability Coefficient – the degree to which variability in a particular characteristic can be attributed to genetics.

High concordance (co-occurrence) suggests high genetic influence

INTELLIGENCE: HEREDITY, & THE ENVIRONMENT

Correlations in Intelligence for Degrees of Genetic Similarity

Relationship	% Genes Shared	Correlation of IQ
Identical twins raised together	100	.86
Identical twins raised apart	100	.75
Non-Identical twins raised together	50	.57
Siblings raised together	50	.45
Siblings raised apart	50	.21
Biological parent (raised by parent)	50	.36
Biological parent (not raised by parent)	50	.20

SUPPORT FOR:

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Genetic contribution – identical twins higher than non-twin siblings

Environmental contribution – identical twins not 100% concordance.

- twins & siblings raised together more similar than those raised apart.

GENETIC-ENVIRONMENT INTERACTIONS

REACTION RANGE – genetics influences a range (upper and lower limits) & environmental factors influence where in this range the individual will fall.