Neural and Linguistic Development

Describe the stages of brain development

Understanding how the brain develops allows:

- Understanding the parts of the brain and how they fit together
- Development of a greater understanding of cognitive neurological impairments in the early stages of development
- Understanding why and how things can go wrong with early neural development

Neural Development

Undergo 3 embryonic stages

- Pre-embryonic (zygote)
    - Conception to 2 weeks
- Embryonic (embryo)
    - End of week 2-8
- Fetal (foetus)
    - 8-birth

Pre-embryonic Stage

- Ovum begins cell division
- Becomes a blastocyst due to repeated cell division
- Outer layer will become placenta
- Innermass will become embryo; *ectoderm, endoderm, mesoderm*

Embryonic Stage

- Organs are formed
- Ectoderm develops into sensory organs, epidermis, nervous system
- Mesoderm develops into the dermis, muscle, skeleton, excretory and circulatory systems
- Endoderm becomes gut, liver, pancreas, respiratory system

Fetal stage

- Nervous system develops more fully and myelination of neurons begins

Formation of the Nervous System

Stages of neural development:
Neural tube formation - Day 8-26
Brain formation - begins during week 4

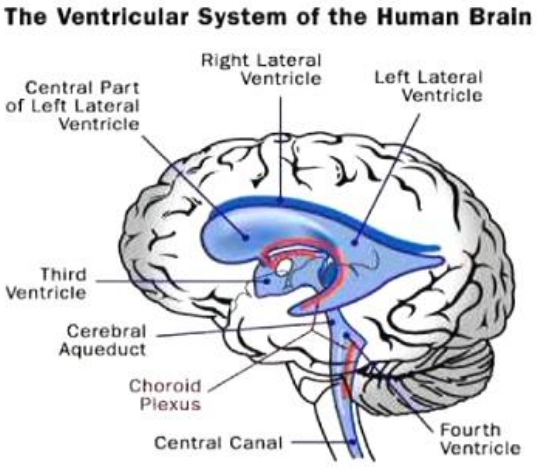
Neural Tube Formation

- Begins as longitudinal thickening of ectoderm
    - Neural plate forms on the surface of the embryo, extends from the head to tail region

- Edges of the plate start to fold; forms the neural groove
- Folds eventually touch around day 22; forms the neural tube
- Cells next to the tube separate, remaining ectoderm forms the neural crest
    - Cranial nerves, spinal nerves (PNS)
- Day 26 - tube differentiates into 2 rings:
    - Mantle layer (inner wall - becomes grey matter)
    - Marginal layer (outer wall - becomes white matter; axons and glial cells)

<u>The Ventricular System</u>

- Derived from the neural canal (centre of the nerual tube)
- Filled with CSF



<u>Timing of Development</u>
First 8 weeks

- If something goes wrong - may result in defectively designed structure/system
    - Teratogenesis - congenital malformations in embryo/foetus
        - Earlier teratogenesis = major congenital defects
        - Later teragonesis = minor defects, functional malformation
- Problem occur after 8th week = failure of growth, development, or refinement of the structure of system

Examples:
Neural tube defects

- Involve the incomplete development of the neural tube
- Occur between the 17-30th day after conception (critical period)

    - Occurs in 4.6/10 000 births
- Related to folic acid deficiency, genetics, maternal diabetes, socioeconomic status

Cerebral palsy

- Covers a variety of non-progressive disorders; characterised by impairment in voluntary movement
- Results from maldevelopment of brain, brain damage prenatally, during birth, shortly after birth
    - Occurs in the developing brain
- Pre-term, low birth weight at higher risk
- Caused by lack of oxygen, infection, impaired rate of growth during pregnancy/early years of life

Cellular level development

- Lifelong trajectory
- Progressive developmental processes balanced by regressive processes that remodel the nervous system during development
    - Progressive processes - cell proliferation, migration and growth, extension of axons to target cells, formation of synapses, myelination of axons
- Epithelial cells lining the neural tube divide to produce neurons and glia
    - Glia - support cells, nourish neurons, collect wastes etc

Explore the neurobiology of brain development

Stages of Brain Development

1. Cell birth

   Neurogenesis, gliogenesis

2. Cell migration
3. Cell differentiation
4. Cell maturation

   Dendrite and axon growth (continues to age 4)

5. Synaptogenesis

   Formation of synapses

6. Cell death and synaptic pruning
7. Myelogenesis

   Formation of myelin

Neurolinguistic development

Locke's Theory of Neurolinguistic Development

- Language learning begins with processes that orient the child to behaviours of people talking; attend to and respond to certain aspects of behaviour
- Responsiveness to facial and vocal activity presumed to be heavily influenced by genetic factors, early experience, supported by specific neural pre-adaptions
- Each phase occurs in a fixed and overlapping sequence, commitment of neural resources

Theory Overview

Age of Onset	Phases and Systems	Neurocognitive Mechanisms	Linguistic Domain
Prenatal	Vocal learning	Social cognition	Prosody and sound segments
5-7 months	Utterance acquisition	Social cognition	Stereotyped utterances
20-37 months	Analysis and computation	Grammatical analysis	Morphology, syntax and phonology
3+ years	Integration and elaboration	Social cognition and grammatical analysis	Expanded lexicon and automated operation

Phase 1 - Vocal Learning

- Strongly oriented to the human face and voice
- Neural mechanisms dedicated to processing faces and facial activity
    - Specialisation in social cognition; orients infants to communication
- Heavy genetic influence
- Social-cognitive operations contribute to initial phases of language learning
    - Right hemisphere
    - Social/cognitive precursors for linguistic capacity
    - Become acquainted with vocal cues;
        - Identify people and emotions
        - Regulate social behaviour
        - Characterise their native language

Phase 2 - Utterance Acquisition

- Rote learning - storage of utterances
- Begin to use formulaic phrases; mimic length, stress pattern, intonation
- Uses correct forms of syntax that may develop later, don't occur elsewhere in their speech
- Provides a sequence of starter phrases used appropriately in specific context
    - Able to speak, regarded as 'talkers'; can't achieve large lexicon, develop language proficiency and flexibility
- First words are formulaic and stored in prosodic type memory
- Right hemisphere - emotional/social
- Storage limitations
- LH not involved