What's Going On In There?

How the Brain and Mind Develop in the First Five Years of Life

By

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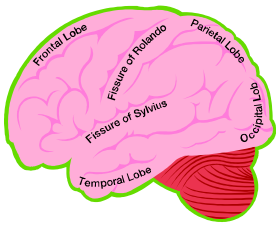
The Basic Biology of Brain Development

What's Going On In There?

Chapter 2

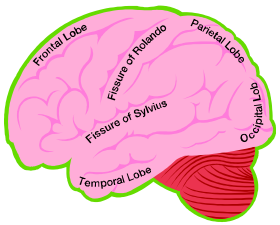
Basic Biology of Brain Development



- Much development occurs before women even realize they are pregnant

- Within 2 days of conception, the embryo divides into 32 cells, w/inner cells becoming the baby's body and outer becoming the placenta (where they fall occurs by chance – 1st instance of environment influencing over genetic determination)

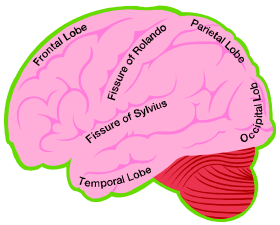
Basic Biology of Brain Development



- Within 1 ½ weeks the top layer of cells become the ectoderm or the first version of the brain and nervous system

- Within almost 3 weeks, the first actual brain tissue begins to form. The development is called neurolation

Basic Biology of Brain Development



- Within 24 hours of conception certain characteristics emerge and have already been genetically predetermined – including gender, complexion, hair color, etc.

- Genes alone will not mold the embryo into emerging person

Brain Sculpting

- Embryonic brain development occurs rapidly
- Within the first month, the brain is emerging and the embryo is forming the separations of its parts – from the spinal cord to the brain, with the brain beginning to separate into forebrain, midbrain, and hindbrain

Brain Sculpting

- Between 5 – 6 weeks the brain formation begins dividing into the right and left hemispheres, then into the major structures (medulla , cerebellum, etc.)

- At 8 weeks of development the baby is two inches long and know called a fetus - all major organ systems are formed and the fetus takes on a visibly human form

Development and Evolution

- There is a similarity between vertebrae embryos - evolution of animals parallels their embryonic development

- At 4 weeks a human embryo looks very similar to any other vertebrae embryo (bird, reptile or mammal), by 6 weeks it only resembles other mammals and by 7 weeks it only resembles primates

Development and Evolution

- It has been easier for evolution to take an existing structure like a limb and turn it into something according to the species such as a wing or arm than to start fresh with each species

The Brain of a Fetus

- Basic functions such as breathing and feeding mature earlier than regions controlling more sophisticated ones such as language or reasoning
- Human nervous system development takes longer in the embryonic stage than other species
- The lower regions of the central nervous system develop specific attributes earlier while higher level (and area) brain development may be formed w/less detail initially

The Brain of a Fetus

- 16 weeks after conception ultrasound can show fingers, toes, 4 chambers of the heart , all in a fetus about 8 inches long
- Although limb movement begins at about 6 weeks, the mother can begin to feel them at about 17 weeks
- At 24 weeks the fetus can survive outside the womb, with the brain being able to direct breathing patterns – but he cortex is still not functional

The Brain of a Fetus

- Even after 9 months of development the baby's cortex in not complete

- Brain development after birth is just as dramatic as before, but pre-birth development just happens at a microscopic level

The Birth and Growth of Neurons

- The human brain is made out of billions of cells or Neurons
- Dendrites of a neuron are the “branches” receiving input and the axon (the “trunk”) relays information
- Information is transmitted via electrical impulses within each neuron

The Birth and Growth of Neurons

- When the impulse reaches the end or axon it is transmitted across a gap, the synapse, to the next neuron's dendrite
- Most neural development occurs from 7-18 weeks of gestation and is called neurogenesis
- By four months of gestation most neurons are formed and those that survive continue to exist until old age

The Birth and Growth of Neurons

- Although most neurons are formed halfway through gestation there are virtually no synaptic connections – it is experience and interaction with the environment that forms the synaptic connections
- Most synaptogenesis occurs through the 2nd year of life
- 83% of dendritic growth (connections between synapses) occurs after birth

Use it or lose it – Natural Selection of Brain Wiring

- Neurons and synapses must get hooked together properly to develop specific skills and abilities in humans
- How the "right" connections are made is still being researched
- During infancy and early childhood the cerebral cortex overproduces synapses (2X as needed)

Use it or lose it – Natural Selection of Brain Wiring

- The overproduction leads to a competition for survival of the fittest synapses
- Experience shapes and solidifies these synapses
- In 1868, Darwin noticed rabbits in the wild had larger bodies and brain than those in captivity

Use it or lose it – Natural Selection of Brain Wiring

- It has been verified, that exposure to enriched environments with extra sensory and social stimulation enhances the connectivity of the synapses, but children and adolescents can lose them up to 20 million per day when not used (stimulated)

Myelination

- In adults dendritic growth and synapse refinement are coated with myelin which serves as an electrical insulation
- When electrical impulses travel from neuron to neuron, some of their "strength" can be lost or "leaked" or can collide and interfere with other impulses
- Myelination speeds up the travel of the impulses and makes their travel more efficient

Myelination

- Myelin is composed of 15 percent cholesterol with 20 percent protein which is why doctors recommend milk for babies. Sometimes high fat diets are recommended to treat epilepsy in children

- Myelination also occurs in order of brain development

Prenatal Influences on the Developing Brain

What's Going On In There?

Chapter 3

Prenatal Influences on the Developing Brain

- Neural Tube Defects
  - Neural tube must be fused to create a proper functioning central nervous system
  - Failure to close can cause defects such as spina bifida and anencephaly
  - NTD's occur in .01 percent pregnancies and more often in female than male fetuses. More common when mother suffers a particular illness during pregnancy

Prenatal Influences on the Developing Brain

- Effects of Nutrition on the Brain
  - From mid-gestation to two years the brain is highly sensitive to quantity and quality of the nutrition it receives
  - Nutrition impacts future cognitive, emotional, and neurological functions
  - Optimally, a woman should gain about 20% of her ideal pregnancy weight

Prenatal Influences on the Developing Brain

- Maternal Drug and Chemical Exposure
  - Alcohol, Cigarettes, Illegal Drugs, Caffeine, Aspartame, and Monosodium Glutamate
  - Other Chemicals and Lead
  - Ionizing Radiation, Nonionizing Radiation, Nonionizing Electromagnetic Radiation, Microwaves and Radio Waves, VDT's, MRI's, and Ultrasound

Prenatal Influences on the Developing Brain

- Maternal Infections
  - Rubella, Cytomegalovirus, Toxoplasmosis, Genital Herpes, Chicken Pox, Syphilis, and Influenza
- Maternal Hormones, Emotion, and Stress
  - The idea of a mother's well being and its impact on the development and health of her child

How Birth Affects the Brain

What's Going On In There?

Chapter 4

Benefits of Birth

- Hormonal cascade causes birth
- Birth stress results in elevated catecholamine hormones
- Catecholamines prepare infant for life outside the womb

Dangers of Birth for Baby's Brain

- Physical trauma, forceps, vacuum extractors
- Cephalohematoma; nerve damage
- Birth asphyxia: danger is a matter of degree
- Greatest concern from birth asphyxia is cerebral palsy
- Fetal monitoring may have a limited role in preventing asphyxia

Childbirth Choices

Systemic Analgesia

- Most commonly used method to control pain
- Drugs can reach the fetus
- Risk of respiratory depression

Epidural Block

- Regional Block
- Pain relief with little loss of lower limb movement
- Hypotension
- Drugs can reach the fetus
- Prolonged labor

Conclusion

- Birth may result in stress/trauma which could affect a baby's cognitive development
- Birth prepares a baby for life on the outside
- Parents should be given access to detailed information about choices of pain management during labor
- Immediately after birth, a baby's brain functions much as it did inside the womb

The Importance of Touch

What's Going On In There?

Chapter 5

Importance of Touch

- Somatosensory system is most developed at birth

- Four types of touch
  - Temperature
  - Pain
  - Cutaneous sensation
  - Proprioception

Touch

- Each modality feels different because signals travel along different paths
- Ability to feel lies in somatosensory cortex on either side of brain
- Orderly map of body's surface
  - not a perfect replica
  - crosses sides of the brain
  - more sensitive areas take up more space

Pain

- Babies can feel pain
- Doctors originally thought that they could not feel pain
- Babies will have infantile amnesia for pain

Benefits of Early Touch

- Essential to sensory motor development, physical growth, emotional well-being, cognitive potential and overall health
- Premature babies are benefited by massage therapy
- Touch is one of the easiest ways of molding emotional and mental well-being

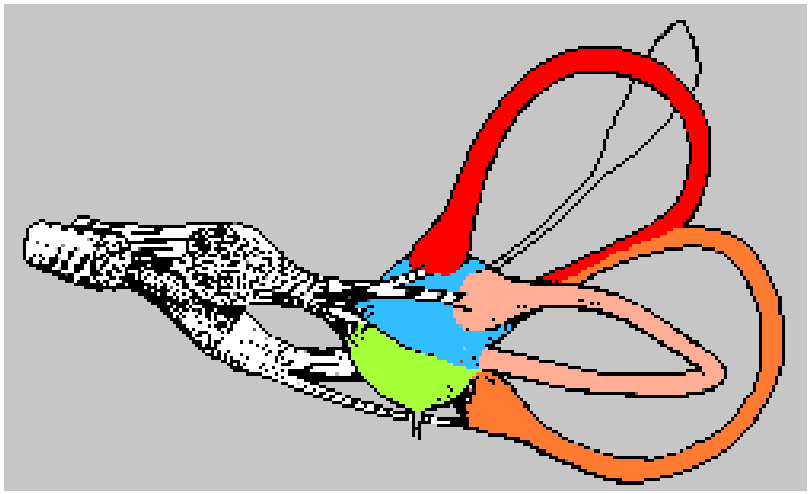
Why Babies Love to Be Bounced

The Precocious Sense of Balance and Motion

What's Going On In There?

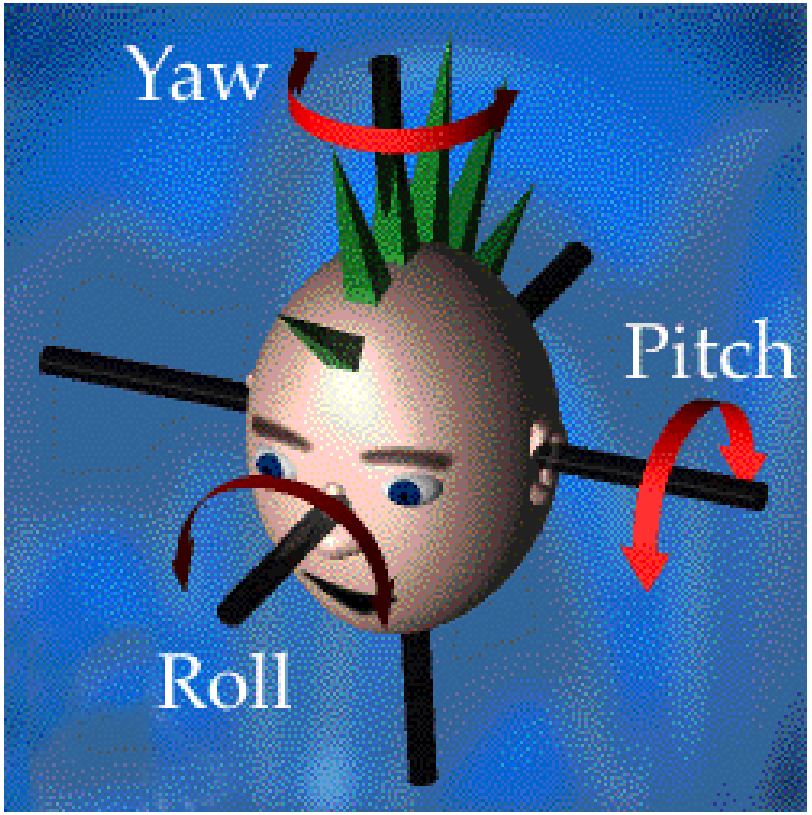
Chapter 6

The Vestibular System



- Named for hollow opening in skull
- Involved in the stabilization of gaze and in the control of balance
- Composed of 3 semicircular canals and 2 otoliths

Vestibular System Function



- Semicircular canals sense rotational movement
- Otoliths respond to linear acceleration and to gravity
- In general operates below the level of consciousness

Prenatal Vulnerability and Development

- Certain drugs (aminoglycosides) damage hair cells in vestibular and auditory pathway
- Defect in vestibular system have a greater chance of being born in breech position
- Vestibular system can be tested by assessing reflex responses: Moro, asymmetrical neck, traction, doll's eye

Benefits of Vestibular Stimulation

- Contributes to development of reflexes and motor skills
- Short-term: soothes and comforts infants
- Continued: decreases infants arousal

The Early World of Smell

What's Going On In There?

Chapter 7

Interesting Points

- Smell, taste and touch: well developed senses at birth
- Smell and taste: "Chemical" senses: neural excitation in response to molecules in environment

Interesting Points

- Information transmitted directly from nose to cerebral cortex – no information processing through lower brain centers
- Rely on smell in infancy more than at any other time

Development of Olfactory System

- 5 weeks: Nasal pit
- 7 weeks: Nostrils
  - Olfactory epithelial cells develop - continuously generated throughout life
- 8 weeks: Olfactory bulb
- 13 weeks: Bulb is walled off with thin bone layer
- 28-weeks: Ability to smell

Smelling

- While well developed early on, experience still important
- Smell not impeded by amniotic fluid
- Amniotic odors: appealing, comforting and important

Smelling

- Mother's Breast
  - Washed vs. unwashed
  - Nursing vs. non-nursing
  - Bottle-fed vs. breast-fed
- Calming effect of mother's scent

Bonding and Social Development

- Babies prefer scent of own mother or caretaker
- Nursing babies: richest olfactory experience
- After breast, it's the neck!
- Scent-marking as develop independence
  - "comfort of Mommy but in a way that they can control"

Taste, Milk, and the Origins of Food Preference

What's Going On In There?

Chapter 8

Introduction

- Along with touch & smell (vestibular senses), the ability to taste emerges early in development
- The sense of taste (gustation) first becomes functional during the third trimester
- Taste ability changes slightly during infancy, but taste preference is highly malleable

How Taste Works

- Like smell, taste is a chemical sense
- Taste buds detect only 4 basic categories
  - - sweet
  - - salty
  - - bitter
  - - sour
- To taste full flavor then involves considerable interaction between taste and the sense of smell

Taste Buds

- Taste receptor cells (special elongated epithelial cells that line the pore of each pit like bud)
- Taste buds are distributed mostly over the perimeter of the tongue (about 4,500 altogether on the tip, sides, back and roof (soft palate) of the mouth, as well as the upper throat
- Each taste bud contains some 40 taste receptor cells

Ability to Taste Begins in Utero

- Taste buds emerge just 8 wks after conception
- By 13 weeks, taste buds have formed throughout the mouth and are already communicating with their invading nerves
- The number of taste buds continues to increase for some time postnatally

Ability to Taste Begins in Utero

- Evidence shows that babies can taste even before birth and are sensitive to different chemicals in the amniotic fluid
- Fetuses can taste some flavors (sweet and perhaps bitter) by the last 2 months of gestation

What is the Function of Prenatal Taste?

- Taste buds mature at the very end of the first trimester
- Amniotic fluid is rich with chemicals that excite taste cells and the amniotic fluid is constantly changing over the course of pregnancy (through mother's diet & even the fetus's own urine)
- Like prenatal smell, a fetus's taste experience in the womb may bias of food preferences

What Can a Newborn Taste?

- Newborns can discern many different flavor, but care only for the taste of sweet
- Newborns can even tell the difference between different types of sugar and concentrations of the same type of sugar

What Can a Newborn Taste?

- Favorite type of sugar is sucrose (table sugar), and it is preferred over fructose (found in fruit)

- Newborns have built in opinions about sweet, bitter & sour. However, they are indifferent to salt. Although they can detect salt, they neither like nor dislike the flavor

Do Babies Consciously Perceive Taste?

- Because taste perception is intimately interrelated to touch perception in the area of the mouth and tongue, taste pathways may form their cortical connections as early as the precocious touch system, allowing early conscious awareness of taste

Changes in Taste Perception

- Babies taste abilities continue to evolve during early childhood – the biggest changes are in the perception of salt (usually around 4 months)
- The delay in development of salt sensitivity is thought to be related to the development of the kidney

Changes in Taste Perception

- The response to salty solutions again changes after 2 yrs of age
- Children's perception of bitterness also evolves
- While taste perception is well developed in infancy, the understanding of what is edible is largely learned

Why Kids (& Adults) Love Sweets

- The bottom line – Sweets taste good because it literally feels good to eat them – they induce pleasurable sensations in the body

- In addition to its calming effects, sugar is known to make babies more alert and to encourage their hand-to-mouth coordination

The Many Pleasures of Nursing

- Milk not only contains sugar, but high levels of fat (which has many of the same calming effects as sweets)
- Fats, too, trigger the release of endogenous opiates, as well as a hormone from the gut called cholecystokinin)

The Many Pleasures of Nursing

- The calming effect of sugar and fats, produced by endogenous opiates, promotes growth and development by helping the baby conserve energy and allowing them to concentrate on learning about their environment

Special Benefits of Breast Milk for Brain Development

- Breast milk contains not only nutrients, vitamins and minerals – it contains enzymes, immune factors, hormones, growth factors, and many other agents not yet identified

Special Benefits of Breast Milk for Brain Development

- Breast milk provides the baby with a large array of antibodies, enzymes and even whole immune cells (machrophages, neutrophils, T-cells, & B-cells) that protect them from most of the infections which the mother has even been exposed

- In many studies, breast-fed children have been found to be smarter than bottle-fed children

Special Benefits of Breast Milk for Brain Development

- The brain undergoes enormous growth between the 3rd trimester of gestation until at least 18 months of age. All of that massive myelination and synaptic reorganization may be facilitated by specific nutrients:
  - - Taurine
  - - Lipids
  - - Non-nutrient Components of Breast Milk

Breast Milk & Early Taste Experience

- No two women's milk is identical, nor any one mother's milk constant at all times
- Variation in breast milk flavors may play an important role in taste development itself

Alcohol & Breast Milk

- Alcohol passes freely through a mother's blood into her milk and can be detected in her milk after about 30 minutes and peaks at one hour post-ingestion

- By 3 hrs. it is nearly gone, although levels remain elevated longer if she consumes more than 1 drink

Alcohol & Breast Milk

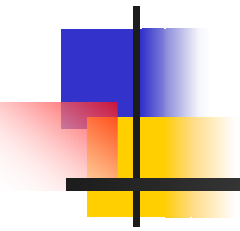
- Alcohol tends to make milk smell sweeter
- Babies sleep less following alcohol ingestion
- Babies score lower on motor skills test at 1 yr. of age; however motor development scores do not seem to be affected by maternal drinking

Does Early Taste Experience Influence Later Preferences?

- Taste preferences are remarkably malleable
- Aside from liking sweet and salt, virtually every other aspect of food preference appears to be a product of experience (an acquired taste)

Little Brains, Big Taste

- Taste is important for children's emotional development
- Certain foods (sweets & fats) literally have mood-altering effects that can calm a baby, improve their attention span, and eventually help them sleep
- Familiar flavors in mother's milk provide a comforting bridge between the womb and the outside world and begin to shape a baby's later food preferences



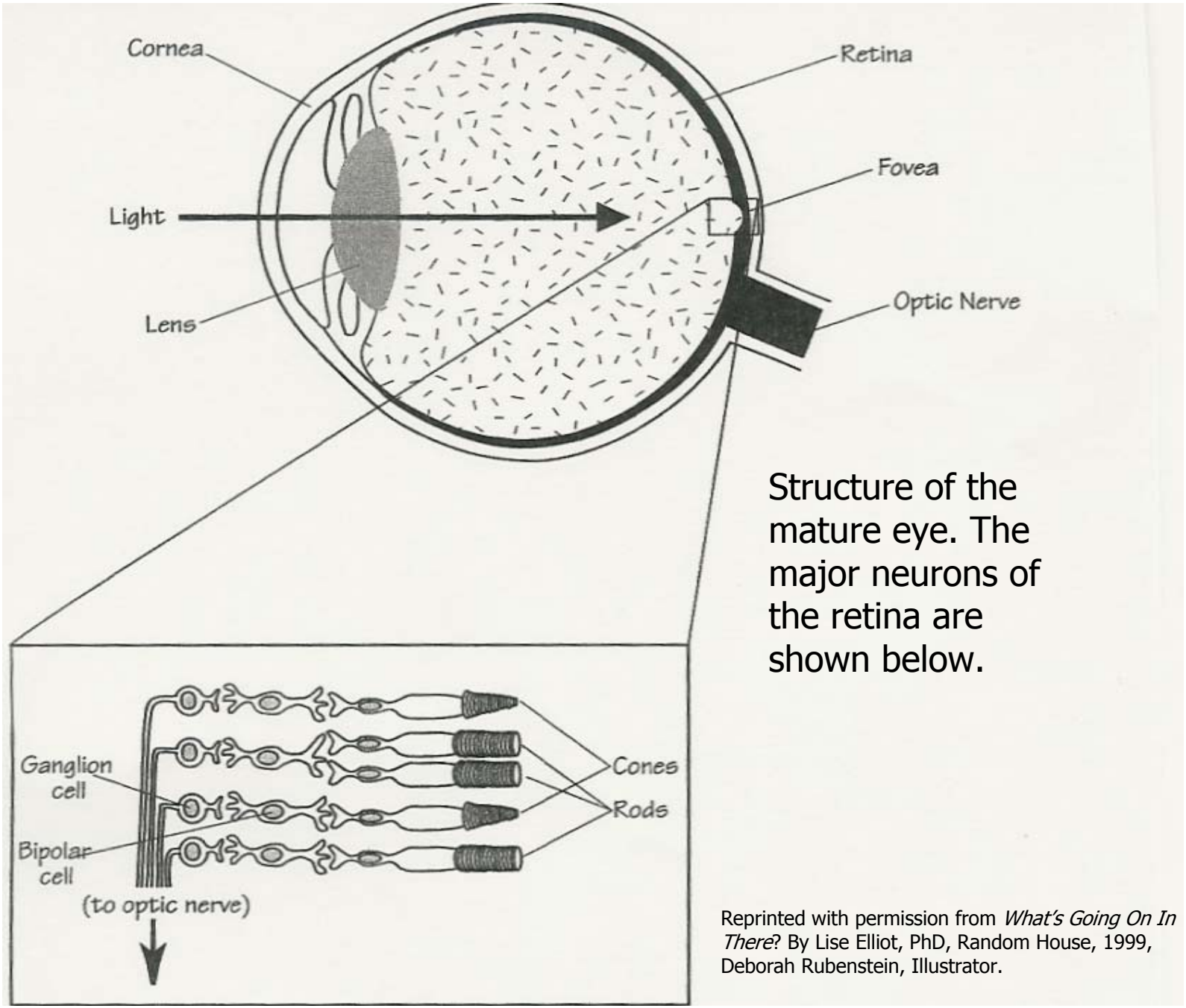
Wiring up the Visual Brain

What's Going On In There?

Chapter 9

Brain Development

- Sense of Vision is Primitive at Birth
- At Six Months all Primary Visual Abilities will have emerged
- Infant's peripheral vision is first to develop
- At One Year Visual Abilities Fully Developed—Nearly as good as an Adult's



Structure of the mature eye. The major neurons of the retina are shown below.

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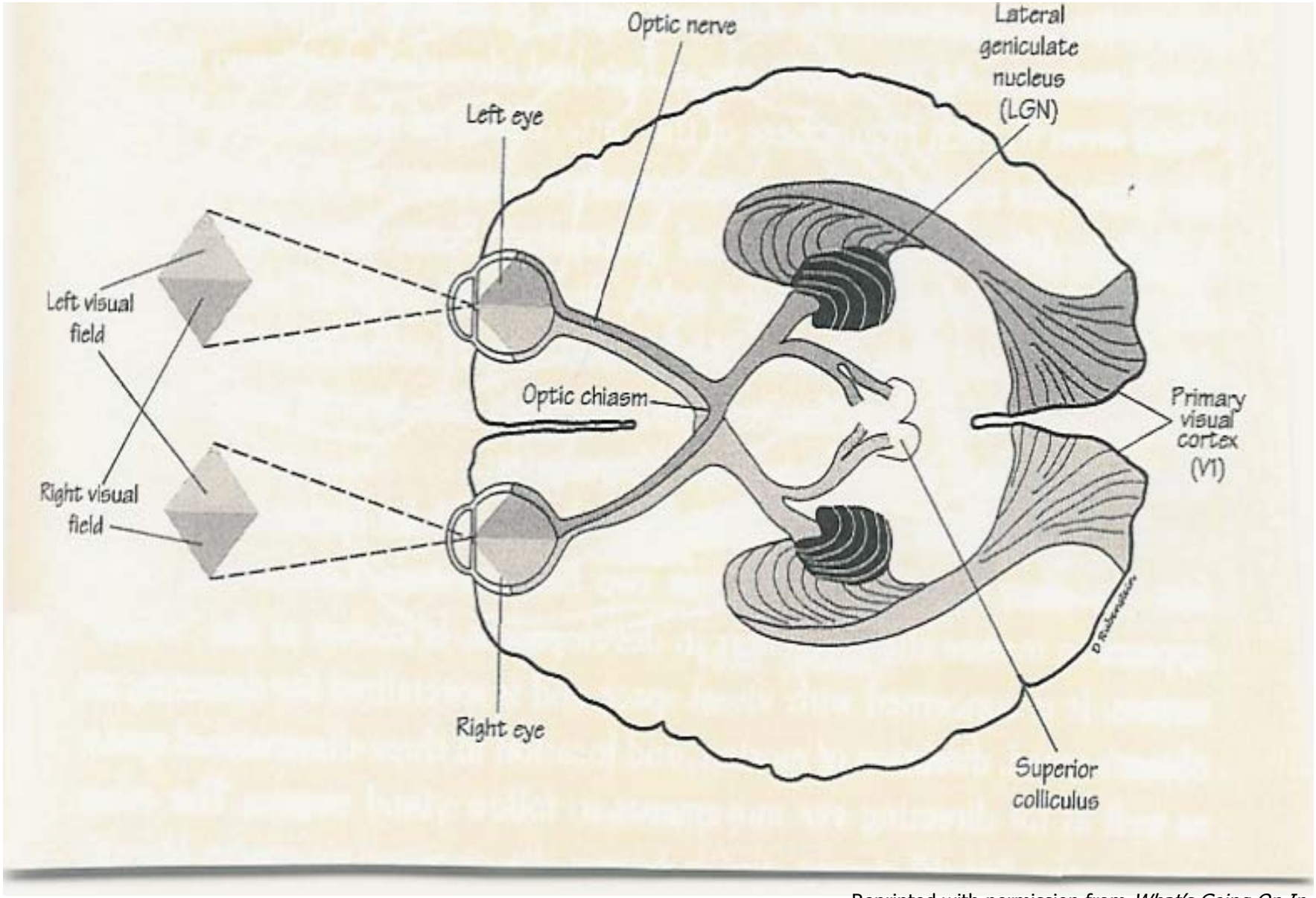
Getting the Wiring Right

- Role of Nature
  - First Phase of Development Controlled by Genes
- Role of Experience
  - In the Act of Seeing
  - Synaptic Pruning-Survival of the Fittest or "most active connections"
  - During the pruning period---until Age 2



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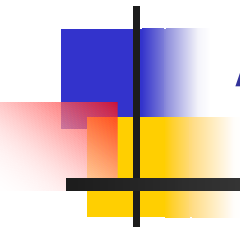
When Something Goes Wrong!

- Up to 5% of Children are born with or will develop visual abnormality
- Congenital Cataract – Easily Detectable
- Strabismus (Cross-eyed)
  - Affects Binocular Vision
  - Can Degrade Fine Acuity
  - Usually shows up in 2-4 months after birth



How Hearing Evolves

What's Going On In There?

Chapter 10

Auditory System

- Receive sound waves
- Translate into electrical signals
- Discriminate different signals into familiar sounds
- Consists of ear, auditory nerve, brain stem, and cerebral cortex

The Ear

Divided into three sections

- Outer ear
  - Flap funnels sound into canal
  - Sound vibrates ear drum
- Middle ear
  - Three bones (malleus, incus, stapes)
  - Amplify vibrations
- Inner ear
  - Cochlea converts vibrations into electrical signal

Sound Impulses Travel

- Sequentially through brain-stem, midbrain, thalamus, to cerebral cortex
- Primary auditory region – upper ridge of temporal lobe
- Information from two ears not segregated
- Compared/combined with input from opposite ear in brain-stem

What Can a Fetus Hear?

- Most fetuses begin hearing by early in the six the month of gestation
- Low-frequency sounds cross mother's abdomen better than high-frequency
- Every reasonably loud sound may influence auditory brain development
- Mother's voice loudest to fetus

What Can a Fetus Hear?

- Older fetuses can discriminate different speech sounds
- Fetuses can remember what they fear – become familiar with environment

What Newborns Can Hear

- Insensitive to quiet sounds
- Discriminate low frequencies better than high ones
- Sound localization – horizontal plane
- Sensitive to overall melody or intonation of spoken language (show preference for native tongue)

How Hearing Improves

Frequency Sensitivity

- By sixth month can perceive high frequency better than low frequency
- Able to distinguish full range of frequencies

How Hearing Improves

Sound Localization

- Both horizontal and vertical planes by sixth month
- Continues to improve gradually until about age 7

How Hearing Improves

Threshold

- Overall hearing sensitivity matures slowly
- Gradually improves until puberty

How Hearing Improves

Temporal Resolution

- Gradual improvement in ability to discriminate sounds in time
- Six month infant requires duration twice as long as adult to distinguish sound

How Hearing Improves

Discriminating Sounds in a Noisy Background

- Ability to mask background noise improves over first two years
- Fully mature at about age 10

Hearing Impairment

Congenital hearing loss

- Any impairment caused either before or shortly after birth
- 1/1000 babies born deaf
- Up to 3% of all children have some minor form of permanent hearing impairment

Hearing Impairment

Prenatal infections

- Rubella virus (German Measles)
  - Attacks both inner and middle portions of developing ear
  - Fetuses infected during first half of gestation likely to be severely hearing-impaired
  - Deafness tends to be severe – may have delayed onset

Hearing Impairment

Prenatal Infections

- CMV (cytomegalovirus)
  - 12% of congenital deafness due to mother's infection – virus can become reactivated and passed on to fetus
- Toxoplasmosis, Genital herpes, and syphilis have also been known to cause hearing loss in unborn children

Hearing Impairment

More than 100 different Drugs and Chemicals are known to specifically damage developing auditory system

- Medicines – certain antibiotics, anticonvulsants, diuretics, antithyroid
- Recreational – tobacco, alcohol
- Environmental – mercury, lead

Hearing Impairment

- Middle Ear Infections
- Otitis media (OM) more common than congenital deafness
- 80% children will have at least one bout before age of three
- Generally doesn't produce any long-term hearing deficits

Final Note

Because language is the primary means we use to teach our children, hearing is probably the most important sense for their intellectual growth.

Motor Milestones

What's Going On In There?

Chapter 11

Motor Milestones

Gross Motor Skill	***Typical Month of Onset***
Holds head erect and steady	1-2
Lifts head and chest with arm support on tummy	2-3
Sits with support	2-3
Rolls tummy to back	3-4
Rolls back to tummy	6-7

Motor Milestones

Gross Motor Skill	Typical Month of Onset
Sits alone	6-8
Pulls to stand	8-9
Crawls	9
Walks with handholds "cruises"	9-10
Stands alone	11-12
Walks alone	12-13

Motor Milestones

Fine Motor Skill	***Typical Month of Onset***
Reflexive grasp	birth
Pre-reaching (ineffective)	1-3
Voluntary grasp	3
Successful reach and grasp	4-5
Controlled reach and grasp	6-7

Motor Milestones

Fine Motor Skill	*Typical Month of Onset*
Pincer grasp (thumb & forefinger)	9
Claps hands	10
Releases objects crudely	12-14
Controlled release	18

Brain-3 Main Parts that are involved in movement

- Cerebral cortex - movement commands are initiated
  - there are three motor areas all located in the back half of the frontal lobes
  - neurons in the "proper" region of the motor cortex send action potentials directly down to the spinal cord through an important pathway known as the **corticospinal tract**

Brain-3 Main Parts that are involved in movement

- Cerebral cortex (cont)
  - primary motor cortex—directly triggers voluntary movements e.g. leg, trunk, arm, hand, face, lips, tongue
  - supplemental motor area and pre-motor cortex—planning and executing more complex sequences of movement e.g. head and face (supplemental motor area) and legs and feet (pre-motor cortex)

Brain-3 Main Parts that are involved in movement

- Cerebellum
  - keeps movements coordinated & precisely timed
  - sits in the back of the brain, underneath the cerebral cortex and behind the brain stem
  - receives input from both the motor cortex (telling what kind of movement is being attempted) & various senses (vision, hearing, balance, & proprioception-telling it what kind of movement is actually taking place)

Brain-3 Main Parts that are involved in movement

- Basal Ganglia
  - includes several distinct clusters, or nuclei, of subcortical neurons
  - located deep inside the brain - under the lobes of the cerebral cortex, atop the brain stem, and adjacent to the thalamus
  - plays a critical role in producing movements

Brain-3 Main Parts that are involved in movement

- Basal Ganglia (cont)
  - people with basal ganglia disorders have great difficulty initiating voluntary movements
  - exerts important control over which motor actions are carried out, suppressing involuntary types
- Parkinson's or Huntington's diseases (basal ganglia disorders)

Motor Development

- **Neuromuscular maturation**
  - fixed process of skill acquisition (first part of this century)
    - Proven Studies
      - 1930-identical twins
      - 1940-Hopi Indian babies

Motor Development

- **Neuromuscular maturation** (cont)
  - Corticospinal Tract—only in mammals; largest corticospinal tract in humans
  - Babinski sign— 4-6 months of life (baby's toes will flare or extend up with stroke at the bottom)
  - After 6 months (baby's toes will curl downward)— if the babinski sign (toes flaring up) persists beyond about six months of age, it is evidence of a possible neurological delay

Motor Development

- Role of the Environment
  - pace of sensory development
  - physical growth
  - strength
  - nutrition
  - motivation
  - emotional well-being
  - daily practice

Motor Development

- If children are neglected may result in:
  - SIDS
  - African infant precocity (the finding that babies from various traditional African cultures are several weeks ahead of the norms; so many researchers believe that differences in rearing style are also responsible

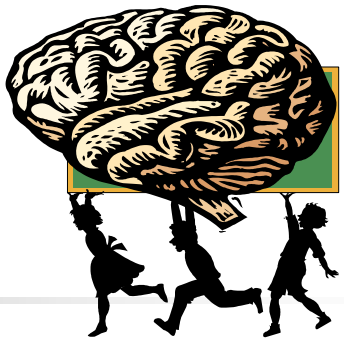
Social-Emotional Growth

I think therefore I feel - or something like that. Goo goo da da!!

What's Going On In There?

Chapter 12

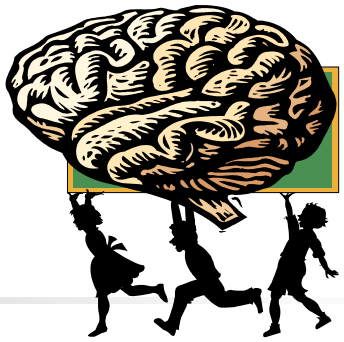
Introduction



- The development of emotional abilities establishes the foundation from which every other mental skill can flourish

- The limbic system is a large set of neural structures that control our social and emotional lives and it is molded by both nature and nurture

Introduction



- The limbic system takes a child's temperament, the inborn "emotional make-up" which is then influenced by experiences with the environment to form our personality

- It sits between the cerebral cortex and the brain stem

Introduction

- The limbic cortex is upper level of the limbic system which modifies and controls our emotional responses
- The limbic cortex is where we "consciously feel" our emotions
- Two amygdala sit between the cortex and the stem, one in each hemisphere, both serving as the gatekeepers that generate emotions

The Emotional Brain

- While the left hemisphere of our brain is the more analytical part, the right hemisphere is where we appreciate emotions associated with experiences affecting the left hemisphere

- The left part of the medial frontal cortex is where we feel good and the right part is where we feel bad

The Emotional Brain

- The limbic system develops from bottom to top with the amygdala formed by the end of gestation
- The limbic system also plays an important role in memory storage

The Emotional Brain

- The 1st 6 months of development are dominated by the lower limbic system - primarily to help meet the baby's physical needs

- At 6 weeks of age a baby begins to smile at other people - actually having started to smile spontaneously since 30 weeks of gestation

The Emotional Brain

- Communicating is the next milestone in social development - with prespeech and protoconversation usually starting at about 6 weeks

- At 6 months the higher limbic centers begin to activate - with babies becoming more emotionally responsive and connected with their surroundings. They genuinely begin to *feel* their emotions.

The Emotional Brain

- The most important social/emotional development in infancy is the emergence of attachment - a baby's strong tie to a primary caregiver and the corresponding caregiver's connection to the baby
- Attachment becomes a child's primary source of security, self-esteem
- Self-control and social skills

Nonmaternal Care, Stress, Gender, Temperament, and Personality

- Most babies manage to bond with mothers regardless of mom's employment status as long as the mother or caregiver is attentive, responsive, consistent and a stable figure in the child's life

- High quality child care can ensure a child's emotional health, improve social competence and advance cognitive development

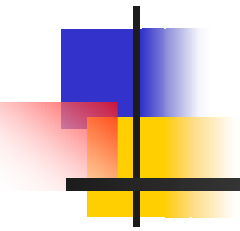
Nonmaternal Care, Stress, Gender, Temperament, and Personality

- Elevated stress hormones can be hazardous to a healthy limbic system
- Emotional differences between boys are girls are innate- girls respond earlier to social stimuli while boys are actually more emotional
- Temperament is innate and connected to neurobiology. It is often reinforced by parental responses

Nonmaternal Care, Stress, Gender, Temperament, and Personality

- Temperament is determined by heredity while about 50% of personality is shaped by experiences - the most important 'limbic tutors" are a child's parents

- Early experiences of abuse "scar" a child's limbic system - they can wire susceptibility to aggression, fear, and pain



The Emergence of Memory

What's Going On In There?

Chapter 13

The Emergence of Memory

- Memory is not a single entity but a patchwork of several different forms of information storage
- Infantile Amnesia - cannot remember events from the earliest years of life
- Memories then grow longer and increasingly conscious throughout the preschool years until elementary school years

The Emergence of Memory

- Short-Term Memory - Used for immediate and ongoing applications
- Long-Term Memory - refers to any kind of recall outside an immediate timeframe and can be recalled at any time
- Explicit Memory - Conscious recollections, who we are and what we know
- Implicit Memory - Knowledge of how to do things

The Emergence of Memory

- Memory is governed by the hippocampus that lies immediately behind the amygdala
- Three other brain regions involved in long-term memory - medial thalamus, basal forebrain, and prefrontal cortex
- The entire nervous system participates because information storage is a fundamental property of neurons

The Emergence of Memory

- The Emergence of Recall - Starts at eight months and beyond and is by definition conscious

- Deferred Imitation - Demonstrate a sequence of events to a young child and test whether they reproduce the sequence. Could explain why children are prone to replicating their parents behavior

Language and the Developing Brain

What's Going On In There?

Chapter 14

Language and the Developing Brain

- Language is hard-wired to the brain
- Grammar is what sets our language apart from other animal communication
- The particular language a child masters, and the way he ends up speaking it, are largely a function of experience
- Early language immersion and practice is necessary for mastering any tongue at all

How Language Works

- Left hemisphere – more verbal side. We literally speak with half a brain. The dominant location of language for more than 95% of people, including a sizable majority of left-handers
- Right hemisphere – responsible for the inflection and overall musical quality that lend important emphasis to verbal communication

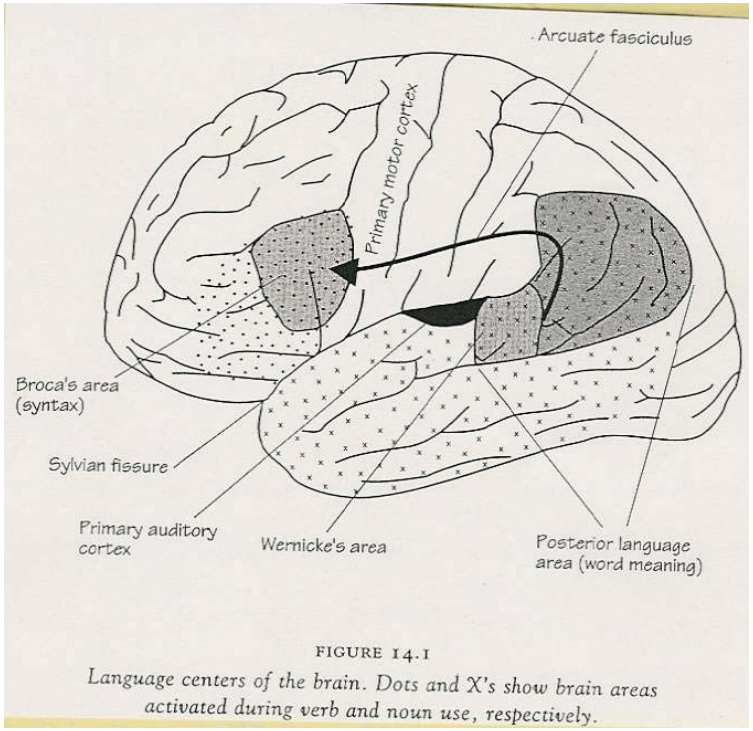


FIGURE 14.1
Language centers of the brain. Dots and X's show brain areas activated during verb and noun use, respectively.

The Critical Period for Language Experience

- Language development is a simple product of brain maturation, of the different schedules for hooking up Wernicke's and Boca's areas and greasing the wires between them

- Just like each of the sensory and motor skills on which it depends, language development is also critically shaped by experience

Language in a Newborn

- Language in the first eighteen months
- Parenting style affects language learning
- Providing early language enrichment

How Intelligence Grows in the Brain

What's Going On In There?

Chapter 15

Intelligence Facts

- There is no single "intelligence center" in the brain
- Intelligence is difficult to measure
- Most IQ tests measure verbal and performance abilities, but do not measure other type of intelligence (e.g., creativity or musical skills)
- Multiple Intelligence: verbal, spatial, mathematical-scientific, musical, bodily-kinesthetic, self- and social-understanding

More Intelligence Facts

- Babies are born with brains ¼ the size of adult brains
- The brain triples in size the first year
- Baby IQ tests do not reliably predict adult intelligence

Why some people are smart and others aren't

- Not because of head/brain size (there is a slight correlation, however)
- High IQ people
  - react faster to various tasks and process information more efficiently
  - have better neural conduction of stimuli
  - burn less glucose while performing mental tasks (children's brains burn more energy than adult brains regardless of IQ)

Baby Milestone Timeline

- ***Four weeks:*** babies can store mental representations of objects
- ***Four months:*** babies can categorize objects by shape/color
- ***Eight months***: frontal lobes "turn on" increasing sense of time, inhibition, and attention skills
- ***Eighteen months***: language and a sense of self develop
- ***Three-Four years:*** discovery of the mind

NATURE, NURTURE, AND SEX DIFFERENCES

What's Going On In There?

Chapter 16

Intelligence varies between children

- Genetic draw
  - faster neural transmission
  - product of experience
  - maternal encouragement of attention
- Environment
  - more attributable to environmental factors in early infancy than at any later time in life

Role of Genes

- Behavioral Genetics: Compare IQ of known genetic relationships to calculate the degree to which intelligence is hereditary.
  - Identical twins– IQ score .86
  - Siblings - .47
  - Parent/Child - score .42 (avg. both parents .72)
- Consensus - genes account for 40% to 50% of one's IQ.

The Role of Environment

- Head Start Program - Increase in IQ
  - Disadvantaged children can benefit
- Adoption Studies - Increase IQ
  - Low-socioeconomic children adopted by high-socioeconomic parents
- "Flynn Effect"- FACT: We are getting smarter
  - Nutrition - Health - Education - Parenting Skill
  - Greater in Visual- Spatial (Visual Media)

Sex Differences in Intelligence

- Brain Development Differences
  - Males have larger brain (8%) than female
  - Males have larger right brain where spatial information is processed, but women are better organized

- Nurture - Play styles - Boys & Trucks - Girls & Dolls

Sex Differences in Intelligence

- Hormones
  - Estrogen and testosterone affect the way males and females think
  - Estrogen promotes mental skills
  - Testosterone promotes better spatial skills
- Experience and Socialization