Atypical Development
CLDDV 160

Chapter 3: Very Young Children With Special Needs

Chapters 1, 2, 3: Children with Disabilities
Prepared by Debbie Laffranchini, MA
I am not my disability...

My disability is part of who I am.

~ Millicent Rogers
Credo for Support

• http://www.youtube.com/watch?v=21uHYEqKO0w
Principles of Human Development
Prenatal Growth and Development

• Embryonic stage
  – 3rd week – 8th week
    • Major organs develop
    • Muscles and nervous system develop
    • Extremities develop
  – Most vulnerable stage of pregnancy
  – Harmful substances or trauma may result in spontaneous abortion or birth defect
Developing Fetus

- Placenta supports embryo and later fetus
- Amniotic sac protects from physical shocks and maintains temperature
- Umbilical cord is largest and most important support
  - Exchanges life-sustaining substance, but not blood
Fetal Stage

- 12 weeks resembles human form
- 16 weeks mother usually feels movement
- Viability is >23 weeks
Perceptual Development

• Vision
  – Preference for complex patterns
  – Preference for 3-D
    • Real objects
  – Preference for faces
  – 20/800 to 20/150 at birth
  – 20/20 around 5 years
  – Face recognition at different angles 7 months
Perceptual Development

• Hearing
  – Startle responses at birth
  – Habituate to sound
  – Sooth to rhythmic music
  – Hear ba/pa 4 – 14 weeks
  – Prefer female voices 4 – 6 months

• Gustatory (taste)
  – Preference for sweet

• Olfactory (smell)
  – Oldest sense
  – Preferences

• Tactile
  – Reflexes present in response to touch
  – Different sensitivity by body part
  – Discriminate warm and cold
Developmental Milestones

• Based on average age which child acquires skills

• Norms are statistically determined
  – Range of normalcy

• At-risk for developmental delay: child exceeds the norms in several areas or the expected ranges in a few areas
Developmental Milestones

Birth – 2 years

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Gross Motor</th>
<th>Fine Motor Adaptive</th>
<th>Personal-Social</th>
<th>Language</th>
<th>Cognitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Kicks a ball</td>
<td>Stacks 6 blocks</td>
<td>Feeds doll</td>
<td>Puts 2 words together</td>
<td>Understands concept of today</td>
</tr>
<tr>
<td>2</td>
<td>Walks up &amp; down stairs</td>
<td>Copies to draw a line</td>
<td>Washes &amp; dries hands</td>
<td>Points to pictures</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Stick with alternating feet</td>
<td>Broad jump</td>
<td>Uses spoon well-only little spilling</td>
<td>Speech 75% understandable</td>
<td>Understands concept of tomorrow &amp; yesterday</td>
</tr>
<tr>
<td>4</td>
<td>Hops on one foot</td>
<td>Copies</td>
<td>Brushes teeth &amp; dresses without help</td>
<td>Names colors understands adjectives</td>
<td>—</td>
</tr>
<tr>
<td>5</td>
<td>Skips heel to toe walks</td>
<td>Copies</td>
<td>Counts understands opposites</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>5</td>
<td>Can balance on each foot for 5 seconds</td>
<td>Copies &amp; draws person with 6 parts</td>
<td>Defines words</td>
<td>Understands right &amp; left</td>
<td>—</td>
</tr>
</tbody>
</table>
Patterns of Growth

• Cephalo-caudal
• Proximo-distal
• Simple to complex
  – Refinement
  – Gross motor to fine motor
• Reflex to intentionality
Physical Growth

• Respiratory system
  – Lungs are main organs
  – Cardiovascular function is critical to normal function of the lungs
  – Nutrition is necessary for normal growth
    • Cerebral palsy, sustain adequate caloric intake

• Cardiovascular system
  – Heart and blood vessels
  – Fetal heart begins to beat approximately 4 weeks gestation
Physical Growth (cont)

• Gastrointestinal system (GI)
  – Processes nutrients
  – Absorbs nutrients
  – Maintain metabolism to support growth
  – Mouth, esophagus, stomach, small intestines, large intestines
  – Excretes digestive waste
  – Excretes waste products

• Neurological system is fastest growing system prenatally
  – Neurons connect to other neurons, causing brain to grow in size, weight, and by area
  – Myelin sheath protects nerves and the connections, allowing nervous system to send/receive messages rapidly
    • When doesn’t develop or damaged, can cause cerebral palsy or inability to visually discriminate
Dentition

- Primary (deciduous)
- Secondary
- Tooth formation occurs in stages
  - Growth
  - Calcification
  - Eruption
  - Tooth loss
Stages of Growth

• Prenatal
• Neonatal (first 30 days)
  – Average 7.5 pounds (5.5 – 10 pounds)
  – 45 – 55 cm (18 – 22 inches)
  – Lose 7 – 10% weight first 5 days
  – Have poor body temperature regulation
  – Fast heart rate, inconsistent breathing
• Infancy
  – Triple birth weight at one year, 1.5 times height
• Toddlerhood
• Early childhood
• Middle childhood
• Adolescent
Theories of Development

- Erik Erikson: psychosocial
  - Genesis of adult mental health problems
  - Trust versus mistrust
    - Feeding, security, affection
    - Hope
  - Autonomy versus shame and doubt
    - Toileting
    - Will
  - Initiative versus guilt
    - Make a plan and do it
    - Purpose
  - Industry versus inferiority
    - Learn skills of society
    - Competence
<table>
<thead>
<tr>
<th>Approximate Age</th>
<th>Psycho Social Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant - 18 months</td>
<td>Trust vs. Mistrust</td>
</tr>
<tr>
<td>18 months - 3 years</td>
<td>Autonomy vs. Shame &amp; Doubt</td>
</tr>
<tr>
<td>3 - 5 years</td>
<td>Initiative vs. Guilt</td>
</tr>
<tr>
<td>5 -13 years</td>
<td>Industry vs. Inferiority</td>
</tr>
<tr>
<td>13 -21 years</td>
<td>Identity vs. Role Confusion</td>
</tr>
<tr>
<td>21- 39 years</td>
<td>Intimacy vs. Isolation</td>
</tr>
<tr>
<td>40 - 65 years</td>
<td>Generativity vs. Stagnation</td>
</tr>
<tr>
<td>65 and older</td>
<td>Ego Integrity vs. Despair</td>
</tr>
</tbody>
</table>

(C) The Psychology Notes Headquarter - http://www.PsychologyNotesHQ.com
Theories of Development (cont)

• Gesell
  – Maturationist theorist
    • Biological process that occurs across time, predictable

• Skinner
  – Behaviorist theorist
  – Child influenced by consequences
  – Two key behavioral principles of learning
    • Reinforcement
    • Punishment

B. F. Skinner
Theories of Development (cont)

• Bandura
  – Behaviorist, cognitivist, social learning theorist
  – Research on aggressive adolescents in the 1950s
  – Reciprocal determinism
    • Person’s psychological processes, language and imagery, interact with person’s environment and behavior
  – Steps for learning through modeling:
    • Attention
    • Retention
    • Motor reproduction
    • Motivation
Theories of Development (cont)

- **Vygotsky**
  - Social/development theorist
  - Social and cultural indicators play key roles in cognitive development
  - Attention, memory, logic, conceptual formation originate from relationships between individuals
  - Limits of cognitive development determined by zones of proximal development (ZPD)
  - Critical time periods for maximal learning efficiency
Theories of Development (cont)

- Piaget
  - Biologist, philosopher, psychologist
  - First psychologist to suggest that children think and process information differently than adults
  - Four intellectual stages of development:
    - Sensorimotor
    - Preoperational
    - Concrete operations
    - Formal operations
  - Intelligence is ability to assimilate and accommodate
    - Ability to take in new information and form new ideas
  - Children actively participate in their learning

<table>
<thead>
<tr>
<th>Stage</th>
<th>Age Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensorimotor</td>
<td>0-2 years</td>
<td>Coordination of senses with motor response, sensory curiosity about the world. Language used for demands and cataloguing. Object permanence developed</td>
</tr>
<tr>
<td>Preoperational</td>
<td>2-7 years</td>
<td>Symbolic thinking, use of proper syntax and grammar to express full concepts. Imagination and intuition are strong, but complex abstract thought still difficult. Conservation developed.</td>
</tr>
<tr>
<td>Concrete Operational</td>
<td>7-11 years</td>
<td>Concepts attached to concrete situations. Time, space, and quantity are understood and can be applied, but not as independent concepts</td>
</tr>
</tbody>
</table>
Theories of Development (cont)

• Bowlby
  – Social learning and psychoanalysis late 1950s and 1960s
  – Attachment and ethnological theory
  – Three phases of separation response that represent important transitions:
    • Protest (separation anxiety)
    • Despair (grief and mourning)
    • Detachment/denial (defense mechanism)
Bowlby’s Attachment

<table>
<thead>
<tr>
<th>Child Terms</th>
<th>Adult Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secure/Autonomous</td>
<td>Secure/Autonomous</td>
</tr>
<tr>
<td>Anxious-Resistant</td>
<td>Preoccupied</td>
</tr>
<tr>
<td>Anxious-Avoidant</td>
<td>Dismissing</td>
</tr>
<tr>
<td>Disorganized/Can not classify</td>
<td>Unresolved/Fearful/Can not classify</td>
</tr>
</tbody>
</table>
Principles and Patterns of Development

• Infants are highly competent organisms
• Infants are socially interactive
• Infants are active learners
• Infant development is multidimensional
• Developmental sequencing is universal
• Skills become more specialized
Passive versus Active Learning

People generally remember... (learning activities)

- 10% of what they read
- 20% of what they hear
- 30% of what they see
- 50% of what they see and hear
- 70% of what they say and write
- 90% of what they do.

People are able to... (learning outcomes)

- Define
- List
- Describe
- Explain
- Demonstrate
- Apply
- Practice
- Analyze
- Define
- Create
- Evaluate

Passive Learning

Active Learning

View Images
Watch a Demonstration
Participate in Hands-On-Workshops
Design/Perform a Presentation - "Do the Real Thing"
Simulate, Model or Experience a Lesson
Design/Perform a Presentation - "Do the Real Thing"
Johnny and Jimmy
1930 – 1942 Silent Study

• http://www.youtube.com/watch?v=2lWrkzygLHI
Principles of Development (cont)

- Plasticity is a phenomenon of brain development
- Critical learning periods exist in normal development
- Infant relationships are the key to cognitive development
- Children undergo several transitions
- Individual differences exist among children
  — Temperament
<table>
<thead>
<tr>
<th>Temperament Dimension</th>
<th>Description</th>
<th>Easy Child</th>
<th>Difficult Child</th>
<th>Slow-to-Warm-Up Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhythmicity</td>
<td>Regularity of eating, sleeping, toileting</td>
<td>Regular</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Activity level</td>
<td>Degree of energy movement</td>
<td></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Approach-withdrawal</td>
<td>Ease of approaching people and situations</td>
<td>Positive</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Adaptability</td>
<td>Ease of tolerating change in routine plan</td>
<td>Positive</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Sensory threshold</td>
<td>Amount of stimulation required for responding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predominant quality of mood</td>
<td>Amount of stimulation required for responding</td>
<td>Positive</td>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>Intensity of mood expression</td>
<td>Degree of affect when pleased, displeased, happy, sad</td>
<td>Low to moderate</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Distractibility/attention span/persistence</td>
<td>Ease of being distracted</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table identifies those dimensions that were critical in spotting basic cluster of temperament and the level of responsiveness for each critical feature. A blank space indicates that the dimension was not strongly related to a basic cluster of temperament.
Factors Influencing Development

• Poverty
• Family structure
• Childcare
• Psychological factors
  – Nurturing environment
  – Bonding
  – Attachment
  – Environmental deprivation or environmental chaos affects social and cognitive development
  – Freedom to explore environment safely with opportunity to experiment and play with appropriate materials
  – Familial stress
• Education
  – Opportunities for child
  – Educational level of parents
  – Safety of school
  – Opportunity for success and positive experiences in school
  – Consistency of school attendance and mobility
  – Value of education to parents
  – Parent’s knowledge of the educational system
Factors Influencing Development (cont)

- **Culture**
  - Educational priorities value values of dominant culture
    - Independence versus cooperative group behavior
    - Competition versus cooperative group behavior
    - Devaluing the practices of other cultures affect children’s development

- **Technology**
  - Television
    - Center of controversy
    - Consumes most time
    - Relationship between time watching television and childhood obesity, aggressive behavior, alcohol and tobacco use, increased high-risk behaviors, accelerated onset of sexual activity, reduction in children’s academic capacity when more than three hours per day
  - Computer
Genetic Disorders
(Batshaw, Chapter 1)

• Genetic disorders
  – 100 trillion cells in the human body
  – Many cell types
    • Nerve cells
    • Muscle cells
    • White blood cells
    • Skin cells
    • Etc
  – All cells have two compartments (except red blood cells)
    • Nucleus (central, enclosed core)
    • Cytoplasm (outer area)
Idealized Cell

- mitochondria
- cytoplasm
- ribosomes
- nucleus
- chromosome
Genetic Disorders (cont)

• Cells
  – Nucleus (except red blood cells)
    • Chromosomes: structures that house genetic code (DNA)
      – DNA
        » Organized into hundreds of units of heredity: genes

• Genes
  – Responsible for physical attributes
  – Responsible for biological functioning
  – Responsible for function of the cytoplasm
    • Waste disposal and release of energy
Genetic Disorders (cont)

- Nucleus: blueprint for growth and development
- Cytoplasm: manufactures the products needed to complete the task
Genetic Disorders (cont)

- Defects occur:
  - Addition of an entire chromosome in each cell
    - Down syndrome
  - Loss of an entire chromosome in each cell
    - Turner syndrome
  - Loss or deletion of a significant portion of a chromosome
    - Cri-du-chat
  - Microdeletion of a number of closely spaced or contiguous genes within a chromosome
    - Chromosome 22q11.2 deletion syndrome: VCFS
  - Single gene defect
    - PKU
  - Altered expression of a gene
    - Rhett syndrome
Chromosome

- Typical human cell has 46 chromosomes
  - 23 pair
    - One from mother, one from father
  - 22 pair autosomes
    - One from mother, one from father
  - 1 pair sex chromosome
    - X from mother
    - X or Y from father
      - Y is much smaller in size
    - XX = female
    - XY = male
  - Some chromosomes have more genes than others
    - Chromosomes 1, 19 and X have 500 – 800 genes
    - Chromosomes 13, 18, 21, and Y have 50 – 120 genes
Chromosomes

HUMAN CHROMOSOMES

Cell Division and Its Disorders

• Two kinds of cell division
  – Meiosis
    • Before conception (reproductive division)
    • Happens only in germ cells in order to create sperm and eggs
    • Cells actually intertwine and may “cross over”, exchanging genetic material
    • Two meiotic divisions
    • Nondisjunction: when chromosomes divide unequally
      – 22 or 24 chromosomes
      – Usually don’t survive
  – Mitosis
    – After conception

• Most commonly found trisomy in miscarriages is trisomy 16
  – Embryos with trisomy 16 are never carried to term
  – Chromosome 16 contains too many genes important to development

• Trisomy 13, 18, and 21 are most commonly observed disorders at birth
  – Contain relatively few genes
  – Intellectual disability
  – Dyshomorphic (unusual) facial appearances
  – Congenital organ malformations
Chromosomal Gain: Down Syndrome

- Most frequent chromosomal abnormality is nondisjunction
- Most commonly occurring in first meiotic division
- Ends up with 24 chromosomes
- 22 chromosomes does not survive
- 90% occur in meiosis of egg
- 5% occur in meiosis of sperm
- 3 – 4% occur as a result of translocation
- 1 – 2% occur as a result of mosaicism
Chromosomal Loss: Turner Syndrome

- 45X affects only girls
- Only disorder in which a fetus can survive losing an entire chromosome
- 99% conceptions miscarry
- 1 in 5,000 births
- 80% are result of meiotic errors in sperm production, receiving no chromosome from father
- Short stature, webbed neck, broad chest, widely spaced nipples, nonfunctional ovaries
- 20% obstruction of left side of heart, caused by coarctation of the aorta
- Typical intelligence
- Visual-perceptual impairments, predisposing nonverbal learning disabilities
- Human growth hormones effective in increasing height
- Estrogen supplementation can lead to emergence of secondary sexual characteristics
- Remain infertile
Mosaicism

• Different cells have a different genetic makeup
  – Trisomy 21 may have in blood cells but not in skin cells or in some brain cells but not all brain cells
  – Often appear that they have a condition but the physical abnormalities and cognitive impairments may be less severe
  – Occurs if some cells lose a chromosome after a normal conception
  – Rare, 5 – 10% of all children with chromosomal abnormalities
Translocations

- Occurs during meiosis or mitosis when chromosome break and then exchange parts with other chromosomes
- Transfers a portion of one chromosome to a completely different chromosome
  - 21 might attach to 14
Deletions

- Part of the chromosome is lost
- Two forms:
  - Visible deletions
    - Seen through a microscope
    - Cri-du-chat
      - Short arm of Chromosome 5 is lost
      - 1 in 50,000
      - Microcephaly, facial dysmorphology, round face, widely spaced eyes, epicanthal folds, low set ears, intellectual disability, high-pitched cry
  - Microdeletions
    - Williams syndrome
      - Deletion in long arm of chromosome 7
      - Intellectual disability, distinctive facial appearance, cardiac defects, unique cognitive profile with expressive language skills beyond what would be expected
    - VCFS
      - Deletion in long arm of chromosome 22
      - May have cleft palate, congenital heart defect, characteristic facial appearance, and/or nonverbal learning disability, cognitive problems, autism
Frequency of Chromosomal Abnormalities

- 25% of eggs have an extra or missing chromosome
- 3 – 4% of sperm have an extra or missing chromosome
- 1% of eggs have a structural chromosomal abnormality
- 5% of sperm have a structural chromosomal abnormality
- 10 – 15% conceptions have chromosomal abnormality
  - 50% of those are trisomies
  - 20% are monosomies
  - 15% are triploidies (69 chromosomes)
  - Remaining chromosomal abnormalities are structural abnormalities and tetraploidies (92 chromosomes)
  - 95% of fetuses with chromosomal abnormalities do not survive
    - Many before pregnancy may be recognized
Genes and Their Disorders

• The problem with extra or missing chromosomes are too many or too few genes

• Genetic disorders can also be a single gene
  – Human Genome Project (public-private partnership to unravel human genes) identified 20,000 – 25,000 genes
    • Prior, it was believed humans had in excess of 100,000 genes
    • Prior, it was believed that each gene manufactured a protein
    • 100,000 proteins are manufactured by 20,000 – 25,000 genes
    • Chimps share 99% of our genes
    • All living organisms have a minimum of 300 genes, all in common
Genes

- Genes are lengths of DNA that form a double helix
- Sides of the ladder are sugar and phosphate molecules
- Rungs are four chemicals: nucleotide bases
  - Cytosine (C)
  - Guanine (G)
  - Adenine (A)
  - Thymine (T)
- Not all genes are “turned on” or expressed at all times
  - Fetal genes, cancer genes
Mutations

• The bigger the gene, the more vulnerable to mutation
• In sperm cells, mutations increase with paternal age
• Mutations occur:
  – Spontaneously
  – Induced by radiation, toxins, and viruses
Single Gene (Mendelian) Disorders

- Autosomal recessive, autosomal dominant, or X-linked
- Duchenne muscular dystrophy
- Fragile X syndrome
- Neurofibromatosis Type I
- Phenylketonuria (PKU)
- Tay-Sachs disease
Autosome Disorders
(first 22 pair of chromosomes)

Autosomal Dominant

Autosomal Recessive
**X-Linked Disorders**

*(sex chromosomes, 23\textsuperscript{rd} pair)*

- Primarily affect males
- Males have a single X chromosome so a single dose of the abnormal gene causes disease
- Carrier mothers pass on the disorder 2/3 of the time
  - 1/3 of the time the cause is a new mutation
- Males are twice as likely to have intellectual disability than females
  - X-linked disorders affect males disproportionately more
  - Unusually large number of genes residing on the X chromosome that are critical for normal brain development, nerve cell function, learning, and memory
    - 10% of all known genetic errors causing intellectual disability are on the X chromosome
      - But only 4% of the genome are located on the X chromosome
- **Most X-linked disorders are recessive**
  - Rett syndrome is the exception
Mitochondrial Inheritance

- Each cell has a nucleus where the chromosomes with their DNA resides with the protein codes for functioning of mitochondria
- Mitochondria reside in the cytoplasm with its own DNA
  - Only eggs have cytoplasm so mitochondria inherited from mothers
- MELAS
  - Progressive, strokes, dementia
- Blindness, deafness, muscle weakness
- 65 mitochondrial disorders
Genetic Testing

• Karyotype
  – Picture of a cell
  – Arrange chromosomes in numbered pairs
  – Identifies numbers of chromosomes and translocations
  – Large deletions and duplications may be visible

• FISH
  – Small deletions and duplications
  – Presences or absence of specific chromosome regions

• Comparative genomic hybridization (CGH) aka chromosomal microarray analysis
  – Limitations

• Urine tests
• Blood tests
• www.genetests.org
Environmental Influences on Heredity

• Prenatal environment
  – Nutrition
  – Diabetes
  – Meningomyelocele
  – Cleft palate
  – Pyloric stenosis
  – PKU

• Postnatal environment
Fetal Development
Chapter 2: Children with Disabilities (Batshaw, Roizen, Lotrecchiano)

• Mature brain has over 100,000,000,000 neurons (100 billion)
  – Book says one billion
• Each neuron connects to 1,000 – 10,000 other neurons
• Brain development is a highly programmed series of overlapping phases
• Each maturational phase has a “critical period”
  – Disruption of development may have irreversible and far-reaching consequences
    • “When” is as important as “what”
<table>
<thead>
<tr>
<th>Time Table of Major Developmental Events in Fetal Brain Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Dorsal induction (pg 27 – 30)</td>
</tr>
<tr>
<td>- 3 – 4 weeks</td>
</tr>
<tr>
<td>● Spina bifida: folate deficiency, anti-epileptic drugs, maternal diabetes, excess vitamin A, trisomies 13 and 18</td>
</tr>
<tr>
<td>● Encephaloceles</td>
</tr>
<tr>
<td>- 4 – 7 weeks</td>
</tr>
<tr>
<td>● Caudal regression syndromes: maternal diabetes</td>
</tr>
<tr>
<td>● Ventral induction (pg 27 – 30)</td>
</tr>
<tr>
<td>- 2 – 3 months</td>
</tr>
<tr>
<td>● Holoprosencephaly: Smith-Lemli-Opitz syndrome, fetal alcohol exposure, maternal diabetes, retinoic acid</td>
</tr>
<tr>
<td>- 3 – 4 months</td>
</tr>
<tr>
<td>● Microcephaly: alcohol, phenytoin, Accutane, radiation, congenital infections, maternal PKU</td>
</tr>
</tbody>
</table>
Environmental Toxicants and Neurocognitive Development

Chapter 3: Children with Disabilities (Batshaw, Roizen, and Lotrecchiano)

- Neurobehavioral disorder: cognitive, behavioral, emotional disorders associated with damage
- 3% of all neurobehavioral disorders in children are directly caused by exposure to environmental contaminants
- 25% of all neurobehavioral disorders in children are caused by interactions among environmental factors
  - Infection
  - Nutritional deficiencies
  - Excesses
  - Life-style factors: alcohol
  - Hyperthermia
  - Ultraviolet radiation/X-rays
Environmental Toxicants (cont)

- World Health Organization estimates that environmental causes account for about 13% of all neuropsychiatric diseases
  - Metals
  - Pesticides
  - Stress, etc.
- Annual cost for lead poisoning is $43.4 billion
- Annual cost for neurobehavioral disorders is $9.2 billion
Susceptible Periods of Development

• Environment affects development
  – Before conception: sperm and ova
  – After conception:
    • Embryo
    • Fetus
  – After birth (up to 20 years)

• Factors:
  – Drugs
  – Chemical toxicants
  – Infections
  – Physical factors
    • Radiation
• Over 1,000 chemicals have been identified as potential neurotoxicants

  – Lead
  • Most studied neurotoxicant
  • Significant problem
    – Lead dust
      » Young children absorb about half of lead they ingest; adults absorb 10% of what they ingest
      » Damages organs, including brain

  • Degree and type of damage depends on:
    – Timing of exposure
    – Dose (maximum blood lead level, lifetime average?)
    – Duration of exposure
Specific Toxicants (cont)

• Lead (cont)
  • Low levels of lead interfere with CNS and neurotransmitter function and results in abnormal myelination
  • Fewer cells involved in cognition and motor function in animals
  • Alters function of dopamine system in animals
    – May explain association between lead exposure, attention deficits, and executive function deficits in children
  • Early exposure decreases adult gray matter, alters white matter (associated with decreased brain volume), and affects language function
  • Treatment: chelation therapy can prevent seizures, coma, and death but cannot reverse the neurocognitive damage
Toxicants:

Mercury

• Elemental mercury is neurotoxic
  – Inhalation of mercury vapor
  – Inorganic or organic compounds

• NO EVIDENCE TO SUPPORT THE CONCERN THAT ETHYL MERCURY WHEN USED AS A PRESERVATIVE IN VACCINES IS NEUROTOXIC

• Extensive review has found no evidence that ethyl mercury in the form of Thimerosal is cause of autism
Toxicants: Mercury (cont)

- Mercury vapor exposure occurs:
  - Breakage of mercury containing devices
    - Thermometers, barometers, fluorescent light fixtures
    - Mercury vapor in individual compact fluorescent light bulb is not sufficient to be toxic; millions is pending environmental health challenge
  - Coal combustion is not likely to cause toxicity because concentrations are low, however...
    - Mercury deposits on land or water environments convert mercury to toxic substances
      - Fish or shellfish are most likely source of mercury but also important source of omega-3 fatty acids, important to normal brain growth
        - Benefits outweigh the risks
        - Avoid high-mercury fish: shark, swordfish, king mackerel, tilefish
        - Eat lower-mercury fish: shrimp, canned light tuna, salmon, pollock, catfish
### Mercury Levels in Fish

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arctic Cod</td>
<td>Bass (Striped, Black)</td>
<td>Bluefish</td>
</tr>
<tr>
<td>Anchovies</td>
<td>Perch (Ocean)</td>
<td>Grouper*</td>
</tr>
<tr>
<td>Butterfish</td>
<td>Plaice - Pollock</td>
<td>Mackerel (King, Spanish, Gulf)</td>
</tr>
<tr>
<td>Catfish - Clam</td>
<td>Salmon (WILD - Fresh or Canned)</td>
<td>Skate*</td>
</tr>
<tr>
<td>Crab (Domestic)</td>
<td>Sardine - Scallop*</td>
<td>Snapper*</td>
</tr>
<tr>
<td>Crawfish/Crayfish</td>
<td>Shad - Shrimp*</td>
<td>Halibut (Pacific, Atlantic*)</td>
</tr>
<tr>
<td>Croaker (Atlantic)</td>
<td>Sole (Pacific)</td>
<td>Jacksmelt (Silverside)</td>
</tr>
<tr>
<td>Flounder*</td>
<td>Squid (Calimari)</td>
<td>Lobster</td>
</tr>
<tr>
<td>Haddock (Atlantic*)</td>
<td>Tilapia</td>
<td>Weakfish (Sea Trout)</td>
</tr>
<tr>
<td>Hake - Herring</td>
<td>Trout (Freshwater)</td>
<td></td>
</tr>
<tr>
<td>Mackerel (N. Atlantic, Chub)</td>
<td>Whitefish - Whiting</td>
<td></td>
</tr>
</tbody>
</table>

*Overfished:*
- Tuna (Canned Albacore, Ahi, Bigeye, Yellowfin)
<table>
<thead>
<tr>
<th>ECO-BEST</th>
<th>ECO-OK</th>
<th>ECO-WORST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchovies</td>
<td>Clams (wild)</td>
<td>Chilean sea bass</td>
</tr>
<tr>
<td>Char, Arctic (farmed)</td>
<td>Cod, Pacific (trawl)</td>
<td>Grouper</td>
</tr>
<tr>
<td>Mackerel, Atlantic</td>
<td>Crab, snow/tanner</td>
<td>Monkfish</td>
</tr>
<tr>
<td>Mussels</td>
<td>Flounder/sole (Pacific)</td>
<td>Orange roughy</td>
</tr>
<tr>
<td>Oysters (farmed)</td>
<td>Lobster, American/Maine</td>
<td>Salmon, farmed/Atlantic</td>
</tr>
<tr>
<td>Sablefish (Alaska, Canada)</td>
<td>Scallop, sea (N.E., Canada)</td>
<td>Shark</td>
</tr>
<tr>
<td>Salmon, wild (Alaska)</td>
<td>Shrimp (U.S. wild)</td>
<td>Swordfish (imported)</td>
</tr>
<tr>
<td>Sardines, Pacific (U.S.)</td>
<td>Squid</td>
<td>Tilefish (Gulf of Mexico/South Atlantic)</td>
</tr>
<tr>
<td>Trout, rainbow (farmed)</td>
<td>Tilapia (Latin America)</td>
<td>Tuna, bigeye/yellowfin (imported longline)</td>
</tr>
<tr>
<td>Tuna, albacore (U.S., Canada)</td>
<td>Tuna, canned light</td>
<td>Tuna, bluefin</td>
</tr>
<tr>
<td><strong>All Eco-Best Fish »</strong></td>
<td><strong>All Eco-OK Fish »</strong></td>
<td><strong>All Eco-Worst Fish »</strong></td>
</tr>
</tbody>
</table>
Toxicants: Mercury (cont)

• Prenatal exposure to extremely high doses of MeHg (mercury from soil or water) results in severe brain damage
  – Microcephaly
  – Seizures
  – Severe cognitive and motor deficits
    • Adults exposed to same levels may have only minimal effects
• Low-dose MeHg has variable results
  – Some studies found decreased IQ, impairment of memory, attention, language, and visuospatial perception
• 2005 – 2008 3% of women of childbearing age in US had blood mercury levels that put children at risk of adverse health effects
• Conclusion: strong association between MeHg exposure in utero and neurocognitive deficits
  – Including small decreases in IQ and abnormalities in neuropsychological tests of memory, attention, language, and visuospatial perception
  – Dependent on timing and amount of exposure
    • High doses adversely affect mitosis
Toxicants: Arsenic

- In high doses, can be fatal
- Chronic exposure can lead to neurotoxicity and cancer
- Exposure usually through contaminated drinking water or industrial sites
  - 100 million people worldwide exposed
  - Crosses the placenta and enters breast milk when mother exposed

Problems with learning, short-term memory, decreased IQ, concentration
Toxicants: Alcohol

- Damage depends on:
  - Amount
  - Timing
  - Duration of consumption
- Moderating factors:
  - Maternal nutrition
  - Stress
  - Tobacco consumption
- Microcephaly
- Behavior problems
- ADHD
- Executive function deficits
- Learning problems
- Brain volume and abnormalities of corpus callosum, basal ganglia, and other brain structures

No Known Safe Level of Alcohol During Pregnancy
Toxicants: PCBs

- **Polychlorinated biphenyls**: industrial chemicals
  - Used in electronics, plastics, paint, pesticide industries from 1930s to 1970s
    - Fat soluble and bioaccumulate and persist for extremely long periods of time
      - Still a concern 40 years later after ban
    - Cross placenta and found in breast milk
    - From food (fish) and contaminated waste sites
      - Farm-raised salmon may be high in PCBs (low in MeHg)
    - Associated with cognitive delays, behavior disorders, growth retardation, and other findings
Toxicants: Pesticides

- Over 1,300 chemicals registered as pesticides in US
- 2001 over 1.2 billion pounds of pesticides used in US
  - Herbicides, insecticides, fungicides
  - ¾ households in US use pesticides
  - DDT banned in 1970 in US, but still used elsewhere in world
- Crosses placenta
- Associated with increased risk of developmental delay, ADHD, autism, deficits in Working Memory Index, and Full-Scale IQ
Toxicants (cont)

- Endocrine Disrupting Chemicals (EDC)
- Multiple toxicants
- Environmental tobacco smoke
- Dietary exposures and ADHD
  - MSG
  - Artificial food colorings (insufficient evidence in US)
  - Sugar
  - Wheat
  - Eggs
  - Small subset of children with ADHD who are made worse by these dietary exposures
Native American's Creed

The earth is your Mother, care for her;
Honor all your relations.
Open your heart and soul to the Great Spirit.
All life is sacred; treat all beings with respect.
Take from the earth what is needed and nothing more.
Do what needs to be done for the good in others.
Give constant thanks to the Great Spirit for each new day.
Speak the truth, but only of the good in others.
Follow the rhythms of nature; rise and retire with the sun.
Enjoy life’s journey, but leave no tracks.