CHAPTER 2: NORMAL MOVEMENT DEVELOPMENT ACROSS THE LIFESPAN
Introduction

☐ In this lecture, you will:

☑ 1) recognize typical and atypical changes in motor behaviors across the lifespan
☑ 2) appreciate factors that influence motor development
☑ 3) apply knowledge of motor development to intervention strategies.
Development: “The changes that occur in one’s life from conception to death”. Is a continuous process throughout one’s entire lifespan and includes changes in cognition, motor, language, social-emotional, and physical characteristics.

Characterized by:

- Acquisition of motor skills during infancy (birth to 1 year) and childhood (1-10 years), followed by period of stability from adolescence (10-19 years) through early and middle adulthood (20-59 years) and finally, a decline in execution of movements during late adulthood (60 years to death)
Dynamic Systems Theory: individuals use all possible strategies to accomplish a task and as physiological systems are modified, the motor behavior changes. Dynamic interactions take place between and among the musculoskeletal, neuromuscular, cardiovascular, pulmonary, and cognitive systems.
Critical periods: as one ages, organizational changes of bodily systems increase the complexity of the collective system, allowing for greater adaptability and more efficient function. There are periods of time when the physiological systems are most vulnerable and may be seriously impacted by both intrinsic and extrinsic factors acting upon the system.
Aging

- Chronological Age: period of time that a person has been alive, beginning at birth. What is your chronological Age? When were you born?

- Biological Age: functional age in different body systems in relation to chronological age.
  - A marathon runner may have biologically younger cardiovascular and pulmonary systems than the same age peer who is not a runner.
Aging

- Using biological age may be more accurate in reflection of changes in a biological system.
- Elements of lifestyle, are changeable and may be used to identify individuals who may or may not age successfully.
Muscles, bones, cartilage, tendons, ligaments

- 5-8 weeks in utero: rapid development

Muscles grow 2 X faster than bones from 5 months to 3 years.

In infancy, Type I fibers (fast twitch) dominate vs. in adults, Type I and Type II are equal.
As individuals age, the size of fibers, muscle fiber recruitment, and quantity of fast-twitch fibers decreases. Thus keeping physically active while progressing into older adulthood may be the primary key.

Males muscles grow faster and bigger during childhood/adolescence.
Musculoskeletal cont

- The skeletal system: follows similar path
- Primary difference between child and adult are presence of growth plates. Bone length is complete when the plates are ossified, 14 years in girls and 16 years in boys.
- Bones continue to grow on surface, until age 30.
- Bones size then stabilizes through middle adulthood.
- Then, bone mass declines women more than men. (menopause). Osteoporosis can develop.
Overall, growth of the system relates to demands placed on the system.

- **Strength**: increases with higher levels of resistance causing the muscle fibers to hypertrophy. As individual’s age, the number and size of muscle fibers decrease.
Flexibility: Infants exhibit limited flexibility due to utero environment. The flexibility increases until ages 10 in boys, 12 in girls and then it begins to decrease. However, this may not be true of athletes, dancers. As activity levels decrease, so does flexibility. Therefore, as age increases, flexibility decreases.

PT and PTA’s can modify these 2 musculoskeletal impairments. The musculoskeletal tissue is modifiable.
Cardiovascular and Pulmonary Systems

- Cardiovascular system = heart and vascular complex
- Pulmonary system = lungs.
- Together, they deliver oxygen and nutrients through the body and remove waste products.
- Development begins at week 3 of gestation, with the heart formed by week 8.
- The heart doubles in size by an infant’s first birthday and increases 4-fold by age 5.
- As the heart grows, the heart rate decreases and blood pressure increases.
Normal heart rates:

newborn: 120-140 bpm

age 6: 80 bpm

age 10: 70 bpm

Capacity to maintain exercise for longer periods and greater intensities increases throughout early childhood.
Lungs develop in fetal life and continue into infancy. Aerobic capacity increases in childhood and is slightly higher in males.

Peak Oxygen consumptions achieved early in adulthood and changes in direct relation to activity levels.
As activity decreases in older adulthood, so do the structural and functional capacities of cardiovascular and pulmonary systems.

Max heart rate decreases, cardiac output is reached at lower levels.

Decreased elasticity of tissues, decreased efficiency of structures, and decreased ability to increase workload.

Aerobic activities can alter these normal aging responses.
Comprised of CNS and PNS

Development begins 3rd week of fetal life. The most critical period of CNS is during first year of postnatal life. Growth of CNS slows after 2 years of age, but continues into adulthood. As the nervous system matures, complexity of gross and fine motor skills and cognitive processes increases.

As with other systems: CNS has capacity to compensate for some changes related to aging, activities may stimulate activation of new growth in dendrites.
Cognitive System  pg. 23

- 5 senses to process, interpret, store, and retrieve information.
- Directly related to problem solving and information processing.
- A child first develops ability to differentiate familiar and unfamiliar people.
- During childhood, higher-level cognitive process emerge.
Cognitive System

- Optimal processing occurs throughout adolescence and into middle adulthood.
- As individual grows older, information is processed more slowly, and the time necessary to perform motor skills increase. Example of decreased cognitive processes: Driving. (delayed execution of task)
Haywood defines: “gradual process of refining skills and integrating biomechanical principles of movement so that the result is a motor behavior that is consistent and efficient”.

Previously, infants were considered passive beings. Infants were thought to produce responses that were stereotypic in nature and referred to as primitive and postural reflexes.
Motor Development

- Contemporary research refutes this: they are seen as competent beings capable of complex interactive behaviors.

- Example: infant’s ability to produce purposeful interactions at birth is observed when the infant turns his or her head to his or her mothers’ voice.
represent an example of infant behaviors that classify infants as passive beings. These reflexes, now referred to as Innate Motor Behaviors, are based on traditional models of CNS organization and motor development theories. They are a result of CNS development and interactions and interdependence of intrinsic and extrinsic factors.

These reflexes are modifiable and represent functional behaviors observed in very young infants.
<table>
<thead>
<tr>
<th>Reflex</th>
<th>Age at Onset</th>
<th>Age at Integration</th>
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<tbody>
<tr>
<td>Suck--Swallow</td>
<td>28 weeks</td>
<td>2-5 months</td>
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<tr>
<td>Rooting</td>
<td>28 weeks</td>
<td>3 months</td>
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<tr>
<td>Flexor Withdrawal</td>
<td>28 weeks</td>
<td>1-2 months</td>
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<tr>
<td>Crossed Extension</td>
<td>28 weeks</td>
<td>1-2 months</td>
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<tr>
<td>Moro</td>
<td>28 weeks</td>
<td>4-6 months</td>
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<tr>
<td>Plantar Grasp</td>
<td>28 weeks</td>
<td>9 months</td>
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<tr>
<td>Positive Support</td>
<td>35 weeks</td>
<td>1-2 months</td>
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<tr>
<td>Asymmetric Tonic Neck</td>
<td>Birth</td>
<td>4-6 months</td>
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<tr>
<td>Palmar Grasp</td>
<td>Birth</td>
<td>9 months</td>
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<tr>
<td>Symmetric Tonic Neck</td>
<td>4-6 months</td>
<td>8-12 months</td>
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The extensive literature on motor development indicates that not all individuals acquire the same motor skills at the same chronological age, nor will every individual exhibit motor behaviors in a fixed sequence of activities.
Motor Development

- Changes in motor performance, are evident throughout life, not just age-dependent, but age-related. Practice of skills can improve performance. While, decreased frequency in performing, causes decline in motor skills.

- Declines in motor skills may be attributable to changes that occur as part of aging process.
Balance reactions

Righting, protective, and equilibrium reactions.

- These reactions involve the head and trunk and provide the body with an automatic way to respond to movement of the center of gravity within and outside the body’s base of support.

- They improve throughout infancy, childhood, and into adulthood. They will decrease in older adults.
Motor Development

- Prenatal (0-40 weeks): Fetuses have been observed reaching, grasping, thumb sucking, and kicking in utero.

- Infancy (Birth to 12 months): At birth infants are capable of purposeful movements: infants turn toward sound of mother’s voice and visually focus on and track objects 8-12 inches from their faces.
Motor Development

- First 3 months: infant gaining control of head in all planes.
- Age 0-1 months:
  - In prone: lifts head, turns to side
  - In supine: head turns side to side. Tracks objects. Prefers head to one side.
  - In sitting: Head upright 1-2 seconds. Slumped in supported sitting.
  - Locomotion: Makes crawling motions
  - Hand: Arm movements are jerky.
Motor Development

- **Age 2-3 months:**
  - In supine: Hand to foot play, hands in midline, hands to mouth
  - In sitting: Head upright bobs. Head lags in pull to sit. Requires support to sit. Rounded back
  - Locomotion: Pivots 30 degrees prone.
Motor Development

- 4-5 months:
  - In prone: Pushes up onto extended arms, pivots in prone
  - In supine: begins rolling supine to sidelying, feet to mouth
  - In sitting: propped sitting, head steady, can turn head in sitting
Motor Development

- **6-7 months:**
  - In prone: Can reach with one hand for toy
  - In supine: lifts head to sit up, rolls supine to prone
  - In sitting: Moves from sitting to prone or quadruped. Sits independently (masters sitting)
  - Locomotion: Moves forward on belly. May crawl backward.
Motor Development

- **8-9 months**
  - Prone: gets to hands and knees
  - Supine: won’t stay in this position
  - Sitting: transfers b/w prone and sitting, pivots in sitting
  - Standing: pulls to stand, stands at furniture, lowers to floor
  - Mobility: crawls forward, cruises along furniture
  - Hand: Points with index finger, takes object out of container
Motor Development

- 10-11 months

- **Standing**: Briefly stands without supports, pulls to stand through ½ kneel, picks up object from floor with support

- **Mobility**: walks with 2 hands held progressing to 1 hand held, bear walks

- **Hand**: puts object in container, grasps crayon, fine pincer grasp
Motor Development

- 12-15 months

  - In sitting: side sits
  - Locomotion: Walks without support, walks backward and sideways, transfers to stand using $\frac{1}{2}$ kneel, squats to retrieve objects and returns to stand, creeps upstairs.
  - Hand: Begins to use objects as tools, assists with feeding, builds 2 cube tower, holds 2 cubes in same hand. Grasps with thumb and first 2 fingers. Pats pictures in book. Turns over container to empty it.
16-24 months:


Hands: Builds 3-6 cube tower. Propels ball (kick and throws)
Motor Development

- 2 years:
  - Locomotion: Rides tricycle, walks on tiptoes, runs on toes, walks downstairs alternating feet, jumps off low step
  - Hands: turns knob, opens and closes jar, buttons large buttons, uses child scissors, 12-15 piece puzzle, folds paper
Motor Development

- **Age 3-4 years**
  - **Locomotion:** Balances one foot momentarily to >3 seconds. Arms reciprocate in running. Throws and catches small ball. Jumps up to 2 ft., hops on 1 foot 2-10 times, walks on a line.
  - **Hands:** 9 cube tower. Dominant hand emerges. Builds bridge with blocks, copies circle/cross, draws squares, matches colors.
Motor Development

- **Age 5-8 years**
  - **Locomotion:** Jumps forward and sideways. Jumps over 6-8 in object. Skips, gallops, bounces large ball, and jumps with rhythm/control.
  - **Hands:** Draws letters shapes and numbers. Places small pegs in pegboard. Prints well. Buttons small buttons.
Motor Development

- Age 9-12 years
  - Locomotion: Mature patterns in running, jumping, and throwing.
  - Hands: Handwriting develops, learns to draw.
Adolescence: (11-19): By 12, 90% of mobility and reaction times have developed. Motor skills, strength, endurance, and coordination continue to develop. If child chooses to play sports, can have a significant role in performance outcome. Manipulative skills are complex and resemble skills observed in adults. Sewing, crafts, musical performance develops.

During this period: children may be genetically predisposed to performing high level motor activities and may stand apart from their peers.
Middle Adulthood (40-59): Aging begins, exercise regimes can control muscle atrophy.

Older Adulthood (60+): Most older adults function well until an acute illness, a traumatic event, or a compounding of small incidents. 30% of individuals over age of 65 experience at least one fall. 30% muscle strength loss by age of 70. 40-50% muscle strength loss by age of 80.
Motor Development

- Aging causes motor skills to become more slow, agonist and antagonist muscle groups have increased co-activation and poor timing, uncoordinated, decreased balance, muscle weakness. Postural control also deteriorates.

- Again, age associated effects are reduced with regular exercise.
Why do we have to know this?

Not in your book!

- Motor milestones:
  - If the child doesn’t accomplish the motor skill within a few months, may be a neurological / musculoskeletal / developmental problem.
  - With a neurological injured patient, you may need to take them back through the developmental milestones to work toward recovering higher level skills
Why do we have to know this?

- Primitive reflexes:
  - With a neurological injury, reflexes that have already integrated, may resurface. OR the reflexes may never integrate in the first place (example: child with CP)
  - Sometimes, you can use the primitive reflex to HELP with your treatment. And, sometimes, the reflex is going to be something you are trying not to elicit.
Play as Therapy: Child-directed activity used to achieve a desired outcome. In therapy: play sessions should be directed to developmental ability and interest of child with activities that motivate the child to practice motor skills be varying the task and the environment.

Adults generally are directed by completing ADL skills. Allowing choice, self-motivation, and error correction within the activity will lead to better ADL skills.