

# DEVELOPMENT OF HUMAN LOCOMOTION

# CHAPTER OBJECTIVES

- Define the concept of human locomotion in humans;
- Describe the different types of locomotion;
- Discuss the development of specific locomotor patterns; and
- Explain the different individual constraints that affect development of locomotor patterns.

# UPRIGHT BIPEDAL LOCOMOTION

- Human beings walk on two feet
  - upright bipedalism/upright bipedal locomotion.
- Humans can move from place to place on land by:
  - Running
  - Galloping
  - Skipping
  - Crawling
- Gait refers to a particular pattern of locomotion.
- Many different constraints interact to encourage or discourage locomotion.

# PRECURSORS TO LOCOMOTION

- At about 2-3 months, the foetus begins to reflexively and/or spontaneously move its legs.
- Movements continue throughout pregnancy.
- Three things to remember about early motor behaviour:
  1. Spontaneous leg movements
    - such as kicking resemble adult walking.
  2. Reflexive stepping exists but does not need to disappear for voluntary stepping to occur.
  3. Motor milestones occur that lead to the skill of upright bipedal locomotion.

# PRECURSORS TO LOCOMOTION

- Locomotion ability exists as from the beginning - hard-wired ability.
- Developments better this hard-wired ability.
- Structural constraints such as height, weight and muscle mass interact to encourage the hard-wired ability.

# THE FIRST VOLUNTARY LOCOMOTOR EFFORTS: CREEPING AND CRAWLING

- The infant must first achieve certain motor milestones
  - lifting the head in the prone (lying upwards) position.
- There must be enough strength to support and move around which is achieved by uncoupling the limbs.
- The environment must allow the infant to move
- The infant must evaluate the environment and see how well it matches individual constraints.
- There are rate limiters and controllers which are overcome once critical levels of development have been achieved.

# THE FIRST VOLUNTARY LOCOMOTOR EFFORTS: CREEPING AND CRAWLING

- Creeping (moving on hands and knees) and crawling (moving on hands and stomach, combat crawl) are the first types of infant locomotor pattern.
- Creeping and crawling follows these progression of skills:
  - Crawling with the chest and stomach on the floor.
  - Low creeping with the stomach off the floor but the legs working together (symmetrically).
  - Rocking back and forth in the high creep position.
  - Creeping with legs and arms working alternatively.
- Progress from rocking to creeping occurs from bilateral to a cross lateral pattern.

# THE FIRST VOLUNTARY LOCOMOTOR EFFORTS: CREEPING AND CRAWLING

- More time spent rocking in high-creep position develops:
  - necessary strength and balance to move on to support themselves in a tripod with one arm off the ground.
- Hand preference is also developed.

# RELATIONSHIP BETWEEN CREEPING AND TYPICAL MOTOR DEVELOPMENT: DOES AN INFANT HAVE TO CREEP?

- Skipping creeping does not lead to dysfunctional development.
- Many children and adults skip creeping and develop and continue to develop in typical fashion.

# WALKING ACROSS THE LIFE SPAN

- People continually change the way they walk as different constraints change.
- The only thing that remains unchanged is the timing of walking.
- Walking is defined by a 50% phasing relationship between legs as well as a period of double support, followed by the single support.

# THE FIRST STEPS: CHARACTERISTICS OF EARLY WALKING

- The steps tends to be independent of the next.
- The steps are shorter with flat feet, toes pointed outwards.
- Feet are spread wide apart to improve balance (stability).
- Arms held higher to improve balance.
- With continued walking, the arms drop firstly to the waist level (middle guard) and later to the sides (low guard).
- Arm swing is unequal and irregular.

# RATE CONTROLLERS IN EARLY WALKING

- Walking starts at least 7 months after birth.
- Constraints:
  - ❑ Legs must move alternatively.
  - ❑ Strength to support on a single limb.
  - ❑ Balance.

# PROFICIENT WALKING PATTERNS

- Stride length increases.
- Changing from flat foot to heel-then-forefoot pattern.
- Out-toeing is reduced.
- Double-knee lock system.
- Pelvic rotation.
- Balance improved
- Coordinated arm swings.

# DEVELOPMENTAL CHANGES IN WALKING DURING EARLY CHILDHOOD

- Developmental changes occur around the age of 2.

# DEVELOPMENTAL CHANGES IN WALKING DURING OLDER ADULTHOOD

- In men:
  - ❑ Step length of the older men gets shorter.
  - ❑ Older men toed out more than younger men.
  - ❑ Reduced ankle extension (downward movement).
  - ❑ Limited pelvic rotation.
- In women:
  - ❑ Shorter step length.
  - ❑ Out-toeing.
  - ❑ Less pelvic rotation.
- This is due to reduced levels of balance.

# RATE CONTROLLERS IN LATER WALKING

- Structural constraints may result from osteoarthritis in the joint or a decline in muscle mass.
- Functional constraints such as balance and fear may change walking patterns (wide base of support, short step length).
- Less likely to walk long distances.
- Decreased walking results in decreased muscle mass and flexibility which further changes the walking patterns.

# OTHER LOCOMOTOR SKILLS

## JUMPING

- Jumping is attempted at a young age = before age 2.
- Jumping = individuals propel their bodies from a surface with either one or both feet and land with both feet.
- Hopping = taking off and landing on the same leg, repeatedly.
- Leaping = a run with a projection forward from one foot to a landing on the other.

# CHARACTERISTICS OF AN EARLY JUMP

- Changes can be observed in various ways:
  - ❑ The age at which a child can perform certain kinds of jumps (age norms)
  - ❑ The distance or height of a jump.
  - ❑ The jumping form or pattern.

# CHARACTERISTICS OF AN EARLY JUMP

## SUMMARY

- Early jumps :
  - no crouching and legs are not extended
  - not straightened
- No use of two-footed take-off or landing
- Lack of coordinated arm movement, the wing or parachute

# PROFICIENT JUMPING

- There are few pointers about proficient jumping:
- Preparatory crouch that stretches the muscles and allow the legs to apply maximal force.
- Take-off with heels and feet leaving the ground at the same time.
- Arms are extended forward, arms swing forward to a position overheard

# DEVELOPMENTAL CHANGES IN JUMPING

- Growth in body size and strength contributes to quantitative improvements in how far children jump.

# RATE CONTROLLERS IN JUMPING

- To perform a two-footed jump, children must be able to:
  - develop enough force to bring their bodies into the air from a stationary position.

# HOPPING

- Adults rarely use hopping to move around.
- Hopping needs to be developed in childhood.
- To hop, one must project and absorb body weight with just one limb and maintain balance on the small base of support that one foot provides.

# CHARACTERISTICS OF EARLY HOPPING

- The support leg is momentarily lifted from the floor by flexing it rather than projecting the body up by leg extension.
- Swing leg is inactive.
- Arms are inactive

# PROFICIENT HOPPING

- Characteristics of proficient hopping:
  - ❑ The swing leg must lead the hip.
  - ❑ The support leg must extend fully.
  - ❑ The hopper must use the arms, which should move in opposition to the legs.
  - ❑ The hopper must flex the support at landing to absorb the force of the landing and to prepare for extension at the next take-off

# DEVELOPMENTAL CHANGES IN HOPPING

- Few children under age 3 can hop repeatedly.
- Preschool years the children becomes proficient hoppers.
- The neuromuscular system changes children's hopping to allow a:
  - softer
  - more cushioned landing.

# RATE CONTROLLERS IN HOPPING

- Hopping likely depends on the postural system's ability to balance the body on one limb for succession of hops.
- Enough force must be generated to lift the body with one limb, recover and quickly generate enough force again to hop repeatedly.

# GALLOPING, SLIDING AND SKIPPING

- Galloping = a step on the lead leg and a leap-step on the trailing leg.
- Skipping = a step on one foot and a step then a hop on the other foot, alternately continuing.
- Sliding = sideways movement.

# CHARACTERISTICS OF EARLY SKILL PATTERNS

- Usually arrhythmic and stiff.
- Arms rarely involved.
- Stride or step length is short and accompanied by flat-footed landing.
- In galloping, the trailing leg may land before the lead leg (See figure 7.18).

# PROFICIENT SKILL PATTERNS

- ❑ The arms are no longer needed for balance.
- ❑ In skipping, arm swing rhythmically in opposition to the legs and provide momentum.
- ❑ The child can use the arms for another purpose during galloping and sliding, such as clapping.
- ❑ Heel-forefoot or forefoot landing prevail.
- ❑ The knees ‘give’ on landing, remaining flexed while they support the body’s weight and then extend at takeoff especially when the child is travelling quickly.

# DEVELOPMENTAL CHANGES

- Galloping is the first to emerge.
- It emerges around the age of 2 when the child has developed a running pattern.
- Sliding is the next step.
- Skipping emerges last around 4-7 years.
- Girls typically perform these locomotor skills at an earlier age than boys = early biological maturation, imitation of other girls and encouragement from family and friends.

# RATE CONTROLLERS FOR THE GALLOP, SLIDE AND SKIP

- Neuromuscular system to coordinate the two limb as they alternately perform asymmetric tasks.