CHAPTER 10
Growth, Motor Development and Physical Literacy

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GROWTH AND MOTOR DEVELOPMENT

- Does not simply follow a predetermined genetic blueprint
- Influenced by personal, social and environmental factors
- Direction
  - Cephalocaudal: head → foot
  - Proximodistal: centre → outward
• Why is it that by high school, some young people enjoy physical activity while others dread it?
• Various factors allow for smooth, motor development and physical literacy
• Example: choosing appropriate activities at various maturation stages

Growth: a measurable change in body size, quantity, or functioning
Maturation: the extent a characteristic resembles a mature biological state
Motor development: the study of how motor behaviour change over time because of biological and environmental influences
PHYSICAL LITERACY

• Integrating a wide range of movement capacities with other important aspects (e.g., healthy behaviours) and applying them to a long-term lifestyle

• Important for:
  • Participating in sports
  • Being fit
  • Overall health and well-being

• Physically literate individuals move with competence and confidence in a wide variety of activities and environments

CRITICAL PERIODS AND READINESS

• Times of particular sensitivity to environmental stimuli during which an exposure can result in child’s optimal development of a skill

• For acquisition of many physical and cognitive skills, it is very early in a child’s life

• Difficulty is determining how early to introduce to physical activity

• Readiness is when an individual is prepared to acquire a particular behaviour or skill and has internal motivation to learn

HOCKEY’S ALL-TIME GREATEST PLAYER

There are many well-known child prodigies who developed their skills early in life. If Wayne Gretzky wasn’t born to be a star, he was certainly raised in this direction. His father, Walter, iced down the backyard of their home and strung lights so young Wayne could practice longer through the cold evenings. All through Wayne’s childhood, the rink was a passion for both of them. In the daytime, Wayne would skate on it and play hockey with the sticks Walter used to shave down for him. In the evenings, they would work together on the drills Walter had worked out. In the end, the timing was critical and Wayne was ready to perform!
Although the general sequence of growth tends to be the same, there is considerable variation. We all pass from infancy through childhood and adolescence to adulthood, but not everyone grows as fast, as much, or in the same way as others.

**INFANCY (<1Y)**

- Males are usually slightly heavier and longer than females at birth
- Extremely rapid growth
  - 3x birth weight
  - ↑ birth height by 50%
### Childhood (1-13y)

#### Early Childhood: ages 1-6
- Loss of baby fat
- Rapid growth
- Good flexibility
- Abundant muscle development

#### Mid Childhood: ages 7-10
- Slower and more constant growth
- Improvements in coordination and motor functioning

#### Late Childhood: ages 10-13
- Growth spurt preceded by fat accumulation

#### Puberty: ages 12-14
- Height spurt
- Reproductive maturation
- Redistribution of body weight

### Compared to boys, girls:

#### Early Childhood: ages 1-6
- Lose less fat

#### Mid Childhood: ages 7-10
- Similar slow, constant growth

#### Late Childhood: ages 10-13
- Have earlier growth spur (10-11 vs. 12-13)

#### Puberty: ages 12-14
- Increase body fat (boys increase lean body mass and decrease body fat)
- Mature earlier (12-13 vs. 13-14) and reach athletic potential in some sports sooner
**Adolescence (14-20y)**

Somatotypes develop:
- **Ectomorph**: linear shape, delicate bone structure, little fat, and long limbs
- **Mesomorph**: well-muscled, little fat, broad shoulders, narrow waist
- **Endomorph**: rounded appearance, heavy bone structure, little bone and muscle definition

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**Test Your Knowledge**

How much do you know about human growth and development? Test your knowledge by answering true or false to the following statements. The answers are provided below and are discussed in more detail throughout the chapter.

- It is recommended that children start sports before they specialize in them. (False)
- The growth spurt occurs approximately two years earlier in girls than in boys. (False)
- There is a significant difference between the female and male physique prior to puberty. (True)
- Boys typically achieve world-class status in swimming and gymnastics earlier than girls. (True)
- Almost 100% of adult height is reached by the age of 16 among girls and boys. (False)
- Movement has little if any relationship to the mental development of children. (False)

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**Gender Differences in Growth & Fitness**

- It is common to hear about gender differences in:
  - Stature
  - Weight
  - Cardiorespiratory fitness
  - Body composition
  - Flexibility
  - Muscular strength
  - How much it’s due to genetic is debatable
**STATURE**

- Standing height
- Similar at birth
- Boys reach maximal height later (18) than girls (16)
- By adulthood, males are on average taller

<table>
<thead>
<tr>
<th>Growth Period</th>
<th>Age</th>
<th>Selected Growth Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conversion: 5 ft 4 in (163 cm) in diameter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Birth (cradle length): Boys: 50 cm (19.6 inches)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls: 49 cm (19.2 inches)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 months (mid-parent length): Boys: 64 cm (25 inches)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls: 63 cm (24.8 inches)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 year (median length): Boys: 70 cm (27.5 inches)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls: 69 cm (27 inches)</td>
</tr>
<tr>
<td></td>
<td>2 years</td>
<td>Length increase: 11.8 cm (4.6 inches)</td>
</tr>
<tr>
<td></td>
<td>3-5 years</td>
<td>Early accelerated growth rate of about 6.7 cm (2.6 inches) per year</td>
</tr>
<tr>
<td></td>
<td>6 years</td>
<td>Sustained growth rate of about 3.5 cm (1.4 inches) per year</td>
</tr>
<tr>
<td></td>
<td>10 years</td>
<td>Sustained growth rate of about 2.8 cm (1.1 inches) per year</td>
</tr>
<tr>
<td></td>
<td>18 years</td>
<td>Weight increases 90% of adult stature</td>
</tr>
<tr>
<td></td>
<td>20 years</td>
<td>Weight increases 90% of adult stature</td>
</tr>
<tr>
<td></td>
<td>Adulthood</td>
<td>Growth of adult stature may add another 3-4 cm (1.2-1.6 inches)</td>
</tr>
<tr>
<td></td>
<td>20-40 years</td>
<td>Stable in males</td>
</tr>
<tr>
<td></td>
<td>Above 40 years</td>
<td>Possible decrease in stature from disabilization and agerelation</td>
</tr>
</tbody>
</table>

**WEIGHT**

- Similar at birth
- Large gains occur during infancy and adolescence
- Males are on average heavier by adulthood
- Much of the weight gain is caused by increases in height and changes in body composition
- Diet and exercise have an obvious impact
# Cardiorespiratory Fitness

### Heart Rate

- **Cardiac Output**
  - **Exercise:**
    - Athlete: 30-35 ml/min
    - Untrained: 20-25 ml/min

### Stroke Volume

- **Faster in children vs. adults**
- 100 vs. 75 bpm
- ~10% lower in boys

### Cardiac Output

- **Lower in children vs. adults**
- Lower in women vs. men
- Resting:
  - Athlete: 50-70 ml/min
  - Untrained: 70-80 ml/min

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### Growth Period | Age | Selected Growth Information
---|---|---
**Infancy** |  |  
- Birth weight
- Birth weight: boys 3.85 kg (8.5 lb)
- Birth weight: girls 3.35 kg (7.4 lb)
- Birth weight: boys are generally heavier than girls due to increased muscle mass.
- Birth weight is determined by genetic factors, nutrition, and environmental factors.  
- Birth weight: boys are generally lighter than girls due to increased muscle mass.
- Birth weight: girls are generally lighter than boys due to increased fat mass.

**1 month** |  |  
- Birth weight: approximately 10% of birth weight.

**1 year** |  |  
- Birth weight: approximately 10% of birth weight.

**2 years** |  |  
- Birth weight: approximately 10% of birth weight.

**2-3 years** |  |  
- Birth weight: approximately 10% of birth weight.

**Adolescence** |  |  
- Birth weight: approximately 10% of birth weight.

**Adolescence** |  |  
- Birth weight: approximately 10% of birth weight.

**Adolescence** |  |  
- Birth weight: approximately 10% of birth weight.

**Adolescence** |  |  
- Birth weight: approximately 10% of birth weight.

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### BODY COMPOSITION

#### Male Fat Content
- At birth: 13%
- Recommended: 10-22%
- More around trunk and less around extremities

#### Female Fat Content
- At birth: 15%
- Recommended: 20-32%
- More evenly distributed

### Comparison of Body Composition Between Sexes and at Various Ages

<table>
<thead>
<tr>
<th>Group</th>
<th>Sex</th>
<th>Height</th>
<th>Mass</th>
<th>LBM</th>
<th>Body Fat %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>158 cm</td>
<td>57 kg</td>
<td>40 kg</td>
<td>43%</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>164 cm</td>
<td>67 kg</td>
<td>52 kg</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>154 cm</td>
<td>56 kg</td>
<td>48 kg</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>164 cm</td>
<td>71 kg</td>
<td>54 kg</td>
<td>23%</td>
</tr>
</tbody>
</table>

### FLEXIBILITY

- Defined as the range of motion about joint(s)
- Affected by joint’s anatomical structure, exercise and stretching, age, and gender
- During overstretching muscle spindles invoke stretch reflex and muscles shortening to protect against injury
- During slow and gentle movements, stretch reflex will not be invoked and muscles relax to stretch
- Stretching should feel tight not of painful and be held for 5-20s
Comparison of flexibility between sexes and at various ages

MUSCULAR STRENGTH

- Maximum force a muscle can exert in a single contraction
- Older children and adults with restricted movement due to inadequate strength usually lead to a sedentary lifestyle
- Strength peaks between ages 20-30 and slowly declines with age
- Grip strength
  - Most common measurement
  - Force exerted when grip dynamometer is squeezed as hard as possible with the hand

DID YOU KNOW?

Just like an elastic band that stretches better once it has been warmed up by a few tugs, it is also better to warm up your muscles before you begin with a light jog or other aerobic activity to warm up your muscles. Warm up to stretch, not the other way around.
Rate and pattern of strength development using grip strength measurement

MUSCULAR STRENGTH

MALES
- Peak begins in 20s
- Peaks after height spur
- Sex hormones = muscularity

FEMALES
- Peak begins in late teens
- Peaks with height spur
- 60-84% less dynamic strength

Weights resistance training:
- Prepubescent children
  - Can make strength gains under strict supervision
  - Otherwise unsuitable and dangerous due to risk for injury
- Adolescents
  - Gain with properly designed progressive strengthening program
- Adults
  - Leads to more active, healthier lives
  - Helps to accomplish daily tasks
Infancy

Early to Mid-childhood

Late Childhood through Adolescence

Motor Development

- Infancy
- Early to Mid-childhood
- Late Childhood through Adolescence

Motor Development

- How movement performance changes over time
- Continuous process of sequential changes
- Movements become more organized and specialized
- By nature (e.g., growth, age, heredity) and nurture (e.g., activity, family, culture)

Motor Development

Infants (0-1Y)
- Reflexive movements (sucking)
- Spontaneous movements (licking)
- Rudimentary movements (rolling)

Early to Mid-Childhood
- Elementary fundamental movements (walking)

Late Childhood & Adolescence
- Advanced fundamental movements
  - Specialized movements are formed by combining skills that are sport-specific
Infancy (0-1Y)

- Motor development related to brain maturation
- Midbrain
  - Reflex centre
  - Most developed at birth
  - Reflexive movements for feeding and protection
  - Sucking, palm grasp
- Cerebrum
  - Controls voluntary movement, memory and sensation
  - Rudimentary movements that are voluntarily controlled
  - Rolling, sitting, reaching
- Cerebellum
  - The “little brain” that controls balance and coordination
  - Standing, crawling, grasping and releasing

Early to Mid-Childhood (1-10Y)

- Development of
  - Perceptual Motor Abilities
  - Physical Proficiency Abilities
  - Fundamental Skills
PERCEPTUAL MOTOR ABILITIES

Vision-Related (80%)
- Clarity of vision: distinguishing details
- Spatial awareness: recognizing an object’s orientation in space
- Coincident timing: intercepting a moving object
- Figure-ground perception: distinguishing an object from background

Non-Vision-Related (20%)
- Tactile perception: information from the skin related to touch, temperature, pressure, and pain
- Kinesthetic perception: awareness of movement and body position without use of sight or sound

PHYSICAL PROFICIENCY ABILITIES

A set of underlying traits utilized during motor performance
- Important for helping learn motor skills and become physically literate
- Include
  - balance
  - coordination
  - agility
  - speed
  - strength (static, dynamic, and explosive)
  - flexibility
  - stamina
  - gross body equilibrium
**Physical Proficiency Abilities**

**Balance**
The ability to maintain the body in a stable position while remaining upright and moving. Balance is required in practically every movement and is essential for movements that require the management of gravitational forces. Balance is highly dependent on a well-developed perceptual motor system and can be developed by repeatedly performing activities that require balance. Holding a desk stand (static) or walking a beam (dynamic) are examples of activities requiring balance.

**Agility**
The ability to change direction and to position the body rapidly and efficiently. It is dependent on reaction time, cognitive processing speed, and speed. Agility is developed primarily by repeating activities requiring agility, such as performing a pummel stool routine, which requires agility to move smoothly between skill items.

**Coordination**
The ability to use your senses harmoniously with the actions of the body to perform specific movements. It is developed primarily by repetition of the activity involved. Educational dance and dribbling activities are examples of activities that require rhythmic coordination.

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**Fundamental Skills**

1. **Stability:** Balancing, spinning, rolling, bending, twisting
2. **Locomotor:** Running, galloping, hopping, chasing, leaping
3. **Manipulative:** Dribbling, throwing, kicking

- Serve as critical foundation to the development of more specialized skills
- Proficiency barrier between fundamental and specialized skills if underdeveloped
- Accompanied by feelings of self-consciousness and embarrassment
- Gender differences due to environmental influences

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**Late Childhood (10-13y) & Adolescence (Teens-20s)**

- Refine existing skills and abilities
- Create and apply skills in a variety of elaborate combinations
- Develop new sport-specific skills
- Also integrate strategies, movements, and concepts across diverse settings
**Expert motor performer**

- More adaptable
- More effective decision making
- Mechanically efficient
- Better detects and corrects errors
- Strategic focus

**Factors Affecting Growth and Motor Development**

- Factors Affecting Growth
- Factors Affecting Motor Development

**Factors Affecting Growth**

- Everyone grows in the same sequence, but at different speeds and final size

- Factors
  - Heredity
  - Nutrition
  - Socioeconomic status
  - Exercise
HEREDITY

• Whether we are short, tall, large, or small is largely determined by the genes we possess at birth
• Environment can have a great impact on the degree to which our genetic potential is expressed

NUTRITION

• “You are what you eat”
• Carbohydrates and fats give energy and proteins build body tissues
• Vitamins, minerals, and water allow various reactions and functions to take place
• Malnutrition
  • May delay growth
  • If not prolonged, can grow to genetically predetermined size
• Overeating
  • Number of fat cells in the body is established during puberty
  • Child who overeats will have trouble keeping weight down as an adult

SOCIOECONOMIC STATUS

• Children from higher socioeconomic classes tend to have larger average body sizes at all ages
• Reasons
  • Nutrition
  • Levels of stress
  • Sleeping patterns
  • Regular exercise
EXERCISE

- Moderate exercise tends to increase bone diameter and density
- Stronger and more durable bones
- Greater length of the non-weight-bearing bones
- Active children and teenagers also show an increased lean body mass and muscle size (hypertrophy) and a decreased body fat
- Negative influences when overdone at a young age

EXERCISE CAUTION

Overuse injuries are becoming more prevalent among young athletes. This should come as no surprise in light of the fact that young athletes are specializing in sports at increasingly earlier ages. Specialization generally entails intense year-round involvement. In fact, it is not uncommon for young athletes to attend sport camps that require them to train anywhere from four to six hours per day. Perhaps even more discouraging are reports that runners as young as four and six years of age are successfully completing marathons.

DID YOU KNOW?

While some stress on the bones is needed for optimal development, too much strain on a bone during a period of growth can lead to osteochondrosis - a de-arrangement of the normal process of bone growth. Little league elbow is one type of osteochondrosis caused by the strain of repetitive throwing motions.
Motor development does not occur in a vacuum. Internal (psychological) and external (sociocultural) forces are continuously moulding it. Psychological factors tend to be overlooked and underemphasized.

**FACTORS AFFECTING MOTOR DEVELOPMENT**

- Motor development does not occur in a vacuum.
- Internal (psychological) and external (sociocultural) forces are continuously moulding it.
- Psychological factors tend to be overlooked and underemphasized.

**PSYCHOLOGICAL FACTORS: COGNITION**

- Involves thinking and learning.
- Dependent on knowledge stored in memory.
- Motor experts cognitively process information more quickly, accurately, and strategically.
- Movement plays an important role in cognitive and motor development, particularly during the period of rapid brain development (0-5y).

- Ages 8-10 and older: Understand that there are various roles besides their own so they can cooperate and learn about teamwork and situation-specific strategies.
- Ages 10-12 and older: Form accurate attributions; understand the potential causes of game outcomes (e.g., effort, luck, difficulty, ability, strength of opponents, weather), which can hinder their motivation and confidence.
- Ages 18 and older: Consistent improvement in mental abilities levels off.

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Kinesiology Books Publisher 57
PSYCHOLOGICAL FACTORS: ACADEMIC ACHIEVEMENT

- Physical education affords all children the opportunity to make important strides in their development.
- Students' academic performance can be enhanced through physical activity, exercise, and team sports.
- Perceptual motor development activities can be used to enhance academic or intellectual performance.
- Physical activity also helps students "let off some steam" so they can focus better and be more alert.

PSYCHOLOGICAL FACTORS: MOTIVATION

- Involves the will or motive to move.
- Influenced by internal beliefs:
  1. Perceived competence: confidence ability to succeed on a challenge.
  2. Control beliefs: feeling of being in control of a challenge.
  3. Outcome expectations: enjoy the results of succeeding on a challenge.
  4. Task value: amount of importance for succeeding in a challenge.

DID YOU KNOW?

A six-year study of 546 elementary-level students found that students who were engaged in five extra hours of physical activity a week actually did somewhat better academically than the less physically active students.
PSYCHOLOGICAL FACTORS: ENJOYMENT

- The goal of physical activity among growing children should be play and enjoyment.
- Children who feel pressured by parents and coaches to perform are often pushed to the limit and lose interest in pursuing an active lifestyle.
- Instead of developing skills for lifelong enjoyment and health, they may dislike a sport or physical activity because of the stress it causes.

PSYCHOLOGICAL FACTORS: SELF-ESTEEM AND CONCEPT

- Self-esteem: value we place on ourselves as persons.
- Self-concept: perception we have of ourselves.
- Involvement in physical activities improves self-esteem and concept in children.
- Different from “athletic competence,” which is related to a perceived level of success in competitive sporting activities.
- How competent you feel at a sport can have a different effect on self-esteem than involvement in an enjoyable physical activity.

PSYCHOLOGICAL FACTORS: SELF-CONFIDENCE CYCLE

- Engaging in physical exercise initiates a self-confidence cycle to help:
  - control your weight
  - protect yourself against various diseases
  - boost your energy level
  - manage stress and anxiety
  - improve your self-esteem
  - develop self-discipline and mental toughness
- You will gradually experience:
  - increased fitness
  - positive shifts in your nutrition habits
  - increased vigour
  - strong sense of self-empowerment
SOCIOCULTURAL FACTORS

- Environment in which children grow and develop has a large impact on their future success in athletics.

- Early involvement in physical activities that lead to positive experiences makes it easier, and often less threatening, for young people to learn and improve their physical skills.

- Important to experience playful and low-stress motor movement opportunities in various settings and with diverse equipment.

From the Research Files

A study by Benjamin Bloom on the development of talent in young children examined the process by which individuals who have reached the highest levels of accomplishment in their respective fields developed their capabilities. The study provided strong evidence supporting the notion that whatever the initial characteristics of the individuals, unless there is a long and intensive process of encouragement, nurturing, education, and training, they will not attain extraordinary levels of capability. Many of the tennis champions studied, for example, began playing tennis between the ages of 3 and 11. An important conclusion to be drawn from this study is that tennis players who reached the highest levels of achievement typically came from families that valued athletics highly. It can then be said with some confidence that "what any person in the world can learn, almost all persons can learn if provided with appropriate prior and current conditions of learning."
SOCIOCULTURAL FACTORS: FAMILY

- Influences the choice to participate in physical activities and the success attained by a child in sports.
- Family views concerning physical activity are often instilled in a child at an early age.
- To increase level of participation among children:
  - Strong parental interest in physical activity.
  - Provision of access to equipment and facilities.
  - Being encouraging and helpful.

SOCIOCULTURAL FACTORS: PEERS

- Family’s influence begins to diminish and the need for peer approval becomes greater at adolescence.
- Decisions concerning participation in sport are influenced by peers.
- Peer group often guides individuals into, or away from, participation in physical activities.
SOCIOCULTURAL FACTORS: SPORTS PARTICIPATION

- Children participate in sports for various reasons:
  - #1: Having fun
  - Improving skills
  - Being with friends
  - Being part of a team
  - Receiving awards (not too important)
  - Winning (not too important)

- Emphasis should be placed on involvement and participation, skill development, and enjoyment of the skill
- Reason often given for withdrawing from sports is excessive stress
- In reality, drop out because of interpersonal problems (such as disliking the coach) or to pursue other leisure activity interests

TEAMS, TEAMS, AND MORE TEAMS

Whereas young children are content to play alone or in small groups, the emphasis changes as children approach adolescence. Team or club participation tends to become increasingly important as we get older. Playing on a team encourages responsibility, division of labour, and working together towards a common goal. These are valuable lessons to learn at a young age and to remember throughout one’s life. However, the emphasis placed on competition and winning should not overshadow the benefits of participation for its own sake.

Stages of Sport Participation

- Sample numerous movement activities.
- Emphasis on fun play, high engagement, and cooperation.
- Focus on a number of quality activities.
- Become more engaged and committed to improving skills.
- Focus on one or a few competitive sports, or pursue a variety of recreational activities.
SOCIOCULTURAL FACTORS: INSTRUCTORS

- Competent coaches can reduce child’s likelihood to drop out of sports
- Many youth sport coaches are volunteers and should become certified
- Should structure a positive learning environment that proactively fosters development of life skills such as moral character
- Overemphasis on winning can undermine ethical behavior
- A child likely be more motivated by specific feedback and encouragement than overemphasis on grades or placement

“Offer constructive criticism by serving up a criticism sandwich.”

This sandwich has three simple ingredients:
- **Start with a slice of praise.** This gets the athlete’s attention and builds trust.
- **Add a healthy spread of constructive criticism.** This should be specific to the movement or activity and should be framed with examples.
- **Finish with another slice of praise.** The athlete should be made to realize that he is capable of improving the skill.

CONSTRUCTIVE CRITICISM

Coaches can use this technique to improve their athletes’ performances and leave them feeling good about themselves.

MOTOR DEVELOPMENT

- Readiness to engage in physical activities is related to various stages of growth and motor development
- Capable motor, perceptual motor, and fundamental movement abilities provide a foundation for physical literacy
- Various motor development phases (reflexes, rudimentary movements, fundamental movements, and specialized skills) are molded by internal factors (growth, cognition, motivation, emotions) and external forces (family, peers, instructors)
- Movement has been linked to improvements in cognitive functioning, achievement and academic work