ITF Coaches Education Programme Level 2 Coaching Course

Biomechanics of tennis: An introduction

By the end of this session you should be able to:

- Understand optimum technique through a practical knowledge of biomechanics
- Improve technical diagnosis and correction
- Understand how power is generated in strokes
- Understand how control is achieved in tennis
- Increase knowledge of the technical characteristics of the modern game

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Biomechanics: Definitions

The study of human motion

The study of the internal (muscular, bone and joint) and external (wind, gravity, pressure) forces affecting human performance

Biomechanics: Areas that involves

- Efficiency and effectiveness of movement
- Sports medicine implications of performance
- Effects of equipment design on performance and the performer

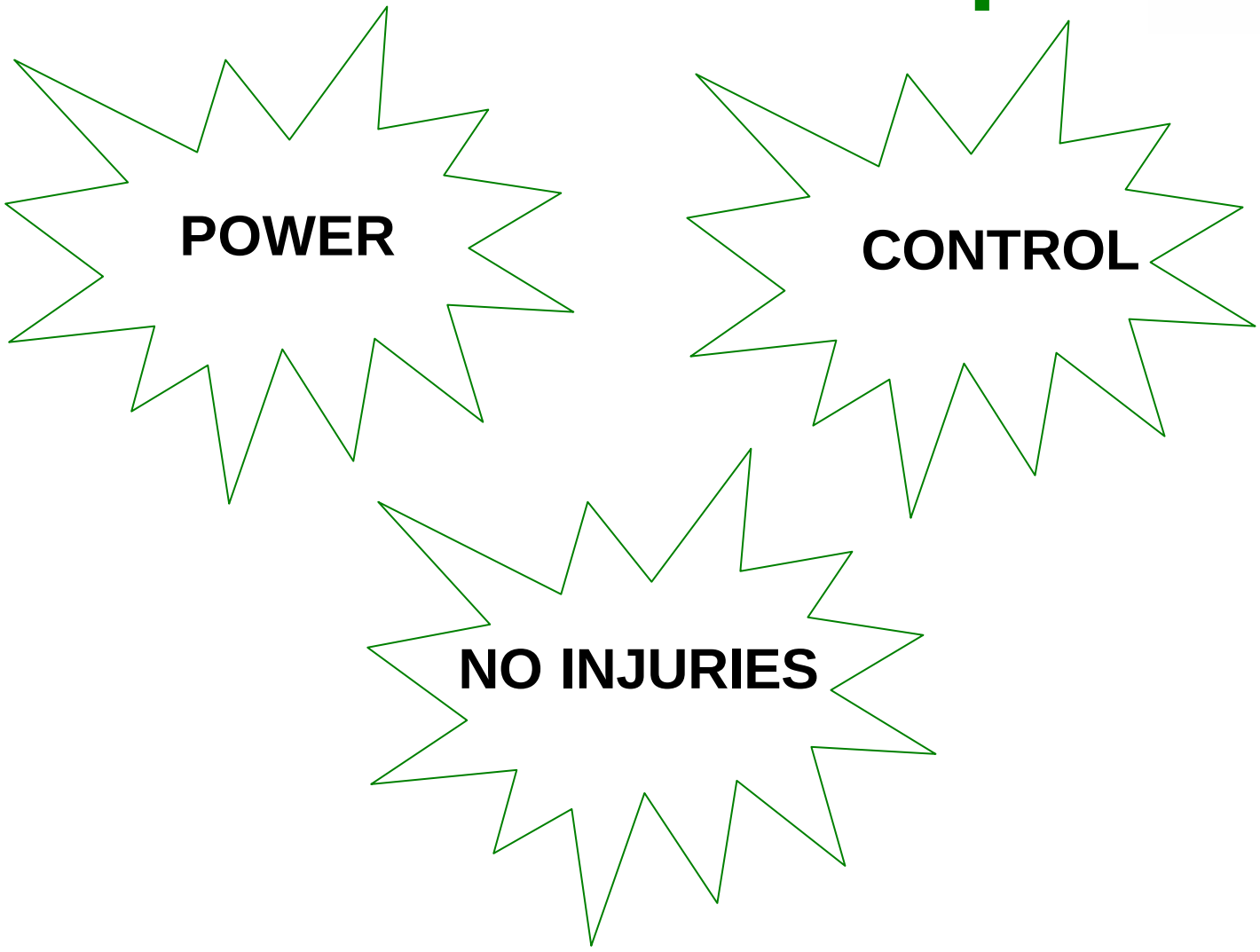
What is optimum technique?

Optimum technique incorporates the most efficient combination of power and control in both stroke and movement technique whilst minimising the risk of injury

Elements of technique

- Efficiency – Economy: less energy
- Effectiveness – Result: OK
- Safety - Injury free

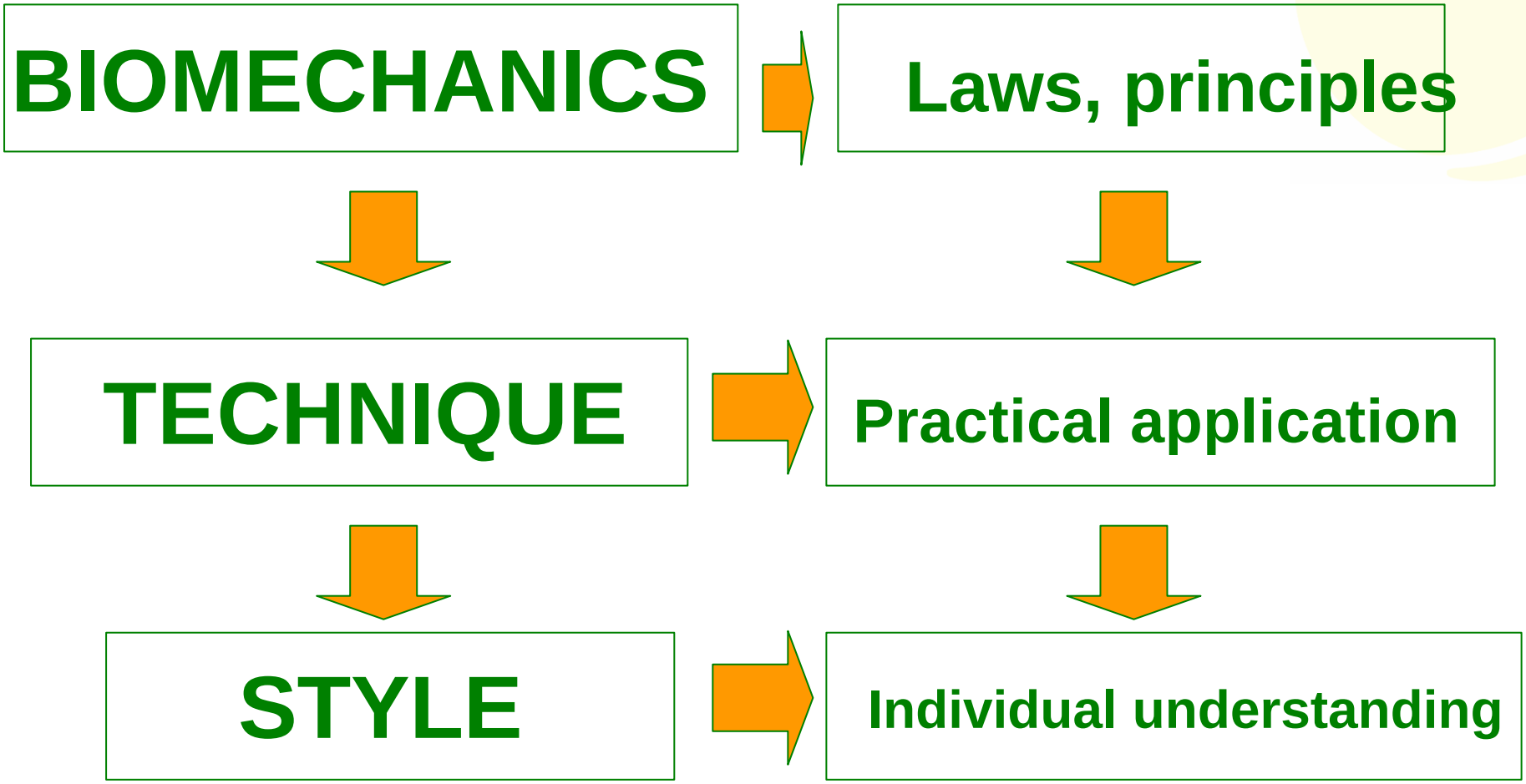
Benefits of technique



BIOMECHANICS

TECHNIQUE

STYLE



STYLE

- Personal interpretation and application of the biomechanics and the technique

Main biomechanical principles for tennis

- B Balance
- I Inertia
- O Opposite force
- M Momentum
- E Elastic Energy
- C Co-ordination chain

Teaching technique

TRADITIONAL	MODERN
• Grip	• B
• Stroke	• I
• Backswing	• O
• Contact point	• M
• Follow through	• E
• Recovery	• C
• Footwork	

What's balance?

- The ability to maintain equilibrium (a state of readiness) either dynamically or statically
- Tennis requires dynamic balance
- It is controlled by the position of the centre of gravity
- It directly relates to vision
- It is controlled by the semi-circular canals in the ear

Factors affecting stability

- Size of the base of support
- Height of the centre of gravity
- Distance of the line of the centre of gravity from the edge of the base of support
- Mass of the body

Important aspects of stability

- Base of support
- Height of centre of gravity
- Position of head over the shoulders
- Arms: Use as orchestra conductor

Inertia

- Law: The body will stay at rest or motion until acted upon by an outside force

- It is the resistance of a body to move or to stop moving

Inertia (II)

- When in ready position: Body has “resting inertia”
- To move the player needs to overcome the resting inertia by using force (muscular contraction) or gravity

Inertia (III)

- When hitting:
  - Bent arm:
    - Smaller moment of inertia
    - Less resistance to rotation
    - More racket speed
  - Straight arm:
    - Bigger moment of inertia
    - More resistance to rotation
    - Less racket speed

Inertia (IV)

- Mini-tennis:
  - Kids move the racket faster if it is a racket with a shorter throat
- When running for a passing-shot:
  - Overcome resting inertia by using gravity and by creating sufficient force against the ground to move

Opposite force

- For every action, there is an equal and opposite reaction
- Stroke and movement are initiated from the legs by pushing against the ground
- The ground pushes the player back up with the same amount of force

Examples of opposite force

- Tossing arm in the serve goes down
- Knee bent in the serve
- Non-playing arm in one handed backhand
- Right leg at the end of the serve
- Left leg in the follow through of 2 handed BH

Momentum

- The force generated by a body
- It is the body's quantity of motion
- It is the amount of mass of the body related to its speed (mass x velocity)
- The mass remains the same for the match, so the greater the velocity, the greater it's momentum

Types of momentum

- Linear: Momentum in straight line

  i.e. “Step into the shot”, down the line shots, slice shots

- Angular: Momentum in a circular motion

  i.e. “Rotate hips and trunk”, cross court shots, topspin shots

Types of momentum

- Both linear and angular occur at the same time

Other type of momentum

- Vertical momentum:
  - In the serve
  - In the smash
- Example of 3 momentums: the serve

Elastic energy

- Energy stored in the muscle as a result of stretching the muscle
- If a player bends the knees and immediately jumps up, he will create more elastic energy than if he remains with the knees bent for about 2 seconds and then jumps up

Elastic energy

- There should not be too long a pause between take back and follow through
- Coaches should encourage a continuous flowing motion for all strokes
- Examples:
  - Split step
  - Pre-stretch in take back

Momentum and elastic energy

- Initiating the stroke from the legs by pushing against the ground
- Ensure that pre-stretching of the trunk muscles occurs by twisting the upper body while keeping the head facing toward the on-coming ball
- Ensure that the racket path allows the production of momentum through a loop or elbow lead take back on the forehand

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Momentum and elastic energy

- All strokes have 2 moments from the mechanical point of view:
  - Pre-stretching
  - Releasing

Co-ordination chain

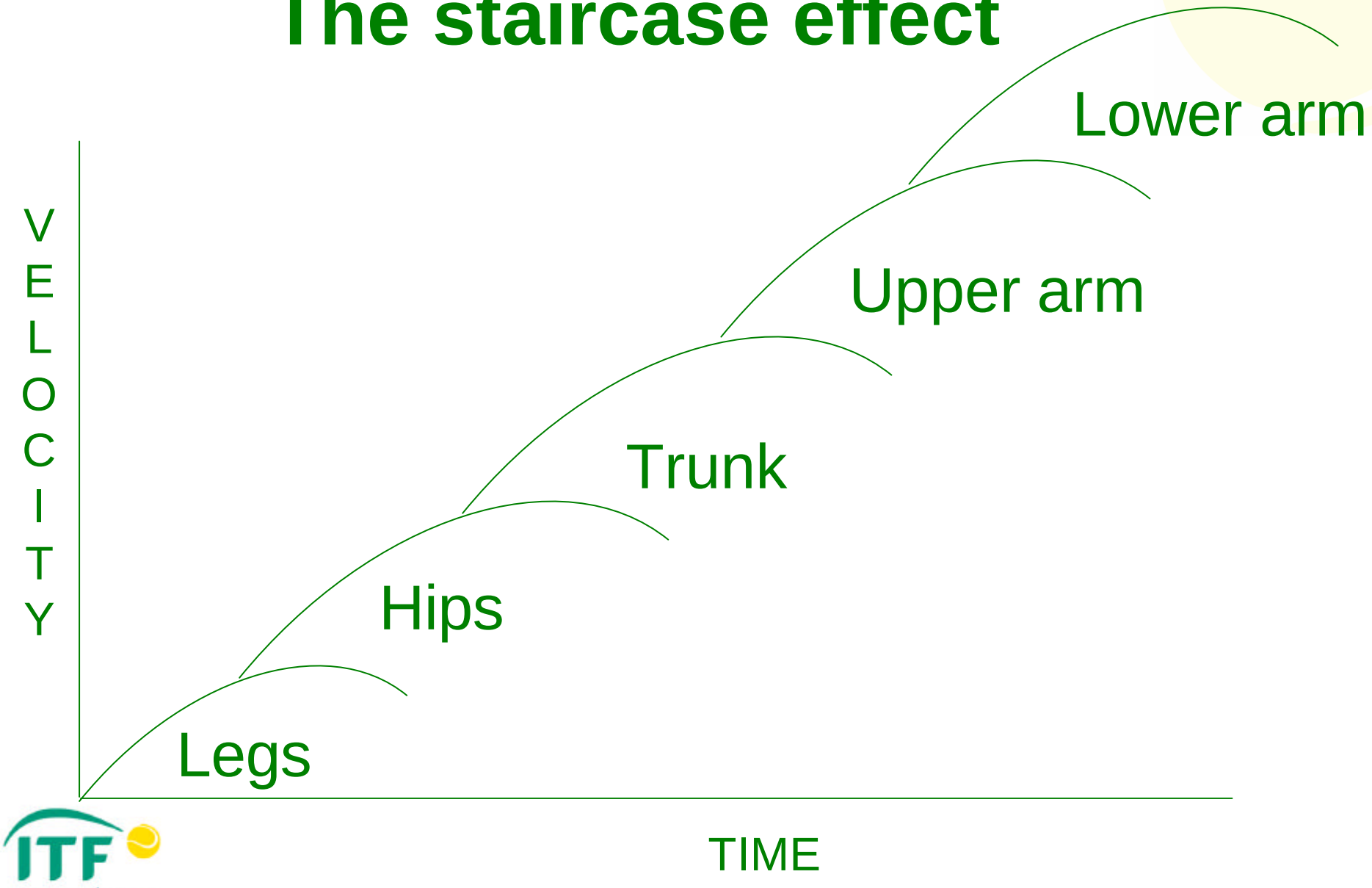
"...the segments of the body act as a system of chain links whereby the force generated by one link, or body part, is transferred in succession to the next link"

J. Groppel (1984)

Sequencing of body segments

Body part	Biomechanics
Legs	Knees (flexion and extension)
Hip	Hip rotation
Trunk	Trunk rotation
Arm/Shoulder	Rotation of arm about the shoulder
Elbow	Elbow extension - forearm pronation
Wrist	Wrist flexion

The staircase effect



Co-ordination chain as the cornerstone of a sound technique

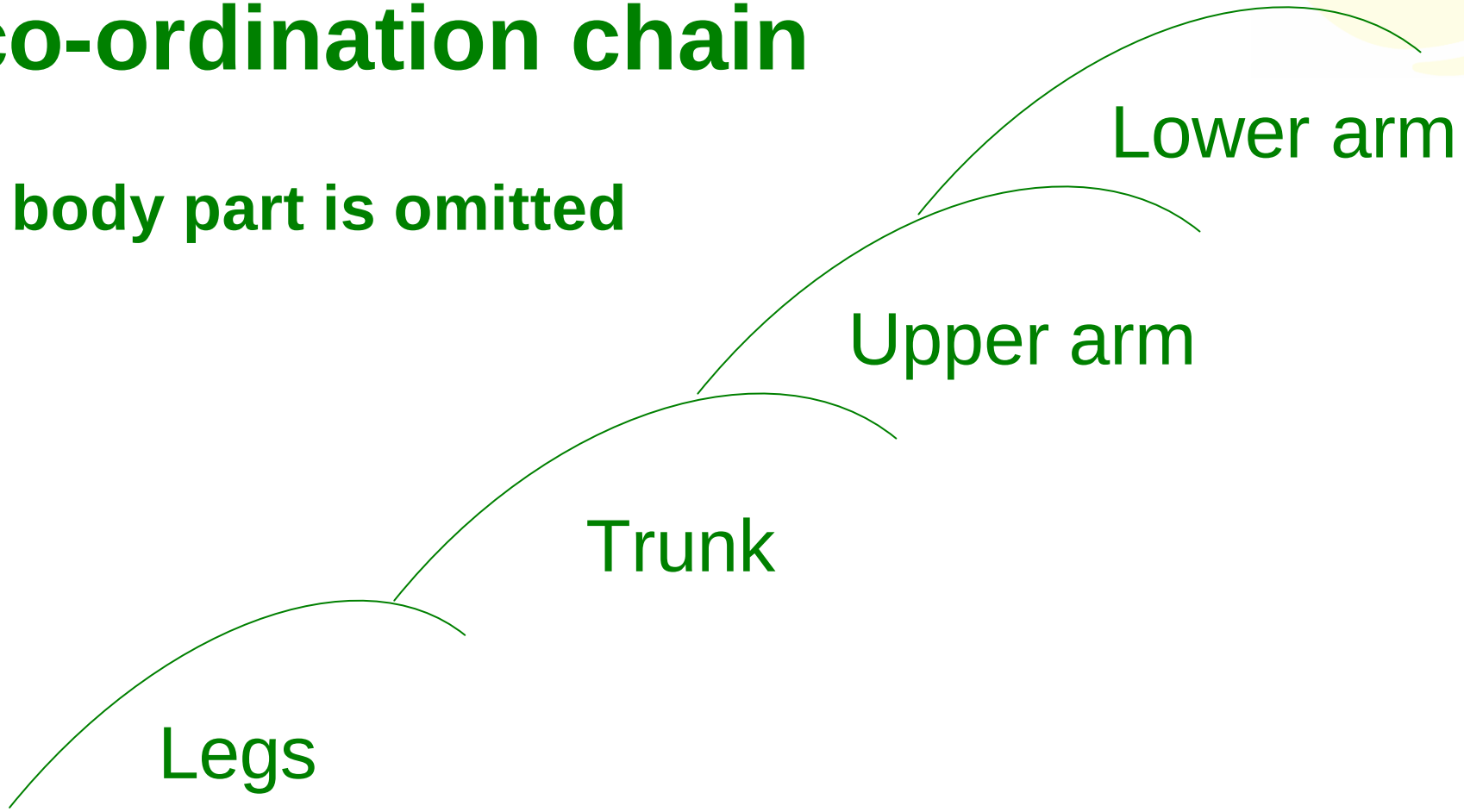
- Maximum power
- Control
- Delays fatigue
- Prevents injury

Co-ordination chain and movement

- Movement starts from the ground up
- Movement should take place from large to small body segments
- Movement should be timed and progressive

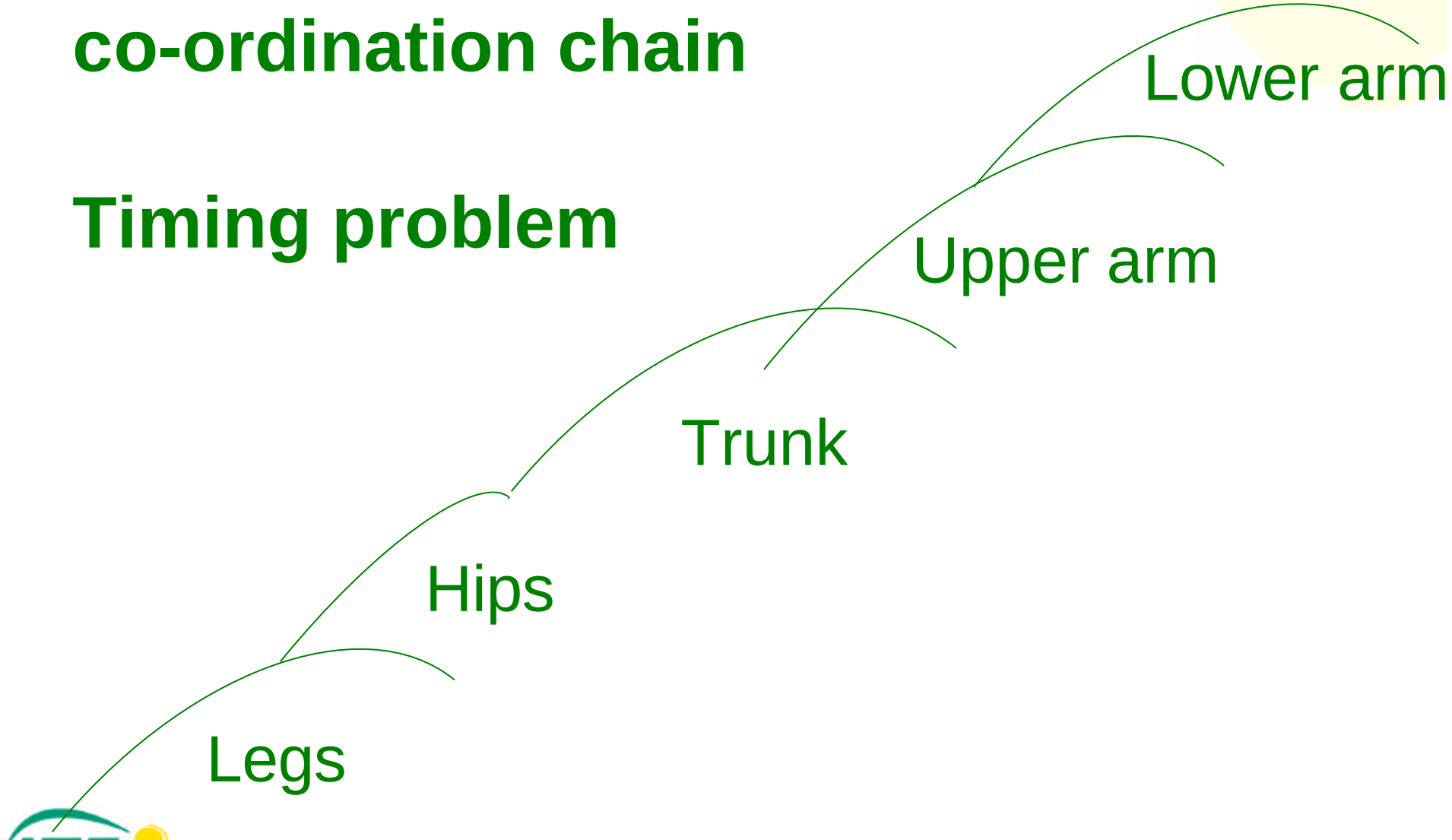
Problems in the co-ordination chain

a body part is omitted



Problems in the co-ordination chain

Timing problem

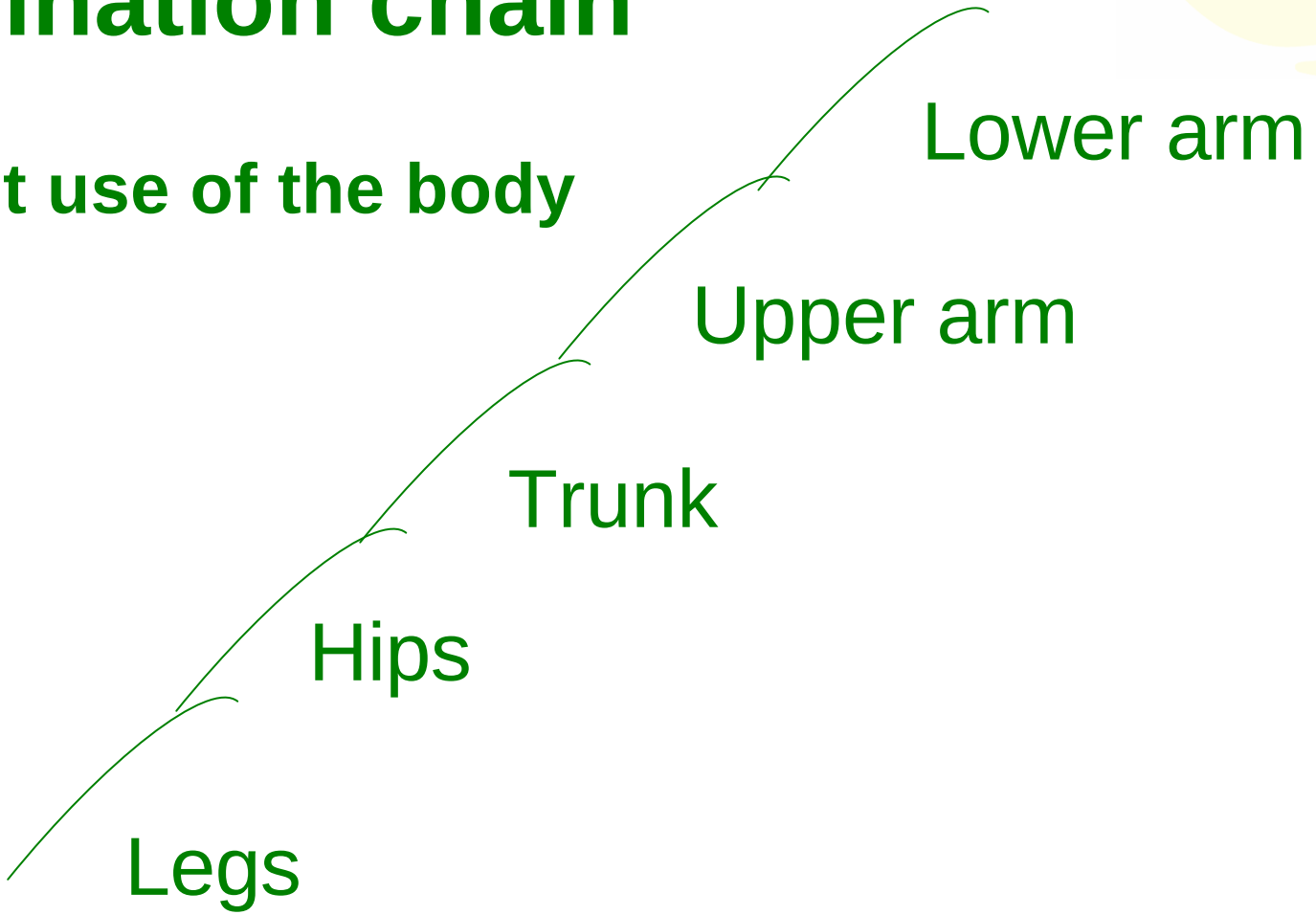


How to create more power in the strokes

- Bending the knees
- Pre-stretching the upper body
- Using action-reaction links
- Stepping in
- Rotating the upper body
- Having the racket close to the body
- Having a good balance
- Taking a longer swing
- Using all segments of the body chain (wrist in volley)

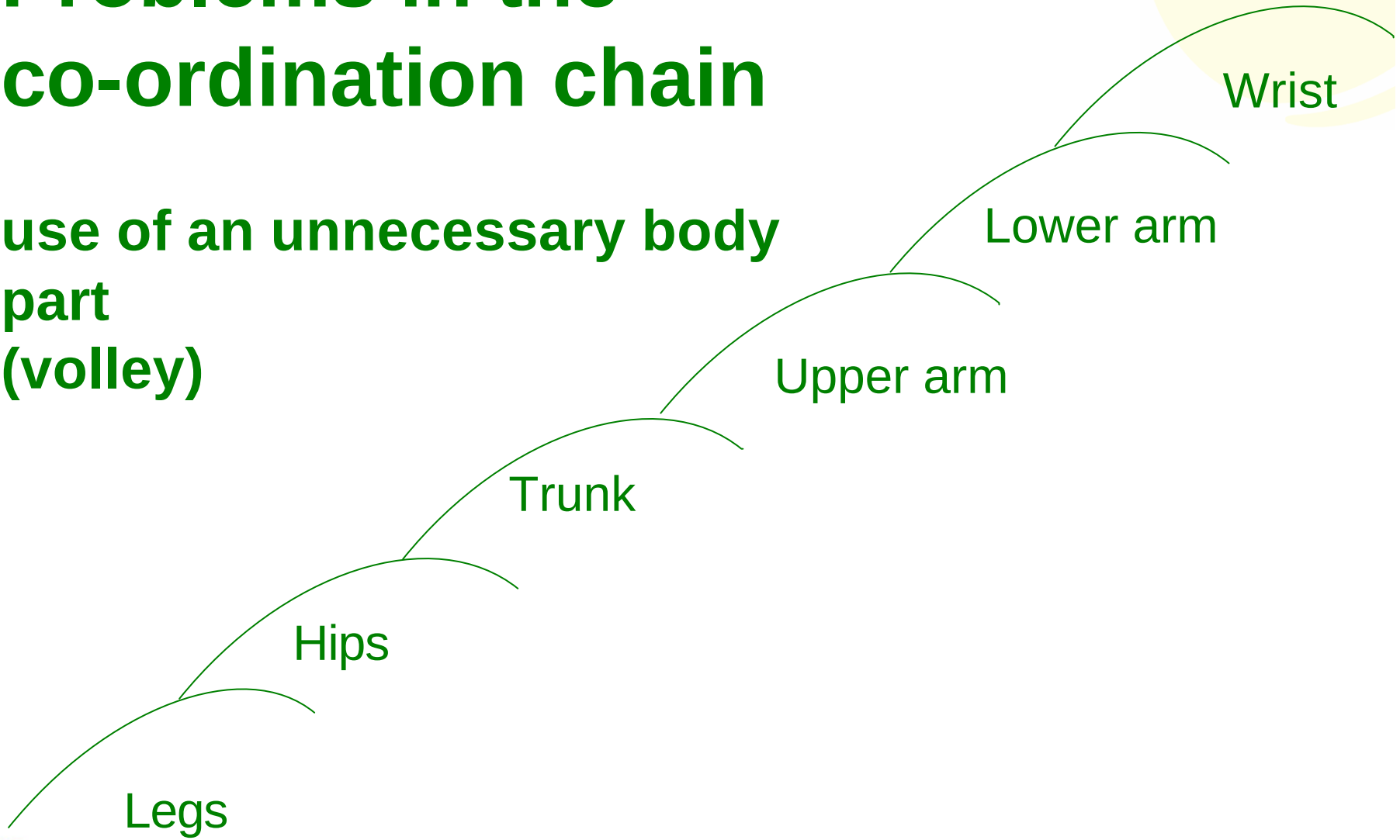
Problems in the co-ordination chain

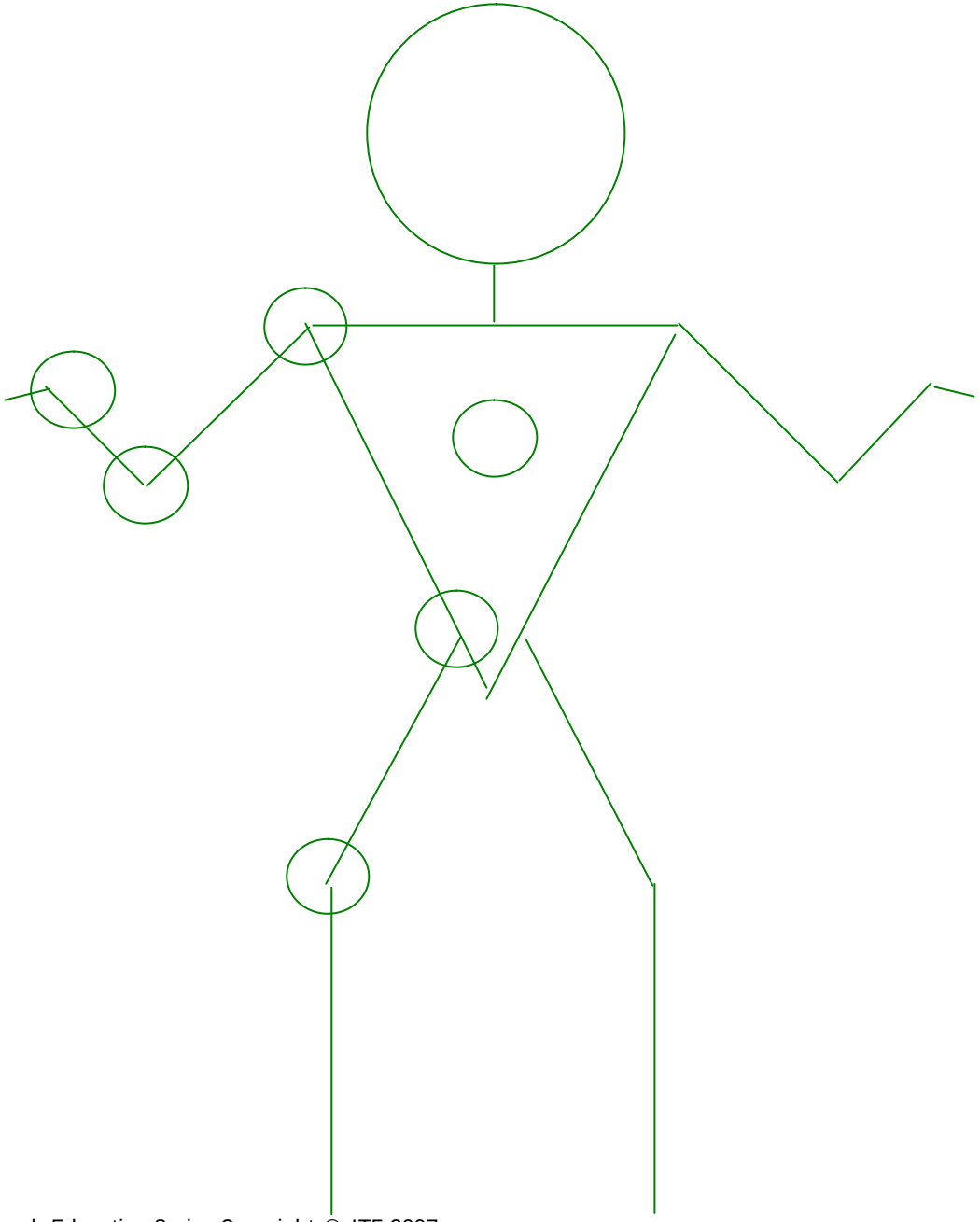
inefficient use of the body parts



Problems in the co-ordination chain

use of an unnecessary body part (volley)





The phases of each stroke

- Preparation and Backswing
  - Tracking
  - Movement to the ball
- Forward swing
- Contact
- Follow through

Preparation & backswing: Biomechanical applications

TRACKING

- Watch the ball and judging the ball flight
- Footwork (including recovery)
- Split-step
- Low centre of gravity
- Inertia

Preparation & backswing: Biomechanical applications

MOVEMENT TO THE BALL

- Footwork
- Body preparation:
  - Torsion “pre-stretch”
  - Ground reaction force
  - Preparation of big muscles

Forward swing: Biomechanical applications

- Balance: Dynamic/Static
- Co-ordination chain
- Momentum (linear and angular)
- Timing and rhythm

Contact:
Biomechanical applications

- Control of the racket face
- Timing and rhythm
- Balance (head, shoulders and trunk)

Follow through: Biomechanical applications

- Balance:
  - Head
  - Shoulders
  - Trunk
- Control of the racket swing

Speed of images

- Naked eye: 10-15 frames per second
- Video: 50 frames per second
- High speed video: 100-500 frames per second