
eduqas
Part of WJEC
Movement analysis, technology and biomechanics.
How can the coach develop my technique?

To answer the big question you will need to be able to complete the following tasks:

1. **Describe the structure and function of the musculo-skeletal system (AO1)**

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2. **Describe the types of muscular contractions (AO1)**

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3. **Analyse the movements that take place at the major joints. (AO3)**

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4. **Describe the classification of the joints and levers using sporting examples to support your understanding (AO1)**

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5. **Evaluate the techniques used to help improve performance. (AO3)**

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6. **Explain why a coach would use performance analysis of a footballer (AO2)**

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7. **Discuss the different performance analysis approaches a coach would use for a dancer compared with a netballer (AO3)**

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1. Musculo-skeletal-system

Question

1. Describe the structure and function of the musculo-skeletal system (AO1)
2. Describe the types of muscular contractions (AO1)

Content

- Functions and the axial and appendicular skeleton; support, protection, movement, blood production and mineral storage.
- Different types of bone (long, short, irregular, flat and sesamoid) and the role of ligaments, tendons and cartilage.
- Functions and structure of the muscular system including: Major skeletal muscles of the human body.
- Muscle fibres and their characteristics; slow twitch (Type I) and fast twitch (Type IIa and IIb)
- Antagonistic muscle action: prime mover (agonist), antagonist, fixator and synergist.
- Types of muscle contractions: isotonic; concentric and eccentric isometric

Knowledge and Understanding

Introduction

How movements occur contributes to successful performance. The skeletal and muscular systems work closely together and are referred to as the musculo-skeletal system. This system will support movement analysis and improvement in technique.

Skeletal system

Knowledge of the skeletal system and how it works helps us to understand movement and explains how skills are performed. The skeleton provides attachments for the muscular system for movement and offers protection for vital organs such as the cardio-respiratory and vascular system. Bones are formed by the ossification.

The average human adult has 206 bones that are divided into the axial and appendicular skeletons. The main functions of these skeletal systems are:

Skeleton	Function	Bones	Sporting example
AXIAL	Protection Shape Red blood cell production	Cranium Thoracic cage Cranium, thoracic cage, vertebral column, pelvis	Heading the ball in football Landing on floor after a tackle in rugby Offers large surface area for muscle attachment
APPENDICULAR	Movement Muscle Attachment	Upper Limbs: Humerus, Ulna, Radius Lower Limbs: Femur, Tibia, Fibula	Bowling in cricket Running in rugby Passing in netball

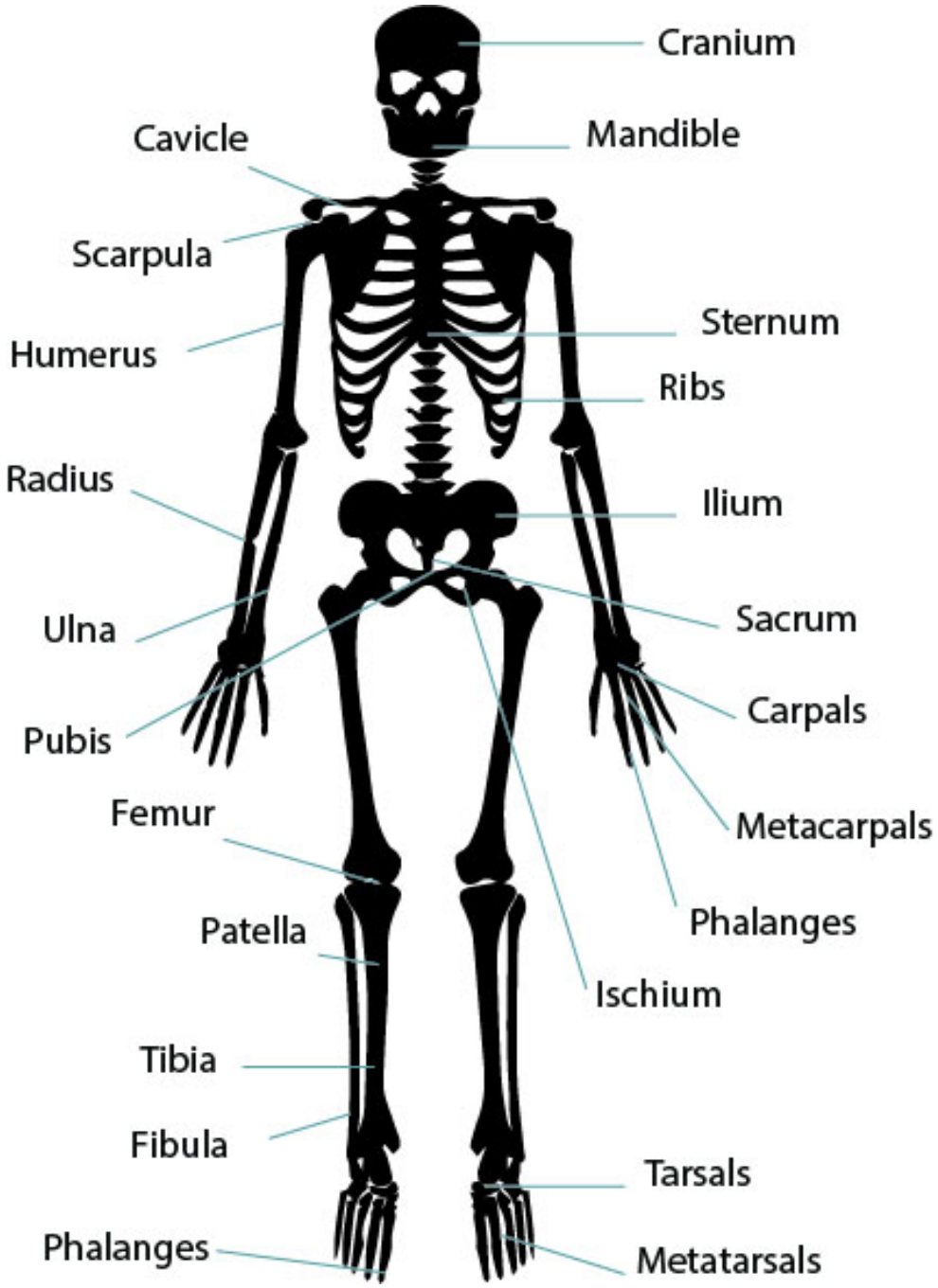
Structure of the skeletal system:

It is important to know the major bones that meet (articulate) at the shoulder, elbow, hip and knee.

How bones are formed

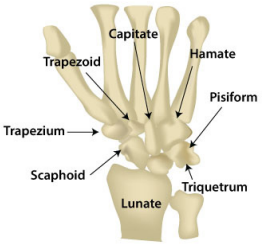
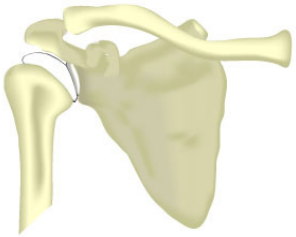
Bones are formed by the ossification of cartilage. This means is all bones start off as cartilage and they gradually turn to hard bone (ossification). Calcium is needed for strong bone growth.

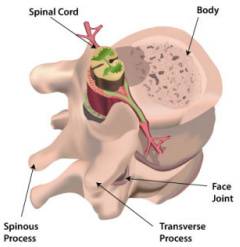
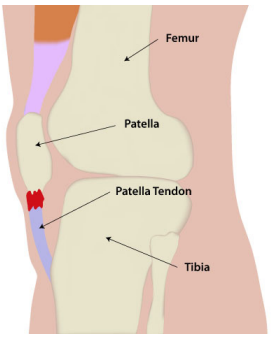
Major bones of the skeletal system:



Types of bones

The human body consists of 5 types of bones; long, short, flat, irregular and sesamoid bones.

Types of bone	Function	Example
Long Growth plates at its ends	Made up of compact bone for strength Ends covered in articular (hyaline) cartilage aids with shock absorption Creates leverage system for movement	Femur 
Short As wide as long, with large amounts of bone marrow	Provides support and stability	Wrist, ankle 
Flat	Provides protection for vital organs Base for muscular attachment Highest number of red blood cells are formed	Cranium, Scapular, Sternum 

Types of bone	Function	Example
Irregular Do not fall into any category	Strength	Mandible, vertebrae 
Sesamoid Embedded in a tendon (tendon attaches muscle to bone)	To protect the tendon	Patella 

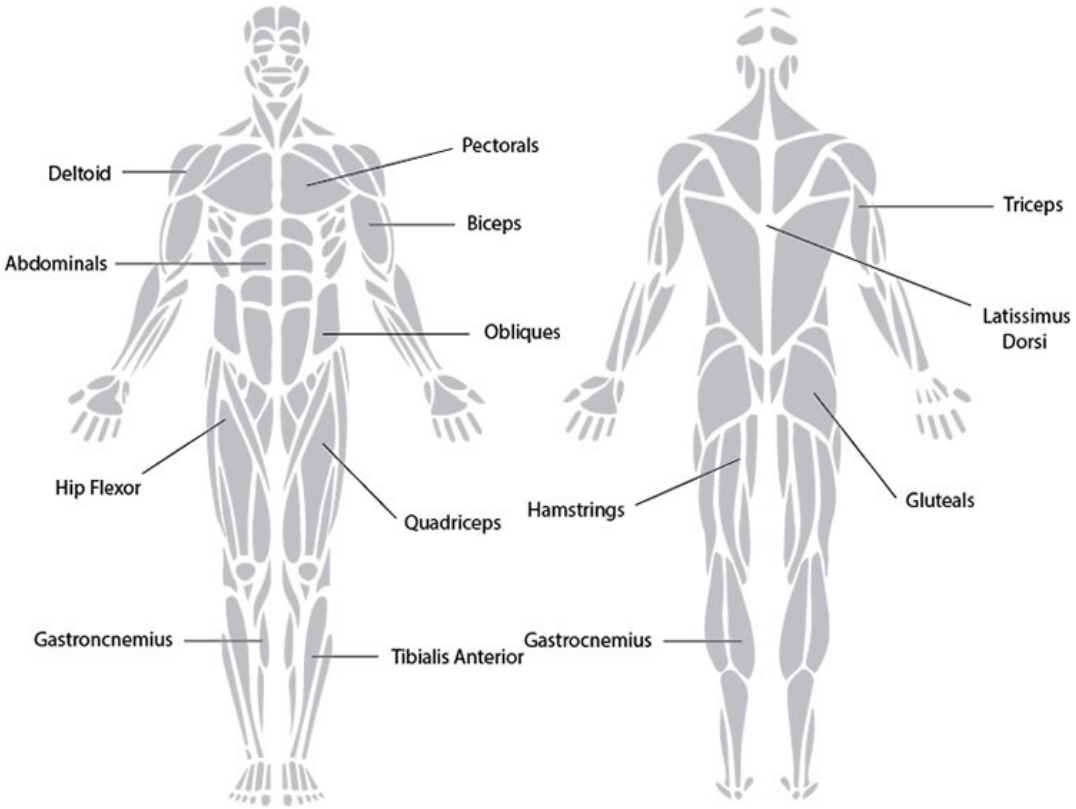
Muscular system

Skeletal Muscles are those that attach to bones and have the main function of contracting to create movement. They are also sometimes known as:

- Striated muscles due to their appearance or
- Voluntary because we have direct control over them contracting

There are over 600 muscles in the human body, all working in pairs (antagonistic muscle action). Knowing the major muscles that cause movement around the shoulder, elbow, hip and knee allows us to analyse movement, the generation of focus and how to improve sporting performance.

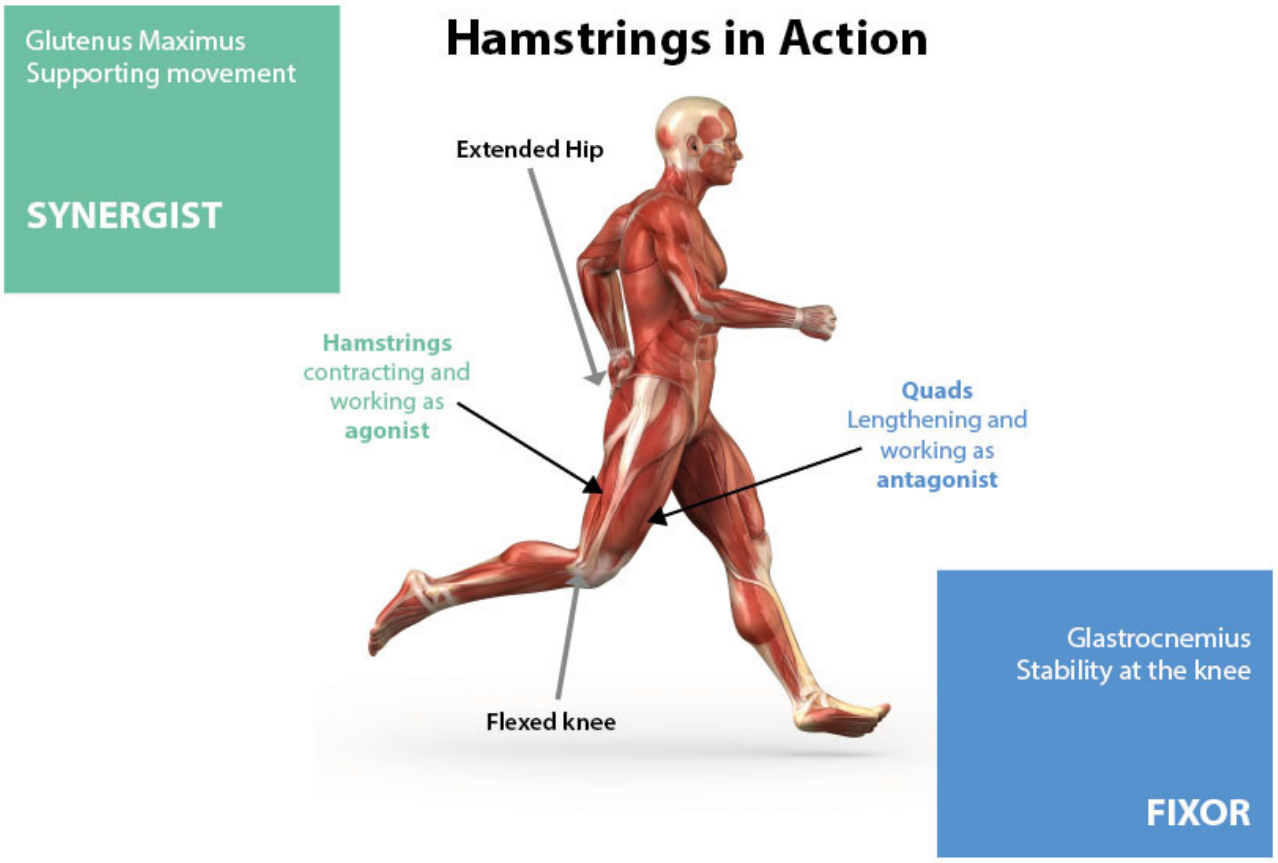
Major muscles of the body:



Antagonistic muscle action

As one muscle contracts to cause the movement another relaxes to allow the movement to take place. The muscle directly responsible for the movement is the agonist and the muscle that relaxes is the antagonist

Forceful contractions can vary allowing, fast movements or small precision actions. Skeletal muscle can only pull, when contracting the muscle pulls one of the bones towards



Skeletal muscle fibre type

Skeletal muscle consists of different fibres depending upon their function, these fibre types contract at different speeds and are suited to different types of activity. The body is made up of a combination of slow and fast twitch muscle fibres. There are two main types which are referred in many different ways:

Type I	slow twitch	oxidative	aerobic
Type II	fast twitch	glycolytic	anaerobic

Type II can be sub-divided into:

- Type IIa: Fast oxidative glycolytic; less force, more fatigue resistant
- Type IIb: Fast glycolytic; greatest force

Depending upon the duration and intensity of training Type IIa fibres are able to take on the characteristics of either Type I or Type IIb muscle fibres.

Characteristics of the muscle fibres:

Characteristic	Type I (oxidative)	Type IIa (oxidative glycolytic)	Type IIb (fast glycolytic)
Structural Differences			
Fibre size	Small	Large	Large
No of capillaries	Large	Moderate	Small
No of mitochondria	Large	Moderate	Small
Myoglobin store	High	Moderate	Low
CP stores	Low	High	High
Glycogen stores	Low	High	High
Functional Differences			
Aerobic capacity	High	Low/moderate	Low
Fatigue resistance	High	Low/moderate	Low
Anaerobic capacity	Low	High/Moderate	High
Speed of contraction	Slow	Fast	Fastest
Force of contraction	Low	High	Highest
Activity	Long Distance	1500m	Sprint

Immediate effects of exercise on skeletal muscle

As muscles contract over each other and alongside bones it causes friction that is converted into heat, which in turn raises the core body temperature.

The effect of a raise in temperature of skeletal muscle:

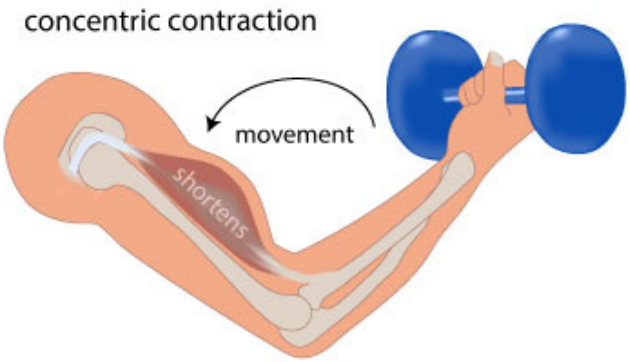
- Reduction in muscle viscosity, leading to improvement in efficiency of muscular contractions
- Greater speed and force of contraction due to the higher speed of neural transmission
- Increase in flexibility and elasticity of muscles, tendons and ligaments

Types of muscular contraction

Skeletal muscular contractions occur as a result of a stimulus being sent to the muscles to produce tension. Muscular contractions can be classified into either isotonic or isometric. Isotonic contractions can be sub divided into concentric and eccentric contractions.

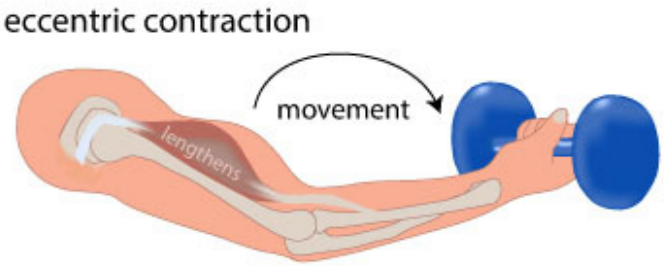
Isotonic contraction

Concentric



- Muscle shortens and pulls
- Upwards movement
- Uses agonist
- Most common contraction
- Weight training

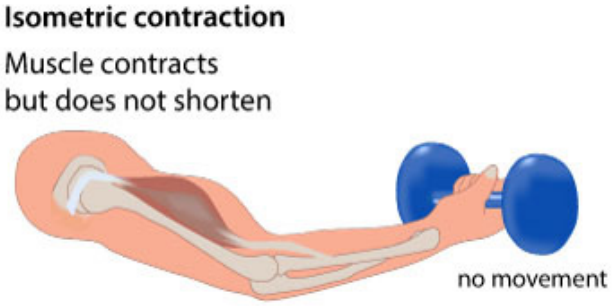
Eccentric



- Muscle lengthens
- Downwards movement
- Uses antagonist
- Control or deceleration
- Opposite of concentric
- Plyometrics

Isometric contraction

- Occurs with no change in length
- Tension stays the same length
- Stops flexion and extension
- Amount of force is related to the
- Length of the muscle
- Scrum in rugby



Overview of musculo-skeletal

- The skeleton provides attachments for the muscular system for movement and offers protection for vital organs such as the cardio-respiratory and vascular system.
- The average human adult has 206 bones that are divided into the axial and appendicular skeletons.
- The human body consists of 5 types of bones: long, short, flat, irregular and sesamoid bones.
- Skeletal muscles are those that attach to bones and have the main function of contracting to create movement. They are also sometimes known as striated muscles due to their appearance or voluntary because we have direct control over them contracting
- As one muscle contracts to cause the movement, another relaxes to allow the movement to take place. The muscle directly responsible for the movement is the agonist and the muscle that relaxes is the antagonist.
- The body is made up of a combination of slow- and fast-twitch muscle fibres.
- Muscular contractions can be classified into either isotonic or isometric. Isotonic contractions can be sub-divided into concentric and eccentric contractions.

2. Movement analysis

Question

1. Analyse the movements that take place at the major joints (AO3)
2. Describe the classification of the joints and levers using sporting examples to support your understanding (AO1)

Content

- Classification of joints: fibrous, cartilaginous and synovial.
- Types of joints: hinge, pivot, ball and socket, gliding and ellipsoid.
- How joint types are linked movement patterns when analysing sporting activities.
- Planes of movement including: Frontal, sagittal and horizontal/transverse planes of the body; sporting examples and patterns that occur along planes.
- Axes of rotation including: longitudinal, horizontal/transverse and frontal/ anterior - posterior axes of rotation; movement patterns that occur along axes of the body.
- Types of movement including: Flexion/extension, abduction/adduction, circumduction, pronation/supination, rotation, plantar flexion/dorsi flexion, lateral flexion and horizontal adduction and abduction.
- Components of a lever system: pivot/fulcrum, effort and load/resistance.
- 1st, 2nd and 3rd order levers. Learners apply their knowledge of levers to sporting examples, e.g. 3rd order lever used for bicep curl.
- Mechanical advantages and disadvantages of different types of lever.

Knowledge and Understanding

Analysis of movement

Introduction

To understand how to improve technically, the athlete or coach must understand the component parts of the technical model and the movements that contribute to successful performance.

Joints and Articulations

Knowledge of the skeletal system and how it works helps us to understand movement and explains how skills are performed. The possible movements at each joint or articulation (where two or more bones meet) can help coaches to understand skill development and performance improvement.

Joints

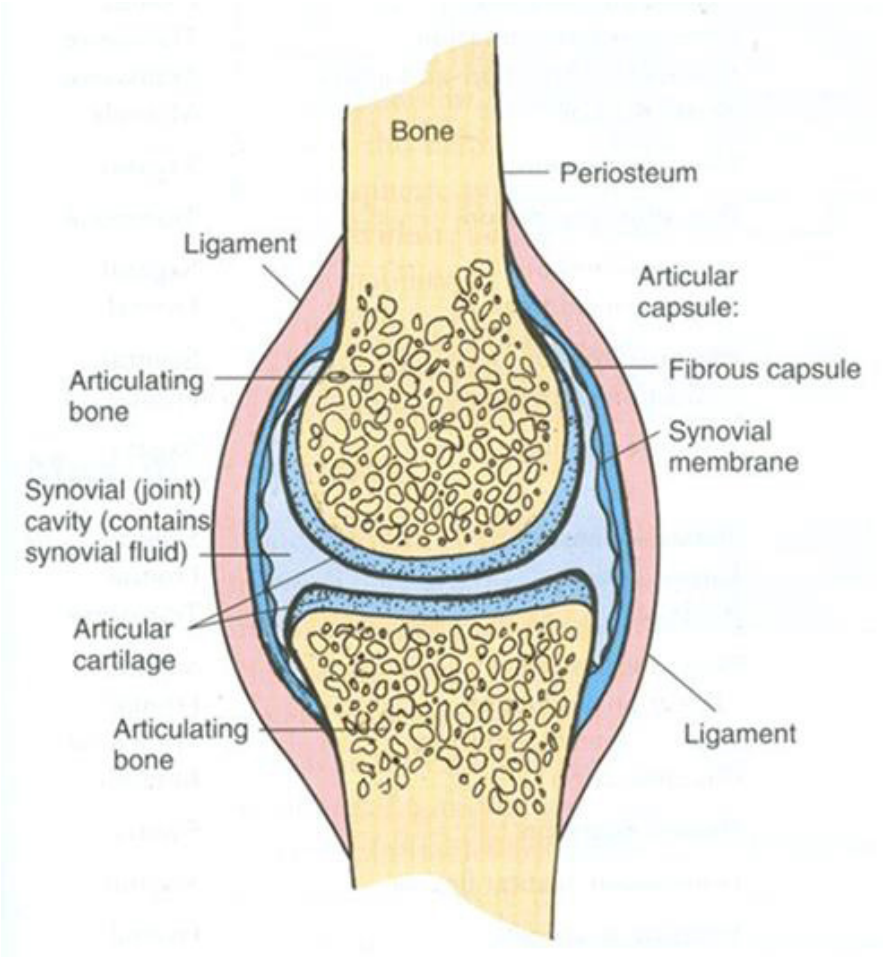
Skeletal joints are classified according to their structural and functional (range and type of movement) characteristics.

Joints (structural classifications):

- Fixed (Fibrous) - e.g. cranium
- Cartilaginous - e.g. vertebrae
- Synovial - e.g. shoulder, knee

Synovial Joints

Most common joint in the human skeletal system, they have a joint cavity and ligaments hold the articulating bones together. These joints are freely movable.



Synovial Joint Structure

Synovial cavity - a fluid filled space that separates the articulating bones

Synovial fluid - lubricates the joint and nourishes the articular cartilage

Articular cartilage - hyaline cartilage covers the articulating surfaces; reduces friction and acts as a shock absorber

Ligaments - connect bone to bone; stabilise the joint

Tendons - connect bone to muscle; enable movement

Types of Synovial Joints

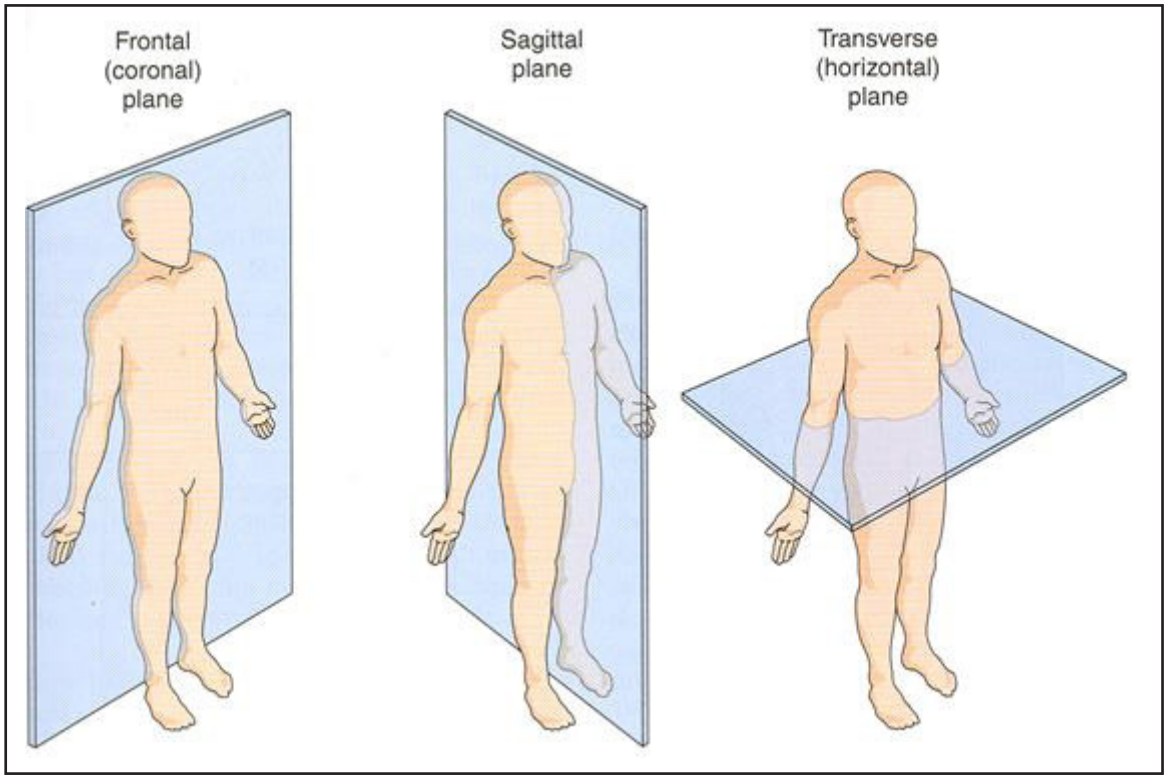
Synovial Joint	Structure	Movement	Example
Ball and socket	Tri-axial,most mobile	Flexion/extension, abduction/adduction, rotation, circumduction	Hip Shoulder
Hinge	Uni-axial, one plane	Flexion/extension	Elbow Knee
Pivot	Uni-axial, one plane	Rotation	Neck - atlanto-axial
Gliding	Bones glide past each other		Carpals, tarsals
Condyloid/ellipsoid	Bi-axial – two planes	Flexion/extension, abduction/adduction	Wrist – radio-carpsals

Analysis of movement

In order to understand sporting performance we need to be able to describe the movement of the human body. Using the planes and axes of movement and joint actions we can describe performance and understand the way people move.

Planes of movement

Planes of Motion: There are 3 imaginary anatomical planes that intersect at the body's centre of gravity, dividing the body into equal portions.

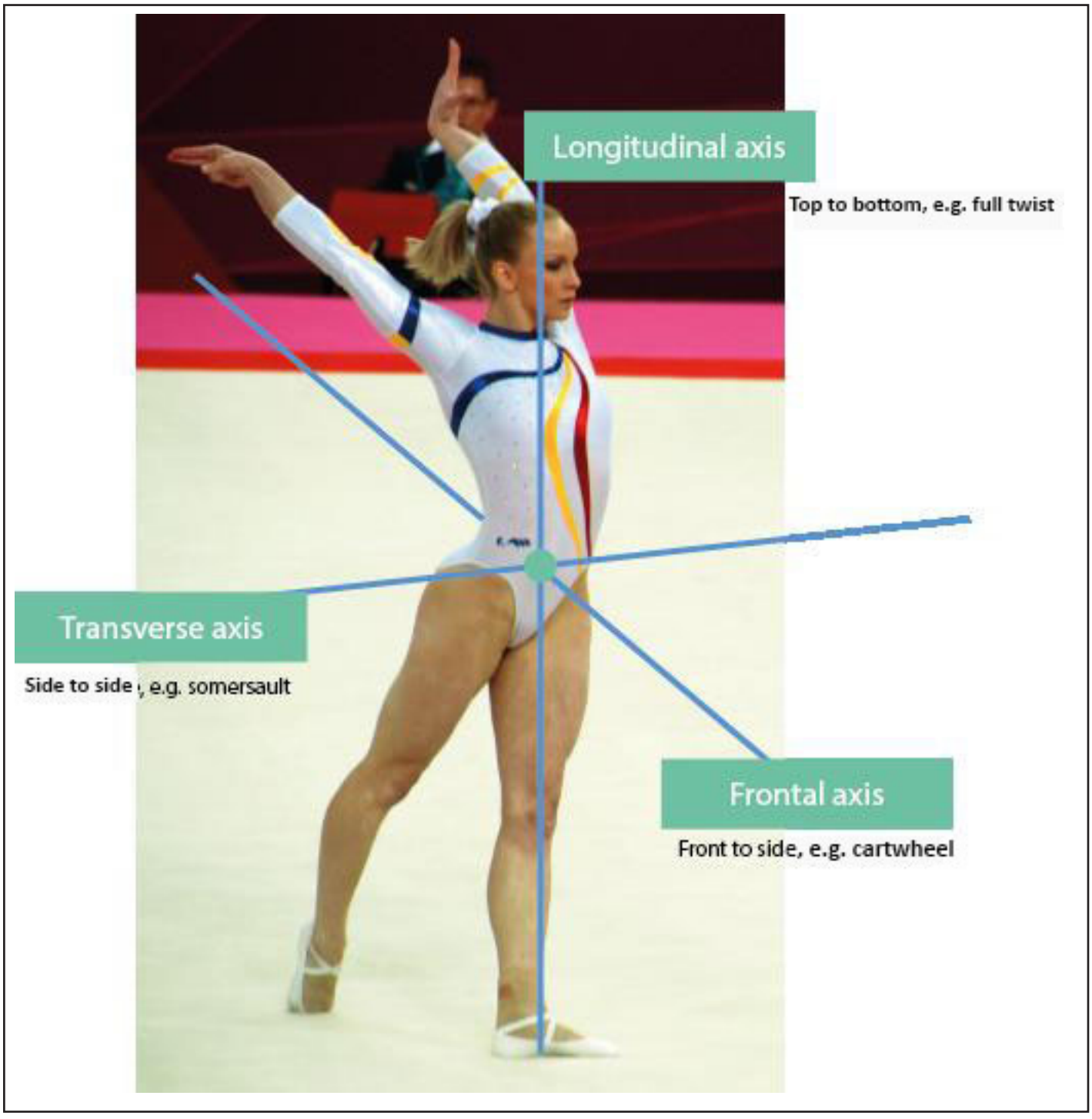


Most movements in sport occur in multiple planes. However, some movements are more planar (in one plane) than others.

When movement is in one plane, it means that no part of the body crosses from one side of the plane to the other during the movement.

Axes of motion

There are 3 imaginary anatomical axes that intersect at the body's centre of gravity. In most sporting actions, movement is about more than one axis.



Movement Patterns

Using the planes and axes of movement and joint actions we can describe performance and understand the way people move.

Joint	Movement	Plane	Axis	Example
Hinge – Elbow	Flexion/extension	Sagittal	Transverse	Biceps curl
Ball and socket – Shoulder	Flexion/extension Flexion – arms up	Sagittal	Transverse	Line out jumping
Ball and socket - Shoulder	Abduction – away, Adduction - toward	Frontal	Frontal	Cartwheel
Ball and socket - Shoulder	Circumduction – combination of movements	Sagittal	Transverse	Bowling
Ball and socket - Shoulder	Rotation - twisting	Transverse	Longitudinal	Golf drive
Ball and socket - Shoulder	Horizontal abduction/adduction	Transverse	Longitudinal	Discus
Ellipsoid – Ankle	Dorsiflexion-toes up, Plantar flexion - pointed	Sagittal	Transverse	Long jump or gymnastics
Ellipsoid – Wrist	Pronation – palm down, Supination – palm up	Sagittal	Frontal	Discus, Rolling ball

Levers

Levers allow us to create movement that is greater than the force applied. The skeleton forms a system of levers that allow us to move.

Functions of levers:

Increase the load that a given effort can move.

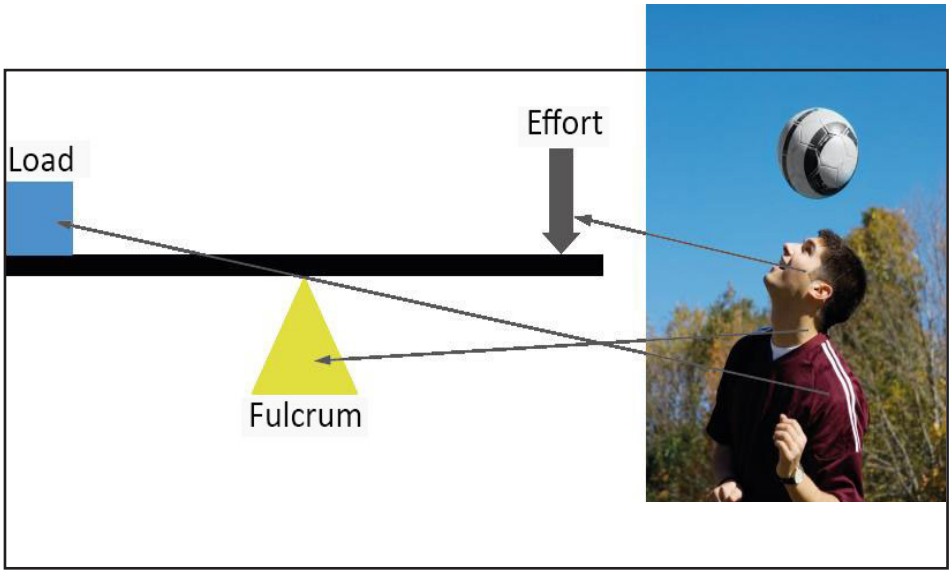
Increase the speed at which the body moves.

Levers are made up from three components:

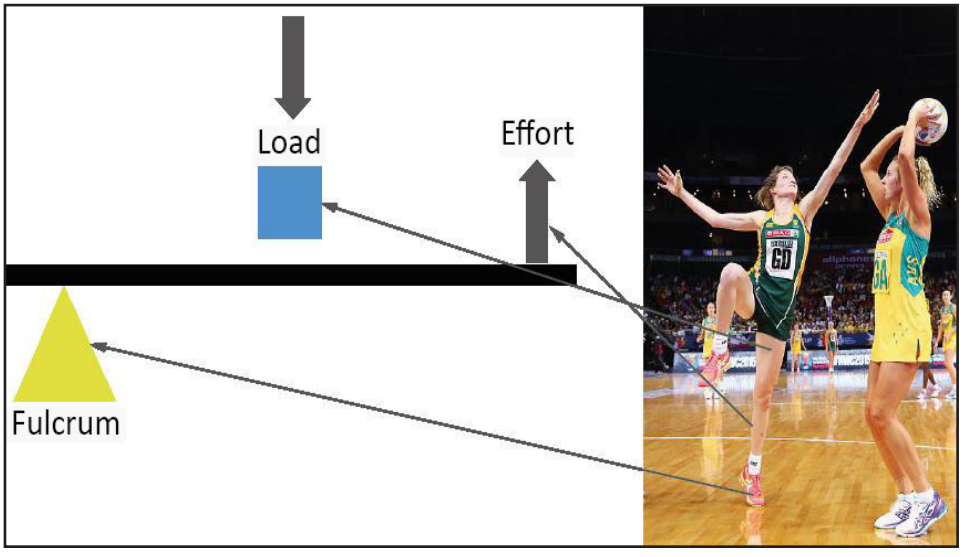
- Fulcrum (pivot)
    - The point at which the lever rotates (pivots) around.
- Effort (force) - muscles
    - The location where the force (effort) is applied.
- Load (resistance)
    - The location of the load/weight that is being moved/lifted.

There are three classifications of lever:

1st Order Lever e.g neck – heading the ball

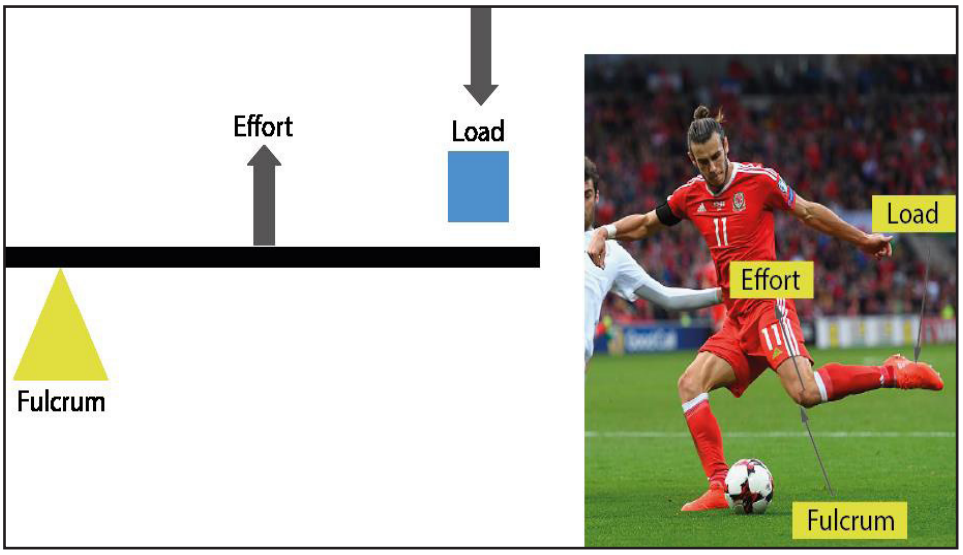


2nd Order Lever e.g. ankle – plantar flexion



3rd Order Lever e.g. knee kicking a ball

This is the most common lever in the human body and it increases the body's ability to move quickly, however it is inefficient at applying force.



Mechanical Advantage

Most levers in the body are 3rd class levers, this means:

- There is a mechanical disadvantage
- The load can be moved quickly
- Therefore, if the arm is extended (resistance arm maximised) during bowling there is a greater speed at the resistance and the ball is released with a greater speed.

Overview of movement analysis

- To understand how to improve technically, the athlete or coach must understand the component parts of the technical model and the movements that contribute to successful performance.
- The possible movements at each joint or articulation (where two or more bones meet) can help coaches to understand skill development and performance improvement.
- Synovial Joints - the most common joint in the human skeletal system, they have a joint cavity and ligaments hold the articulating bones together. These joints are freely movable.
- There are 3 imaginary anatomical planes that intersect at the body's centre of gravity, dividing the body into equal portions; Sagittal, Frontal and Transverse.
- There are 3 imaginary anatomical axes that intersect at the body's centre of gravity. These are; transverse, frontal and longitudinal.
- Levers allow us to create movement that is greater than the force applied.
- Most levers in the body are 3rd class levers.

3. Biomechanical principles

Question

Evaluate the techniques used to help improve performance. (AO3)

Content

- Newton's three laws of motion; Laws of inertia, acceleration and action/reaction and their application within sport.
- Momentum, impact and impulse; Defining the terms momentum (a product of a moving object's mass and velocity), impact and impulse. Force – time graphs; how to interpret information from a force - time graph.
- Stability; Stable, unstable and neutral equilibrium link with base of support and centre of mass. Factors affecting stability; mass, size of base, height of centre of mass, points of contact.
- Linear and angular motion; Position, distance, displacement, speed, velocity, acceleration and their application to sport. Moment of inertia and conservation of angular momentum.
- Projectile motion; Gravity and weight: factors affecting the flight of an object - velocity, height of release and air resistance. The different between parabolic and asymmetric flight paths. Lift forces; Spin: Magnus effect, Bernoulli principle; boundary layers.
- Fluid mechanics; Fluid friction: factors affecting fluid resistance; laminar flow and turbulent flow and its effect on drag. Importance of streamlining in sport; air resistance.

Knowledge and Understanding

Newton's Laws of Motion

Knowledge of the factors that cause movement are based on forces and underpinned by Newton's laws of motion. Knowledge of these Laws help us to understand the demands of performance on the body and explain how successful performance can be developed through the training principles and analysing technique.

There are three laws of motion:

Newton's 1st Law:

A body continues in its state of rest or motion in a straight line unless acted upon by an external force.

Application to sport

A winger will continue to run in a straight line to cross the ball unless the opposition comes across to tackle them.

Newton's 2nd Law:

The rate of change of momentum of a body is directly proportional to the force causing it and the change takes place in the direction in which the force acts.

Application to sport

If a rugby player, during the execution of a penalty, applies a force to a ball, it will move in the direction that this force is applied, and acceleration of the ball will be in proportion to the force applied.

Newton's 3rd Law:

To every action there is an equal and opposite reaction.

Application to sport

In the start blocks in athletics, a force is applied to the blocks by the athlete, at the same time an equal force and opposite force comes back from the blocks resulting in the athlete moving forward out of the blocks.

Momentum, impact and impulse

Momentum allows us to understand how mass and velocity influence the movement of athletes. Impulse allows us to explain how force and time can cause the athlete to start moving or change direction.

Definitions:

Momentum can be defined as the quantity of motion. This is a product of mass and velocity (velocity is the speed something is moving in a given direction).
In sport, momentum can be increased by using a heavier bat in cricket or running faster with the ball.

Impulse is the product of force and the time it takes to apply the force.
In sport, the follow through of the racket in tennis allows the racket to have the longest contact (impact) with the ball and therefore apply force to the ball for a longer time. This maximises the time that the force is applied.

Application to sport

If a hammer thrower wants to increase impulse they can do it one of two ways:

1. **Apply a greater force – moving the arm faster therefore becoming stronger**
2. Apply the force for a longer time – do more spins and release the hammer at the last possible moment.

For example:

An 18 year old hammer thrower applies a force of 25N (Newtons) for 1 second during 1 turn.

Impulse = force x time

I = 30 × 1

I = 30 Ns

If the hammer thrower achieves 4 spins in 3 seconds

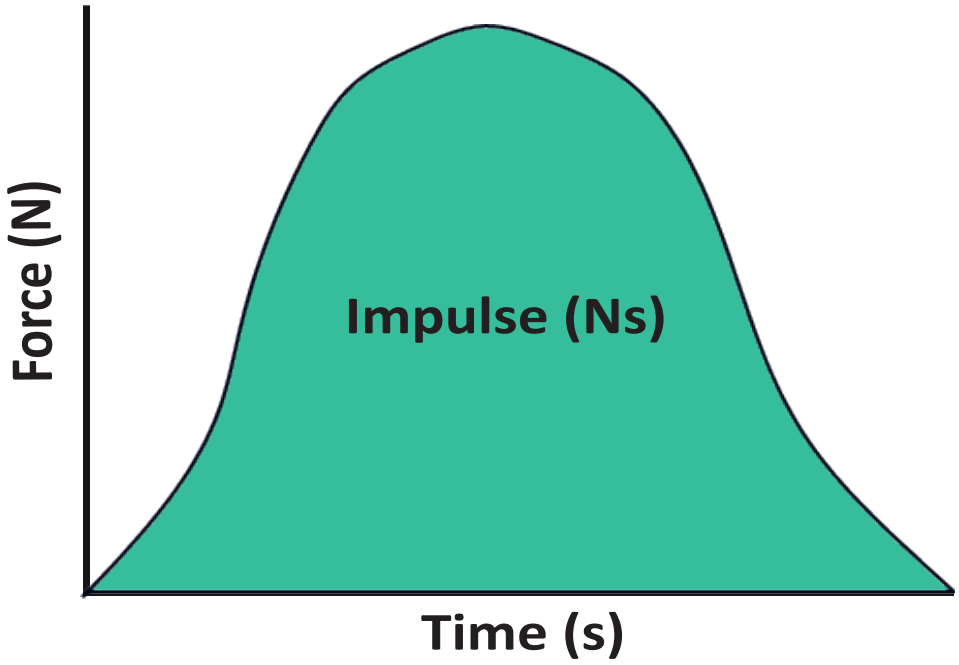
I = 30 × 3

I = 90 Ns

Force - time graphs

Force - time graphs are often used to demonstrate impulse. The area of the graph is the impulse.

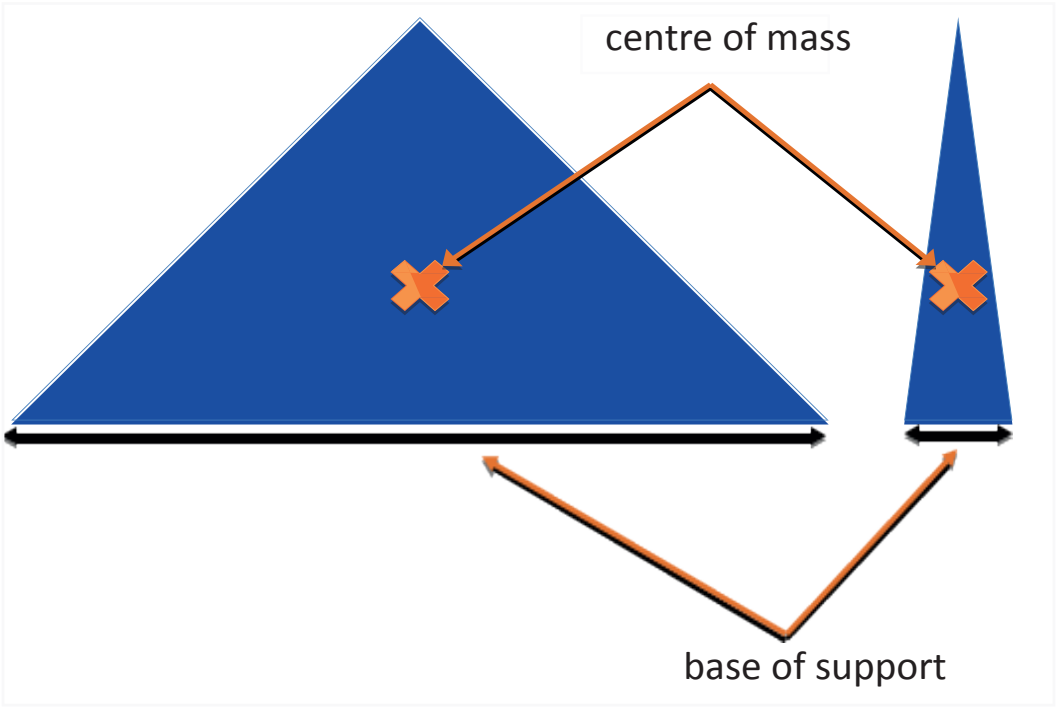
Force is measured in Newtons and will increase and then decrease over time.



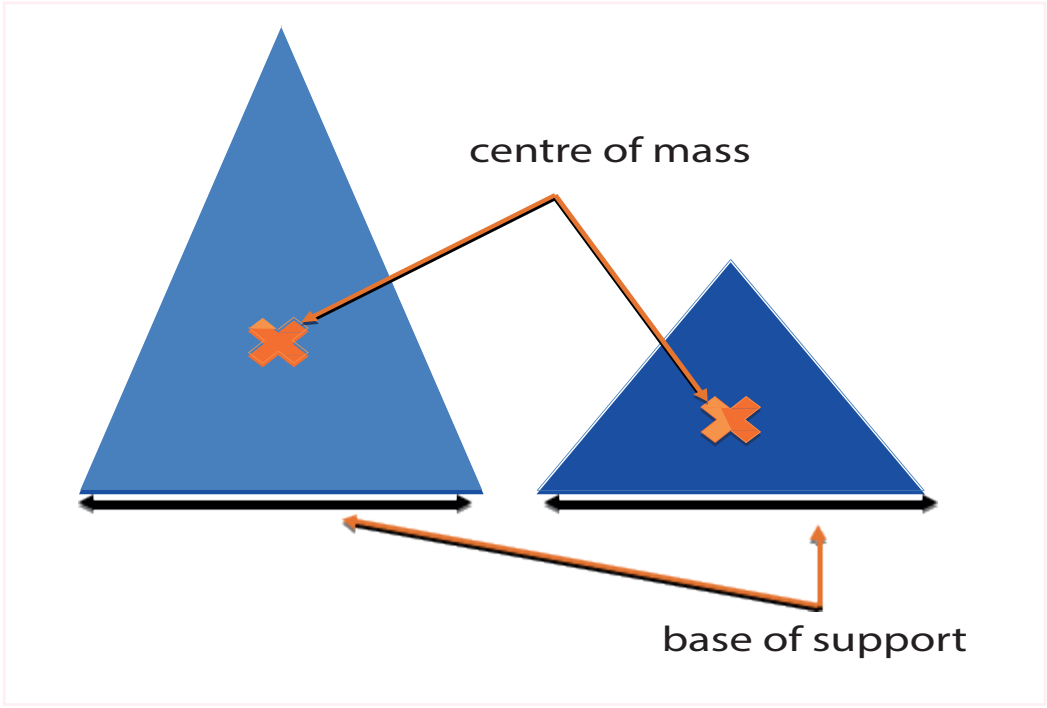
Stability

In many sports, athletes need to be balanced and stable in order to perform successfully. Understanding of the factors that affect balance and stability allows for understanding of performance. Balance and stability can be understood through knowledge of a person's centre of mass.

An object with a larger base of support is more stable:



An object with a lower centre of mass is more stable:



These concepts are vital when getting into the correct body position to maintain or reduce stability.

Application to sport:

A sprinter in the blocks wants to reduce their stability so that they fall out of the blocks. This is achieved by reducing the base of support – weight just on fingers. However, a canoeist wants to increase their stability to reduce the chances of capsizing. They achieve this by lowering their centre of mass down into the boat.

Linear and angular motion

Understanding motion allows us to explain how an athlete moves as a whole object in the performance. The human body moves due to rotations at joints, as such, human movement is not only linear, but involves angular motion (rotation).

Linear motion allows us to understand how quickly the athlete or object is travelling and in which direction.

SPEED = DISTANCE/TIME

Understanding at which speed a player can travel can offer valuable information for training and even team selection.

Angular motion relates to rotating movements at joints. A cyclist will produce angular movement at the legs, pushing the pedals to achieve linear motion.

Moment of Inertia is the body's resistance to motion, where the mass is widely distributed the moment of inertia is larger, compared with the concentrated mass closer to the mass centre the moment of inertia is smaller.

Application in sport

A speed is vital to sporting performance in cycling, the faster a cyclist can pedal the greater the linear motion. This will be produced from angular motion. The contact area of the tires reduces the moment of inertia. A wider wheel in mountain biking increases the moment of inertia requiring more force to overcome it but it increases stability allowing more control for the cyclist.

Another example of reducing moment of inertia is tighter tucks in diving and gymnastics.

Projectile motion

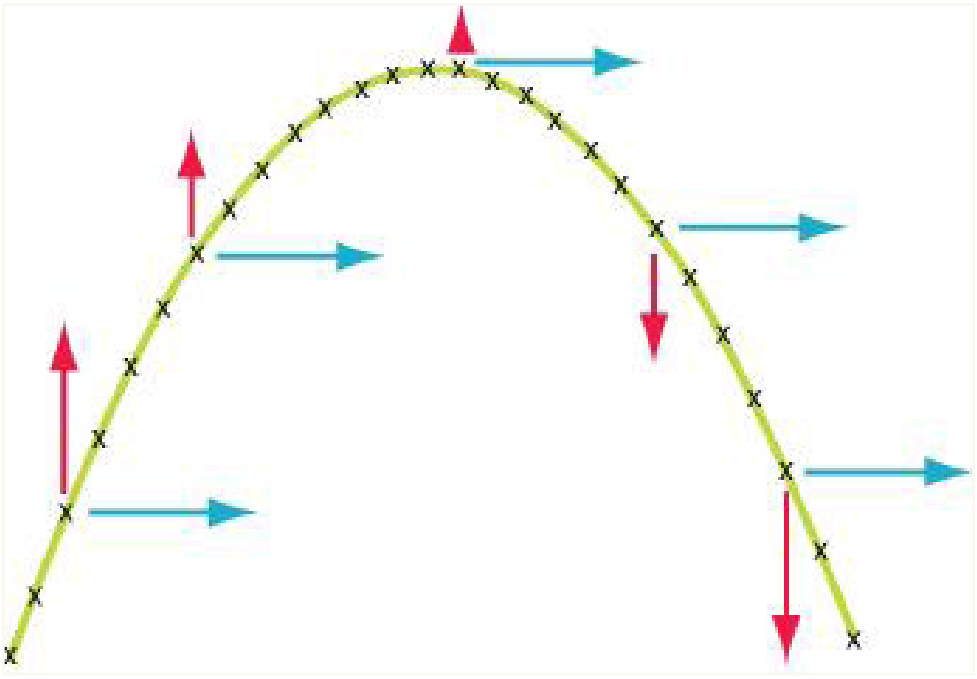
Understanding projectile motion and the factors that influence objects or athletes in flight allows us to explain technique and skill performance.

Knowledge of projectile motion allows for us to maximise performance in sports that require objects or athletes to travel maximum distances. A projectile is any object or body that is in flight. The flight path (trajectory) of the object is influenced by gravity and air resistance.

There are three key factors that determine the path of the projectile:

1. Angle of projection
2. Height of projection
3. Velocity of projection

It is sometimes easier to consider projectile motion without the following factors; air resistance, friction, spin and air flow around the object being thrown.



There is a relationship in projectile motion between the vertical velocity (red arrows) and the horizontal velocity (blue arrows). This relationship and distance is dependent upon the three factors above. As the object reaches the top of the parabola the vertical velocity decreases as demonstrated by the size of the arrows (similarly as the object comes closer to the ground the vertical velocity increases).

Parabola is a symmetrical curve, the path of a projectile follows this curve under the influence of gravity.

Bernoulli Effect

The Bernoulli principle refers to changes in fluid (water and air) speeds due to changes in pressure.

If a fluid flows around an object at different speeds, the slower moving fluid will exert more pressure on the object than the faster moving fluid. The object will then be forced toward the faster moving fluid (low pressure). A product of this event is either lift or down force.

e.g. air moves quickly over the top of a discus resulting in lift.

Magnus Effect

This is the Bernoulli principle applied to spinning objects. The side of the object that is spinning in the direction of the air will result in a high velocity air flow and therefore low pressure.

e.g. in a penalty kick, curling the ball in towards the posts rather than trying to kick it straight.

Fluid mechanics

It is important for us to understand the effects of fluid mechanics in order to understand how we can move better through air and water and therefore, ultimately improve performance. Bernoulli and Magnus effects work on the same principles.

Streamlining

To conserve energy and improve performance, technological advancement in equipment and coaching has allowed companies and coaches to design or improve technique that presents very little resistance to fluid (gas or liquid), increasing speed and ease of movement.

Drag Force

Drag forces resist motion and therefore generally restrict sports performance. Performers need to overcome drag forces. There are three major factors that affect drag force:

- Cross sectional area – standing up on a bike compared with sitting down
- Surface properties – swimming caps and compression clothing
- Speed of the object – greater the speed the more air resistance

Laminar and Turbulent Flow

As fluid (liquid or gas) flows past an object, the fluid nearest the object slows down because of its viscosity. The region of fluid that is affected is called the boundary layer. By altering the boundary layer drag can be reduced. There is dramatic change in drag as flow transitions from laminar to turbulent, resulting in a 65% reduction in drag.

Application to sport

The majority of sports try to reduce drag and air resistance to help with the conservation of energy. Compression clothing in most sports reduces drag. Footwear in the majority of sports focuses on the increasing friction increasing impact and impulse.

Sports such as swimming analyse the laminar flow and attempt to alter boundary layers minimising the turbulent flow.

Sports such as cricket attempt to create more boundary layers on the ball creating more turbulent flow to generate swing in cricket – the uneven surface of the ball creates an asymmetrical wake and the ball moves in the direction of the turbulent flow.

Overview of Biomechanical principles

- Newton's three laws of motion:
  - Newton's 1st Law: A body continues in its state of rest or motion in a straight line unless acted upon by an external force.
  - Newton's 2nd Law: The rate of change of momentum of a body is directly proportional to the force causing it and the change takes place in the direction in which the force acts.
  - Newton's 3rd Law: To every action there is an equal and opposite reaction.
- Momentum allows us to understand how mass and velocity influences the movement of athletes.
- Impulse allows us to explain how force and time can cause the athlete to start moving or change direction.
- Force - time graphs are often used to demonstrate impulse.
- Balance and stability can be understood through knowledge of a person's centre of mass.
- Stability is increased by making the base larger and lowering the centre of mass.
- Linear motion allows us to understand how quickly the athlete or object is travelling and in which direction. SPEED = DISTANCE/TIME
- Angular motion relates to rotating movements at joints. A cyclist will produce angular movement at the legs, pushing the pedals to achieve linear motion.
- Moment of Inertia is the body's resistance to motion.
- A projectile is any object or body that is in flight. The flight path (trajectory) of the object is influenced by gravity and air resistance.
- There are three key factors that determine the path of the projectile: Angle, Height and Velocity of the projection.
- The Bernoulli principle refers to changes in fluid (water and air) speeds due to changes in pressure.

- Magnus Effect - this is the Bernoulli principle applied to spinning objects. The side of the object that is spinning in the direction of the air will result in a high velocity air flow and therefore low pressure.
- Fluid mechanics looks at the movement through air and liquid, applying the principles of increasing and decreasing, drag through streamlining and altering laminar flow.

4. Performance analysis and technology

Question

1. Explain why a coach would use performance analysis of a footballer (AO2)
2. Discuss the different performance analysis approaches a coach would use for a dancer compared with a netballer (AO3)

Content

- Reasons why coaches observe and analyse performance and the limitations of simply using real time observations.
- Qualitative and quantitative approaches to analysing performance: choosing the correct method and analysing data (physical, technical, tactical and behavioural).
- Performance analysis in the media.
- Technology for the performer, coaches and officals; developments in equipment.
- Technology for the officials; Technological advances such as instant replays.
- The advantages and disadvantages of the growth of technology in sport including the notion of 'technological doping' and the concept of a 'level playing field.'

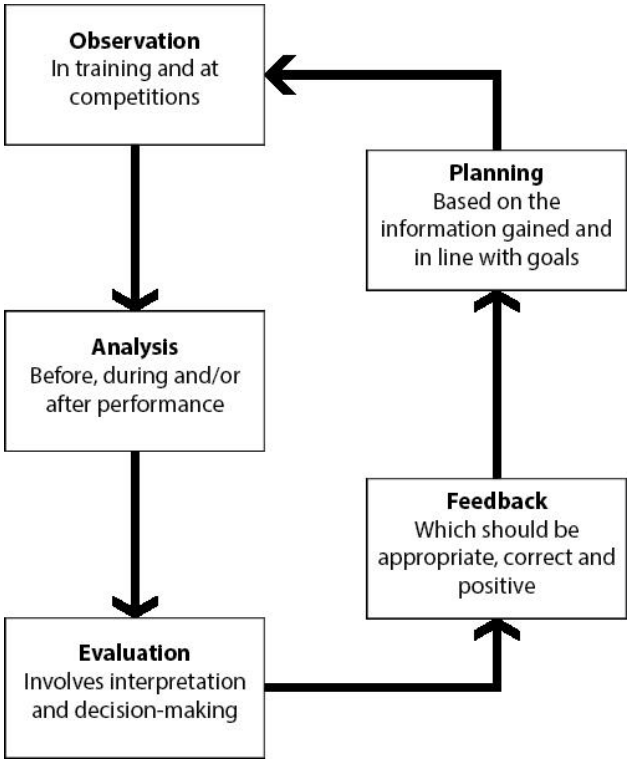
Knowledge and Understanding

Introduction

Performance Analysis involves the ability to identify playing/performing strengths and areas where improvements are required by both individuals and teams. It is a source of feedback to the coach, teacher and ultimately the performer. Performance analysis is about creating a reliable record of performance by means of observations that can be analysed, with training programmes and team selection adapted based on these observations.

Performance analysis plays a key role within the coaching process and informs all aspects of the model.

The coaching process:



Physical Analysis of Performance

Monitoring and evaluation of physical human performance is mainly carried out through fitness testing; within sport the margins of winning and losing are extremely fine with physical preparation being one of the elements to success. Fitness testing provides coaches with an overall fitness profile of the sportsperson. These profiles will be specific to that sport or even the position they play e.g. a gymnast will have a different fitness profile to that of a winger in hockey due to the differing demands of the sport and position. Modern forms of testing at an elite level are getting more complex using highly specialised monitoring and recording equipment. Such specialised tests are deemed Laboratory Tests.

The coach and the performer can use physical analysis data to: -

- Identify strengths and weaknesses in fitness
- Make large or finite changes to a training programme
- Develop an ongoing fitness profile of the performer
- Set highly specific goals
- Monitor progress of training or recovery
- Offer baseline data or benchmarking against norms or comparative data

Analysing Technical and Tactical Aspects of Performance

Tactical and Technical Performance analysis can be broken down into two separate but related disciplines:

- Notational/match analysis, where you analyse individual or team performance based on a number of different performance indicators. E.g. time in possession, number of shots etc. or individually, number of tackles, successful passes, interceptions etc.
- Biomechanical Analysis, where you analyse the performance of a skill e.g. javelin throw or activity and analyse the performance based on the key points of the skill e.g. Head, arms, legs position at the point of release of the javelin. This often uses highly specialised use of video to measure joint angles, force production, body rotation etc.

The two disciplines use similar methods to collect data, and both rely on technology for the analysis of data.

Notational Analysis

In both individual and team sports, it is difficult for coaches to notice and remember all the key events during a match or performance, using just their powers of observation. Memory is not reliable enough to provide the detailed information necessary for performance development. A study by Franks and Miller (1986) showed that football coaches were less than 45% accurate in their post-game assessment of what occurred during a game. Factors that affect a coach's perception include: -

- The vast amount of information in a game/performance
- Retention of the information
- The emotions during the game/performance can cloud judgement
- Pre-conceived ideas and personal bias of players and opposition
- Different coaches look at different performance indicators e.g. very subjective

Notational Analysis systems have been developed to provide far greater objectivity (definite statistics etc.) rather than the coaches' subjective analysis.

Notational Analysis has progressed rapidly over the last decade and has been facilitated by advances in technology available to coaches. It can take the form of real time notation (during the event) or post event analysis (after the event). Notational analysis is acknowledged as an aid to performance development at all levels where it is utilised.

Methods of Notational Analysis

Performance can be analysed in a variety of ways using notational analysis:

- Individual assessment of players within the team, for example, strikers in football
- Assessment of an aspect of performance for the whole team, e.g. monitoring of scoring effectiveness in basketball
- Assessment of unit performance e.g. attacking play in netball

Real Time Analysis

With the use of technology and a rationale for data to be collected a template is devised and performance is noted for each aspect based on the template (Key performance indicators KPI). The coach/analysis team or computer record the aspects and present a summary where necessary to coaches, players, and team.

Advantages of real time analysis

- Immediate information is provided to the coaches
- Coaches can act on this information to change players, tactics etc.
- Opposition can be analysed and again, changes can be made accordingly

Disadvantages of real time analysis

- Limited amount of information can be recorded
- Difficult to process, so much information for the recorder
- Computer analysis requires specialist training

At a grass roots level this form of analysis takes place usually by the coach making notes and recording key moments during the game. This is far more subjective than objective.

Post-Match/Performance Video/Computer Analysis

Post-match notational analysis involves the use of specialised computer software with a recording of the match with the coach or performance analyst noting a number of outcome. After viewing and 'coding' matches performance analysts produce video/ computer compilations of aspects of play for later use. Furthermore, statistical data is also gained from the matches. It is a very useful method for players to be responsible for taking ownership of developing their own sporting performance.

GPS systems are now commonplace within elite sport; these systems acquire information about the players in either match or training situations. Modern GPS systems measure distance covered, speed over set distances, heart rate and even the force of any collision or impact. Such information can be used for personal training, formulating changes in tactics and team sessions in terms of length and intensity or even team selection.

Advantages of Post-Match Video/Computer Analysis

- Permanent record of performance, which can be used to compare past and present levels of performance
- A record of opposition performances
- Slow-motion, freeze frame can provide precise analysis
- Identifying distance covered, different intensities of work, heart rate and impact forces etc.
- Training can be far more specific

- Players can use it for self analysis, which is often a more powerful form of analysis than coach feedback

Disadvantages of Post-Match Video/Computer Analysis

- Modern analysis computer programmes can be expensive
- Specific training is needed to make full use of the equipment
- Very time consuming. A full match of any sport can take up to 20hrs to analyse fully

General use of performance analysis

- Specific to event
- Appropriate timing
- Detailed analysis own performance and opposition
- Objective Feedback
- Motivation

Biomechanical Analysis

Biomechanics is the science concerned with the internal and external forces acting on the human body and the effects produced by these forces. At the highest levels of sports in which techniques play a major role, improvement comes so often from careful attention to detail that no coach can afford to leave these details to chance or guesswork. For such coaches knowledge of biomechanics might be regarded as essential. This area of performance analysis is widespread in predominantly individual sports where complex full body movement is required e.g. gymnastics; athletics field events and sprinting etc. Highly specialised cameras, sensors and computer programmes have been designed to provide exceptional detail and data about a performer's technique. This data is then used by the coach and athlete to improve areas such as efficiency of movement, increased force production, and aerodynamics. The margins of winning and losing have become so fine at the highest level of sport that athletes and coaches are seeking every advantage possible.

Analysis in Sport Psychology

Sports psychology analysis looks and tries to predict behaviour of athletes and in certain situations, allowing the coach the opportunity to intervene and attempt to support and sometimes change patterns of behaviour.

Psychological assessment / analysis:

1. Initial Interview
2. Behaviour Observation
3. Testing

Intervention strategies

1. Interview

Interview is more purposeful and organised than just conversation, but less formalised and standardised than a psychological test. However it is carefully planned and deliberate.

Types of Initial Interview:

- Case-history interview (concrete facts, dates, events, etc.)
- Diagnostic interview (expression, posture, mood and emotions, intellect, abnormal mental trends)
- Pre-test & Post-test Interview (administering personality test)
- Crisis Interview (deflect potential for disaster and prevent crisis)
- Pre-therapy interview (elicitation of specific information)

2. Behaviour Observation

Behaviour is observable across:

- Vocal (e.g. sighing, tonality, intensity)
- Facial expression (e.g. grimacing)
- Gesture (e.g. rubbing)
- Posture: excessive stiffness, compensatory positioning, referred to as bracing or guarding
- Locomotion (e.g. limping)
- Specific skilful activity: smooth vs. erratic patterns, range of motion (i.e. amplitude)

Strategies for Improving the Observation Reliability

1. Decide on target behaviours that are both relevant and comprehensive.
2. Consider the possibilities for reactivity (i.e. influence of awareness that one is being observed)

Personality Testing

- Eysenck (EPI) - neuroticism & introversion (r = .50)
- State-Trait Anxiety Inventory (STAI) Spielberger & Lushene,1970
- Profile of Mood State (POMS) - McNair, Lorr & Droppleman,1971; tension, depression, anger, vigour, fatigue, confusion, total mood disturbance
- Athletic Motivation Inventory (AMI) - Tutko, Ogilvie (1969); Ability to cope with emotional stress, dedication to the coach and sport, desire to be successful in athletics
- Sport Competition Anxiety Test (SCAT) - Martens,1977; "Tendency to perceive competitive situation as threatening and to respond with feelings of apprehension or tension" Ludvig, 1981

Interventions would then be undertaken to improve the sportspersons psychological state. E.g. relaxation techniques, mental rehearsal and positive self-talk.

Technology

Technology in sport and sporting performance has had a significant impact on the performer, spectator, official and coach. Technology is embedded within recreational activities such as cycling, 'fitbits' GPS tracking as well as the latest technical sport/ performance clothing and shoes. The use of technology focuses on marginal gains, and the commercialisation of these products sometime creates a culture of the product not performer.

Performance

Technology is widely used by athletes to aid training and performance, it tends to be used pre, during and post competition; being used to specifically target key aspects in training; analysis of performance; analysis of opposition and advancements in coaching. The athlete will use technology to support them with:

- Training
- Equipment and clothing
- Technique
- Analysis of others

Coaching

Technology is an integral part of coaching, maximising the potential of athletes and analysing the opposition. Coaches use a variety of methods for different types of reasons:

1. Performance analysis: more objective, rather than subjective.
2. Technical analysis: margin gains of techniques. Qualitative.
3. Quantitative Data: to develop training programmes and selection.

Officiating

Sport is multi-billion pound global entertainment business. Its commercialisation, sponsorship and spectators, has increased pressure on officials to make the correct decisions. The consumer (spectator) needs to feel engaged and submerged in this process. Officials use a variety of technological developments to:

1. Communicate – with other officials, spectators can listen in
2. Decision-making –objective decisions to help make correct decisions

Advantages and disadvantages of performance analysis and technology

Advantages	*Disadvantages*
Performer	
More objective look at performance	Performance is subjective for some performers
Data rich in terms of Qualitative and Quantitative	Too much focus on data
Recovery/reduce injury	Availability and cost of equipment
Improved equipment, margin gains	Marginal gains –win at all costs
Collaborative approach to performance	Ownership of Performance
Coaches	

Analysis becomes more objective Clear identification of need: focused approach to preparation of training and performance Research opposition and apply tactics Can support team selection	Analysis also has subjectivity and can be qualitative knowledge of results compared with knowledge of performance Can focus on the wrong aspects and opposition rather than own performance Lacks human approach
Officials	
More objective decisions made increasing confidence Information easily shared Decisions more reliable and accurate	Removes accountability Only at Elite level Lacks spirit of fair play

Overview of performance analysis and technology

- Performance analysis can provide information on Technical, Tactical, Physical and Behavioural aspects of sport
- Physical analysis is mainly carried out through fitness testing and GPS data from training and matches
- Notational analysis is the method for recording information from a match and can be either real time analysis or post-match analysis. Coach observation is only 30-45% accurate.
- There are also other problems associated with coach observation:
    - The vast amount of information in a game/performance is difficult to retain
    - The emotions during the game/performance can cloud judgement
    - Pre-conceived ideas and personal bias of players and opposition
- Technical and Tactical data is usually gained from video/computer/GPS analysis. It provides objective data from statistical information
- Every aspect of a performance can be analysed from individual to unit and team performance
- Biomechanics also provides technical data in terms of forces, joint angles, and aerodynamics to name a few
- Psychological analysis and profiling can gained via coach observation, questionnaires and interviews.

Acknowledgements

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