HSC PDHPE
SUMMARY NOTES FOR THE HSC EXAMS

WRITTEN BY A STUDENT WHO OBTAINED A BAND 6 IN THE SUBJECT

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Factors Affecting Performance

How does training affect performance?

Energy systems

Alactacid (ATP/PC) System

Source of fuel

The process of resynthesis of ATP (adenosine-Tri-Phosphate/Creatine Phosphate) goes on continually until the ATP/PC stores have been exhausted, which normally r ages between 10-12 seconds. When ATP is broken down (creating energy) the ADP reacts with creatine phosphate within the myocyte and resynthesises ATP. Therefore, creatine phosphate provides a source of fuel for the ATP/Pc system.

Efficiency of ATP production

Once the energy stores have been exhausted, the systems immediately begin replenishing stores of PC, and there for ATP. The rapid recovery time of PC is very short, and 50% of the stores are restored within 30s, and after resting, the PC stores will be replenished after two minutes.

Duration

ATP in itself only has a short span of 1-2 seconds, anything longer relies on the resynthesis of ATP via the PC, and will last a further 10-12 seconds

Cause of fatigue

Fatigue is cause by the depletion of ATP and PC stores and failing to resynthesis ATP. Therefore, once PC supplies are depleted fatigue begins

By-products

N/A

Process and rate of recovery

Once the energy stores ar depleted, the rate of recovery is within two minutes. However, 50% is recovered within 30 seconds

Lactic Acid System

Source of fuel

The lactic acid systems major source of fuel is carbohydrates in the form of sugar travelling in the bloodstream, known as blood glucose, and the glycogen stored in the muscles, known as muscle glycogen. The system relies on anaerobic glycolysis for its production of ATP. Glycolysis is the breakdown of glucose to produce ATP. In anaerobic glycolysis the glucose (sourced from glycogen in the muscle or glucose in the blood) is turned into lactic acid as it produces ATP.

Efficiency of ATP production

This is a very efficient system as it continues to resynthesise ATP molecules after the ATP/PC system has ceased. The breakdown of glucose and glycogen provides energy which will result in the resynthesis or regeneration of ATP molecules to be used for muscular contraction in a short time. However, it also produces lactic acid in the process.

Duration that the system can operate between 30 seconds and three minutes depending on intensity. The less intense the activity the longer it will last. This is because its producing lactic acid at a slower rate, and therefore doesn't fatigue as quickly.

Cause of fatigue

When the body is working under sub-maximal activity, the body will produce pyruvic acid, which produces lactate (due to insufficient O2). This increases the hydrogen ion concentration in the body and subsequently causes fatigue. At this point the athlete's performance decreases as does intensity and muscles start to tire, and performance is affected. By training athlete can build tolerance to lactate and rate of removal.

By-products of the energy production

The by-product of the lactic acid system is pyruvic acid. This increases the amount of lactate and hydrogen ions in the blood

Process and rate of recovery.

Depending on the duration and intensity of the activity somewhere around 20mins to 2 hours till lactic acid is removed from the blood. With a shorter recovery if an appropriate cool down is completed. After exercise, the lactic acid returns to the kidney to be used as fuel for later on

Aerobic

Source of fuel

The aerobic system sources its fuel from carbohydrates, then fats, then proteins. Most humans have fats available to be used and so have a limitless supply of fuel to keep creating ATP molecules, these fats are broken down into glycerol and free fatty acids. This is essential in changing the structure of fat, so it can be broken down in the presence of oxygen.

Efficiency of ATP production

the aerobic system is very efficient and is able to provide an endless supply of energy to resynthesis ATP for sustained physical activity over a prolonged time period.

Duration that the system can operate

The aerobic system can provide energy from 2-3 minutes, to a few hours, depending on the individual and intensity. At low intensity the system can provide energy for hours/days. A variance in an intensity will see a change in the duration of time.

Cause of fatigue

Fatigue occurs in the aerobic system due to the endurance work that depletes the body of glycogen. Slow twitch muscle fibres are rich in oxygen and glucose; however, when the glycogen stores are depleted, the body becomes tired. The system then begins to rely on fats as an energy source, but this requires more oxygen to break down and as a result, the body temperature and the rate pf respiration increases.

By products of energy production

The by-products of the aerobic system are water and carbon dioxide. Carbon dioxide is released as a by-product of cellular respiration and water is lost through sweat.

The process and rate of recovery

The rate of recovery is dependent on the length of time that the system is used, for example, if the system was only used for a short time, it requires a shirt recovery time, this is because not all glycogen stores were depleted. In contrast if all glycogen stores were used it can take days for the body to recover.

Examples for each

- Alactacid system (ATP/PC) – 100m sprint, 50m freestyle
- Lactic acid system – basketball
- Aerobic system – marathon running.

Types of training and training methods (FADS)

Aerobic – continuous. Fartlek. Aerobic interval. Circuit

Overarching goal of aerobic training is to make an athletes body more efficient at using oxygen. Aerobic training should follow the FITT principle,

Frequency	Three times a week
Intensity	Around 70-80% of maximum HR
Time	Minimum 20 mins each session
Type	Continuous, fartlek, interval

Continuous training

This type of training involves sustained aerobic effort without rest intervals. Examples include swimming, jogging, cycling. Too much continuous training will cause overuse injuries in some athletes.

Fartlek

Fartlek involves alternating bursts of high intensity activity while still maintaining the longer slower style of training. For example, an athlete could be jogging at 6km/h and then sprint to 20km/h then slow back to 12km/h, this is aerobic activity mixed with anaerobic efforts. This type of training is extremely useful in condition players in sports such as rugby union and league.

Aerobic/long interval

Interval training involves periods of structures work interspersed with rest periods in a set pattern. This allows athletes to work at higher intensities with rests in-between, to minimise overuse injuries. For example, a coach could tell his team to run 3 laps of the oval in a certain time and give them the 4th lap a walk within a given time, and then told to repeat.

Circuit training

Circuit training involves athletes moving from one activity within a set time, before moving on to the next activity with little to no rest. For example, a triathlete could do 20 mins of cycling, 20 mins of running, and 20 mins of swimming, rotating between activities.

Anaerobic

Anaerobic training specifically develops power, strength and speed. Whilst also increasing the lactate threshold and inflection point. Anaerobic training will speed up anaerobic glycolysis allowing for ATP to be produced at a faster rate than an untrained athlete. This affects performance by allowing the higher intensity activities to be performed for longer, improving recovery allowing for a repeat in this intensity to be performed quicker and for an extended duration, and improvements in strength, power or speed allow for further and faster throws and kicks.

Anaerobic/short interval

Anaerobic/short interval training involves high intensity work with a maximum recovery of 2 minutes. This gives the creatine phosphate time to replenish for the next interval. The advantages to this type of training include muscles developing a higher tolerance to the build-up of lactate and an improved performance by increasing the efficiency of the cardiovascular system. Examples include teams using this training to develop strength power and speed in their athletes.

Flexibility

Flexibility refers to the range of movement (ROM) of joints. Comes in active; Flexibility training affects performance by allowing the athlete to use the correct technique in skill execution and preventing injury. For example, by stretching a sprinter can utilise full knee lift and hip extension to achieve full stride length and optimise speed and power. The degree of flexibility carries among people with age (older = less flexible), gender (females > males) and temperature (warm = flexible). Passive stretching includes static and PNF and is produced by an external force (sit and reach) active stretching is ballistic and dynamic and is **produced by an athlete contracting muscles (straight leg lift)**

Static

This is a form of passive stretching and consists of stretching a muscle to its farthest point or limit that is uncomfortable yet not painful and is held in that position for a period of 15–30 seconds. For example, sit and reach. This type of stretching is predominantly used for warm ups and cool downs. It can also be used by individuals who have an injury and are trying to restore their full range of movement, while gently stretching the muscle.

PNF (proprioceptive neuromuscular facilitation)

PNF involves a static stretch for 30 seconds, followed by an isometric stretch for around 5-10 seconds, and then lengthening the muscle to hold another static stretch. This type of training is effective as the muscle can relax better after it has undergone a maximum isometric contraction. An example of PNF stretching includes, to put your leg up on a chair, stretch your hamstring for 30 secs, perform an isometric contraction by pushing your heel down against the chair until the uncomfortable nature of the stretch is diminished, then

further lengthen your hamstring and hold the stretch for another 10 sec. This method of training is most suited to sports where the athlete's joint may be forcefully taken beyond the active ROM. For example, rugby.

Dynamic stretching

Dynamic stretching is when an athlete performs movements that take their joints through their ROM to produce temporal stretches of selected muscles. These movements are continuous, and the stretch is not held. This type of stretching simulates most closely the movements and stretching involved in the majority of sports and is often used during a warm up.an example is in a warm up before rugby coaches can make athletes do lunges.

Ballistic stretching

Ballistic stretching involves a bounce of swing for extra stretch than what is normal. This type of stretching can cause potential injury as the bounce can override the stretch reflex mechanism. However, for elite athletes in the sport of AFL, it can be beneficial as a leg swing replicates a kick in the sport.

Flexibility is an important component of an athlete's fitness regime and can benefit their overall health by:

- Preventing injury
- Reducing the muscle soreness after sport or activity
- Increasing coordination
- Relaxing the muscles during and after sport or activity

Strength training (resistance training)

Strength training is any training that is done which will improve an athlete's strength. This type of training affects performance by causing muscular hypertrophy, which is a growth in myocyte cross-sectional area.

Terminology

- Strength: the muscles ability to apply force against resistance
- Power; the muscles ability to supply force at a quick rate
- Strength endurance; the muscles ability to tolerate fatigue over a period of time
- Absolute strength; the maximum force that a muscle can generate
- Relative strength; the strength/mass generated by a muscle relative to a person weight

- Isotonic program; exercises that contract the muscle by either shortening it concentrically or extending it eccentrically (bicep curl)
- Isometric program; exercises that require the muscle to apply force without changing muscle length (pushing against wall)
- Set; a fixed number of groups of repetition
- Reputation; the number of times that an exercise is repeated without stopping
- Repetition maximum (RM); an individual's maximum amount of weight in 1 rep/
- Resistance; the load that is used in the exercise (kg of dumbbell)
- Volume; repetition x set x resistance
- Hypertrophy; muscle growth, the size of the myocyte increasing
- Atrophy; muscle decreasing; the size of the myocyte decreasing
- eccentric contraction: Lengthening of the muscle fibres.
- concentric contraction: Shortening of the muscle fibres

free/fixed weights

Free weights often involve lifting dumbbells, barbells and sometimes the weight plate itself. This method of training causes the body to not just develop the major muscles being used in the activity, but also develops the smaller muscles used to stabilise the movements. Fixed weights utilise machines to lift the weight and often have a pulley system. The advantage of this method is that it helps the athlete to learn the correct technique and to experience equal resistance throughout the full range of motion. Weight training is the dominant form of resistance training when large gains in strength are required or when a large resistance is desired. It is most suited to sports that require large amounts of strength or power. These sports include: rugby, shot-put, Greco-Roman wrestling, and American football.

Elastic/resistance strength training

Elastic training uses various forms of elastic to provide the resistance to develop strength. The intensity of this type of training is limited and the resistance increases as the elastic is stretched. The benefit of this method is that it is highly portable making it useful in-home gyms or for personal trainers. This method of strength training is often used in rehabilitation, especially of weaker muscles. This method of training is best suited for sports, which require use of the smaller muscles. These sports include: arm wrestling, darts and Javelin.

Hydraulic machines

Hydraulic training uses machines, which use water or air compression to provide the resistance throughout the movement. This method of training increases the resistance the faster the movement is executed. So, with slow movements the resistance is small, whereas with a quick movement the resistance is large. This method of training is good for sports that require fast movements through a resistance. These sports include: rugby league, swimming, boxing and other martial arts

Principles of training

"People old Run Very Slowly to Work"

The major objective of training is to improve performance. The body has the ability to react to physiological and environmental stressors and must adapt to them. This adaptation occurs over time and with practice and often leads to improved performance. Training programs are designed to challenge athletes both mentally and physically in the pursuit of improving their exercise capacity and efficiency. The following can be applied it improve performance. x

Progressive overload

Progressive overload is when the workload for a training session is increased progressively as the athlete adapts to training, for example, each week increasing repetitions of chest press to allow the body to undergo strain and subsequently improve performance. Improvement will only occur when the athlete undertakes a training load exceeding what the body is normally accustomed to and is forced to operate beyond its normal range

Examples include increasing running speed, increasing weight, increasing distance, shorter rest etc.

Reversibility

For athletes to maintain and improve performance, they must continually train. If training is stopped, gains made by the athlete will decline at approximately one-third of the rate of acquisition.

A study of an Olympic rower in the United Kingdom found that after 8 weeks of rest it took the same athlete 20 weeks to achieve the level of fitness they had prior to the rest. After 8 weeks of training previous fitness levels had returned to about 50 % of their normal level.

Variety

Variety is important to prevent the boredom of athletes, whilst also allowing them to gain more complete adaptations. New activities / skills can improve performance, whilst also increasing the motivation of the athlete. For example, a marathon runner could cycle or swim to give a variety, whilst also improving the cardiovascular fitness of an athlete.

Specificity

Specificity means working the muscles, energy systems and movement patterns specific to an athlete's sport. The activities should reflect the goals and needs of the athlete. Incorporating exercises which mimic movements of the activity or target the muscle groups most commonly used will result in the greatest gains in performance.

For example, a marathon runner may run outside in comparison to on a tread mill as the outside varying terrain is similar to the terrain of a marathon

Training Thresholds

There are a number of training thresholds at which fitness gains can be made. This different intensity must occur to enable the adaptation necessary to improve performance

The aerobic threshold is achieved at 70% of the athletes MHR and is the point at which training effect can take place.

The aerobic training zone occurs between 70-85% of MHR, which is sufficient to create significant fitness gains

The anaerobic threshold is the point which accumulates in the blood at a rapid rate. The lactate inflexion point is the point at which the body can no longer generate output and lactic acid accumulates quickly and time that the bod takes to fatigue decreases. This occur between 85-100% of MHR

For strength, 6RM max strength/power, 12RM hypertrophy, 15RM muscular endurance.

Warm up and cool down

The warm up should be included in a training session, in order to reduce injury, increase body temperature, blood circulation, stimulating the cardiovascular system as well as mentally preparing.an example of a warmup for an aerobic scenario includes a gradual pulse raiser, such as a short jog etc, with dynamic stretches

A cool down is after a session and is designed to return the body to the pre-session state, as well as reduce muscle soreness etc. the cool down is typically low intensity and includes static stretching.

Application of the principles of training

	Progressive	Reversibility	Variety
Aerobic (marathon)	W1 – 8km in 1 hour W2 – 9km in 1 hour W3 – 10km in 1 hour	Athlete must ensure rest isn't to long for loss of physiological and physical gains	Athlete can swim or cycle to give the cardiovascular system a different strain
Strength (powerlifting)	W1 – 70% RM to 10 reps, 4 set W2 – 80% RM to 10 reps, 4 set W3 – 90% RM to 10 reps, 4 set	Athlete must ensure rest isn't to long for loss of physiological and physical gains	Athletes can use different machines to target specific muscles. E.g. Leg curl, resistance bands.
	Specificity	Thresholds	Warm up and cool down
Aerobic (marathon)	A marathoner to be specific to their sport, they must do lots of road running as this is where they will be competing, in contrast to treadmill.	Lower intensity (60-80% of MHR) for a prolonged period of time that's continuous	gradual pulse raiser such as running at very low intensity for short distance,
Strength (powerlifting)	Targeting the same muscles as squatting, for example, resistance bands for power and smiths machine for technique	Higher intensity, explosive movement with high weight and longer rest periods	Cycling on bike to warm up legs. Body weight squats for technique and power, with dynamic stretching such as leg swings

Physiological adaptations in response to training (HOMERS)

Resting heart rate

Resting heart rate is the number of times your heart beats per minute at rest. The heart consists of cardiac muscle and like any muscle that undergoes training it will undergo hypertrophy and become more efficient. A consequence of training is a lower resting heart rate than pre-training. This is due to a more efficient cardiovascular system as well as stroke volume. It is common for elite athletes to have resting heart rates as low as 30-40 bpm. Due to an efficient stroke volume, after training there is usually a reduction in the resting heart rate. This is more apparent during the recovery phase of training, as athletes with stronger hearts recover faster.

Stroke Volume and cardiac output.

The stroke volume is the amount of blood pumped out of the heart (left ventricle) per contraction (beat). As the heart becomes more efficient as a result of training, the left ventricle actually becomes muscularly thicker thus more forceful and ejects more blood. The heart is also more forceful now with each beat as an adaptation.

Cardiac output is the total amount of blood pumped out of the heart per minute. To calculate this, multiply the stroke volume by the heart rate. Trained athletes usually have 25-40L per minute, while untrained athletes have closer to 15-20L per minute. The heart rate will rise normally under maximal or submaximal activity to increase the ventilation rates around the body. As the stroke volume is bigger, the cardiac output will rise accordingly due to training. This then increases the amount of blood being sent around the body:

Cardiac output (CO) = Stroke volume (SV) X heart rate (HR)

Oxygen uptake and lung capacity

Oxygen uptake refers to the amount of oxygen the body uses per minute and is the maximum capacity of an individual's body to transport and utilise oxygen. It is also known as VO2 max. It is a key indicator of an athlete's cardiovascular endurance. A high VO2 max denotes a very efficient system of oxygen delivery to the muscles, which is significantly enhances performance.

Lung capacity isn't altered with aerobic training, but remains a significant factor in supplying energy to the cardiovascular system. A slight increase in vital capacity (air that is expelled after maximal respiration) and a small decrease in residual volume (the amount of air that must always be present in the lungs.) tidal volume tends to increase during maximal effort exercise where the individual breaths in and out more oxygen.

Haemoglobin level

Haemoglobin is a molecule on that is contained within the red blood cell, and binds with oxygen to transport it around the body in the blood. Aerobic training stimulates the body to produce more haemoglobin the increase the oxygen carrying capacity of the blood and the working muscles. The

most effective method to increase haemoglobin levels is by altitude training. Athletes will train high in the high where air pressure is slow to improve performance.

Muscle hypertrophy

Muscle hypertrophy refers to an increase in muscle size. Athletes will train to increase muscle hypertrophy sit equates to increase in muscular strength and endurance. This helps improve performance by allowing the athlete to exert a greater force and to repeat movements more often. his is very beneficial in sports that require, strength, power, or muscular endurance. Such sports include: shot put, sprinting, rugby, NFL, AFL, Ice-hockey, and martial arts.

Effect on fast/slow twitch muscle fibres.

Slow twitch fibres are effective in endurance events such as long distance running and swimming or cycling. When developed, there is an increase in hypertrophy, myoglobin content enzymes, mitochondrial function, glycogen stores and capillary supply. Slow twitch fibres are more efficient at using oxygen to generate fuel (ATP), creating a resistance to fatigue.

Aerobic training can result in:

- Hypertrophy of ST fibres
- Increased capillary supply to muscle fibres meaning an increase in blood supply (more oxygen to working muscles)
- Increased number/size of mitochondria (energy factory of cells) leading to more efficient energy production
- Increase in myoglobin content (oxygen travels from cell membrane to mitochondria)

Fast twitch fibres contract quickly facilitating explosive movements over a short duration. Developing these fibres is useful for anaerobic events, short intervals and resistance training. Benefits from anaerobic training are quickly apparent but cause fatigue to set in rapidly.

Anaerobic training can result in:

- Increased efficiency of ATP/PC supplies
- Hypertrophy of FT fibres
- Increased tolerance to lactic acid
- Faster/more forceful muscle contractions due to greater number of FT fibres

How can psychology affect performance?

Motivation

Motivation is a condition that drives behaviours and keeps them going once started towards a set goal. This concept can be applied to sport and training as well. There are several types of motivation which may drive an athlete to improve performance and work towards goals

Positive and negative

Positive motivation (carrot)

Positive motivation refers to the pleasure or reward an athlete receives when completing a task, goal or event. Most athletes experience this feeling of pleasure when they complete a task, goal or event, or when they receive a reward. These positive memories then motivate them to repeat the conditions, so they can experience the same feelings and reward again. The level of motivation will be influenced by the strength of the positive feeling and the nature of the reward.

Negative motivation (stick)

Negative motivation describes the pain or negative consequences an athlete experiences when they fail to complete an event or task correctly or unable to achieve their goals. Most athletes will be familiar with the negative emotions and/or consequences which result from failure and will strive to avoid the pain by performing well and meeting their objectives. The level of motivation is once again affected by the intensity of the pain or the severity of the consequences of failure.

Intrinsic and extrinsic

Intrinsic

Intrinsic motivation comes from within an athlete and is an internal desire to do well. It refers to the athlete taking part in an activity for the joy and satisfaction from doing the activity; it makes them feel good with the rewards being purely internal. Athletes who are intrinsically motivated usually want to learn more about the sport and their performance. This is a stronger form of motivation because it involves personal desire to do well.

Extrinsic

Extrinsic motivation is motivation that comes from an external as opposed to an internal source. An activity is extrinsically motivated if it is performed primarily for external reinforcement such as rewards, food, fame or money. Extrinsic motivation can also take positive and negative forms. For example, teammates may provide positive motivation by celebrating with the athlete when they score a goal. An example of negative motivation would be a coach punishing an athlete by withdrawing privileges if they fail to complete a 100m swim within an allotted time frame.

Anxiety and Arousal

Arousal refers to the physiological processes of the body and its ability to respond to certain situations. Arousal causes adrenaline to be released by the body, which leads to increased heart rate and blood pressure as well as sweaty palms.

Anxiety is a body's response psychologically to a given stimulus or situation. If the psychological problem is persistent it can lead to physical problems, such as accidents or poor performance. For example, lack of sleep before a grand final can lead to poor decisions made in the game

Trait Anxiety and State Anxiety

A personality type that has a tendency towards perceiving conceivably non-dangerous situations as threatening or non-threatening. This type of anxiety varies from person to person. Athletes with a high level of trait anxiety will tend to be more anxious when confronted with a threatening situation. They are likely to become more anxious prior to competition, which is a major cause of anxiety in athletes called competition anxiety.

An example of this is where a team which loses five games in a row will continue to see things in a negative way and continue to lose or accept it will happen.

State anxiety is an emotional response of an athlete to threatening demands or dangers to a particular situation. Symptoms of state anxiety may include sweaty hands and nervousness; it is a response at a given point in time but can change from moment to moment. This type of anxiety can be attended to by health professionals and will become less of an issue.

An example may be a golfer suddenly becoming over-aroused when they have to putt in front of a large crowd. Focusing and concentration will help them block out noise and expectations of others and allow the task to be completed.

Sources of Stress

Under Athlete Control	
Internal	External
Self esteem Fear of success or failure State Anxiety Personal expectations coping style	Reactions to opposition Focus on event Aspects of environment Planning
Not under Athlete Control	
Internal	External
Injury Ilness Trait anxiety Prior success/failure	Audience Media Expectations of others Environment (weather, ref) The opposition

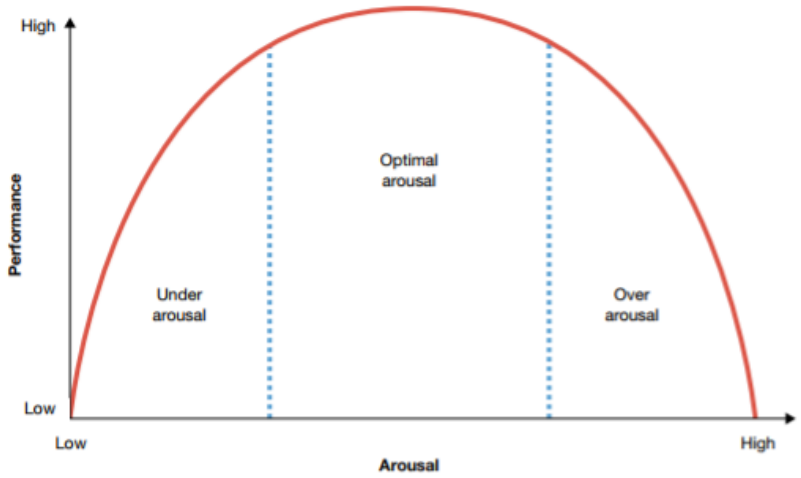
There are many sources of stress in our lives and each person's source will be different. Past experience, personal support and personal expectations will have an influence on what is perceived as a stressor. Stress can come from internal or external sources, which may be under the control of the athlete.

Optimal Arousal

There are two major theories for arousal: these are drive theory and the inverted U-theory.

The inverted U-theory

According to this theory, the athlete will be performing best if working in the zone of optimal arousal and in particular at the point of optimal arousal.



The drive theory

Relates performance to arousal, where an athlete has the necessary skills and their drive to compete is aroused by being psyched up for performance.

Psychological strategies to enhance motivation and manage anxiety

Concentration/attention skills (focusing)

Concentration is the ability to completely focus attention on appropriate cues to enable optimum performance. Both internal (how body feels mentally/physically and respond) and externally (crowds, environment etc.)

Experienced athletes learn how to switch off their concentration when it is not needed, so that they can avoid fatigue. They can also return to concentration quite easily if they have been distracted and focus on the task at hand

There are many ways athletes can practise concentration and focus on a task. First, the athlete needs to learn to relax a little and this could be as simple as controlling breathing. Then they can go through the process of centring. Centring allows the athlete time to redirect their negativity or anxiety into the present task, and is critical in maintaining focus and concentration. If it helps an athlete maintain concentration a key word can be used to bring their mind back to the task much like meditation

Mental rehearsal/visualisation/imagery

Visualisation

Involves the athlete to relate specifically to pictures in their mind of a performance that will be undertaken. It is imagining what the skill or parts of the skill will look like from their perspective. Often spectators may see downhill skiers visualising their performance with their eyes shut and moving their body as if they are on the mountain and going through the markers of the course.

Mental rehearsal

also involves images an athlete may form of skilled performance. Combined with good physical practice, this can lead to better acquisition of skills (or improve existing skills) and improve an athlete's concentration and confidence in particular sporting situations. Mental rehearsal involves more than just picturing the activity; it includes all the surrounding activity that goes with the actual performance, such as spectators or noise made from the crowd, weather conditions, and any other external factors that the athlete cannot control.

Mental rehearsal can improve performance by:

- Elevating the body to optimum arousal levels
- Providing a clear idea of what has to be done
- Heightening concentration
- Narrowing thoughts to a single task
- Reduce performance anxiety

Relaxation techniques

People who are over anxious or over-aroused can utilise a range of relaxation techniques to calm them down. When a person is relaxed their blood pressure lowers, their heart rate slows down and the tension in their muscles eases up, allowing them to more effectively focus on a task and control their own movements.

Some of the techniques which athletes use include:

- Listening to music
- Watching TV or a movie
- Massage
- Controlled breathing exercises
- Pilates, Yoga, hypnosis and meditation

They may also use:

- **Progressive muscular relaxation**: relaxing specific muscle groups using exercises; an effective technique to counter excessive arousal.
- **Mental relaxation:** relaxing the body and mind through controlled breathing.
- **Mental rehearsal**: repeatedly visualising the performance of a task to prepare
- **Meditation:** focussing your thoughts using repetitive images and sounds
- **Centred breathing:** releasing tension before performance through controlled breathing

Goal setting

Goal setting

- Gives direction, short & long-term goals
- sense of achievement, improvements, pride, self-confidence, performance, less stress and anxiety, prevents boredom
- Behavioural and performance goals

SMART:

- **S**pecific – e.g. reduce time by 1 min in 6 months
- **M**easurable – e.g. never miss training, train at 70% MHR
- **A**djustable – reset so it is achievable e.g. 5 rebounds a game
- **R**ealistic – but challenging
- **T**ime – create a timeline for goals to be met (prevent boredom)

How can nutrition and recovery strategies affect performance

Nutritional considerations

Athletes need to eat a nutritious, balanced diet to fuel their body. An adequate diet also avoids the need for supplementation and delays the onset of fatigue while aiding the recovery process after a performance.

Muscles need energy and the major source of energy is carbohydrates, which are broken down into glucose or stored as glycogen in the liver or muscle

Pre-performance, including carb loading

Pre-performance and carbohydrate loading are strategies conducted by athletes prior to competition to ensure their energy stores reach optimum levels during competition.

Shows how different individuals should prepare for excise by increasing percentage of carbohydrate intake

POPULATION GROUP	CARBOHYDRATE (%)	PROTEIN (%)	FAT (%)
General population	>55	12–15	<30
Athletes	>55	12–15	<30
Athletes (>60–90 minutes/day)	65–70	12–15	<20

Carbohydrate loading is a strategy involving changes to training and nutrition that can maximise muscle glycogen (carbohydrate) stores prior to endurance competition. It is estimated that carbohydrate loading can improve performance over a set distance by 2–3%. For anyone exercising continuously for 60 minutes or longer, carbohydrate loading is a proven form of boosting endurance, such as in cycling or triathlon.

- Traditional method of carbo loading – 7-10 days before, decrease CHO/3-4 days hard training (maintaining BMR), 3-4 days decreased training/increased CHO (body stores more ready for famine)
- Recommended Method – 4-7 days prior taper (softer in preparation) training, 3 days prior CHO increased to 70-80%, reduce training

Trained athletes can store more glycogen (CHO) due to increase in insulin sensitivity (blood glucose absorbed quicker)

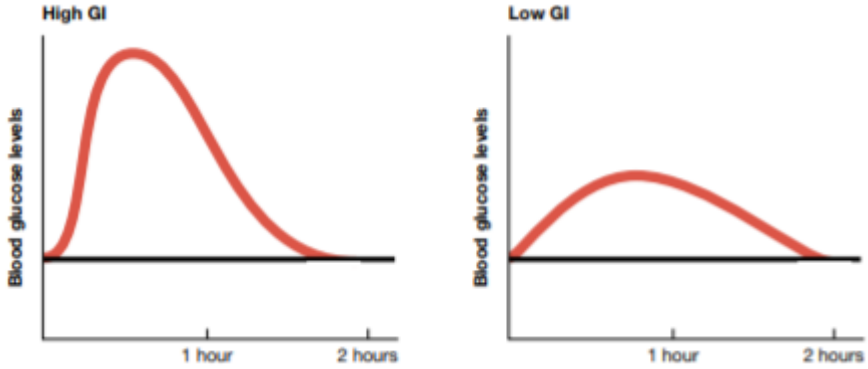
GLYCOGEN LEVELS	NORMAL POPULATION UNTRAINED 45% AVERAGE DIET	NORMAL POPULATION UNTRAINED 75% CARBOHYDRATE DIET (PRE LOADING)	TRAINED ATHLETE 45% CARBOHYDRATE DIET (PRE LOADING)	TRAINED ATHLETE 75% CARBOHYDRATE DIET (PRE LOADING)
Liver Muscle	100 g 280 g	130 g 360 g	100 g 280 g	160 g 720 g

Nutritional considerations and foods to eat before performance

3–4 HOURS FROM COMPETITION	1–2 HOURS FROM COMPETITION	<1 HOUR FROM COMPETITION
crumpets with jam or honey + flavoured milk baked potato + cottage cheese filling + glass of milk baked beans on toast breakfast cereal with milk bread roll with cheese/meat filling pasta or rice with a sauce based on low-fat ingredients (e.g. tomato, vegetables, lean meat)	liquid meal supplement milk shake or fruit smoothie sports bars (check labels for carbohydrate and protein content) breakfast cereal with milk cereal bars or fruit fruit-flavoured yoghurt	sports drink carbohydrate gel cordial sports bars jelly lollies

Glycaemic Index

The glycaemic index was provided by dietitians to gain a better understanding of the types of carbohydrates athletes were ingesting. The simple or complex carbohydrates were categorised according to their effects on blood glucose levels. As shown in Table 3.4, foods rated 72 or above are high glycaemic (GI) and are good for replenishment following a performance. Foods rated 55–70 are moderate GI and those below 55 are low GI or slow release carbohydrates. Although both high and low GI foods will eventually release the same energy over time, as shown in Figure 3.3, low GI foods are thought to have more sustained release over time. This is of more benefit to endurance athletes rather than the spike that occurs in high GI foods which are good for an immediate increase of blood glucose to the system. Normal overnight sleeping will lower the glycogen levels in the liver and muscles and a small meal or drink high in carbohydrates in the morning will replenish these to maximum levels for performance.



HIGH (GI > 85)	MODERATE (GI = 60–85)	LOW (GI < 60)
white bread wholemeal bread nutrigrain cornflakes weetbix potato rockmelon raisins bananas corn chips sugar/honey cordial/sports drinks glucose	pasta/noodles popcorn porridge potato chips/crisps Special k white rice (boiled) sweet corn sponge cake oranges orange juice chocolate	apples/pears cherries peaches apple juice (unsweetened) All-bran baked beans lentils ice cream yoghurt fructose brown rice (boiled) milk (all types) peanuts

During performance

Main fuel source

CHO and fat (no need for CHO supplement if <60min). The decision to take carbohydrates during exercise is dependent on the length of activity, the intensity and the environment the athlete is performing in, for example, during hot weather glycogen is quick to break down.

Why athletes will take carbohydrates during exercise.

- The main one is to maintain blood glucose levels ready for when they drop low.
- These carbohydrates are broken down into glucose and may be used before stored glycogen.
- Fats can also be used before stored glycogen; this is called glycogen sparing.
- Finally, the blood glucose can be used to replenish glycogen stores as they are performing. A refuelling target of 30–60 grams of carbohydrate per hour of activity is a good starting point when supplementing carbohydrates during exercise.

Example of supplements to refuel during exercise per hour

1*litre* sports drink	1.5 sports bars	2 sports gels
600ml cola	3 cereal bars	2 large bananas

Why drink water?

- Maintain temperature (replace sweat which cools body)
- Blood volume – best for replenishing fluid
- Delay onset of fatigue
- Prevent dehydration
- Avoid caffeine and alcohol the day before and day of comp
- TOO MUCH? – bloating, increased urination

Why drink sports drinks?

- Contain electrolytes-sodium (stimulates absorption of CHO and H2O from small intestine, reduces urine, fluid loss & dehydration); potassium (helps muscle fiber contractions)

PERIOD	TIME AND FREQUENCY OF FLUID INTAKE	AMOUNT
Before exercise	20–30 minutes	500–600 mL
During exercise	Every 15–20 minutes	200 mL
After exercise	Immediately after training	500 mL for every 0.4 to 0.5 kg of weight lost

If 3kg lighter at end of session – need 1.5x this amount to rehydrate effectively (4.5 litres)

Post- performance

After extensive performance glycogen levels in both the muscle and liver are depleted. For the athlete's recovery and preparation for the next performance, it is important that the body is returned to its normal state as soon as possible.

To do this, it is recommended that the athlete intakes a high carbohydrate diet within the first two hours of performance, as it will restore glycogen levels in the body and start to repair tissue caused by the activity. This is also the perfect time to try and replenish because the insulin will rise quickly as a result of increased blood sugar levels and maximise the storage of the glycogen. In particular, high glycaemic foods (see Table 3.4) will assist replenishment. Fruit and vegetables such as watermelon and potato are also important, as they carry extra nutrients, such as potassium and other vitamins, needed for muscular contraction. During recovery glycogen levels are restored, electrolytes are rebalanced, and tissues are repaired. In the post-performance stage, the muscle can restore its glycogen content by about 5% per hour. Athletes may hasten recovery by consuming at least 50 grams of high or moderate glycaemic carbohydrates within the first 2 hours when resynthesis of glycogen is highest. If the exercise was strenuous and lasted a long time, glycogen stores may need refuelling and resynthesis of glycogen can take up to 24 hours. The total amount of carbohydrates ingested during this time is important for recovery. Protein is also needed after performance to help with tissue repair. Some examples of carbohydrate and protein rich foods are:

- 1–2 sports bars (check labels for carbohydrate and protein content)
- 250–300 ml milk shake or fruit smoothie
- 250–300 ml liquid meal supplement.

If an athlete is 3 kilograms lighter at the end of a training session or game, then they will need to replace 1.5 times this amount and take on 4.5 litres of fluid to rehydrate the body effectively.

Supplementation

A good diet will negate the need for supplementation of various components of foods. Any dietary deficiencies can easily be fixed, but this should be under the guidance of a sports nutritionist or a doctor.

Vitamins/minerals

Minerals (electrolytes)

Help muscle contraction, nerve transmission, growth, maintenance & repair e.g. sodium, potassium, calcium, magnesium, chloride (form salts that conduct electrical energy), iron (hemoglobin), calcium (bones, teeth & prevent osteoporosis)

Vitamins

Help in chemical reactions & converting food into usable forms of energy e.g. A, D, E, K fat-soluble (stored in body), B & C water-soluble (urinated out, need replenishing)

PROBLEMS

Iron deficiency (anemia), females, blood loss, sweating heavily, poor diet, heavy training; too much iron (damage gastrointestinal tract); athlete on high CHO diet (take iron supplements to avoid eating protein over CHO)

Protein (amino acids)

Build & repair tissue, muscle contraction, resists diseases, minor energy source

Meat, fish, dairy, bread, cereal

- *Supplements claims*- reduce fatigue, increase muscle size, improve recovery time)
- *EVIDENCE?* – no scientific evidence to prove this, expensive (just change diet), excess cannot be stored (burned for energy or stored as body fat)

Athletes, like weight lifters, need to consume extra protein during the initial stage of training. Protein can help them building up muscle mass/recover from intense training where muscle fibre tearing occurs, & repair is necessary.

Caffeine

Stimulant increase concentration & awareness 1-3 hrs. (sports requiring quick thinking & reactions)

Decreases athlete's perceived exertion

Theory

burn more fat and less CHO, glycogen sparing

SIDE EFFECTS

muscle tightness, dehydration (diuretic), nausea, lack of sleep, headaches

Creatine products

Creatine

combines with phosphate to resynthesize ATP molecules (meat, fish, chicken, stored in skeletal muscle & as free creatine)

20-30g per day over 5 days found to increase storage in muscle (by up to 25-50%), improves short duration activities (by 1-3% single activity or 5-15% repeated activities)

SIDE EFFECTS

weight gain (storage of water), then muscle weight gain (if you work out), potential for kidney damage and the risk of inhibiting the body's natural formation of creatine

Recovery strategies

Recovery – time following game or training from fatigue to being ready for next performance

- Active recovery – helps remove lactate
- Good recovery – reduces fatigue, speeds up repair

In order to return the body back to its pre-workout condition, proper nutrition and active recovery exercises must be maintained. These strategies help athletes to prepare for upcoming training and events.

The two main elements of these strategies involve the removal of metabolic by-products (e.g. adenosine, carbon dioxide) and the implementation of a nutritional plan to replace lost fluids and energy.

Physiological strategies, e.g. cool down, hydration

Cool down

- active warm down to stretching
    - Disposes of lactate
    - Restores muscles to previous length and range of motion e.g. static stretch
    - Decrease muscle tension

Hydration

- drink fluids to restore lost weight
    - Avoid alcohol (diuretic, interferes with CHO uptake)
    - 12 to 24 hours after exercise, for every 1.5 kgs. lost, 1 litre of water should be replenished

Neural strategies e.g. hydrotherapy, massage

Hydrotherapy

- *Deep water running* (injury, decreases muscle soreness, and delayed onset muscle soreness, reduced swelling)
- Ice baths – in ice 2-10 degrees for 1 min, out for 1 min, back in (injuries, soreness, bruising
- Spas – relax muscles, lowers arousal levels (<15) min
- Hot & Cold showers – stimulates nervous system and arousal levels (2min hot, 1 min cold, repeat)

Massage

- Reduces lactic acid levels, muscle soreness
- Aids soft tissue injury, tight muscles (postural deformities, stress origin & insertion of muscle)
- Returns neural pathways to full working order
- Realign muscle fibres
- Break down scar tissue
- Decrease fatigue
- Avoid first 48 hours of soft tissue injury

Tissue damage strategies e.g. cryotherapy

After athletes participate in competition or strenuous activity, they may suffer from an array of tissue damage, ranging from microscopic muscle tears, caused by heavy-resistance training, to minor sprains and bruises.

Cryotherapy

- cooling as a means of treating injuries
    - Vasoconstriction decreases blood & scar tissue at site, inflammatory response
    - RICE – rest, ice, compression, elevation (10 min)
    - ICE MASSAGE – realigns muscles, transports lactic acid out

Psychological strategies e.g. / relaxation

- Flotation tanks (salty water to aid floatation)
- Lowers BP, improves temperaments, decreases motor neuron response to stress
- Soothing music
- Good sleep (7-9hrs) and 1 day of rest
- Warm baths
- Showers
- Meditation – decrease HR, ventilation rate, BP, relax muscles
- Progressive muscle relaxation

How does the acquisition of skill affect performance?

Stages of kill acquisition

By understanding how skills are learnt athletes can improve their performance and develop from a beginner to a skilled performer

Cognitive

This is the beginner stage of skill acquisition, and is largely focused on the mental concentration (cognitive) on the skill rather than practice in order to execute the skill properly.

During this stage the errors are high, as this skill is new, however individuals may transfer knowledge of habits and skills from other sports. Coaches should give simple instructions and demonstrations to avoid overloading the beginner with information, as this could disprove their level of skill acquisition.

Furthermore, coaches may maximise feedback and compliment the beginner when they are doing something right, whilst also giving them the opportunity to slightly improve.

For example, learn how to pass the ball

Associative

This is the stage that the athlete begins to focus these learnt skills and apply them when confronted with open skills and respond during closed skills. The skill becomes more fluid and smooth, with still many errors as they move along the continuum, however aren't as frequent as in the cognitive stage.

Practice is essential to this stage, as the athletes begin to get a "kinaesthetic sense" or 'feel' for the skill, they begin to correct their own errors, however still benefit from immediate feedback to help improve technique etc. Practice at this stage also starts to take the skill from a closed situation to encompass more open-style practice sessions, which enables the athlete to receive a broader range of skill development.

For example, rather than learning about the pass, focusing on where the pass is going and how to pass accurately.

Autonomous

The autonomous stage is the final stage of learning where skills become largely automatic in their execution with consistency. Due to the autonomous execution of the skill, the athlete can focus on other aspects of the game, such as who to pass to etc. this task is also able to be executed with speed, consistency and efficiency.

The autonomous athlete knows what the movement feels like and can self-correct performance, however, external feedback may be beneficial. To further improve this aspect, coaches may force the athlete to perform this skill under immense pressure with several cognitive processes simultaneously, such as avoiding and drawing and passing.

Characteristics of the autonomous stage include: kinaesthetic sense, good anticipation, consistency of performance, and technique. Athletes can correct their own movements midway through the movement to adjust to oppositional movements or environmental interference. They consistently perform the skill well with minor errors occurring rarely. For example, passing further ahead due to wind.

For example, due to wind passing ahead of player or drawing and passing to create space.

Characteristics of the learner

The rate at which an individual learns the skills required for their sport or activity will depends on a number of factors including personality, heredity, confidence, prior experience and ability. Each individual is unique, so the rate and extent they acquire new skills will vary from person to person.

Personality

Examples

- Aggression (ice hockey)
- High level trait anxiety (not good for quick thinking)
- Motivation level
- Optimistic – maintain high motivation & arousal levels
- Lack of mental capability
- Willingness to learn & take risks

Heredity

- Certain sports have specific somatotypes (body types – ectomorphic, mesomorphic and endomorphic) e.g. high jumpers tall and linear, basketballers tall and muscular
- Ratio of fast to slow twitch muscle fibers. Eg sprinters high % fast twitch
- Height – limb length e.g. rowers, swimmers
- Talent identification – choose an athlete based on somatotype then taught the sport eg Yao Ming 7ft 3in
- Conceptual ability – ability to visualise a movement and act it accordingly

Confidence

- Belief in oneself & abilities
- Coach must make all activities achievable
- Increased confidence can be due to heredity (large size makes you feel confident about being tackled) & previous positive experiences (high % of scoring penalty shots in previous water polo games makes you confident about scoring the next one)

Prior experience

- Having seen the skill being performed before
- Familiar with rules
- Helps with cognitive stage
- Having played a similar or modified skill (transfer of skills)

Ability

- The way individuals understand new skills
- Coaches should make skills age-specific
- Talented young athletes are often more mature in using skills eg problem solving, decision making, planning
- Spatial and tactical awareness, coordination, reaction time, kinaesthetic sense

The learning environment

The nature of the skill

Skill	Explanation	Example
Open	An open skill is performed in a constantly changing environment (weather, opposition, surface)	kicking a goal in Australian Rules Football
Closed	A closed skill is performed in the same conditions every time	weight lifting

Gross Motor	A gross skill requires large muscle groups (legs, back, chest)	running
Fine Motor	A fine skill uses small or isolated muscles (wrist flexors, bicep)	shooting

Skill	Explanation	Example
Discrete	A discrete skill has a clear beginning and end	flip in gymnastic
Serial	A serial skill combines a number of separate smaller skills to perform the larger more complex skill	lay up in basketball
Continuous	A continuous skill repeats a specific movement over and over again	running.
Self-paced	A self-paced skill has its timing and speed determined by the performer,	tennis serve
Externally paced	An externally paced skill has its timing and speed determined by external factors like opposing players or music	rhythmic gymnastics or batting in baseball.

The performance elements

The foundations of a sport (e.g. passing a football) aren't enough for an athlete to become successful. Athletes must perform these skills under pressure and respond to their environment. Decision making, strategic and tactical development are performance elements that enhance an athlete's ability to perform.

To perform athletes must be provided with opportunities to advance their learning. The coach is responsible for recognising what those needs are and providing the athlete with the relevant activities and challenges. Open communication is essential, so the athlete knows where to focus their attention and how to execute the skill.

The use of modified games with a targeted focus on development is called game-sense approach. There are several key areas of development coaches should focus on.

Decision making

Refers to the various decisions made by any athlete during a performance. E.g. where to hit the ball

Coaches can use effective questioning, video analysis and problem solving to enhance this process. Incorporating variation and creativity into training sessions can also have a positive effect.

Strategic and tactical development

Strategy is the method to achieve a goal (where a player should be at what time)

Tactics are gaining advantages over the opposition, & normally connected with game sense. (moving to space)

Strategic and tactical development comes through technical efficiency, understanding the game, and good execution. Through successful coaching and practice, players can make use strategies and tactics to gain an edge over competitors, Coaching must train this by putting players in game related exercise rather than closed skills. This will enhance the use of tactics and improve performance.

Practice method

Continuously practicing a variety of methods can lead to vast improvements in the skill set of athletes. Practice and training are important because they nurture the development and understanding of necessary skills, tactics and fitness which are required to be successful. There are several classifications of practice methods.

Practice Method	Explanation	Example
Massed Practice	Massed practice involves the learning of one motor skill in a continuous, consistent and repeated practise in a session with no variation until the skill is mastered or learnt, with low rest intervals. • Beneficial in a motivated athlete or beginner • However, can lead to demotivation and boredom	Practicing Lineouts until they are perfect.
Distributed Practice	Distributed practice occurs when a range of skills are practised in a training session. It involves short practice sessions interspersed with rest or intervals of other skills, and allowing time for feedback. • Beneficial for cognitive learners, as well as demotivated and lower skilled as they can rest.	Practicing lineouts, then scrums, the ball skills
Whole Practice	Training the skill in its entirety. • Beneficial for advanced learners, who need to train and develop skill which can't be broken down into separate mechanisms and practiced alone.	Swimming
Part Practice	Part practice is when the skill is broken down into its smaller parts and each part is practiced in isolation before being joined together. It is often used for teaching serial skills that have smaller skills that make up the larger skill	Basketball layup.

Feedback

Feedback consists of constructive commentary and information pertaining to a particular performance or skill. It is an extremely important element in all skill acquisition stages, as it can help athletes to improve their performance. Feedback can have three main effects. It can

- reinforce the execution of successful skills
- correct and change unsuccessful performances
- motivate the athlete to persevere with their training.

Feedback Source

Intrinsic	Attained internally, by the athlete. And how the movement felt, can be judged by the kinaesthetic sense.	Connection with the ball in rugby.
Extrinsic	Comes from an outside source	video analysis, coach, or audience.

Feedback timing

Concurrent	as the performance occurs - compliments intrinsic feedback. Athlete may make changes to their movement, so they can apply this next time. This is simultaneous with execution and is relayed throughout the body by the proprioceptive mechanism.	coach stopping a golfer mid-swing to correct their grip on the handle
Delayed	Delayed feedback is given after a skill has been completed, usually via an external source	analysis from a coach or video.

Feedback type

Knowledge of Performance	information provided about the process of movement normally provided externally after its completion	coach giving technical advice on the tennis serv
Knowledge of Results	feedback that provides information about the task or skill outcome of the skill execution	Swimming time

Read PDHPE in FOCUS for extra reading

For right hand side of syllabus see PDHPE.net for basketball layup

Assessment of skill and performance

Characteristics of skilled performance (kinaesthetic sense, anticipation, consistency, technique)

Skilled performers are usually:

- Physiologically advanced, giving the, heightened perceptive abilities contributing to increased performance
- Superior coordination as the neuromuscular pathways are trained
- Composure under pressure and copes with negative consequences of performance
- Correct response to environmental demands
- React quickly (unhurried) to a response, smooth & efficient, advanced skills, use less energy
- Well organized, reads game, anticipates, adapts, consistent
- Higher level kinesthetic sense, selective attention

Objective and subjective performance measures

A measure is a way to gauge performances, and are used to appraise, judge and give opinions based on performance

An objective measure is independent to the observer, and is a quantitative measure such as time or height jumped. These aim to remove human error and bias from results. Coaches can use this to track and monitor improvements in performance. Has some limits such as doesn't give a holistic representation in some sports such as ball touches in soccer, could be doing good off the ball work.

A subjective measure is dependent of the observer and can be based on opinions. Many sports such as boxing etc. are based on subjective measurement.

Validity and Reliability of tests.

Tests can be used to measure components of athletic performance, such as fitness etc. These tests must be valid and reliable to ensure that athletes are achieving improvements, and if changes are needed in their preparation for competition.

Reliability refers to the reproducibility of a measurement. A test is reliable f the same equipment, conditions and procedures are used and achieve similar results. For example, similar results in beep test. (same temp humidity, terrain, etc.)

A **valid** test is designed to measure what the tester is set out to measure. For example, if a coach wanted to measure an athlete's flexibility, a sit and reach test would be valid, whilst the beep test would not. The validity is reinforced by comparing the measurements with expected values. This can be done by referring to a set criteria or percentile bands of that particular test and the athlete being tested

A test can be reliable but not valid, but can't be valid if unreliable

Personal versus prescribed judging criteria

Personal versus prescribed judging criteria seeks to contrast the personal likes or dislikes of performance, compared to more formal judging through the use of criteria. It is prescribed judging criteria that refers to the use of criteria to make subjective performance measures more objective.

Personal judging relies on the judge giving their impression of what they have seen. This isn't ideal for competition as each individual has their own personal interpretation and would make judging unreliable and inconsistent Personal criteria is often used by the general audience, which is subjective because of their feelings, emotions, and biases play a role int his assessment. Rating scales or checklists can make personal criteria more creditable because it gives some guidance as to the opinion that has been given, however, this may only be a personal checklist of what the judge is looking for.

In contrast, a prescribed judging criteria increases objectivity, as this is proved by a professional organisation and can be used to officially judge competition, ensuring accuracy and fairness for all athletes. For example, a gymnastics routine which must include an aerial somersault as part of the floor routine. The judge is now looking for that particular element to give an opinion of the performance. Judges will look for certain components worth a certain amount of points in a routine. Depending on the execution of the skill judges may deduct a set amount of points if the skill was executed poorly

See PDHPE.net for right hand side of syllabus