INFORMATION PROCESSING DURING THE PERFORMANCE OF SKILLS IN PHYSICAL ACTIVITY

MODELS OF INFORMATION PROCESSING AND EFFECTIVENESS IN THE LEARNING AND PERFORMANCE OF MOVEMENT SKILLS

How is information processed by the brain in such a way as to convert information received from the surroundings into muscular activity? The following models attempt to explain what the brain does during this process.

Welford's model of information processing

In Welford's model (see figure 91):

- **Display** refers to the range of actions and things that are happening in the surrounding environment of the performer.
- **Perceptual mechanism** refers to the part of the brain which perceives the surroundings (via sight, sound and touch).
- **Decision mechanism** refers to the part of the brain which makes decisions.
- **The effector mechanism** is the part of the brain which carries out the decisions and sends messages to the limbs and parts of the body which act out the relevant skill.
- **Intrinsic feedback** is the feedback as to what actually happens to the body via the proprioceptors, which inform the brain about balance, muscle tensions, limb positions and angles and so on.
- **Extrinsic feedback** is the feedback via the result (response) of the actions made, what happens in the game or performance or to a ball or the other players in a game, the results of which feed back as part of the display.

Whiting's model of information processing

In Whiting's model (see figure 92):

figure 91 – Welford's information processing model

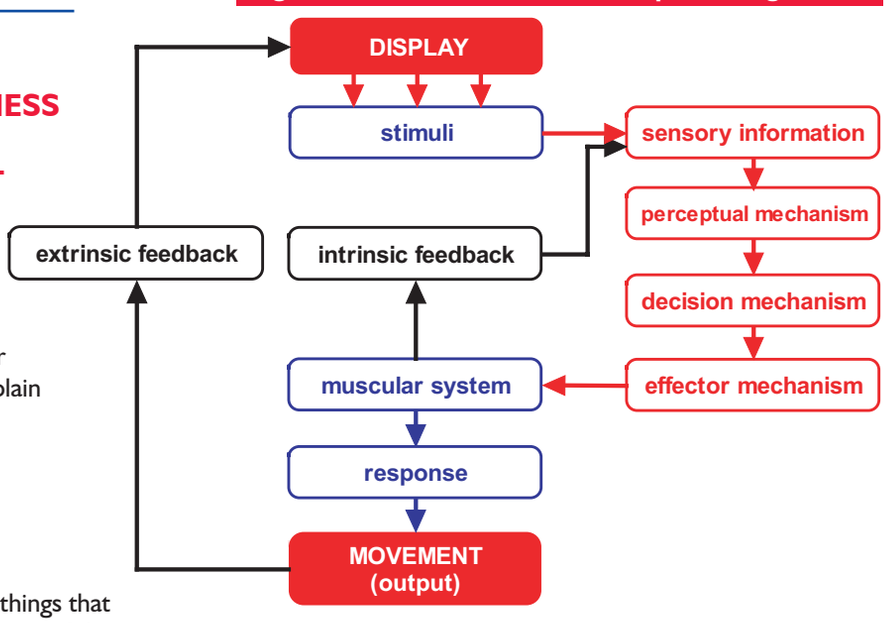
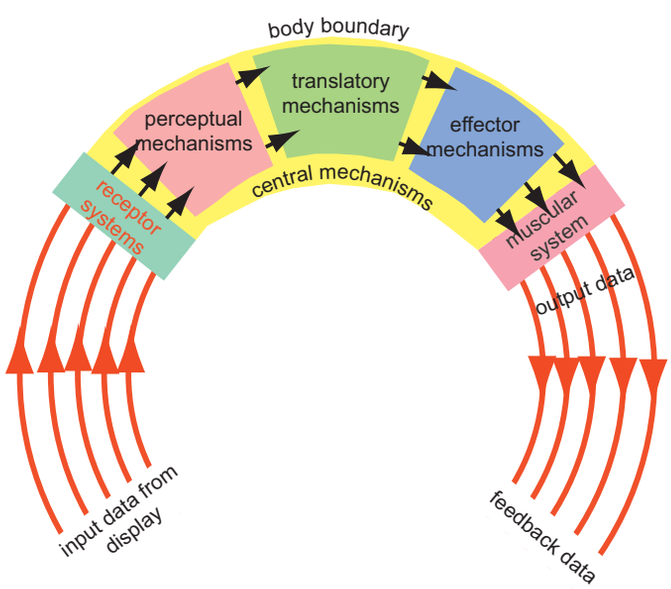


figure 92 – Whiting's model of information processing



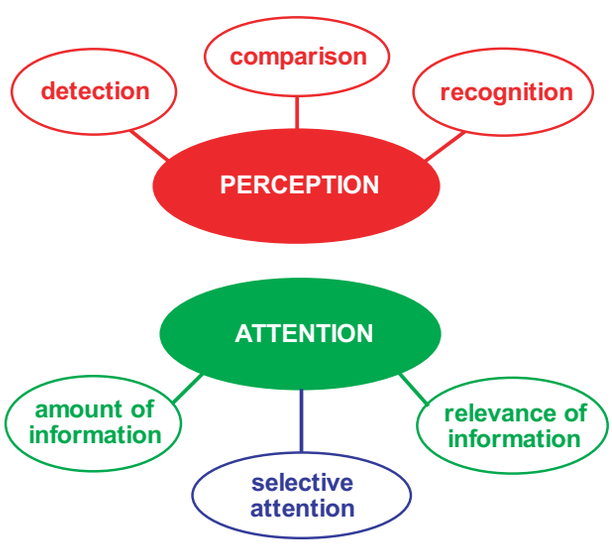
Whiting's model

- **Input data from display** involves information from the environment which enters the brain via the **sense organs**. For example, before catching a ball, the catcher sees the ball and is aware of the thrower's movement.
- **Receptor systems** refers to the **sense organs** which receive information.
- **Perceptual mechanism** is the part of the brain which perceives the surroundings and gives them meaning.
- The **translatory mechanism** consists of the part of the brain which makes decisions and sorts out and processes the few relevant bits of information from the many inputs from the surroundings.
- The **effector mechanism** is the part of the brain which carries out the decisions and sends messages to the limbs and parts of the body via the nervous system.
- **Output** involves the effector mechanism and muscle movement. The nerves send messages to the muscles which move in order for the ball to be caught.
- **Feedback** is **information** which is used **during and after** an action or movement which enables a performer to adjust or change performance according to this new information.

Perception and attention

These elements are ideas which should be understood before concepts relating to memory can be explored – see figure 93.

figure 93 – perception and attention



Perception

Perception is described in the jargon as **stimulus identification**. As information is received from the environment, the performer needs to **make sense** of it, to **interpret** it and to **identify** the elements which are **relevant** and **important**. Perception consists of three elements:

- **Detection** - the performer needs to be aware that something notable is going on around him / her, where the ball is, where the other players are from both sides in relation to the pitch dimensions, what the goalkeeper is doing - in a field game situation.
- **Comparison** - in which the performer will compare what is happening with his / her past experiences of similar situations, where are the players in comparison with set plays rehearsed in a training situation?
- **Recognition** - in which the performer realises that what is happening requires a response or an activity in response, what is the response to the rehearsed set play?

Attention

Attention relates to:

- **Amount of information** we can cope with, since the amount of information we can attend to **is limited**, and therefore we have limited **attentional capacity**.
- **Relevance of the information**. The performer must therefore attend to only **relevant information**, and **disregard irrelevant** information. This is called **selective attention**.

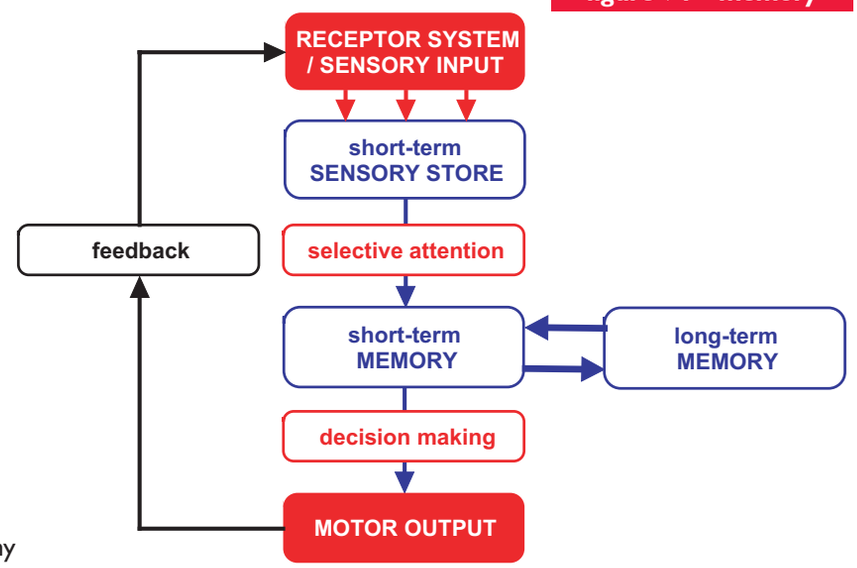
Selective attention

This is the process of sorting out **relevant** bits of information from the many which are received. Attention passes the information to the **short-term memory** which gives time for **conscious analysis**. A good performer can **focus totally** on an important aspect of his / her skill which **can exclude other elements** which may also be desirable. Sometimes a performer may desire to concentrate on several different things at once.

When some parts of a performance become **automatic**, the information relevant to those parts does not require attention, and this gives the performer **spare attentional capacity**. This allows the performer to attend to new elements of a skill such as tactics or anticipating the moves of an opponent. The coach will therefore need to help the performer to make best use of spare attentional capacity, and will also need to **direct the attention** of the performer to enable him / her to **concentrate** and reduce the chance of **attentional switching** to irrelevant information or distractions.

Memory and its role in developing movement skills

figure 94 – memory



The term memory describes the functions of the brain which enables a person to **recall** information about past events. Memory can be broken down into the following stages (see figure 94):

- **Short-term sensory storage (STSS)** is the **area of the brain** which receives information and holds it for a **short time** (less than 1 second) **prior to processing**. Information deemed unimportant is lost and forgotten and replaced by new information.
- **Selective attention** is used to sort out **relevant bits of information** from the many which are received.
- **Short-term memory (STM)** is the **part of the brain** which keeps information for a short period (20 - 30 seconds) after it has been deemed **worthy of attention**. The STM can carry between 5 and 9 separate items of information which can be improved by chunking. The information can be used for problem solving (**decision making** in which it is decided what to do) or passed on to the long-term memory for permanent storage.
- **Long-term memory** is the **part of the brain** which retains information for **long periods of time** - up to the lifetime of the performer. Very **well-learned information** is stored, and LTM is **limitless** and not forgotten but may require a code for the information to be recalled.

Strategies for improving retention

Retention of information and facts in the memory can be improved by (see figure 95):

figure 95 – retention

Knowing how:

- **Educate** the performer about the details of a skill.
- **Explain** what to do and how to do it.

Brevity:

- Be **brief**.
- Do **not overload** the short-term memory which can only hold small amounts of data.

Clarity:

- Keep advice / instruction **simple** and **clear.**
- **KISS** - keep it simple stupid.
- Carefully **separate** similar skills to enable the performer to distinguish between them.

Chunking:

- More information can be held in STM if information is **lumped together** (this is called chunking).

Organisation:

- Organise the process of learning to ensure the information is **meaningful**.

Chaining or association:

- **Link new** information **with old** already learnt information.
- Multiple links can form a chain.

Practice:

- **Practice makes perfect**.
- Perfect practice makes a skill perfect.
- **Repetition** of any information or skill will enable it to be remembered.

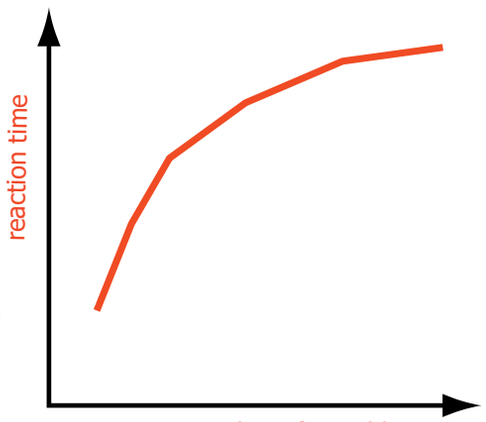
Reaction time and developing effective performance in physical activity

Reaction time

- **Reaction time (RT)** is the time between the **onset** of a stimulus and the **start** of the response. This is an **inherent ability** or trait. The stimulus could be kinaesthesia, hearing, touch, vision, pain, or smell. From this list, the fastest reaction times occur to stimuli at the front of the list, the slowest to those at the end of the list.
- **Movement time** is the time it takes to **complete the onset** of a movement.
- **Response time** is the time it takes to **process information** and then to **make a response**. **Response time = reaction time + movement time.**

figure 96 – Hick's Law

showing increase in reaction time as number of stimuli increases



Choice reaction time

If **several stimuli** are given but only one must be selected for response, then a choice must be made of which stimulus to respond to. The **more choices** a person has, the **more information** needs processing, and the **longer it takes** to process the information, the **slower** the reaction time. This is **Hick's Law** (see figure 96).

Anticipation

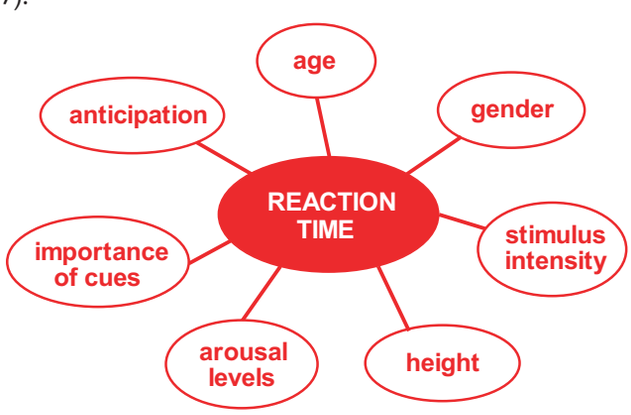
This is the ability to **predict** future events **from** early signals or **past events**.

Reaction time can be **speeded up** if the performer learns to anticipate certain actions. Good performers **start** running motor programmes **before the stimulus is fully recognised**, they anticipate the strength, speed and direction of a stimulus, which would enable a performer to partially eliminate the **PRP** (psychological refractory period – see below).

However, **opponents** will also be trying to anticipate the performer's own actions, and a good performer will attempt to **increase** opponents' reaction times by increasing the number of choices of stimulus they have. For example, increasing the number of fakes or dummies (Matt Dawson / Jason Robinson in Rugby).

Factors affecting reaction time

figure 97 – factors affecting reaction time



- **Age**, the older we get, the slower our reaction times (see figure 97).
- **Gender**, males have quicker reaction times than females, but reaction times reduce less with age for females.
- Increase in **stimulus intensity** will improve reaction time, a louder bang will initiate the go more quickly than a less loud bang.
- **Tall people** will have slower reactions than short people because of the greater distance the information has to travel from the performer's brain to the active muscles, short sprinters tend to win 60m races.
- **Arousal levels** affect reaction times. Arousal levels are best when the performer is alert but not over aroused.
- The performer must attend to the most **important cues** (which act as a stimulus).
- Factors like body language / position might give a cue which enables the performer to **anticipate** a stimulus by for example, identifying favourite strokes or positions, particularly if the play involves an attempted dummy or fake.

Improving response times

Response times can be improved using the following tactics (see figure 98):

- **Detecting the cue**, in which the **stimulus** (starter's gun) is sorted out from the **background** (spectator noise).
- **Detecting relevant cues**, in which the relevant stimulus is picked out from other possible ones.
- And **choice reaction time is reduced** by eliminating alternative choices.
- **Decision making**, in which performers work on **set pieces** in open skill situations so that an **'automatic'** complex response can be made to a simple open stimulus.

- **Change in attentional focus**, in which the performer practices **switches of concentration** quickly from one situation (for example, opponents in defence) to another (for example, field of play in attack).
- **Controlling anxiety**. Here, we know that anxiety would increase response times, so the performer would reduce anxiety by using **calming** strategies.
- **Creating optimum motivation**, in which the performer / team uses **psyching-up** strategies.
- **Warm-up** ensures that sense organs and nervous system are in their **optimum state** to transmit information and that the muscles are in an optimum state to act on it.

figure 98 – improving response times

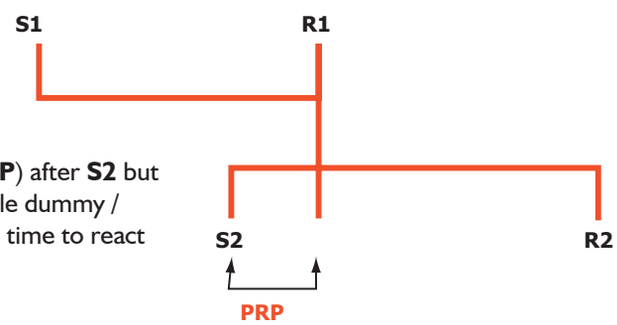
Psychological refractory period

The **psychological refractory period (PRP)** is about what happens when after an initial stimulus (which may cause a reaction) there is a presentation of a **second stimulus**. This has the effect of **slowing down** the processing of information causing a **time lag** (this is the **PRP**) between the relevant stimulus and an appropriate response. For example, selling a dummy in Rugby.

Example

Looking at figure 99, **S1** (1st stimulus) would be the dummy. **S2** (2nd stimulus) would be the definite move. If the dummy (**S1**) had been the only stimulus then the reaction would have been at time **R1**. In the meantime, **S2** has happened, but the performer cannot begin his / her response to this until the full reaction **R1** has been processed by the brain, so there is therefore a period of time (the **PRP**) after **S2** but before the time break to **R2** can begin. A person who can do a multiple dummy / shimmy (Matt Dawson / Jason Robinson) can leave opposition with no time to react and hence miss a tackle.

figure 99 – psychological refractory period



Single channel theory

This theory says that a performer can only attend to **one thing at a time**, so information is processed **sequentially**, that is one after another. Attentional switching would occur by **transferring attention** from one situation to another, so although attention would be **shared** between situations, only one situation would be attended to at a time (one then two then one then two …..). Therefore this can only be done if each situation requires **small** attentional capacity.

Practice questions

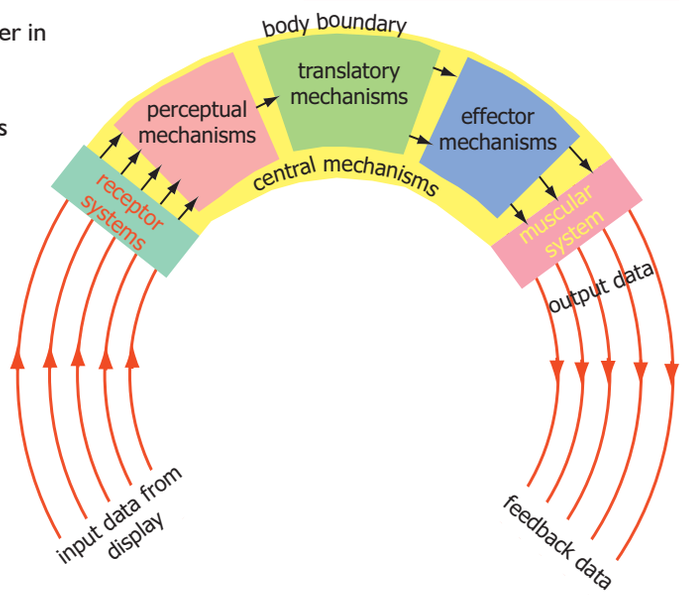
1) Identify the three main receptor systems used by a performer in sport.
Where is the filtering mechanism found in an information processing model? Explain what happens with information as it passes through this mechanism. 5 marks

2) a) Describe what is meant by the term feedback, and briefly describe three functions of feedback.5 marks

b) Where possible explain the kinds of feedback available to a performer which would be classified as:
i) intrinsic and internal, and ii) extrinsic and internal.
4 marks

3) Improvement in performance of a skill can be better understood by reference to the processes involved. Figure 100 shows Whiting's information processing model.

figure 100 – Whiting's model



3) a) Explain the meanings of the terms: perceptual mechanism, translatory mechanisms, and effector mechanisms, and relate these terms to stages in the Whiting model. 5 marks

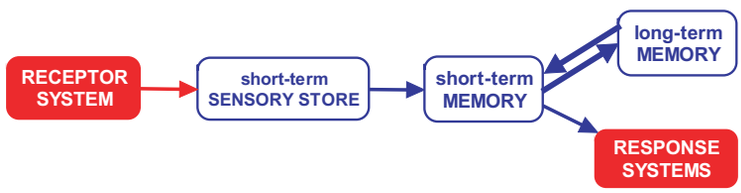
b) The diagram also shows five arrows entering the perceptual mechanism and only one leaving. What is the name given to this process and why is it necessary? 4 marks

c) Identify three factors which might help a performer with his / her perceptual mechanisms. 3 marks

4) a) Using figure 101 representing the human motor control mechanism, explain what is meant by short-term memory and long-term memory. 2 marks

b) How can information be retained in the long-term memory? 4 marks

figure 101 – human motor control mechanism



5) a) Using the example of a table tennis player receiving a serve, what information would be held in the short-term sensory store and for how long? 4 marks

b) Name and describe the purpose of the process by which information is transferred from the short-term sensory store to the short-term memory. 4 marks

6) a) Explain the difference between reaction time, movement time and response time? What advice would you give to a sprinter to cut down on reaction time at the start of a race? 4 marks

b) Sketch and label a graph to illustrate Hick's Law.
How does the number of choices available to a performer affect his / her performance? 4 marks

c) When taking part in a badminton game, the shuttle occasionally hits the netcord during a rally, and the receiver has to adjust his or her return shot. This causes a delay before the final response can be made. What is this delay called and explain why it occurs? 4 marks

d) What factors could affect response time in any game or sport? 4 marks