Higher Human Biology

Unit 3: Neurobiology and Communication

Course notes
The nervous system

The nervous system analyses sensory information from the body and the external environment. Some of this information is stored for possible future use. Appropriate voluntary and involuntary motor responses are made by initiating muscular contractions or glandular secretions.

Divisions of the nervous system

*Figure 1* below shows that the nervous system can be divided into two areas:

1. the central nervous system (CNS) and
2. the peripheral nervous system (PNS).

Sensory and Motor Pathways

The peripheral nervous system contains two pathways:

1. the sensory pathway consisting of sensory nerve cells (or neurons)
2. the motor pathway consisting of motor nerve cells (or neurons).

Sensory nerve cells carry nerve impulses to the CNS (i.e. to the brain or spinal
cord) from receptors. Some receptors are located in external sense organs e.g. the skin, eye etc, others are found in internal organs e.g. the pancreas which contains receptors which detect the level of glucose in our blood. The function of the sensory pathway is to keep the brain in touch with the body's external and internal environments.

The brain analyses, processes and stores some of this information. It's job is to then act on this information by sending nerve impulses via the motor pathway to the body's effectors (muscles or glands). An appropriate response is then occurs e.g. enzyme or hormone secretion or muscle contraction. See Figure 2 below.

![Figure 2  Flow of information through the nervous system](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/human/thennervoussystemact.shtml)

Further division of the nervous system
The peripheral nervous system can be divided into the:

1. **Somatic** nervous system (SNS)
2. **Autonomic** nervous system (ANS)

1. **Somatic nervous system**
This system controls the voluntary movement of the body's skeletal muscles i.e. regular body movements such as moving an arm picking up a pencil etc. So, this is a system we are in control of as it always involves conscious thought. This is achieved via sensory and motor pathways as outlined in Figure 2. However, the somatic nervous system is also responsible for certain reflex actions.

**Example of an event involving the somatic nervous system**
Imagine, for example for you are selecting four of your favourite chocolates from a large box of chocolates. The chocolates act as a visual
**stimulus.** Nerve impulses pass from the eye via *sensory* nerve cells to the *brain*. Decisions/choices are made and nerve impulses are then sent via *motor* nerve cells to the *skeletal muscles* of the arm and hand to allow the *voluntary response* needed to pick up the chocolates.

2. **Autonomic nervous system**

This part of the nervous system regulates the *internal* environment (*homeostasis*) by controlling structures and organs like the heart, bronchioles, and blood vessels. This control is *involuntary* because it normally *automatically* without the person consciously having to *think* about it – we *don’t notice* when our blood vessels change in size or when food is pushed through our digestive system.

The autonomic nervous system can itself be divided into two different parts (divisions):

1. **sympathetic** division
2. **parasympathetic** division

These two divisions are described as being *antagonistic* to each other. Both divisions can affect many of the *same* structures but they have an *opposite* effect on them. This is shown in *Figure 3* below.

![Figure 3 Antagonistic nature of the sympathetic and parasympathetic divisions](image-url)
Note particularly, the antagonistic action of the sympathetic “fight or flight” as opposed to the parasympathetic “rest and digest” responses on heart rate, breathing rate, peristalsis and intestinal secretions.

Web site - up to 6.05min
http://www.youtube.com/watch?v=x4PPZCLnVkA

Parts of the Brain

The brain is organised into three interconnected layers:

- the central core
- the limbic system
- the cerebral cortex

The central core

The central core contains the:

1. **Medulla** that regulates the basic life processes of breathing, heart rate, arousal (the state of being awake and aware of our external environment) and sleep. These processes are involuntary and happen automatically.

2. **Cerebellum** which is responsible for controlling balance and posture and movement.

Parts of the Brain

1. medulla
2. cerebellum
The limbic system

The limbic system (see Figure 4 below) of the brain processes information for memories and influences how emotional (fearful, anxious, happy) and biologically motivated (thirsty, hungry) we are. This is the area of the brain where the hypothalamus is located. The hypothalamus is connected to the pituitary gland which it influences by regulating the hormones that this endocrine gland produces (see Figure 5 below). The hypothalamus therefore acts as a link between our nervous system and our endocrine (hormonal) system. The pituitary gland is also part of the limbic system and it helps to regulate homeostatic mechanisms such as the:

✓ contraction and relaxation of smooth, involuntary muscles (during vasoconstriction or vasodilation)
✓ body **temperature**
✓ **water** balance

![Limbic System Diagram](http://www.youtube.com/watch?v=ZfDX5khN54t)

**Figure 4** Limbic system of the human brain

**Figure 5** Position of the hypothalamus and pituitary gland in the limbic system
The cerebral cortex

The cerebral cortex is the outer layer of the cerebrum, and it is the centre of conscious thought. It also:

- receives sensory information (from receptors)
- co-ordinates voluntary movements
- makes decisions
- recalls memories
- alters our behaviour in the light of experience

The cerebrum is split by a deep cleft into two halves called the cerebral hemispheres. There are several distinct areas of these cerebral hemispheres. Figure 6 below shows some of these areas on left cerebral hemisphere - the right cerebral hemisphere is a mirror image of this. Each of these distinct areas performs a particular function.
The two main areas, are the sensory and motor areas. There are other areas that are associated (linked) with these two main areas that deal with:

- thought processes
- language
- personality
- imagination
- intelligence

The left cerebral hemisphere deals with information from the right visual field and controls the right side of the body. The right cerebral hemisphere deals with information from the left visual field and controls the left side of the body. Information is transferred through an area at the centre of the cerebrum called the corpus callosum which is shown in Figure 7 below.

![Corpus Callosum](image)

**Figure 7** Position of the corpus callosum in the brain

The corpus callosum is a large bunch of nerve fibres that link the two sides of the brain. Whatever happens on one side of the brain is quickly communicated to the other side via the corpus callosum.

The role of corpus callosum then, is to get the two halves of the brain to work together as an integrated whole.

Web site - up to 6.05min
http://www.youtube.com/watch?v=zx53Zj7EYQF
Perception
Perception is the process by which the brain analyses and then makes sense out of the sensory information we receive from our surroundings. Although many perceptual experiences depend on information from our sense organs other than our eyes, the following notes concentrate on visual perception. Visual perception allows us to:

1. segregate objects from one another and their background
2. recognise what different objects are
3. judge how near or far away (i.e. distance) objects are from us

1 Segregation of Objects
The first stage in the development of visual perception is the appreciation of an object's shape. Perception allows us to segregate objects from one another and their background.

Here the triangle appears to stand out from the background (a white circle) in an obvious manner. This form of perceptual organisation is called the "figure-ground" phenomenon. The part seen as the "figure" - in this example the triangle - stands out from (is segregated from) the white background - the "ground", even although they are printed on the same two-dimensional piece of paper. Sometimes we can switch between the two and this causes an alteration between the figure and the ground, and this is what happens when we view optical illusions.
The brain can also perceive shapes once the gap has been filled in - this is called “closure”. An example of closure is shown below in Figure 8.

2 Recognition

Shape is extremely important when recognising objects - more important than colour or texture.

Figure 9 above represents five different types of fruit based on their colour. It is not possible to identify the fruits based on their colour as the only visual cue. Figure 10 represents the same five fruits, but this time their shape is used as a visual cue. It is now possible to recognise the apple, banana, pear and orange. To recognise whether it is a lemon or a lime, colour would also be needed.

We use shape to characterise and differentiate objects from one another during early learning. This information is then stored in our long-term memory. The most important feature of an object's shape is its general outline.
“Perceptual set” is brought about by previous experience, and this can influence which sensory data we perceive or ignore. In an investigation, group A were shown pictures of small mammals including rodents. Group B were shown pictures of humans – some of whom were bald and wore glasses. Each group was then shown the ambiguous “ratman” diagram shown in Figure 11 below.

![Figure 11 “Ratman”]

Most people in group A perceived a mouse or a rat, whereas most people in group B perceived a man with a bald head wearing glasses.

3 Judging distance (or perception of distance)

The distance of one or more objects from the eye is indicated by the presence of one or more visual cues that can be seen. Visual cues include:

(i) the size of an object in relation to another - the further away an object is from the eye, the smaller it is perceived to be as shown by the sleepers on the railway line in Figure 12 below.

![Figure 12 Visual cues]

(ii) the height of an object in relation to another - again, the further away an object is from the eye, the smaller it is perceived to be as shown by the telegraph poles above.
(iii) **superimposition** - this is when one object partially blocks the view of another. The blocked object is perceived to be further away.

**Binocular disparity**

Each eye views an object from a slightly different **angle**. This means that there is a slight **difference** (disparity) between the **images** of the **same object** formed by the two eyes. The closer the object is to the viewer, the **greater** the disparity between the two images. When nerve impulses from the two eyes reach the **brain**, they are **superimposed** and processed into a **single** picture with depth. As a result, we get a 3D picture and are able to judge **distances** well.

**Perceptual constancy**

A person’s visual perception of their surroundings remains the same (shape, and size) no matter how far away or close an object is. Size constancy is thought to depend, in part, on **past experience** and **stored knowledge**, and, in part, on the cue of **relative size**. Imagine that you move towards a shelf to fetch a knife from a knife block. The image of the knife in the eye becomes bigger the nearer you get to it. However, the image of the shelf and the knife block also get bigger, so the relative size of the various objects to one another doesn’t change.

**Memory**

Memory is the storage, retention and **retrieval** of information. This includes past experiences, **knowledge** and thoughts. Our memory enables us to deal with future situations in the light of past experiences. In the absence of memory, we would be unable to manage even the slightest task without having to relearn it first. All information entering the brain passes through **sensory memory** and then enters **short term** memory. Information is then passed to **long term** memory or it is discarded.

(i) **Sensory memory** (level 1)

Stimuli from our surroundings are perceived continuously as sensory images by the brain. Sensory memory (SM) lasts a few **seconds** (i.e. it is short-lived). Only a **few** are **selected** and **transferred** to level 2.

(ii) **Short term memory** (level 2)

Most of the information that is transferred into this second level of the system consists of visual and auditory images. However, our short term memory (STM) holds only a **limited** amount of information - about **seven**
items at any one time. Our STM therefore has a **limited capacity** and items are held for a very **short** time. However, during this time the **retrieval** of items is very **accurate**. After this, they are either transferred to level 3 or they are **lost** by **displacement** (pushing out old information by replacing it with new incoming information), or by **decay** (when a group of neurons briefly become activated, fragile “memory traces” that have form are broken down).

**Chunking**

STM can be **improved** by “**chunking**”. A “**chunk**” is a meaningful piece of information made from **several smaller** pieces. To most people who are familiar with the date of the Scottish Referendum on Independence in 2014, 2014 is one chunk of information and not four. However to most people 4021 is four chunks of information (unless it happens to be your PIN number!!!). Since our short term memory can only hold about **seven** items at one time, **chunking** is a useful method to help to increase this. We use chunking to help us to remember phone numbers.

<table>
<thead>
<tr>
<th>Code for Glasgow</th>
<th>Area Code</th>
<th>Private Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0141</td>
<td>629</td>
<td>3810</td>
</tr>
</tbody>
</table>

**Working memory**

Our working memory is an **extension** of our short-term memory. It processes, manipulates and controls information while it is held in the STM. This then allows us to perform **simple cognitive tasks**. For example, you have been asked to think about all the rooms in your house that have lamps in them and then calculate the total number of lamps. To do this, you form a mental image of your home and then do a visuo-spatial tour of each room. You then use your **working memory** to count the lamps, and then add this to a running total in your **STM**.

**Long term memory (LTM) - Level 3**

The **transfer** of information from our STM to our LTM is due to **rehearsal**. Rehearsal is when you **repeat** something that you are trying to **memorise** over and over to yourself. This process helps to **lengthen the time** we **retain** this information in our STM. In many cases, rehearsal then allows information to become **encoded** and **transferred** to our LTM from where it can be retrieved at a later date.
During encoding, information is organised into categories such as personal information and problem solving skills. Information is encoded in our STM either by:

- repetition - referred to as shallow encoding or
- linking it with previous memories - referred to as elaborative encoding

It is thought that our long-term memory is able to hold an unlimited amount of information which is stored for a long time, perhaps even permanently. The transfer of information between our STM and LTM is summarised below in Figure 13.

This model is an oversimplification of how our memory works. The three levels of memory should not be thought of as occupying three distinct regions of the brain.
**Location of memory in the brain**

Several different types of memory exist within our LTM. What they are concerned with and their locations in the brain, are summarised in the table below.

<table>
<thead>
<tr>
<th>Type of memory</th>
<th>Concerned with</th>
<th>Possible location in the brain</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>episodic</em></td>
<td>remembering events and experiences</td>
<td>region of cerebral cortex where the sensory information was first received and encoded</td>
</tr>
<tr>
<td><em>semantic</em></td>
<td>remembering facts and concepts</td>
<td></td>
</tr>
<tr>
<td><em>procedural</em></td>
<td>remembering skills (e.g. how to ride a bicycle)</td>
<td><em>motor</em> region of cerebral cortex</td>
</tr>
<tr>
<td><em>emotional</em></td>
<td>remembering positive or negative associations with certain stimuli</td>
<td>links between limbic system and cerebral cortex</td>
</tr>
<tr>
<td><em>spatial</em></td>
<td>remembering where things are placed in relation to other things</td>
<td>limbic system</td>
</tr>
</tbody>
</table>

**The cells of the nervous system**

*Neurons* are specialised cells that receive and transmit *electrical* impulses. There are three types of neuron:

1. *sensory* neurons
2. *inter* neurons
3. *motor* neurons

See *Figure 14* below.
Every neuron has dendrites, a cell body and axons. The axons are surrounded by a myelin sheath. The myelin sheath insulates the axon and increases the speed at which an electrical impulse travels through the axon from node to node.

![Structure of a Typical Neuron](image)

*Figure 15  Structure of a neuron*

*Figure 15* above, shows the structure of a typical neuron. Myelination, which is the production of the myelin sheath, continues from birth to adolescence. As a result of this, responses to stimuli in the first two years of life, are not as rapid or as co-ordinated as those of an older child or adult. Certain diseases destroy the myelin sheath (e.g. multiple sclerosis) and this results in a loss of coordination.

Web site  
[http://www.youtube.com/watch?v=cUL6uWh2UeMk](http://www.youtube.com/watch?v=cUL6uWh2UeMk)

Web site  
[http://www.youtube.com/watch?v=VIoDr8ugbqI](http://www.youtube.com/watch?v=VIoDr8ugbqI)

**Glial cells**

Glial cells physically support and maintain interconnecting neurons, but they do not transmit electrical impulses. They help to maintain a homeostatic environment around the neurons by controlling the chemical composition of the fluid surrounding the neurons. Glial cells also remove any debris by phagocytosis. *Figure 16* on the next page shows how a glial cell connects neurons. Finally these cells are involved in myelination - the production of new myelin when the myelin sheath of a neuron is damaged by toxic substances.
Neurotransmitters

A gap called a synapse exists between two inter-connecting neurons as shown in Figure 17 below. This “gap” is called a synaptic cleft.
Chemical messengers called neurotransmitters are released at the axon of one neuron, then the pass across the synaptic cleft and trigger an electrical impulse in the dendrite of the next neuron in the pathway. This is how messages are relayed from neuron to neuron both within and out with the brain and how neurons therefore connect with other neurons, muscle fibres and endocrine glands.

As the diagram on the previous page shows, neurotransmitters are stored in vesicles. They are then released into the synaptic cleft on the arrival of an electrical impulse. The neurotransmitters then diffuse across the synaptic cleft and bind to receptor sites on the dendrites on the next neuron in the pathway. There are many different receptors and it is the receptor that determines whether or not the signal is excitatory or inhibitory.

An example of a neurotransmitter is acetylcholine. This chemical can have both an excitatory or inhibitory effect. If acetylcholine is released into the synaptic cleft between a motor neuron and a skeletal muscle cell it makes the cell contract - this is an example of an excitatory signal. However, if acetylcholine is released into the synaptic cleft between a motor neuron and a heart muscle cell it reduces the rate and strength of contraction of this cell - this is an example of an inhibitory signal.

Neurotransmitters must be removed from the synaptic cleft in order to prevent continuous stimulation of post synaptic neurons. Neurotransmitters are removed by enzymes and then re-uptake occurs. (The enzyme breaks down the neurotransmitter into non-active products which are then reabsorbed by the presynaptic neuron. These non-active products are then used to resynthesise the active form of the neurotransmitter again. The neurotransmitter is then stored in a vesicle for re-use).

Filtering out weak stimuli

An impulse can only be transmitted across a synapse and then on through the post-synaptic neuron when a certain minimum number of neurotransmitter molecules have been released. A postsynaptic cell may receive information from several neighbouring neurons. Synapses are able to filter out weak stimuli that arise from insufficient secretions of neurotransmitters. In this instance, the synapse acts as an unbridgeable gap. However, many weak stimuli can trigger
enough neurotransmitter molecules to be secreted from many presynaptic neurons **simultaneously** or in **rapid succession**, and this is enough to fire off an electrical impulse.

This series of weak stimuli which can trigger enough neurotransmitter to fire off an impulse is called **summation**.

**Types of neural pathways**

Neurons are found to be connected to one another in many different ways in the CNS. This allows many complicated interactions to occur between them, and thus allows the nervous system to carry out its many complex functions. The following notes are on these different neural pathways.

a) **Converging neural pathways**

*Converge:* to come together and meet at a common point

In a convergent neural pathway, impulses from **several sources** are channelled towards, and then meet at a common destination as shown in **Figure 18** below.

![Neural convergence](image)

*Figure 18*  Converging neural pathway

This brings about a **high concentration** of excitatory or inhibitory signals at a **common** neuron (labelled 4 in the above diagram) and this helps to **increase their sensitivity** to these signals.

b) **Diverging neural pathways**

*Diverge:* to branch out from common point

In a divergent neural pathway, the route along which an impulse is travelling **divides**. This type of pathway therefore influences **several neurons** at the same time. This is shown by **Figure 19** on the next page.
c) **Reverberating neural pathways**

Reverberation: a sound that occurs repeatedly

In a reverberating neural pathway, neurons later on in the pathway have axon branches that form **synapses** with neurons that occur **earlier** in the pathway. This arrangement enables nerve impulses to be **recycled** and so the **presynaptic** neurons are repeatedly stimulated. This is shown in *Figure 20* below.

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**Development of new neural pathways**

New neural pathways can be developed to create new responses, bypass areas of brain **damage**, or suppress reflexes or responses to sensory impulses. This remarkable ability of brain cells to become altered as a result of new
environmental experiences is called **plasticity of response**.

**Neurotransmitters, mood and behaviour.**

1. **Endorphins**

   Endorphins are **neurotransmitters** that **stimulate** neurons that are involved in **reducing pain intensity** - in other words, endorphins are our natural pain killers. They work by combining with **receptors at synapses** and so **block** the transmission of pain signals. The **level of endorphin secretion increases** in response to:
   - severe **injury**
   - prolonged and continuous **exercise**
   - **stress**
   - certain foods (e.g. **chocolate**)

   *Increased levels* of endorphins are also connected with feelings of **euphoria**, regulation of **appetite** and the release of **sex hormones**.

   Web site
   [http://www.youtube.com/watch?v=T6pE1OPD02c](http://www.youtube.com/watch?v=T6pE1OPD02c)

2. **Dopamine and the reward pathway**

   Dopamine, which is produced in several regions of the brain, is also a **neurotransmitter**. Neurons which secrete or respond to dopamine are involved in the reward pathway. This pathway is activated when we are involved in **beneficial** behaviours linked with **survival**, such as eating when we are **hungry**, or drinking when we are **thirsty**. Dopamine induces the feeling of **pleasure** and it also **reinforces** particular **behaviours**.

   Web site
   [http://www.youtube.com/watch?v=kVoYpiiy7jg](http://www.youtube.com/watch?v=kVoYpiiy7jg)

**Neurotransmitter related disorders and their treatment**

Many drugs used to treat neurotransmitter related disorders are very similar to the neurotransmitters themselves.

**Agonists** are chemicals (drugs) that **bind to and stimulate specific receptors** on the membrane of **postsynaptic** neurons in a neural pathway. They therefore **mimic** a neurotransmitter. When agonists bind to these specific receptors, they
block the action of the naturally occurring neurotransmitter, but agonists still trigger the normal cellular response that would have been brought about by the neurotransmitter. See Figure 21.

**Antagonists** are chemicals (drugs) that bind to and then block specific receptors on the membrane of postsynaptic neurons in a neural pathway. By blocking the receptor sites, an antagonist prevents the normal neurotransmitter from acting on them. This results in the normal transmission of nerve impulses in that neural pathway being greatly reduced or even brought to a halt. See Figure 21.

![Image of agonistic and antagonistic drugs on neural receptors]

Other drugs can disrupt a neural pathway because they inhibit the enzymes that degrade (break down) neurotransmitters into non-active products or they inhibit re-uptake. In other words they prevent the removal of neurotransmitters from the synaptic cleft.

**Mode of action of recreational drugs**

Many recreational drugs affect the transmission of nerve impulses in the reward pathway of the brain, and, in turn, this then affects a person’s state of consciousness. This is because these drugs alter a person’s neurochemistry, which can lead to changes in:

- **mood** the person might feel happier, more confident, depressed, aggressive etc
- **cognitive thinking** the person is unable to carry out complex mental tasks such as making decisions or solving problems
- **perception** the person misinterprets environmental stimuli. Sounds, colours and /or a sense of time seem altered
- **behaviour** the person is able to stay awake for longer and can talk endlessly about themself

Web site
http://www.youtube.com/watch?v=XVYyQeOIV3U
Recreational drugs interact with neurotransmitters in different ways. They can either:

- **stimulate** the release of a neurotransmitter
- **initiate** the action of a neurotransmitter by acting as an **agonist**
- prevent (block) a neurotransmitter from binding to receptors by acting as an **antagonist**
- **inhibit** the **degradation** (breakdown) of a neurotransmitter by an **enzyme**
- **inhibit** the **re-uptake** of neurotransmitters from a synaptic **cleft**

**Drug addiction and tolerance**

**Drug addiction:** a chronic disease that causes the sufferer to **compulsively** seek out and use the drug regardless of the consequences.

**Drug tolerance:** (or desensitisation)

Drug tolerance is said to have built up when a user's reaction to an additive drug is found to have **decreased** in **intensity** compared to previous times, even although the **concentration** of the drug has remained **unaltered**. (In these circumstances, a **larger** dose will be required to bring about the original effect.)

**Drug desensitisation and sensitisation**

**Drug desensitisation**

Desensitisation is due to the **repeated** use of a drug. Repeated use of a drug that acts as an **agonist**, results in certain **neuroreceptors** (e.g. those that promote the release of the neurotransmitter dopamine) being repeatedly **stimulated**. This then causes **heightened feelings** of well-being or **euphoria** in the drug-taker.

The nervous system however, compensates for the **overstimulation** of these receptors, by **reducing** the number of these receptors. However, the **remaining** receptors then become **less sensitive** to the agonist drug. This leads to drug **tolerance** (also called desensitisation) because a **larger dose** of the drug will now be required to **stimulate** the **reduced number** of these **less sensitive receptors** as shown in **Figure 22** opposite.

Web site

[http://www.youtube.com/watch?v=5f1nmqiHIII](http://www.youtube.com/watch?v=5f1nmqiHIII)

Figure 22  Desensitisation
Drug sensitisation

Repeated use of a drug that acts as an antagonist, blocks certain neuroreceptors and so prevents the normal neurotransmitter from acting on these receptors. The nervous system compensates for the reduced stimulation of these receptors by increasing the number of receptors. In addition, the receptors become sensitive to the antagonistic drug. When the number and sensitivity of receptors is increased as a result of repeated exposure to a drug acting as an antagonist, this is called sensitisation. This can result in excessive drug-craving and ultimately drug addiction.

Web site
http://www.youtube.com/watch?v=ukFjH9odsXw
Communication and social behaviour

The effect of infant attachment

Humans are social animals. This is because the vast majority of humans prefer not to lead a solitary existence. To operate successfully, members of a community must be able to communicate with each. Communication can be verbal, written or non-verbal (e.g. body language and facial expressions). Communication between human beings at birth and continues throughout life.

Web site
http://www.youtube.com/watch?v=KC73tDpHQA

Infant attachment

Early infant attachment, usually with a mother or other primary carer, is very important for a child to be able to develop stable relationships in the future. The tie that binds a baby to the carer is called infant attachment and this becomes evident between 6 and 9 months.

The first infant attachment is indiscriminate as far as the baby is concerned, but as the months go by, the baby is only interested in selected people.

The “strange situation”

The “strange situation” is a research tool that has been devised to investigate infant attachment. This tool is used by experts to determine if a child is demonstrating secure or insecure attachment to their primary carer. The “stange situation” allows a hidden observer to study the behaviour of a baby:

- with the mother/primary carer
- with a stranger
- alone

Secure attachments

Signs of a child having secure attachments include:

- the infant plays with toys and investigates freely when the mother/primary carer is present
- the infant displays major distress when the mother leaves them
- the infant goes to it’s mother immediately for comfort when she returns and then calms down quickly
- the infant is more attached to it’s mother than to a stranger
The more secure the attachment of an infant to their mother/primary carer the more likely they are to investigate their immediate environment since they feel safe to do so. This, in turn, gives them an opportunity to learn and develop their cognitive abilities. A securely attached infant is more likely to benefit from these opportunities than one that is insecurely attached.

**Insecure attachments**

*Signs* of a child having insecure attachments include:
- the infant does not play with toys or investigate freely even when the mother/primary carer is present
- the infant displays indifferent, or mild distress when the mother leaves them
- the infant resists comfort from a stranger in the absence of it's mother
- the infant displays inconsistent behaviour e.g. wanting and resisting comfort at the same time after the mother returns
- the infant may show signs of anger or try to hit the mother after she returns.

Humans depend on adults for a long period of their life. This provides time for socialisation and learning to occur and for social competence to develop. Social competence is necessary if interaction with other people is to be successful.

**Methods of control**

The method of control adopted by parents (and other influential adults in their life) affects a child's social competence. There are three main methods of control:

1. **Authoritative** ("unreasonably strict")
   - Reasons for rules are never explained. The child is expected to obey without question. Little or no warmth is demonstrated towards the child.

2. **Authoritative** ("demanding but responsive")
   - Warm, nurturing and emotionally supportive towards the child. Reasons for rules are explained. Gives direction and expects responsible behaviour and explains what the consequences of unacceptable behaviour will be. Respectful of the child.

3. **Permissive** (excessively lenient)
   - Warm, and nurturing towards the child. Responds to child's needs and wishes. Limits are not set, rules are not laid down. Responsibilities are not assigned. Adopts a “no discipline” approach and doesn't try to keep the child under control. Allows the child to regulate their own behaviour.
The effect of communication

1. **Non-verbal communication**
   
   Non-verbal communication is sending or receiving *wordless* messages, and it plays an important role in forming relationships. On some occasions, it can be used to *reinforce verbal* messages or it can be used to add to information that is being transmitted verbally. Non-verbal communication can signal attitudes and emotions. Facial *expressions* and *hand* signals are examples of non-verbal communication.

   Web site
   http://www.youtube.com/watch?v=9cX6VaIy2yA

2. **Verbal communication**
   
   Language combines basic sounds into *spoken words*. These words are then represented by *written symbols* like those shown in *Figure 23* below.

   ![Figure 23 Language as written symbols](http://www.youtube.com/watch?v=29Woge-u9re&list=UUaL7wQ4RJGp9NMdUwJf7oth&index=7)

   These sounds and symbols represent information that can be arranged into simple *categories* (words) and more complex *hierarchies* (phrases, sentences and *paragraphs*). The fact that humans are able to *communicate* verbally has resulted in the sharing and transmission of knowledge, the development of cultures and social evolution. Language therefore helps to accelerate learning and *intellectual* development.

   Language makes much of our behaviour *unique* and it sets us apart from other animals.

The effect of experience on the learning process

Learning is defined as a *permanent* change in behaviour that occurs as a direct result of *experience*.

1. **Practising**
   
   Practising by *repeatedly* using the same motor skills results in a *motor pathway* being established. Hence the saying “practice makes perfect”, e.g. riding a bicycle, playing the piano. Practice also improves performance, and lack of practice results in the skill becoming “rusty”.

   Web site
   http://www.youtube.com/watch?v=29Woge-u9re
   Web site
   http://www.youtube.com/watch?v=BlzlLq765Q
Results from a finger maze investigation can be recorded and then displayed as a **learning curve** graph like the one shown on *Figure 24* below.

![Learning curve of typical set of results](image)

*Figure 24  Learning curve of typical set of results*

2. **Imitating**
   A great deal of human behaviour is learned by **observing** and **imitating** the behaviour of others.

![Imitating](image)

Web sites
http://www.youtube.com/watch?v=t_Me5znI0NY
http://www.youtube.com/watch?v=orxqu_NSw6A

3. **Trial and error**
   Trial and error is a learning tool that is used to solve **problems** by doing something over and over again until we get it right. This means that we learn trying, but if our try is an **error**, we learn something too. This type of learning can be demonstrated using a rat.

   A rat is put into a specially designed box as shown in *Figure 25* on the following page. It explores the box, touches the floor and leans against
the sides of the box. At some point, the rat pushes the lever and food immediately appears in the food tray.

![Figure 25 Trial and error learning in rats](image)

If the rat is only **rewarded** with food when it presses the lever. It soon learns to **link** pressing the lever with the delivery of food (it's **reward**). This is why teachers use **rewards** a learning strategy.

Web site
http://www.youtube.com/watch?v=kzNIV0mTROU

4. **Motivation**

Motivation is the **desire** that we have in us that makes us **want** to participate in the learning process. Animals, including humans, are motivated by many factors such as thisrt, **hunger** and curiosity. Scientists have investigated the effect of **motivation** on an animal's ability to **learn** by **comparing** how well **hungry** and **well-fed** rats can negotiate a **maze** as shown below in **Figure 26**. They are then given food as a **reward** at the end of the maze.

![Figure 26 Maze used to research the effect of motivation on learning](image)
Below is a set of results using such a maze with a hungry and well fed rat.

<table>
<thead>
<tr>
<th>Trial number</th>
<th>Average number of errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>well fed rat</td>
</tr>
<tr>
<td>1</td>
<td>135</td>
</tr>
<tr>
<td>2</td>
<td>145</td>
</tr>
<tr>
<td>3</td>
<td>135</td>
</tr>
<tr>
<td>4</td>
<td>145</td>
</tr>
<tr>
<td>5</td>
<td>130</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>7</td>
<td>135</td>
</tr>
<tr>
<td>8</td>
<td>140</td>
</tr>
<tr>
<td>9</td>
<td>125</td>
</tr>
<tr>
<td>10</td>
<td>120</td>
</tr>
<tr>
<td>11</td>
<td>130</td>
</tr>
</tbody>
</table>

The reliability of the results of the above experiment could be improved by using many hungry or well fed rats rather than just one of each. The fact that many trials were done however with each rats helps to make the results more reliable.
5. **Reinforcement of behaviour**

When behaviour is repeated and the behaviour is rewarded, it becomes **reinforced**. Reinforcement is a consequence that will **strengthen** an organism’s future behaviour as it tends to make an organism **repeat** a certain piece of behaviour. During reinforcement, the **reinforcer** (such as a **reward** or praise) **increases** the **probability** of the response being **repeated**.

**Shaping** is the rewarding of behaviour that **approximates** to the desired behaviour.

Web sites
http://www.youtube.com/watch?v=Nd6rUQzMA2o  http://www.youtube.com/watch?v=q6gE4z4yIzU

If behaviour patterns are **not rewarded**, they are likely to **disappear**. This is called **extinction**.

6. **Generalisation and discrimination**

**Generalisation** is the tendency to respond to stimuli which are **similar**.

For example a child who has been bitten by a large dog will then be afraid of **all** dogs - this is called **generalisation**. However, the same child might fear **large** dogs only - this is called **discrimination**. So, discrimination allows the learner to **distinguish** between different but **related** stimuli. **Learning** to discriminate is essential for a child to prepare itself to cope with everyday life.
Social influence

1. Social groups

Humans are social animals which means that we prefer to interact (socialise) with other people rather than being on our own.

A  Social facilitation

Many people are motivated by their need for status. Many people feel the need to be admired and impress other people in their social group. Given this, perhaps the presence of other people can affect an individual's performance. Research has shown that people work at a faster rate and achieve more when they are placed in competitive situations. This increased performance in the presence of others (especially if it is competitive) is called social facilitation.

B  Deindividuation

Group pressure is a powerful force. People find it difficult not to participate in the actions of their social group and sometimes end up behaving in a manner which is out of character. This loss of personal identity in a group tends to lead to diminished restraints on behaviour. This is called deindividuation.

Web site – start at 2.05min
http://www.youtube.com/watch?v=OFsO0b97e9g4

Deindividuation is often used to explain the anti-social behaviour of some groups which would not be demonstrated by individuals from these groups if they were on their own. Once under group pressure, individuals think and act differently. This often takes the form of an anti-social mob, the members of which have temporarily lost awareness of their own individuality and responsibilities.

Influences that change beliefs

1. Inernalisation

As a result of persuasion, an individual might change their beliefs about
something. This is called **internalisation**. Supermarkets and **politicians** and try to effect internalisation. Politicians tried to persuade the people to vote “yes” or “no” in the Scottish referendum campaign in 2104. Some of the debates, speeches, posters and newspaper resulted in people being **persuaded** to vote one way or the other.

Web site
http://www.youtube.com/watch?v=9_heYiAIaTI

**Identification**

If a person changes their beliefs just to be like someone else, this process is called **identification**. The person that they want to identify with is someone they either **admire** or they are **influenced** by. This is why “celebrities” are used to endorse products in TV adverts.

Web site
http://www.youtube.com/watch?v=qLTQJKIyraQ
http://www.youtube.com/watch?v=rVL7wAcZ3wY
http://www.youtube.com/watch?v=N0pYvC3ajDk
Slabs on ground
http://www.youtube.com/watch?v=z9Sen1HTu5o

Scientific method
http://www.youtube.com/watch?v=wlb7tLJy5AI

Chemical reactions
http://www.youtube.com/watch?v=EWOwAu7XWJs

http://www.youtube.com/watch?v=kr7dGPOwzsA