Psychology Factsheets

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Neurotransmitters

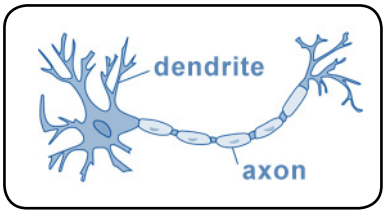
This Factsheet is about **neurotransmitters** and the influence they have on emotion and behaviour. The Factsheet includes exam hints and examiner comments which will support your learning. The worksheet gives you the opportunity to apply what you have learned to exam style questions using information contained in this Factsheet. Words in bold are explained in the glossary.

The examiner will expect you to be able to:

- Understand the function of neurotransmitters.
- Explain the influence of specific neurotransmitters on emotion and behaviour.
- Draw on research evidence to support your understanding of how neurotransmitters influence emotion and behaviour.

Introduction

Before the introduction of electrical telegraphy, people sent messages via smoke, light and semaphore. Later, telegraph poles became a common sight following the introduction of the electrical telegraph in the early 19th century. Theses (now outdated) systems of communication transmitted signals from one location to another and translated them into messages. In the 20th century, radio telegraphy replaced electrical telegraphy and now, in the 21st century, we have a host of wireless technologies including electronic mail, text and instant messaging. The purpose of these systems is to transmit signals from one specific location to another. The human body has its own internal system for transmitting signals between specific locations. This system is called **neurotransmission**.



Neurotransmitters are the body's messengers. They are electrochemicals that carry signals from one specific nerve cell, or **neuron**, to another. Examples of neurotransmitters that you might have heard of are **dopamine** and **serotonin**. The release of neurotransmitters is stimulated by an electrical impulse called an **action potential**. When an electrical impulse travels through the body of a neuron it releases neurotransmitters. The neurotransmitters travel out of one neuron through the **axon** and cross into the gap, or **synapse,** in between neurons. The electrical impulse is picked up by receptors on the **dendrite** of a corresponding neuron. The axons and dendrites of specific neurons that communicate with one another fit together perfectly like a lock and a key. And just like a lock and key, a specific axon relates to a specific dendrite of a corresponding nerve cell.

When the neurotransmitter and receptor connect, a message is transmitted to either fire an action potential, which starts the process again, or to inhibit firing. This whole process is known as neurotransmission.

> ***Exam Hint:*** *Remember:* ***A*** *(Axons)* ***D*** *(Dendrites). Axons carry action potential* ***A****WAY from the cell body; Dendrites* ***D****ETECT the impulse in the corresponding nerve cell.*

Psychologists have discovered that neurotransmission plays an important role in behaviour, thought and emotion. The body's central nervous system responds to external stimuli from the environment as well as internal changes in the body. It responds by transmitting electrochemical messages in the form of specific neurotransmitters. Neurotransmission has been found to have an effect on mood, memory, mobility, sexual desire, sleep, appetite and mental health. This Factsheet will examine the effects of four specific neurotransmitters; **serotonin**, **dopamine**, **acetylcholine** and **GABA**.

> ***Exam Hint:*** *Top band candidates demonstrate a sound understanding of the role of physiological systems on emotion and behaviour.*

Serotonin

Serotonin is a neurotransmitter with a variety of functions including the regulation of mood, appetite, sleep and sexual desire (libido). Serotonin is released when we eat and has a role in reducing hunger and letting us know that we feel full. Higher levels of serotonin are released if we eat something that is irritating and/or potentially toxic to the digestive system, signalling us to stop eating it. The higher levels of serotonin also help us to expel what we have consumed more quickly, therefore reducing the potentially harmful effects of the substance.

Serotonin also plays a role in sexual libido. For example, decreased sexual desire can occur in people taking medications that raise serotonin levels, such as antidepressants, while libido may increase if serotonin is lowered, for example by the consumption of alcohol. Some psychologists believe that the effect of serotonin on libido can be explained in **evolutionary** terms. It makes sense, perhaps, that an individual who is low in mood and/or energy should conserve their limited energy for hunting and gathering rather than using it to procreate. The priority for our ancient ancestors would have been on survival first, reproduction second.

One of the more commonly known functions of serotonin is its effect on mood. Serotonin is known to increase feelings of happiness and decrease feelings of anxiety. Low levels of serotonin lead to low levels of arousal and lack of positive emotion, including symptoms of depression. People suffering from depression and anxiety may be

prescribed drug treatment such as **Selective Serotonin Reuptake Inhibitors (SSRIs),** which help to maintain the serotonin connection between nerve cells and therefore have a positive impact on mood. The success of SSRIs in the treatment of depression supports the role of serotonin as a mood regulator.

Kasamatsu and Hirai (1999) observed the effects of serotonin on mood and behaviour. They studied a group of Buddhist monks on a 72-hour fasting pilgrimage. Researchers took blood tests from the monks and found that serotonin levels spiked after around 48 hours resulting in visual hallucinations. The researchers concluded that sensory deprivation triggered the release of serotonin, which affected mood and arousal and altered the way that the monks experienced their environment.

Exam Hint: *The success of SSRIs in the treatment of depression can be used as supporting evidence for the role of the neurotransmitter serotonin in regulating mood.*

Dopamine

Dopamine is a neurotransmitter most often associated with pleasure. If we do something enjoyable, which varies from person to person but could include eating chocolate or going on a roller coaster, dopamine is released which enables us to experience pleasurable feelings. Because the pleasurable feelings stimulated by dopamine feel so good, we are stimulated to do the pleasurable thing again, i.e. eat more chocolate or have another go on the roller coaster. People with lower levels of dopamine seem to seek out activities that artificially increase dopamine levels. These people might be perceived as thrill-seekers. Research suggests that in some instances, low levels of dopamine can lead to addictive behaviour as individuals become dependent on activities that increase dopamine levels. Dopamine is low è the individual does something that increases dopamine levels è they experience pleasure è they like the pleasurable feeling è they repeat the dopamine-stimulating activity. The dopamine theory could explain addictions to drugs, alcohol, and even sex. Furthermore, addictive substances such as cocaine and amphetamines have been found to increase the release of dopamine in the brain, which stimulates the individual to take more of the substance and become addicted.

Exam Hint: *The terms positive/negative in relation to symptoms of schizophrenia do not denote value as in good/bad. Instead, positive (+) signifies the addition of characteristics not usually present while negative (-) signifies the absence of characteristics ordinarily desired.*

The neurotransmitter dopamine has also been implicated in psychotic conditions such as **schizophrenia**. The **dopamine hypothesis** is one explanation of symptoms such as paranoia, visual and auditory hallucinations and delusional thinking. These are referred to as *positive* symptoms, not because they are good, but because they refer to an *excess* of characteristics that would not ordinarily be present. *Negative* symptoms, on the other hand, refer to the *absence* of characteristics such as *lack* of emotion, *loss* of motivation and social withdrawal. Antipsychotic medication is effective in reducing the positive symptoms of schizophrenia. It works by antagonizing dopamine receptors in the brain. The effectiveness of antipsychotic medication therefore lends support to the dopamine hypothesis of schizophrenia and to the regulatory effect of dopamine.

Examiner Comment: *Many candidates present muddled reference to the dopamine hypothesis. While it is important to note the significance of dopamine in psychotic disorders, it is inaccurate to say that disturbed levels of the neurotransmitter cause conditions such as schizophrenia. The research does not support cause and effect.*

Acetylcholine

Acetylcholine (sometimes abbreviated to ACh) is a neurotransmitter with receptors situated widely throughout the body and brain. The effects of acetylcholine include decreased heart rate and increased production of saliva. Acetylcholine plays a major role in movement. When it is released, it causes a series of mechanical and chemical reactions that result in the contraction of muscles. When there is a lack of acetylcholine in the neuromuscular junction, the reaction stops and the muscle relaxes. A deficiency of acetylcholine can result in reduced mobility and/or motor dysfunction; high levels are associated with muscle tremors and convulsions.

Acetylcholine also has an effect on memory and learning. Disruption of acetylcholine impairs our ability to learn simple tasks and factual information. Disruption of acetylcholine to the hippocampus can result in forgetting. A deficiency of acetylcholine in certain regions of the brain has been associated with **Alzheimer's disease** which is a degenerative brain disorder characterized by the loss of social skills and dementia. Another neurotransmitter associated with Alzheimer's disease is **glutamate**; an **excitatory** neurotransmitter associated with memory and learning.

Acetylcholine comes from the chemical choline, which is a nutrient in foods such as eggs, seafood, and nuts. A deficiency of choline therefore affects the function of both mind and body.

Martinez and Kesner (1991) observed the effects of acetylcholine on behaviour in an experiment using rats. The animals were trained to navigate a maze in order to access food. They were then divided into three groups. The first group were injected with a chemical that blocked acetylcholine receptors. The second group were injected with a chemical that returned acetylcholine receptors to a resting state. The third group received no injections and were used as a control group. Findings showed that rats in group one were slower at navigating the maze and made more errors than rats in the other two groups. Rats in the second group were fastest and made fewer mistakes overall. Researchers concluded that acetylcholine played an important role in creating a memory of the maze. It could therefore be suggested that the neurotransmitter acetylcholine results in an increase in memory function and that lower levels of acetylcholine decrease memory functioning. A limitation of this, and any research using non-human animals, is the extent to which findings can be generalised to humans.

Exam Hint: *When citing research studies to support your answer, make sure your focus is on linking with the question. For example, in the example given here, it is not necessary to recall the specific names of the chemicals injected into the rats (method). It is more important to describe the findings and conclusions.*

Examiner Comment: *Examiners award marks for clarity and conciseness in essay answers. It is therefore good practice to 'bookend' your essay with a brief introductory paragraph, telling the examiner what you are going to include, as well as a brief conclusion to summarise your main points, as illustrated in this Factsheet.*

Gamma-Sminobutyric Acid (GABA)

GABA is a neurotransmitter widely located in the neurons of the brain's cortex. It has a role in motor function and vision and is indicated in conditions such as epilepsy and **Huntington's disease**, a degenerative condition that affects neurons in the brain and spinal cord that co-ordinate motor function. Drugs used to treat these conditions increase levels of GABA in the brain and therefore reduce symptoms, such as tremors and seizures. An important psychological function of GABA is its role in regulating anxiety. It is known as an **inhibitory** neurotransmitter because it inhibits the reactions of neurons that might have become overstimulated, as is the case in states of anxiety. The function of GABA, therefore, is to reduce over activity in the body's systems and restore a state of calm.

Evidence for the role of GABA comes from the effect of artificial stimulants, such as caffeine, which work by inhibiting its release so that the brain becomes stimulated. Conversely, medications such as **benzodiazepines** which are used to treat anxiety are effective because they enhance the effect of GABA by reducing neural activity.

Exam Hint: *The success of benzodiazepines in the treatment of anxiety can be used as supporting evidence for the role of the neurotransmitter GABA.*

Conclusion

Neurotransmitters are electrochemical messengers that transmit signals from one specific neuron to another. Research suggests that they have considerable influence on mood and behaviour, in both human and non-human animals. This supports the theory that both mood and behaviour have physiological origins. It is not accurate, however, to say that neurotransmitters *cause* specific moods or behaviours but that they *influence* mood and behaviour. Research highlights the interaction between physiological factors and environmental stimuli, supporting a correlational effect.

Neurotransmission is an effective way to communicate messages through the brain and body. Thus, neurotransmitters such as serotonin, dopamine, acetylcholine and GABA affect specific moods and behaviours.

Glossary

Acetylcholine: Neurotransmitter associated with mobility, memory and learning.

Action potential: Electrical impulse that stimulates the release of a neurotransmitter.

Alzheimer's disease: Degenerative brain disorder characterized by dementia and associated with a deficiency of acetylcholine.

Axon: Long projection of a neuron that conducts an action potential away from the cell body.

Benzodiazepines: Group of medication used to treat anxiety which enhance the natural effects of GABA.

Dendrite: Branches of a neuron that receive action potentials away from other cell bodies.

Dopamine: Neurotransmitter associated with pleasure and reward.

Dopamine hypothesis: A physiological explanation of schizophrenia.

Evolutionary: Explanations of behaviour suited to our ancestral environment.

Excitatory: Enhancing action, for example of the neurotransmitter glutamate which enhances nerve impulses in the neuron.

GABA: Inhibitory neurotransmitter associated with anxiety.

Glutamate: Excitatory neurotransmitter associated with memory and learning.

Huntington's disease: Degenerative neurological disorder characterized by tremors and associated with a deficiency of GABA.

Inhibitory: Reductive action, for example of the neurotransmitter GABA which reduces nerve impulses in the neuron.

Neuron: Nerve cell.

Neurotransmission: Process of sending electrochemical messages through the central nervous system.

Neurotransmitters: Chemical messengers that carry communication between neurons.

Schizophrenia: Psychotic disorder characterised by symptoms such as paranoia, hallucinations and delusions.

Selective Serotonin Reuptake Inhibitors (SSRIs): Drug therapy used in the treatment of depression and anxiety.

Serotonin: Neurotransmitter associated with mood, libido and appetite.

Synapse: The gap between two neurons.

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Worksheet: Neurotransmitters

Name: _____

1. Explain the effects of neurotransmission on human mood and behaviour.

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2. Outline one study that demonstrates the effect of neurotransmitters on human mood and behaviour.

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3. Discuss the suggestion that mood and behaviour have physiological origins.

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4. To what extent do neurotransmitters affect our mood and emotion?

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5. How can the success of drug treatments such as SSRIs, benzodiazepines and antipsychotics in the treatment of psychological disorders be used to support the role of neurotransmitters?

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