

Module: Biological Foundations of Mental Health

Week 5

Biological basis of learning, memory & cognition

Topic 1

Cerebral cortex and mental health – Part 1 of 3

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Lecture transcript

Slide 4

In previous topics, you have learned about the structure of the brain and the sensory and motor areas of the cortex. In this topic, we will look at the function of the association cortex and specifically the frontal lobes. You will learn about the high-order control functions that allow us to deal with new situations and the vital role of the frontal lobes in this behavioural and cognitive flexibility. We will also look at what happens when the frontal lobes are affected by acquired or developmental disorders.

Slide 5

The brain is traditionally divided into different areas. The cortex can be divided into primary sensory and motor areas, secondary sensorimotor areas, and association cortices. This topic will focus on the functions of the association cortex and the relevance of this part of the brain for understanding acquired, developmental, and psychiatric disorders.

The association cortex takes information from primary and secondary sensory and motor cortices as well as the brain stem and thalamus. It sends information to the cerebellum, basal ganglia, and hippocampus. And information also flows between the different association cortices.

Slide 6

We often think about information flowing from lower to higher-level areas in the brain-- for example, from primary visual cortex to regions where objects are recognised and named. However, information also flows top-down from higher-level areas to modulate activity in primary sensory cortex. In this way, our expectations from context or prior experience can influence how we interpret ambiguous stimuli.

This top-down influence is responsible for some interesting perceptual effects. For example, take a look at these blobs. Can you see anything meaningful in them? Now have a look at this picture. Here are those blobs again. Do you see what they are now? The blobs haven't changed, but the top-down information in your brain has. Now your knowledge from the picture helped you complete the perception of the blobs and see them as a face.

The association cortex integrates sensory and motor information to produce meaningful perception of the world around us. But it does more than this. It allows abstract representation and supports flexible behaviour.

Slide 7

The association cortex can be divided into three-- the posterior or parietal association area, the limbic or temporal association area, and the anterior or frontal association area. These association areas have different but interconnected functions. The posterior association area is important for attention and the convergence of sensory information. Here, the visual, auditory, and somatosensory information meets. The limbic association area is involved in forming long-term memories and emotional responses which will, in turn, affect how we behave. The anterior association area-- the frontal lobes, including the prefrontal cortex-- is vital for planning, decision making, and working memory.

The frontal association area is particularly important for mental health. Many psychiatric and neurodevelopmental conditions are believed to involve abnormal functioning of the frontal lobes, and especially the prefrontal cortex.

Slide 8

The frontal cortex plays a vital role in a set of higher-order cognitive processes termed executive functions. What are executive functions? This is a term that covers lots of different control functions that allow flexible behaviour. These include generating, planning, monitoring, switching, and inhibiting behaviour. All these are especially important when we are faced with novel situations or challenges.

Think about a time when you have had to cope with change-- for example, if you have a bathroom redecorated and maybe have a light switch where you used to have a pull cord. You might find you reach up automatically to where the light pull used to be. Your frontal lobes need to kick in to help you inhibit that now-irrelevant action. Let's take a closer look at some executive functions and how they are typically tested or measured.