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The Learning Brain

Lecture Overview

This lecture is intended to serve as an introduction to educational neuroscience and to illustrate *some* of the many ways in which brain and environment influence behaviour. Neuroscience is a multidisciplinary field studying the brain on spatial scales from the molecular to neural systems, and on temporal scales ranging from picoseconds to across a lifetime. Examples will be provided examining such spatial and temporal variability with regard to learning. This lecture is *not* intended to be prescriptive in the sense that there will be no suggestions made for how educational practice or policy might be altered or shaped in the future.

We begin by acknowledging that many attempts have been made in recent years to apply advances in our understanding of brain function to the field of education. We address some of the abundant brain myths, from the notion that we only use ten percent of our brain through to the mistaken idea that fewer than six to eight glasses of water a day may lead to brain shrinkage.

We then explore how the brain is related to learning from three angles: cognitive function and neural pathways, the neurobiological basis of memory formation, and the neurobiological consequences of stress and use of recreational drugs such as cannabis on learning. 'The glass brain' will be introduced and the complexity of the neural substrates of general intelligence (g-factor) and memory considered. We will outline the molecular mechanisms underlying associative memory in neural circuits, considering the role of glumatate and GABA in learning, together with the proposed role of sleep in synaptic functioning. The effects of stress and the neurochemical signalling enzyme protein kinase C on memory will be elucidated, and recent research examining the effects of skunk cannabis on brain regions involved in memory and cognition will be described.

The middle part of the lecture will address genes, environment and the learning brain. We define what a gene is, clarifying what genes do and don't do along the way (for the most part, they are probabilistic, not deterministic). We will think about the role of genes in brain structure, together with recent research investigating how genes may not just be linked to reading and mathematical ability, but to academic performance across GCSE subjects. To impress the idea that genes contribute to rather than completely determine such abilities, we will employ research showing that teaching method can affect brain regions and reading ability. We also consider epigenetics and the influence of learning, first, a musical instrument, and second, two or more languages on brain development and function.

In the final part of the lecture, we turn to neuroplasticity and changes in the brain across the lifespan. Illustrating the human connectome and its development, we focus on new research endeavours such as prenatal brain scanning of brain networks and the Developing Human Connectome Project. We track changes in the adolescent brain such as the development of structural connectivity and consider sex difference in brain structure and function. Finally,we provide examples of experience-dependent structural plasticity and the effect of cognitive training on the cognitive function of older adults.

We conclude with a brief acknowledgement of the challenges facing educational neuroscience together with the thoughts of leading researchers in the field.

Further Reading - Books

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