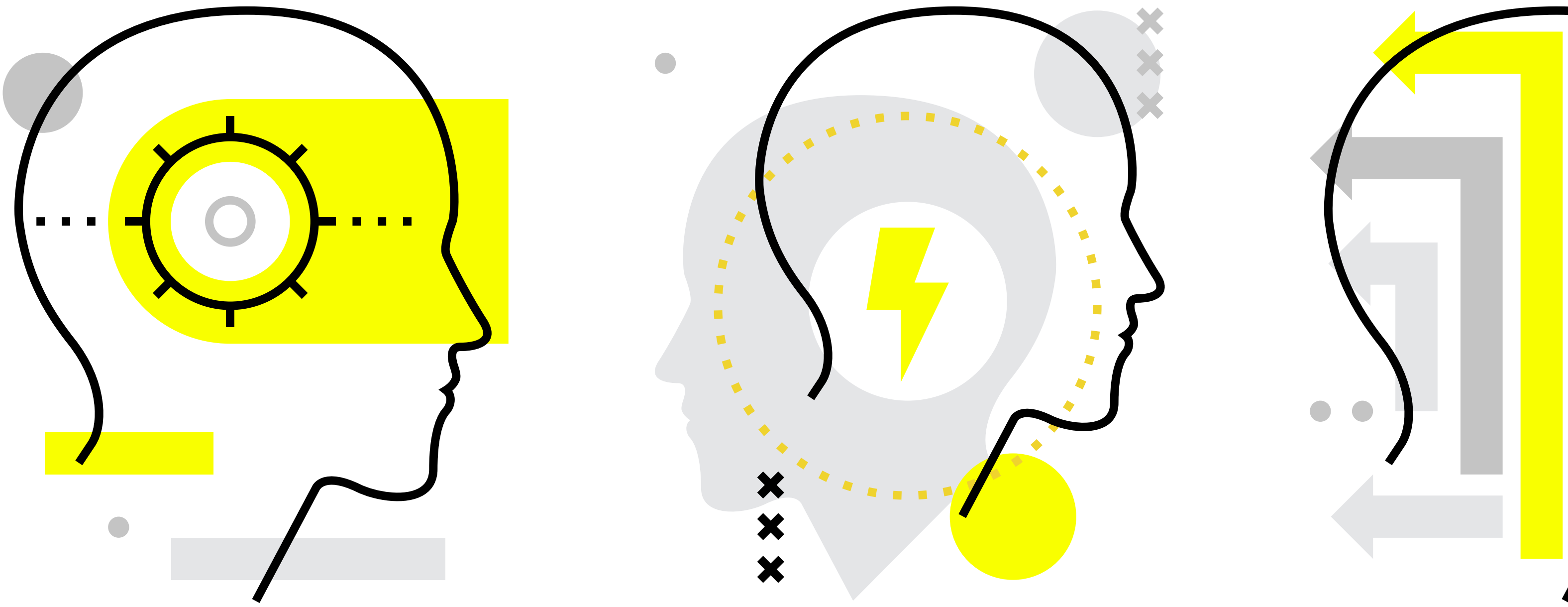


UNDERSTANDING THE SCIENCE BEHIND PERFORMANCE

BY KATHRYN HUME

Applying cognitive science can drive performance that sustains competitive advantage in a world of accelerating change and increasing global competition.

Encompassing psychology, neuroscience, education, anthropology and linguistics, cognitive science can provide insights on why humans behave as they do. With this knowledge it is possible to design environments and situations that drive motivation and build requisite capability which combine to deliver desired individual, team and organisational performance.

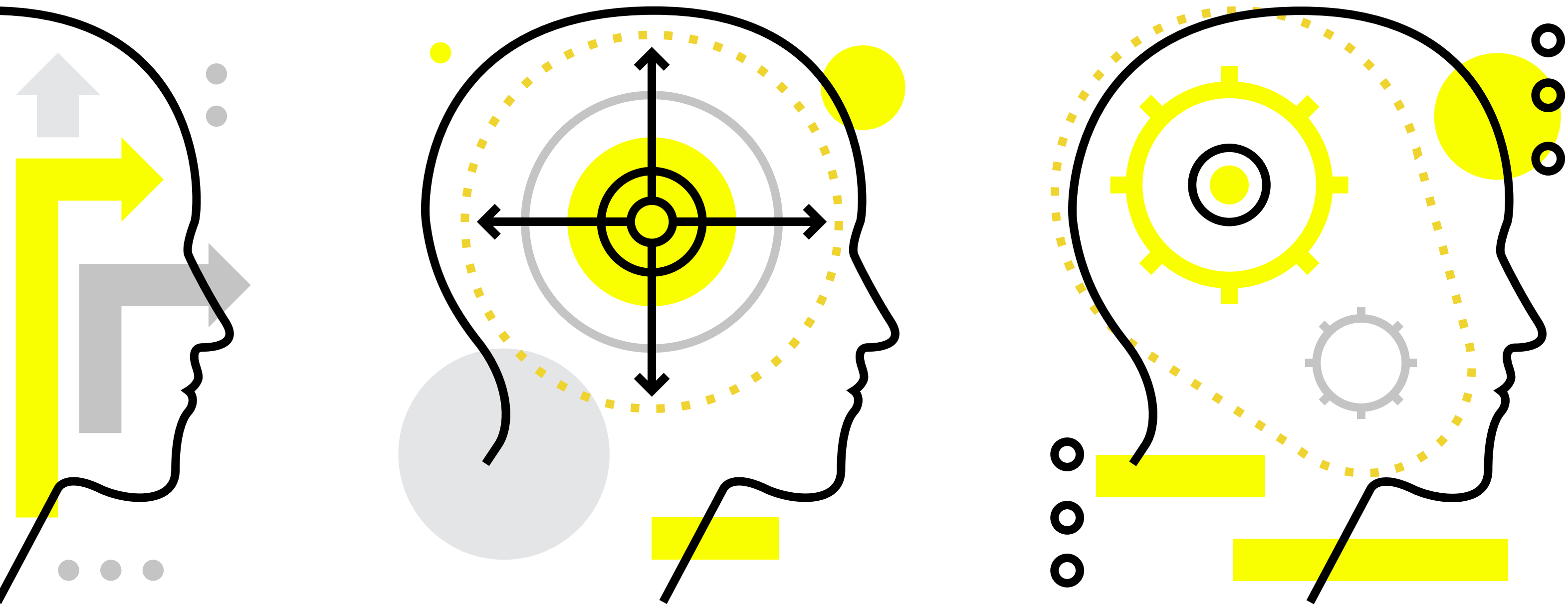
Here we will explore how learning professionals can utilise different scientific theories to provide environments and frameworks that facilitate knowledge development, enabling individuals to continuously improve performance over sustained periods.

COGNITION

Cognition refers to the process of acquiring knowledge – and knowledge is an enabler for performance. Cognitive science can be used to inform the design of learning environments and situations to achieve predetermined goals.

There are, however, many factors that influence behaviour. Knowledge alone cannot be assumed to lead to performance. However, in the future of work, where humans will be required to perform tasks that computers are not capable of, knowledge work will be crucial to ensuring we are able to supplement computing capabilities.

To improve performance, learning professionals must determine what knowledge is required and how to support individuals to develop knowledge that can be retrieved efficiently so it can be applied to find innovative solutions to problems that need solving.



INFORMATION PROCESSING THEORY

Information processing theories outline how the mind functions to create memories. The underlying assumption of this theory is that the mind is similar to a computer in the way it stores information.

In this theory, stimuli are first perceived via the five senses: taste, sight, smell, touch and sound. Sensory memory will filter out stimuli that it determines are irrelevant or unfamiliar. These stimuli then progress from sensory perception, through working memory, to long-term memory.

Significantly for learning professionals, information that is not processed using working memory is lost. This explains why merely presenting information cannot be assumed to guarantee learning. Support must be provided to identify what knowledge is required for the desired performance and then the learning must be designed in a way that encourages individuals to engage with sensory input to process it, making it available in long term memory for retrieval and application.

MODEL OF WORKING MEMORY

Baddeley and Hitch's model of working memory suggests that working memory comprises of several subsystems. These subsystems are guided by what they refer to as a 'central executive'. This filters and converts auditory and visual stimuli into knowledge that is stored in long-term memory via the phonological loop and visuospatial sketchpad respectively.

Supporting these subsystems to work together, rather than compete, will allow for more information to be processed simultaneously. For example, when designing eLearning, it is important the audio provides an explanation of what is being displayed visually on the screen. This is of particular importance for individuals who have limited prior knowledge.

Processing information with working memory stimulates neurotransmitters in the brain to form connections between neurons known as synapses through a process called synaptogenesis. These connections allow electrical signals to be transferred, and this is believed to result in memory formation.

It is also believed that stimulating the brain generates new non-neuronal cells known as oligodendrocytes which promote the thickening of the myelin sheath (white matter) that forms to insulate the membrane protecting neuronal axons. This process is known as myelination and it increases the speed and strength of electrical signals. Multitasking disperses myelin production, so it is important to avoid being distracted by competing stimuli to allow the learner to focus their attention.

Engaging working memory therefore supports memory by strengthening synapses and thickening the myelin sheath to allow for faster retrieval of information stored in memory and more efficient cognition when these memories are applied to perform a task.

COGNITIVE LOAD THEORY

Memory is further strengthened when information is stored in a framework of related concepts rather than individual pieces. This is referred to as a 'schema' or 'mental representation.'

Cognitive load is the effort required to process information with working memory. Reducing cognitive load is important to free up capacity of the working memory. John Sweller demonstrated that the existence of mental representations was a distinguishing factor between novices and experts in their ability to solve problems. Retrieving information contained within a mental representation allows more efficient application as it requires less cognitive load, thus freeing up the working memory for processing new information rather than retrieval of old information.

DELIBERATE PRACTICE

In their book, *Peak: Secrets from the New Science of Expertise*, Ericsson and Pool debunk the myth that performance is predetermined by genetic predisposition and propose a process of deliberate practice to systematically improve performance over an extended period. This is achieved through a dedicated approach to developing the most appropriate mental representations:

- Determine the desired level of performance
- Identify an expert performer
- Determine the mental representations that underlie the expert's ability to perform
- Provide instruction, just outside the learner's comfort zone to develop these mental representations
- Provide immediate feedback supported by additional instruction
- Repeat the process as a series of steps to continually improve performance

Individuals undertaking deliberate practice must adopt a mindset that intentionally applying effort will lead to a longer-term goal. Mistakes should be seen as learning experiences and not a reflection of self-worth. The value of this approach is derived from building schema or mental representations to support efficient retrieval of information to allow creative thinking and problem solving.

The challenge for learning professionals is in identifying the existing mental representations of experts in a particular area and then providing support to other individuals to develop these mental representations through deliberate practice.

KNOWLEDGE BUILDING AND EMOTIONS

Nick Shackleton-Jones' affective context model suggests mental representations are created by our emotional responses to experiences. This has significant implications for learning professionals aiming to support learning. It means individuals will engage working memory to filter sensory inputs differently, given the variability of past experiences and potential emotional responses. What is important to one individual may not be to another.

Individuals who care about the outcome are more likely to be engaged; however, for those who do not care, it will be necessary to first arouse their interest. This may be achieved by incorporating information into a story and relating it to something the learner cares about, and will be further enhanced by building on existing mental representations derived through emotional responses to past experiences.

5 STAGES OF LEARNER NEED

Mosher and Gottfredson's 5 stages of learning need identify situations where individuals are more likely to care and, therefore, be more likely to engage their working memory for learning.

These are:
1: NEW - Learning for the first time
2: MORE – Expanding on the initial learning
3: APPLY - Applying what you've learned
4: PROBLEM SOLVING - When things go wrong
5: CHANGE - When things change

It is important that learning is available at these critical points as this is when learners are more likely to apply the mental effort required to process information. At these stages, individuals are likely to be seeking out information to perform better in their roles and may benefit from a simple resource such as a checklist. This will provide the requisite sensory stimuli to prompt the individual to engage their working memory to build on existing mental representations that they can then draw on and apply to their work.

LEARNING IN THE FLOW OF WORK

Resources that support performance allow learning to occur in the flow of work. Information is contextualised to build on existing mental representations so knowledge can be retrieved more efficiently in the future. Learning at the point of need allows people to continue doing their work whilst learning, minimising disruptions and optimising immediate and long-term performance.

Cognitive science provides insights into how the mind works which can be drawn upon to inform the design of environments that facilitate performance while supporting knowledge development. In a world of accelerating change and digital disruption, humans are increasingly required to perform tasks that computers are not yet capable of. This requires continuous learning to adapt to new situations. Building mental representations of information can reduce the cognitive load required to retrieve information. This allows humans to utilise cognitive capacity for higher order thinking tasks to support them to find innovative solutions to solve problems.

KATHRYN HUME

Kathryn Hume is a learning and change consultant who partners with organisations to build learning cultures to drive performance, innovation and improvement. Contact via www.kathrynhume.com or LinkedIn.

FURTHER READING AND RESOURCES

Cognitive Loan During Problem Solving: Effects on Learning (John Sweller, 1988, University of NSW) http://csjarchive.cogsci.rpi.edu/1988v12/i02/p0257p0285/main.pdf

A Few Thoughts on Cognitive Load (Nick Shackleton-Jones, 2019, LinkedIn) https://www.linkedin.com/pulse/few-thoughts-cognitive-load-nick-shackleton-jones/

How to Use The 5 "Moments of Need" Model in Corporate eLearning (Christopher Pappas, 2014, eLearning Industry) https://elearningindustry.com/use-5-moments-of-need-model-in-corporate-elearning

Peak: Secrets from the New Science of Expertise (Anders Ericsson & Robert Pool, 2017, Houghton Mifflin Harcourt)

Working Memory (Alan D. Baddeley & Graham Hitch, 1974, University of Stirling) https://app.nova.edu/toolbox/instructionalproducts/edd8124/fall11/1974-Baddeley-and-Hitch.pdf