

A modern paradigm

Barry Johnson and Mandy Geal explore the importance of neuroscience in learning

When we learn, we change. We change what we do and the way we do it. Our behaviours develop and we understand things we didn't understand before. Learning changes the physical structure of our brain and results in its organisation and reorganisation. Learning is always happening – consciously and subconsciously. Yet, when developing training, we spend most of our time focused on the content we want people to know rather than helping them learn. As a result, we often fail to engage them and fail to help them transfer their learning into action.

Good instructional design will go a long way toward creating learning. But it can be improved using some powerful new neuroscience understanding into how we learn; understanding that can help us create a training process that is both effective and more efficient.

Purchasers of training often believe they get more for their money if more content is included in a training session. Neuroscience clearly demonstrates this is counter-productive because

neuroscience has changed the very basis of our understanding of learning.

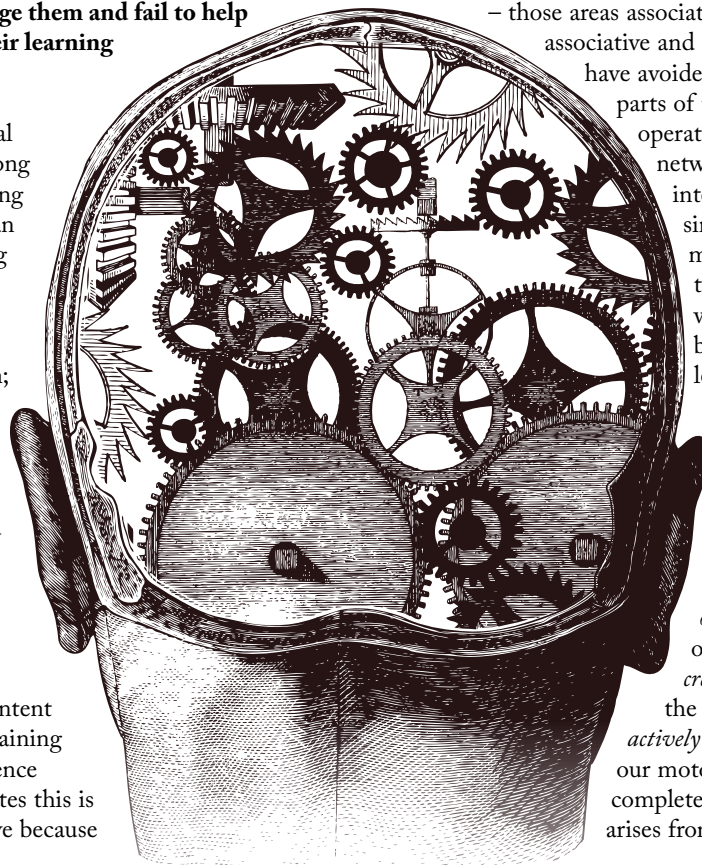
We will present a model that provides a simplified neuroscience description of a learning cycle, developed primarily by James Zull¹. We will focus on the traditional organisational training structure and process to aid understanding, and what happens in the brain during learning.

The learning cycle begins with gathering information followed by reflection, creating and then active testing. Each step of the cycle is associated with a different region of the brain

– those areas associated with sensory, associative and motor functions. We

have avoided describing specific parts of the brain, as the operational functions are networked and highly interactive but our simple descriptions may provide a way to understand the workings of the brain as related to learning.

Zull's learning cycle consists of four stages: *gather sensory experiences* through the sensory cortices; *engage in reflective observation* drawing on the temporal lobe; *create new concepts* in the prefrontal cortex; *actively test* through our motor cortices. The complete cycle of learning arises from the very structure



of the brain and results in new and lasting physical connections. Zull suggests that the power and duration of learning is related to the regions of the brain engaged. The completion of the entire cycle is required for lasting change in behaviour and performance.

The first part of the cycle engages the sensory cortices, which receive input from the outside world in the form of sensory inputs, usually visual, auditory and motor. These cortices are where concrete external experience is first recorded in the brain for the remaining elements of the learning cycle to use. In a current typical training programme, this part of the cycle dominates, receiving most information and explanations. Large portions of courses focus heavily on learners gathering information. What is worse is that course content is overburdened, primarily by words, orally or text, through death by PowerPoint or computer screens.

To improve the quality of learning there is a simple rule – ask don't tell. Let the participants participate. This not only creates action, reinforcing the memories the learners have, but also brings the sensory cortices into play. David Ausubel² placed considerable emphasis on what the learner already knows as being the primary determinant of whether and what he/she learns next. Ausubel views learning as an active process, not simply information assimilation. Learners seek to make sense of their surroundings by integrating new knowledge with that which they have already learnt. To him, new learning related to that which a person already knows is meaningful. Meaning happens when new information is taken into a person's existing cognitive structure and is related to the previously learnt content, forming new connections between this new information and the existing information.

Reflection, the second part of the Zull cycle, engages the temporal lobe. During reflection, the brain integrates the gathered sensory information. Reflection is private to the learner and requires time for learners to pause and digest. Without reflection, learning can be disconnected, shallow and transitory. Reflection is a search for connections – conscious and subconscious – and it works better when distractions are eliminated, allowing the brain to focus attention on integrating the information received. Alterations in the brain that occur during reflection make the nerve cells more efficient or powerful. Reflection is not a break for coffee. It is focus, a quiet time for the learner to engage in the learning process.

Reflection time must be built into the learning events we design, and careful thought given to

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the quantity of information that can be covered. Therefore appropriate pacing of the delivery of that information is essential. Research clearly demonstrates the benefits of spacing and it would seem that one benefit of spaced practice is the opportunity it gives for reflection – both conscious and subconscious. Giving learners reflection questions or integrative assignments can further increase opportunities for reflection.

Creation occurs in the prefrontal cortex and involves the manipulation of information in working memory to create new relationships and new meaning for the learner. The learner shifts from receiving and absorbing information to creating knowledge in the form of abstractions such as ideas, concepts, symbolic representations and plans. The created meaning is attached to the prior knowledge networks and learners create their own understanding.

Creation often involves language: learners take a huge step when they assemble their understanding into specific language. We should insist that they do it. Language is a plan for action; our insistence is that a learner explains something “in your own words”. It means more than just words. It means that you, the trainer, want to see understanding and you want it to lead somewhere.

Zull also notes that people create in the unique way their brains operate. What works for one person is not necessarily the way it works for another person. Learners need to understand in their own way. Repetition by the trainer tends to result in a loss of meaning and creation. Learners must create their own ideas to achieve learning. Trainers must give control to the learners. “We must trust the brain to think,” says Zull. The work of Robert Bjork³, a cognitive psychologist at UCLA, aligns with, and strengthens Zull's model.

The final phase of each element of the learning is active testing, a physical process that engages the motor cortex. It allows the brain to make the abstract concrete by converting mental models into physical events – taking action. According to Zull, any action inspired by ideas qualifies as active

References

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- 3 R.A Bjork, “How to Succeed in College: Learn How to Learn”, *Observer* (March 2001, Vol14. No3) APS 912). <http://bit.ly/1uf99XD>



4 S. Wang, "The Neuroscience of Everyday Life," *The Great Courses* <http://bit.ly/1lab7ip>

5 B. Tuckman, *Operant Conditioning, Education.com* (2009) <http://educate.co/18RvX6v>

6 The Maritz Institute. *The Neuroscience of Learning: A New Paradigm for Corporate Learning.* (2010). <http://bit.ly/16kZ3t8>

testing; reading another book on the topic; talking to someone about the book; explaining and talking about what was learnt; hearing what someone else thinks; searching the topic on the web; seeking out people who have experience and talking to them; setting up experiments to test. One of Bjork's findings, which aligns with and expands the concept of active testing, is that retrieving memory reinforces learning. Notice how the learner is in control.

To increase learning effectiveness all elements of the learning process must be enacted. We repeat, in much training it is usual that only the first element, sensory reception (gathering), is fully enacted. A learning event must allow for gathering, reflection, creation and practice of retrieval. While employing this approach may seem to require greater time and effort, in actuality it is more efficient: the result is that what is learnt is more deeply embedded and the learner more able to apply learning on the job dramatically increases. Training is about changing behaviour. Practice and more practice reinforces the learning.

The inclusion of all elements of the cycle may require an initial slowing down and a reduction in the quantity of content that is covered in a learning event, the result will be an increase in the quality of learning, resulting in a difference between time and money well spent or time and money wasted. Slowing down is counterintuitive but it is imperative when one weaves in an understanding of how the brain functions. Deciding what is really most important becomes a critical design step.

To create and change this buzzing brain network, we need more than just activity – we need emotion. And for the brain, emotion means chemical neurotransmitters such as adrenalin (fight or flight) and dopamine (reward). When our network connections are awash with emotion chemicals, synapse strength is modified and the responsiveness of neuron networks can be dramatically changed⁴.

The thinking parts of our brain evolved through entanglement with older parts that we now know are involved in emotion and feelings. Emotion and thought are

physically entangled. This brings our body into the story because we feel our emotions in our body, and the way we feel always influences our brain. Skinner's operant conditioning, positive and negative reinforcement, comes into play here as they trigger the positive emotions⁵.

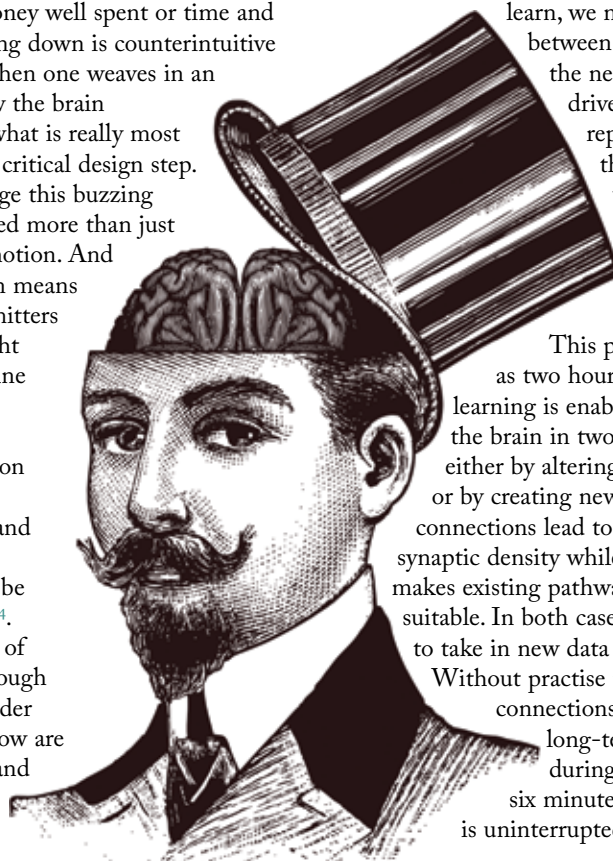
Another powerful way to help people engage in the learning cycle is to increase learners' awareness of the very nature of the learning process by teaching metacognitive strategies – that is thinking about thinking. During this process, the learner is examining the brain's processing when learning, and, in the process, deepening learning. By helping learners consciously adopt more effective learning strategies and giving them insight into the power of those strategies we can affect the quality of day-to-day informal workplace learning.

Learning is not just changing external behaviour, but changing the very wiring of the brain as it relates to those behaviours. Deep, lasting change is possible at all ages. Neurons, or the cells of the brain, possess biochemical pathways that link with other neurons via connections called synapses. When a neuron 'fires', i.e. is active, electrical signals travel down the pathway and across the synapses (chemically) to other neurons in a complex network. The signals are managed by the neurotransmitters in the brain. When we

learn, we make new connections between neurons. As we practice, the neurons that control and drive that thought or action repeatedly fire. Neurons that fire more frequently will also grow more connections (synapses) until the pathway between them becomes permanently connected.

This process can take as little as two hours when uninterrupted learning is enabled. So learning affects the brain in two different ways – either by altering existing connections or by creating new connections. New connections lead to an increase in overall synaptic density while altering connections makes existing pathways more efficient or suitable. In both cases, the brain is remoulded to take in new data and, if useful, retain it.

Without practise the synapses die and the connections are lost. The transfer to long-term memory takes place during sleep and can happen in six minutes, providing the process is uninterrupted.



It follows that experts and novices have different synaptic densities and learn differently – a distinction that can help us design more effective and higher impact learning. Experts have more connections and interconnections, stronger ties between connections and a better-organised knowledge structure. This makes it easier for them to acquire and assimilate new information and retrieve prior knowledge.

Novices with far fewer prior connections cannot hold new information in isolation. Working memory is more actively engaged, more energy is expended in learning and there is a greater challenge in moving knowledge through the learning cycle and into long-term memory.

Breaking learning into chunks that are manageable for novices is critical according to Zull. Another difference between novices and experts is that experts can quickly sort through sensory data and identify which are important and which aren't. Novices see the details but cannot identify which are important. For novices, part of the learning process must include helping them sort through the fine details and guide them in determining what is important. When training novices, it is important to look at the world through their eyes (sometimes not such an easy task for experts). When training experts, it is important to respect the depth and richness of their neural networks.

Expertise is specific. Every individual is a novice in some areas and an expert in others. Expertise in specific domains is not easily transferable to other domains, meaning that training needs to be tailored to the expertise level of the participants. If the participants contain a mix of expertise levels, training needs to respond to individual needs to the extent possible.

We need to actively help learners make meaningful connections and tap into prior knowledge and experience. Metaphors, analogies and stories are powerful vehicles for tapping into existing knowledge and experience; effective ways of making connections, seeing patterns and making meaning.

Avoid explanations. Knowledge consists of networks of neurons. Your knowledge is actually physically different from your learners. Your explanations use your networks; and for your learners to understand it, they have to use theirs. Let them explain to you.

The critical differences between how novices and experts learn has important implications for how we organise learning. If the participants are a mix of expertise levels, solutions should take into account the needs of those different levels.

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Whether learning is informal or formal, the way people work with information and what they need for it to make an impact stays constant. Helping people create connections, between new information and what they already know, between the big picture and the details that comprise it is a key to lasting learning. Learning is manifested in behavioural change from the ability to recall information, through cognitive skills such as logic and reasoning, to skilled communication and physical skills.

Zull and Bjork provide powerful arguments for changing the typical ways that learning events are conducted – and reinforced. The insights we can glean from the human sciences give us the ability to construct more effective learning and reinforcement strategies that align with how the brain learns. They also provide a stronger basis for suggesting that reinforcement is a critical component of learning. They suggest formal and informal learning must become less rigid, with reinforcement being embedded into on-the-job, informal learning⁶. Off-the-job learning events are merely a start of the learning process.

When designing, developing and delivering learning, we need to keep all of the elements of the learning cycle in mind, and continuously return to the cycle as a framework. It is important that learners must create their meaning and their learning. Giving learners maximum control of the learning experience is more than a 'nice-to-have,' it is necessary for deep learning to occur.

Learning and development practitioners can engage better with neuroscience by developing an understanding of the key concepts. Engage the managers, who are the commissioners of learning, so that they are integral to the training process, and help them recognise that training requires practise, which takes time and repetition. Most importantly it is people who contribute to profits, so training is an investment and the managers are investors. **TJ**

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