# Science of Learning questionnaire

| Concepts about learning | Is it true (according to our current thinking)? |
| --- | --- |
| 1. Children learn better when they receive information in their preferred learning style (for example, visual, auditory or kinaesthetic) |  |
| 2. Rehearsal of freshly-learnt knowledge and understanding causes it to become automatically accessible |  |
| 3. Differences in hemispheric dominance (left brain or right brain) can help to explain individual differences amongst learners |  |
| 4. Motivation can be stimulated by rewards such as praise and tokens for achievement, new experiences, provision of choice and shared attention |  |
| 5. Retrieval/recall of new information helps it to be retained more permanently in the brain |  |
| 6. We only use 10% of our brain |  |
| 7. Applying knowledge in new situations makes it easier to recall and use it |  |
| 8. Fearfulness and anxiety reduce the brain’s ability to ‘pay attention’ to and process information |  |
| 9. The oldest part of our brain is the lizard / reptilian brain, which is responsible for our most primitive urges |  |
| 10. Brain development has finished by the time we reach secondary school |  |
| 11. When a brain region is damaged, other parts of the brain can take up its function |  |
| 12. Environments that are rich in stimulus improve the brains of pre-school children |  |

# Science of Learning questionnaire

(see below for explanations of neuromyths)

| Concepts about learning | Is it true (according to our current thinking)? |
| --- | --- |
| 1. Children learn better when they receive information in their preferred learning style (for example, visual, auditory or kinaesthetic) | No |
| 2. Rehearsal of freshly-learnt knowledge and understanding causes it to become automatically accessible | Yes |
| 3. Differences in hemispheric dominance (left brain or right brain) can help to explain individual differences amongst learners | No |
| 4. Motivation can be stimulated by rewards such as praise and tokens for achievement, new experiences, provision of choice and shared attention | Yes |
| 5. Retrieval/recall of new information helps it to be retained more permanently in the brain | Yes |
| 6. We only use 10% of our brain | No |
| 7. Applying knowledge in new situations makes it easier to recall and use it | Yes |
| 8. Fearfulness and anxiety reduce the brain’s ability to ‘pay attention’ to and process information | Yes |
| 9. The oldest part of our brain is the lizard / reptilian brain, which is responsible for our most primitive urges | No |
| 10. Brain development has finished by the time we reach secondary school | No |
| 11. When a brain region is damaged, other parts of the brain can take up its function | Yes |
| 12. Environments that are rich in stimulus improve the brains of pre-school children | No |

# Neuromyth explanations

## 1. Children learn better when they receive information in their preferred learning style (for example, visual, auditory or kinaesthetic)

This is a widely believed and very influential neuromyth, with a thriving industry producing commercial products for schools. It is based on the idea that students learn better when material is presented in their preferred style, traditionally visual, auditory or kinaesthetic (VAK) (Simmonds, 2014). This can lead to children being labelled as, for example, ‘visual’ learners, and having information presented to them in a primarily visual way. Whilst it is true that individuals have preferences for the way that they learn, and that everyone is unique in their strengths, there is very little evidence that being taught to a particular style is beneficial. Since our brains are highly interconnected and we do not learn through one sense alone, a multimodal approach is key. There is evidence, for example, that performing actions or gestures when learning new vocabulary can aid learning when compared to reading or listening (Zimmer et al., 2001). It is argued that teachers should present information in the way that is most appropriate for the content and context, taking prior knowledge, strengths and interests of pupils into account (Willingham, 2010).

## 3. Differences in hemispheric dominance (left brain or right brain) can help to explain individual differences amongst learners

The neuromyth that hemispheric dominance explains individual differences may have arisen from the knowledge that certain functions are localised in a particular hemisphere, for example many elements of language processing are left-lateralised (Goswami, 2004). Despite this specialisation, all cognitive tasks use both hemispheres of the brain and there are huge connections between the two hemispheres via the corpus callosum.

## 6. We only use 10% of our brain

The idea that humans only use part of their brain may have come from Einstein, who reportedly responded in an interview that he only used 10% of his brain (OECD, 2007). Alternatively, it could be attributed to misinterpretations of brain imagery, where activation in the brain is only observed over a threshold set by the researcher. In reality, healthy individuals use all of their brain, all of the time.

9. The oldest part of our brain is the lizard / reptilian brain, which is responsible for our most primitive urges

We do not have a lizard brain inside our mammal brain, inside our primate brain (known as the ‘Triune Brain’). Paul McLean was a neuroscientist in the 1960s and 1970s, and in 1978 reported on his findings when he removed the part of a male monkey’s brain that he identified as the reptilian brain (it looked like it). He found that the monkey was less aggressive, however this part of the brain (globus pallidus) performs numerous functions as it does in reptiles. He therefore associated the reptile brain with aggression. This is not true. All vertebrates have the same basic brain structure e.g. cortex, cerebellum, and all mammals have a neocortex. Evolution suggests that the brain is modified rather than new sections growing on top. Differences are mostly to do with connections in the brain.

## 10. Brain development has finished by the time we reach secondary school

This links to the idea of “critical periods” for learning and the “myth of three”, where a child’s development is believed to be fixed at three years old (Howard-Jones, 2018). Whilst it may be true that educational intervention is best implemented early on, the ability of humans to learn throughout life is demonstrated by activities that require brain plasticity, such as learning to read (Howard-Jones, 2018). The idea that there is a ‘critical’ period for learning suggests that it is not possible for learning to occur after this time, whereas studies show that learning can happen at any age, albeit not as easily (Goswami, 2004) and these optimal periods are now referred to as ‘sensitive’ periods. During these times, the number of synapses rapidly increases (synaptogenesis) then a process of pruning occurs where frequently used synaptic connections are strengthened and rarely used connections are eliminated (Blakemore & Frith, 2005). However, this myth may have originated in monkeys who reach sexual maturation at age three, whereas brain development in humans in some areas, such as the frontal cortex, continues throughout adolescence (Blakemore & Frith, 2005). Knowing that learning can happen at any age means that teachers can prepare children for lifelong learning.

## 12. Environments that are rich in stimulus improve the brains of pre-school children

Some of the evidence to support the ‘enriched environment’ myth came from research on rodents, where rats in a ‘complex’ environment’ performed better and faster at a maze learning task than those in poor environments, and changes in their brains were observed (Diamond et al., 1987). The enriched environment referred to though, was a cage with other rodents and objects that attempted to mimic a wild environment and was only ‘complex’ in comparison to the environment of a laboratory rat (Diamond et al., 1987). This helped to promote the idea of “hot-housing” pre-school children with highly enriched environments, in the hope that this would disproportionately improve their learning (Howard-Jones, 2018). It may have been supported by research that early visual deprivation in cats led to virtual blindness from which they could not recover, whereas deprivation in fully grown cats had no such effects (Hubel & Wiesel, 1970). This suggested that if certain learning experiences are not present in a child’s early years, their brain would never acquire those skills (Blakemore & Frith, 2005). However, in the absence of extreme circumstance, evidence shows that staff training and adult-child interactions are the most important indicators of quality that influence learning (Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004). The impact of this neuromyth was to increase the resources aimed at pre-school children to create an unnecessarily over-stimulating environment, which may have come at the expense of other more worthwhile interventions. Exploiting on this anxiety were a number of manufacturers designing products to stimulate the brain (Howard-Jones, 2010).

## References

Blakemore, S.-J., & Frith, U. (2005) The learning brain : lessons for education: Malden, MA : Blackwell Publishing.

Diamond, M. C., Greer, E. R., York, A., Lewis, D., Barton, T., & Lin, J. (1987) Rat cortical morphology following crowded-enriched living conditions. Experimental Neurology, 96(2), pp. 241-247.

Goswami, U. (2004) Neuroscience and education. British Journal of Educational Psychology, 74(1), pp. 1-14.

Howard-Jones, P. (2010) Introducing neuroeducational research neuroscience, education and the brain from contexts to practice / Paul Howard Jones. London: London : Routledge.

Howard-Jones, P. (2018) Evolution of the Learning Brain: Or How You Got To Be So Smart: Routledge.

Hubel, D. H., & Wiesel, T. N. (1970) The period of susceptibility to the physiological effects of unilateral eye closure in kittens. The Journal of physiology, 206(2), pp. 419-436.

OECD. (2007). Understanding the Brain: The Birth of a Learning Science. Paris: OECD.

Simmonds, A. (2014). How neuroscience is affecting education: Report of teacher and parent surveys: Wellcome Trust.

Sylva, K., Melhuish, E., Sammons, P., Siraj-Blatchford, I., & Taggart, B. (2004) Effective pre-school education: A longitudinal study funded by the Dfes, 1997-2004. Institute of Education, Nottingham.

Willingham, D. T. (2010) The Myth of Learning Styles, Change, 42(5), pp. 32–35.

Zimmer, H. D., Cohen, R. L., Foley, M. A., Guynn, M. J., Engelkamp, J., & Kormi-Nouri, R. (2001) Memory for action: A distinct form of episodic memory?. Counterpoints: Cognition, Memory, and Language.