

**NEUROSCIENCE COURSE**  
**MODULE 10**

## HOW NEUROSCIENCE CAN IMPROVE OUR EVERYDAY LIFE

Neuropedagogy, neuropsychology, neuroeconomy, neurophilosophy: the branches of neuroscience are constantly expanding. Interest in neuroscience is clearly growing. Neuroscience was born out of a simple question: how does the brain work? Its applications initially focused on the diagnosis and treatment of neurological and psychiatric disorders.

For some time now, however, they have shifted away from the purely theoretical domain and are now integrated into everyday life. We call upon neuroscience to enhance relationships at work and improve employees' productivity. We use it to facilitate learning in children or improve adults' capacity to learn.

Thanks to neuroscience, we can also assist people who suffer from psychological disorders or patients with addictions. Neuroscience is even used to improve relationships in couples now. Understanding one's partner and being understood by them helps to avoid conflictual situations. This is why scientists and mere mortals alike take such an interest in neuroscience.

But is neuroscience as effective as we think? Can it really encourage humans to surpass themselves? These questions are particularly important because many people – sometimes including those from the world of science – tend to answer them with a yes. Thus, neuroscience is thought to help with:

- overcoming any form of addiction with ease;
- transforming the learning process into child's play;
- increasing professional potential.

This is far from an exhaustive list, but the objectives mentioned here are at least achievable. The most common problem nowadays is the tendency to turn neuroscience into something it is not: a panacea. How can neuroscience be truly useful in everyday life, and how can it improve the existence of those who use it?

### Application of neuroscience in everyday life: how to improve the cognitive capacities

Reducing stress, boosting creativity and improving memory: these are all things that many people would like to achieve. Even if these tasks seem difficult, particularly after reaching a certain age, they are far from being impossible. Individuals can improve their cognitive faculties, regardless of their age and health condition. The contributing factors are the following:

- sleep and rest;
- diet;
- physical exercise;
- artistic activities;
- hobbies.

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### ★ Sleep

Humans spend one third of their life asleep. This might seem like a lot, but sleep is essential for the body. To better understand the role played by sleep, let's consider the case below.

#### → Example

*Sarah is part of a group of volunteers involved in a study to measure the impact of sleep on health in general and the cognitive faculties in particular. For five days in a row, she was allowed to sleep for just five hours a day. When she wakes up on the fifth day, she is exhausted. She feels heavy and weary. She would be more than willing to go back to sleep because she doesn't feel she has the strength and energy she needs to face the day.*

*Based on her personal observations, not only did she fall asleep very quickly, but she also slept very deeply. She doesn't remember anything between the moment when she fell asleep and the moment she was woken up. The assessments she has undergone every day since the start of the experiment show that, as well as her physical state, her psychological state seems to have declined. Her mood is quite low by the fifth day.*

*Analysis of the electric currents at the surface of her brain confirms her sensations. The long delta waves, which characterize deep sleep, have increased considerably. Everything seems to indicate that Sarah's body is trying to compensate for the reduction in the amount of time spent sleeping by making her sleep deeper.*

This example reveals some important information. First, a lack of sleep is harmful to the body and never goes unnoticed. Second, the cognitive capacities of someone suffering from a lack of sleep are inevitably impaired. There is no doubt that someone who is tired and suffering from low mood will not be able to memorize information normally, for example. Their level of concentration will also be minimal.

The consequences of a lack of sleep are not the same in all humans. Some are completely disoriented after one or two days of poor sleep, whereas others manage to resist for four, five or even six days.

Sleep and all its different phases are perceived as states that support the vital and adaptive functions in several domains: neurophysiological, physiological and, of course, cognitive. It is important to note that the impact of sleep on the body's functions is closely linked to the structure of sleep itself. This means that we will notice changes from birth all the way until death.

Generally, sleep is very often seen as a mandatory stop to all voluntary activities. We are used to comparing sleep to a sort of standby mode, a bit like for a computer. There are indeed some similarities, but it would be inaccurate to consider the two states as the same.

A computer on standby momentarily suspends all its operations. When the brain is asleep, however, it simply changes its mode of operation. The way it functions will depend on the phase of sleep it is in.

There are two main phases that alternate throughout the period spent asleep: slow, non-REM sleep and REM sleep.

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### ★ Non-REM sleep

This is itself divided into three phases: the falling asleep phase, the light non-REM sleep phase and the deep non-REM sleep phase.

#### ➔ Falling asleep

This is the phase during which the body prepares to rest. The individual is not completely asleep yet, but they are also not fully awake. During this stage, the breathing slows and the muscles relax. The consciousness is increasingly cloudy.

#### ➔ Light non-REM sleep

This is a phase of actual sleep, but it is not very deep. During this phase, any kind of disruption (noise, light, etc.) may wake the subject. However, they will not feel as if they have been woken up. They will get the impression they were asleep. It is important to mention that this phase is the longest overall. Around 50% of total sleep is made up of light sleep.

#### ➔ Deep non-REM sleep

As the name indicates, this is the deepest phase of sleep. The individual is completely cut off from the outside world. This is the phase that can be compared to standby mode on a computer, because brain activity is reduced to the absolute minimum. The whole body is at rest and the individual can recover from all their accumulated fatigue. This phase only accounts for around a quarter of total sleep. Studies have shown that the amplitude of this phase is deeper and longer at the very start of sleep. The phases that follow will be a little lighter.

### ★ REM sleep

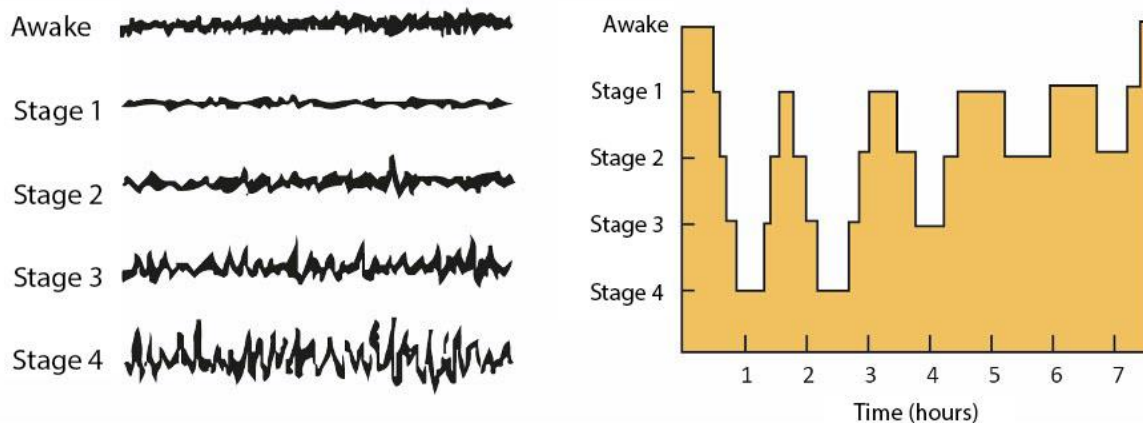
This phase follows that of non-REM sleep. It is described as paradoxical because the subject displays signs of both wakefulness and very deep sleep. The individual seems paralyzed, their muscles are completely sluggish. This is the dream phase. They do not occur automatically, but this is the period when they occur if indeed, they do.

The situation is different for parasomnia, which can occur during this period or during any other phase of sleep. Paradoxical sleep represents the final phase of the sleep period.

The phases of sleep alternate and the length of each one is closely linked to the subject's age and lifestyle. Babies sleep for up to 18 hours a day and have phases of non-REM sleep, or more specifically deep non-REM sleep. The period of time decreases as the individual develops and, in older age, the maximum duration of sleep is only 6 to 7 hours. Furthermore, the phases of non-REM sleep are increasingly short.

The diagram below shows the brainwaves of a young adult during sleep.

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All studies that have been carried out to date prove that short-duration sleep deprivation (when subjects sleep for 4 or 5 hours rather than 7 or 8 hours, for example) has no serious effect on the body. It can cause a certain degree of discomfort, but the subject will be able to make up for this quickly; their cognitive capacities will not be compromised.

However, the more the duration of this deprivation increases, the harder it is to recover from. A sleepless night will have negative consequences that are more difficult to deal with, for example. The first faculties to be affected are attentional (for example alertness), followed by the cognitive, emotional and psychological faculties.

The more the duration of the deprivation increases, the more significant the negative effects will be. Eventually, in addition to problems affecting the cognitive and attentional faculties, the individual will have to face psychological difficulties such as fatigue and dizziness.

The final important aspect is purifying the body. A study conducted by Dr Maiken Nedergaard, from the Faculty of Medicine at the University of Rochester in New York, showed that the brain benefits from sleep in order to get rid of all the toxins accumulated there. She states that “sleep helps restore the brain by flushing out toxins that build up during waking hours”.

All this information leads us to draw an obvious conclusion: sleep is vital for the body to be able to function properly in general, and the brain in particular. However, there is no standard duration. Taking the characteristics of an adult, we generally state that 7.5 to 8 hours of sleep are required, but this is far from being static.

For some people, this amount of sleep will be ample. Others will need at least 9 hours of sleep to recover. It will depend on the subject’s lifestyle and genetic factors. As surprising as it might seem, lots of people do not know how to sleep. In order to sleep well and give the body an optimal amount of rest, it is crucial to respect one’s biological clock and the phases of sleep.

It is useful to consider the different types of sleep regulation. There are two:

- Homeostatic regulation, which can be compared to an hourglass: the more one side empties, the fuller the other side becomes. In the present case, the desire to sleep will increase as the body becomes tired. Once the subject has rested, the need will disappear.
- Circadian regulation, which is linked to the individual’s biological clock. The propensity for sleep is very strong between 1 and 5 a.m. and between 2 and 4 p.m.

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Sleeping conditions also have an impact on the quality of sleep. Sleeping for 9 hours on a cold, hard floor in a brightly lit room will not help the body to recuperate. Regardless of the time of day when the individual wants to rest, it needs to be done in a dark room.

The absence of light causes melatonin, which is also described as the sleep hormone, to be secreted. In reality, it is more like the darkness hormone, because this is when it is secreted. Nevertheless, it helps the individual to fall asleep, and a lack of it can cause insomnia. Sleeping in the dark during the day helps the body to avoid harmful disruptions that could have a negative impact on the quality of sleep.

It is desirable to avoid both light and noise pollution in order to achieve good sleeping conditions. The optimal temperature for good quality sleep is 19°C (this is an average figure; it depends on individual characteristics). A comfortable mattress and pillow that are suited to the individual's body are also essential.

### ★ Diet

Here, we are not talking about the neurobiology of eating behavior, but rather the foods that improve brain function and the cognitive faculties. As Hippocrates stated, "let food be thy medicine". But why is it important to focus on the brain and not on the body as a whole?

First, although it only accounts for 2% of the body's weight, the brain alone consumes around one-fifth of our daily calorie intake. Add to this the fact that this is the organ that is responsible for managing the rest of the body and it is easy to understand why it is so important to pay close attention to one's diet. Furthermore, all the foods that are useful to the brain are useful to the rest of the body too.

Several studies conducted over the past two decades have shown that a good diet can slow the progress of certain diseases like Alzheimer's disease. If it does not halt the development of the disorder, it very often relieves the negative impact of certain symptoms. A good diet is therefore essential for both healthy individuals and those suffering cognitive decline or conditions like dementia.

Keeping the brain well fueled involves supplying it with a balanced, constant intake of:

- ➔ carbohydrates;
- ➔ omega 3 and omega 6;
- ➔ antioxidants;
- ➔ vitamins;
- ➔ minerals;
- ➔ water.

### ★ Carbohydrates

Carbohydrates play a decisive role in the proper functioning of the body. However, their consumption must be limited, and it is especially important to restrict consumption of carbohydrates that have been chemically treated. This means, for example, that wholemeal bread should be prioritized over white bread. The same applies to pasta, rice and wholegrain cereals, etc.

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### ★ Hydration

Given that the brain is 80% water, it is not difficult to make a direct link between staying hydrated and optimal brain function. Dehydration kills faster than a lack of food. Thus, to ensure optimal brain function, it is important to drink at least 1.5 liters (50 ounces) of water a day. It must be water and not coffee or alcohol. Alcohol, for example, dehydrates the body.

Water can be replaced with juice, but only if it is natural and does not contain any artificial sweeteners. Some drinks, like tea and mate, have a positive effect on brain performance. Even in this case, however, it is important to maintain a balance.

### ★ Omega 3 and 6

We often tend to encourage consumption of omega 3. In reality, it is not only omega 3 and 6 that are important but also 'good' fatty acids. There are three categories of fatty acids: essential fatty acids, monounsaturated fats and saturated fats.

### ★ Essential fatty acids

These are described as essential because they make up the body's cells. The body cannot synthesize them itself. The essential fatty acids are omega 3 (alpha-linolenic acid) and omega 6 (linolenic acid). These fatty acids can be found in foods like:

- ➔ salmon;
- ➔ sardines;
- ➔ herring;
- ➔ mackerel;
- ➔ tuna;
- ➔ eggs;
- ➔ trout, and many other types of oily fish.

Although fatty acids play an important role, they should be consumed with care, especially when taking dietary supplements. An excess of omega 6 will reduce the effects of omega 3 and thus harm the body. This is why it is vital to maintain a balance between these two fatty acids.

### ★ Monounsaturated fats

Fats play a less important role in the body than essential fatty acids, but it is an important one nevertheless. They are an integral part of the cells in the nervous system, so consuming them helps to ensure it functions properly. Monounsaturated fats can be found in:

- ➔ nuts;
- ➔ linseed oil;
- ➔ olive oil;
- ➔ walnut oil;
- ➔ pumpkin seeds;

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- ➔ flax seeds;
- ➔ avocado;
- ➔ rapeseed oil;
- ➔ chia seeds.

### ★ Saturated fats

Consumption of this category of fats should be limited as much as possible. They have no positive effect on the body. Many studies have shown that they have more of a harmful impact than a useful one.

Overall, consumption of fats is vital to ensure the nervous system functions well. The proof of this is the fact that myelin is made up of almost 70% lipids. A lack of fat prevents the body from forming new synaptic connections. In the event of a severe deficiency, the connections already formed and the neurons will degenerate.

### ★ Vitamins

These are mostly B vitamins, namely B1, B6, B9 and B12. They play an active role in the memorization process. As a result, a deficiency will have harmful repercussions on the cognitive functions in general. There are many sources of B vitamins.

- ➔ **B1:** this can be found in black beans, eggs, salmon, nuts, lean ham and pork.
- ➔ **B6:** this can be found in turkey and chicken, salmon, tuna, chickpeas, potatoes and pistachios.
- ➔ **B9:** this can be found in all poultry offal, flaxseed, pulses, asparagus, soya and spinach.
- ➔ **B12:** this can be found in meat (red and white), fish, eggs, seafood, offal and dairy products.

### ★ Antioxidants

The impact of antioxidants on the body is well known. Given that the ageing of the brain is also the result of its oxidation, consumption of antioxidants will slow the process. All fruits and vegetables need to be incorporated into the diet. However, some have a stronger action than others.

Blueberries are one of the fruits that contain the most antioxidants. The same is true for cranberries, strawberries, blackberries and raspberries. Indeed, recent studies have shown that continued consumption of blueberries could help to slow memory loss considerably. The same phenomenon is observed in people who eat vegetables on a continued basis.

### ★ Minerals

Here, we will focus on iron. The functions of this mineral include oxygenating the body and, of course, the brain. It also plays an active role in the production of dopamine and serotonin. The former has a significant influence on movement control, attention and organizational skills, whereas the latter is involved in regulating sleep, appetite and mood. As such, an iron deficiency will lead to the brain being deprived of oxygen, but it will also have harmful consequences on the cognitive and attentional capacities. The following foods are particularly rich in iron:

- ➔ vegetables (green);
- ➔ pumpkin seeds;

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- ➔ red meat;
- ➔ offal;
- ➔ wholegrain cereals;
- ➔ wholegrain bread;
- ➔ quinoa;
- ➔ shellfish.

In general, to guarantee that the brain can function optimally and increase the potential of the cognitive faculties, it is advisable to consume plenty of fruit, vegetables, wholegrain cereals and pulses. The intake also needs to include dietary fiber, fish, white meat, eggs, seeds, nuts, cottage cheese, onions and garlic, as well as spices like turmeric and ginger.

With regard to drinks, pure water is best, but green tea is suitable too. Fans of juice should make it themselves, without adding any refined sugars. Confectionary should be avoided, but a small amount of dark chocolate can be eaten from time to time.

### 🌟 Physical exercise

It is common knowledge that physical activity strengthens the body. For a long time, however, scientists overlooked the fact that it also helps to improve the cognitive capacities. Several recent studies have shown that practicing a sport on an ongoing basis can help to prevent neuronal impairments and fight effectively against functional decline of the brain.

Physical activity causes endorphins to be released. These are pleasure hormones that not only reduce stress but also give the individual a sense of deep satisfaction. Sport also improves sleep quality and the cognitive faculties. However, the effects of exercise are far from being restricted to producing endorphins.

A study conducted by scientists at Columbia University Vagelos College of Physicians and Surgeons found that it led to the secretion of another hormone: irisin. This hormone causes neuronal growth in the hippocampus, which helps to improve memorization and learning. It also plays a protective role, particularly against neurodegenerative disorders like Alzheimer's disease.

Overall, sport increases neuroplasticity, strengthens synaptic connections, develops neurogenesis and improves the brain metabolism. All these effects will only be visible if the individual becomes very involved in a physical activity. Doing ten minutes of exercise a year will have no positive impact on health. The effort made therefore needs to be continued, but not necessarily intensive. One hour of walking or cycling a day is plenty.

The most difficult task is to choose an appropriate physical activity. Here are some tips to follow to make the best choice.

First, the form of physical activity chosen needs to bring enjoyment to the individual who practices it. This means, for example, that if indoor sports are a real form of torture they inflict on themselves solely to improve their memory, it would be better to stop. Instead, simply taking a walk into town could be preferable. Walking at a brisk pace will achieve exactly the same effects as exercising indoors, without causing any feelings of frustration.

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Next, the individual's age and physical parameters need to be taken into account when choosing an activity. It is normal for an adult to cycle for 2 hours a day, but this would be abnormally intense for a young child and should be reduced to a maximum of 30 minutes.

Finally, the intensity should be increased gradually. Jumping into a 3-hour session of exhausting exercise from the very first day will not be helpful. In fact, the most important thing when practicing a physical activity is consistency. It is better to do 30 to 45 minutes of exercise a day than exhausting 3-hour sessions. The body will get used to it and the intensity and duration of exercise can be increased gradually.

### ★ Arts and hobbies

The arts have long been used to improve the cognitive faculties of patients suffering from neurodegenerative disorders. Elisabeth Grimaud, a doctor of cognitive psychology and psycholinguist, declares:

"I had memories of elderly people in retirement homes who were a little sad, so I wanted to add a more fun and enjoyable dimension to memory training. My logic was to use language, which is a brain function that is more preserved during the ageing process, to train the others that are more fragile. That was how I had the idea to do brain training using poetry and word games. Then I expanded the range of activities to visual arts, music and singing."

A wide range of artistic activities can be used to improve both adults' and children's cognitive capacities.

### ➔ Music

The impact of music on development has been known since antiquity. In those times, at least in Greek civilization, music played a specific role. Ancient scholars associated each category of music with a mood and a concrete state of mind. The interest in the use of music as a therapeutic tool encouraged several researchers to study the real scientific scope of this artistic activity.

Studies conducted by Trehub in 2003 revealed the decisive role played by music in communication between mothers and babies from a very early age. Gruhn, Galley and Kluth focused on the impact of music on cognitive development. In 2016, Peretz demonstrated its importance for social cohesion. A gene, AVPR1A, was even identified that has a direct impact on individuals' musical aptitude.

Music is both an emotional vehicle and a form of communication that is perceived by everyone, including babies from birth. It also improves neuroplasticity and restructuring of the brain. Practicing music is also thought to modify the density of white matter in the hippocampus, which is involved in long-term declarative memory.

This is also believed to lead to an increase in the volume of grey matter in the perirolandic region (upper anterior walls and premotor cortex) of the inferior temporal gyrus and visual areas, interconnected regions that ensure the integration of multimodal sensory information.

As such, it is not surprising that we use music to overcome many different psychological and even physiological disorders. Music is used to treat hearing, sensorimotor, language, memory and mood disorders, and even pain.

### ➔ Drawing and painting

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These types of art have a similar impact to music. Like the latter, drawing and painting are forms of communication. People who are traumatized or stressed and who have difficulty expressing their feelings are often encouraged to externalize them in a different way, that is through art.

If we focus on the purely cognitive functions, art is often used within a context of learning to improve memory and facilitate learning as a result. Like with music, practicing art can also help to hone orientation skills in people suffering from amnesia after a trauma.

### ➔ Hobbies (sewing, pottery, knitting, etc.)

People who practice these activities as a hobby and not professionally often say that they help them reduce their stress levels. However, this is more of an emotional impact. From a cognitive perspective, all these activities help those who practice them to develop their attentional capacities and their memory.

These pastimes also help to develop creativity. At first, individuals are likely to simply copy existing designs. Over time, however, they end up building a more creative approach and manage to express their own vision.

It is important to note that beyond improving individual faculties and cognitive capacities, engaging in artistic pastimes and activities promotes the development of interpersonal relationships. People who practice a similar artistic activity or share a passion for a hobby tend not only to talk to each other about it, but also share their experience.

### ★ Summary

Cognitive neuroscience as a whole seeks to help individuals to improve their capacities. Studies carried out over the last three decades eventually revealed the unknown aspect of activities we were accustomed to doing mechanically, with no idea of their practical significance. Nowadays, we make more effective use of all the positive impacts they offer.

In the early 19<sup>th</sup> century, it would have been difficult to help someone who was suffering from problems with learning, for example. Now, specialists will put together a concrete, individual action plan that will help individuals overcome their difficulties. The plan will take all aspects of the problem into consideration, from the subject's diet to their habits and lifestyle, in order to maximize their chances of success.

## Application of neuroscience in teaching

Over the last decade, technological advancements in brain imaging have seen a rise in the applications of neuroscience in the world of education. A much-debated issue in preschool education is how to determine when a child is ready to start learning to read.

Trying to teach a child to read when they are too young can make the process painful for both the child and the teacher. Educators have established effective behavioral methods that are used in the classroom to assess a child's capacity to read.

Today, neuroscientists can improve this prediction by examining the brain of a child undergoing phonological tests. This evidence, combined with the behavioral approaches used by the teacher, can reduce the anxiety that arises in later readers.

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Thus, a new term has emerged: neuropedagogy! This approach is completely different to education, fusing educational science and neuroscience. The aim is to make things easier for professionals working in education and improve the process for students.

What is the value of applying neuroscience for students? To answer this big question, we will set out a few particularly interesting exercises in the following section.

### Exercises for learning while having fun

#### ★ Exercise no. 1

This exercise is aimed at both adults and children. Its objectives are as follows:

- ➔ to improve working memory;
- ➔ to improve concentration and inhibition;
- ➔ to improve mental arithmetic ability;
- ➔ to relieve the mental fatigue caused by routine;
- ➔ to reduce cognitive decline.

This is a relatively simple and easy exercise to carry out, which does not take very long and will be considered even by very young children as a form of play. However, this game will be useful to them because it will ultimately help them to process a relatively complex practice.

For this exercise, you can use a pack of 52 cards with the 10s and face cards (kings, queens and jacks) removed. However, the symbols (diamonds, clubs, hearts, spades) might confuse the brain and interfere in the exercise. As such, we recommend that you make your own cards numbered from 1 to 9 (the number will be written in the middle of the card). You will also need to make 20 other cards, namely:

- ➔ 5 with a + sign
- ➔ 5 with a – sign
- ➔ 5 with a x sign
- ➔ 5 with a ÷ sign

The exercise involves drawing cards from each pile (one made up of the numbered cards and the other made up of the mathematical symbol cards), memorizing them, then performing a mathematical operation. This exercise should be done at least once a day, for 10 to 15 minutes.

Drawing the numbered cards will be considered the first stimulus (S1) and drawing the symbol cards will be considered the second stimulus (S2).

**For the first 2 weeks**, you need to do exercises 1, 2 and 3 set out hereafter, in a sequence. Each one lasts 5 minutes, so you need to do 15 minutes of exercises three times a day.

#### ➔ First exercise (5 minutes)

Gather all the numbered cards (S1), and then all the cards with the mathematical symbols + and – (S2). Shuffle each pile and place them both in front of you, face down.

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Draw two S1 cards one after the other, one card per second. Look at each card so you form a mental image of it, then place it face down on the table. You need to see the contents of the cards (figures) written in your mind, one underneath the other (vertically) rather than side by side (horizontally). You are not allowed to look at the cards again once they have been placed on the table.

Then draw one S2 card. Look at it, memorize it and form a mental image of it, then place it face down on the table. You are not allowed to look at it again.

In your mind, you need to visualize the cards and the operation formed, then give the result of the calculation.

**For example: For S1, you draw 2 and 9. For S2, you draw +. In your mind, you need to form the operation  $2 + 9$  and give the result: 11. Check the result is correct by turning the cards over.**

Repeat this exercise four times.

If you succeed in two out of the four attempts, you can move on to the next level; otherwise, start the exercise again until you do.

In the next level, you increase the difficulty by drawing three S1 cards and two S2 cards. Repeat this exercise four times. If you succeed in two out of the four attempts, you can move to the next level. If you failed (which is normal), move down to the previous level (two S1 cards and one S2 card) and start the four attempts again.

**For example: From the S1 pile, you draw 2, 9 and 6. From the S2 pile, you draw + and -. In your mind, you do  $2 + 9 - 6$  and give the result.**

In the next level, you increase the difficulty by drawing four S1 cards and three S2 cards. If you've found the exercise easy up until now, that will change at this level. Repeat this exercise four times. If you succeed in two out of the four attempts, you can move to the next level. If you failed (which is normal), move down to the previous level and start the four attempts at that level again.

**For example: From the S1 pile, you draw 2, 9, 6 and 4. From the S2 pile, you draw -, + and +. You visualize  $2 - 9 + 6 + 4$  in your mind and give the result.**

For each higher level, take one more card from the S1 pile and one more card from the S2 pile. Always do four repetitions of the exercise per level. If you succeed in two out of the four attempts, you can move up to the next level; otherwise, move back down to the previous level.

If you generate mental images easily as you do this exercise and the following exercises and are comfortable with mental arithmetic, you can go quicker and start at a higher level (for example with four S1 cards and three S2 cards).

### ➤ Second exercise (5 minutes)

This exercise is almost identical to the first, with just one difference: when all the cards have been drawn, you need to sort the numbers you draw from the S1 pile into ascending order before performing the operation.

**For example: You draw 9 and 2 from the S1 pile and + from the S2 pile. First, you need to sort them into ascending order in your head (so 2 and 9), then perform the operation:  $2 + 9 = 11$ .**

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You then proceed in the same way as for the previous exercise: move on to the next level if you succeed in two out of four attempts and move back down to the previous level if you fail.

### → Third exercise (5 minutes)

This exercise is almost identical to the first, with just one difference: once all the cards have been drawn, you need to apply the opposite sign in order to perform the operation.

**For example: You draw 9 and 2 from the S1 pile and + from the S2 pile. You are not going to calculate  $2 + 9$ , but  $2 - 9$ .**

You then proceed in the same way as for the previous exercise: move on to the next level if you succeed in two out of four attempts and move back down to the previous level if you fail.

\*

**In weeks 3 and 4**, you will continue to do 15 minutes of exercises three times a day.

### → First, second and third exercise (5 minutes)

Start with the first exercise at your highest level, i.e., the level at which you succeeded in two out of four attempts. For example, if you finished week 2 with two successful attempts having drawn five S1 cards and four S2 cards, you will start the first exercise at this point rather than at the stage with two S1 cards and one S2 card.

As long as you succeed in one out of four attempts, you can move to the next level. As soon as you have reached your limit, move on to the second exercise. Never go back to the previous level. Then move on to the third exercise, following the same principle.

### → Fourth exercise (5 minutes)

Add the five  $\times$  cards and the five  $\div$  cards to the S2 pile; it now contains 20 cards.

Carry out the fourth exercise following the model of the first exercise. Pay attention to the order of operations!

**For example: You draw 2, 9 and 4 from the S1 pile, and  $-$  and  $\times$  from the S2 pile. Thus, the operation will be  $2 - 9 \times 4$ . However, the result will not be  $-28$ ; it will be  $-34$ , because you will not perform the calculation as follows:  $2 - 9 = -7$ ;  $-7 \times 4 = -28$ . Rather, you will calculate  $9 \times 4$  (i.e., 36) first, then  $2 - 36$  (i.e.,  $-34$ ).**

The principle for going up and down a level is the same as for the first exercise.

If you draw the division sign, round the result and do not give the remainder. If the division is too difficult, substitute the division sign for the addition sign.

### → Fifth exercise (5 minutes)

Complete this exercise following the model of the second exercise.

**In weeks 5 and 6**, you will continue to do 15 minutes of exercises three times a day. You should start to feel more comfortable, but the mental torture isn't over yet.

### → Sixth exercise (5 minutes)

Start at your highest level, i.e., the level at which you succeeded in two out of four attempts.

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### ➔ Seventh exercise (5 minutes)

Draw four S1 cards, but only take into account one card out of each two. Also draw one S2 card.

**For example: You draw 2, 9, 6 and 7 from the S1 pile, and a – card from the S2 pile. You eliminate the 9 and 7 cards and perform the following operation:  $2 - 6 = -4$ .**

The rest of the exercise unfolds in the same way as for the first exercise.

Thus, if you succeed in two out of four attempts, you will draw five S1 cards and two S2 cards. If you draw 7, 5, 9, 3 and 4 from the S1 pile and x and – from the S2 pile, you will do  $7 \times 9 - 4 = 59$ .

### ➔ Eighth exercise (5 minutes)

The principle is the same as for the previous exercise, but with an added difficulty: once you have performed the calculation, you need to indicate which cards you eliminated, and in order.

**For example: You draw 9, 5, 6, 4, 3 and 5 from the S1 pile, and – and + from the S2 pile. You need to do  $9 - 6 + 3$  and give the result (i.e., 6), then state that you eliminated the 5, 4 and 5.**

### ★ Exercise no. 2

This mental imaging exercise draws on all the sense organs. It helps to develop the memory and improve creativity.

To do this exercise, you need to have a group of objects in front of you that, individually or collectively, have the following characteristics:

- ➔ two objects that make a noise when you bang them together;
- ➔ one object that gives off a light scent;
- ➔ one food item;
- ➔ one slightly warm object;
- ➔ one slightly cold object;
- ➔ one rough or soft object.

To begin, look closely at the objects that make a noise when you bang them together. With the same amount of attention, log the sound they produce in your mind. Then, close your eyes and focus on the mental representation of the two objects.

Once the mental image is precise, reproduce the sound produced by banging the two objects together in your head, while keeping the image of them in your mind. You have just associated a visual image with an auditory image.

Open your eyes and check the accuracy of your mental visual and auditory images compared with the reality, looking closely at the two objects and banging them together again.

Repeat steps 1 to 4 until the images are precise and form rapidly.

You can then move on to the other objects, to associate the visual images with the tactile, somatosensory, olfactory and gustatory images and form all the possible combinations.

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### ★ Exercise no. 3

The aim of this exercise is to help students hone their spelling. It adopts the principle of the game snakes and ladders.

This exercise is easy to carry out and is not considered by children to be a form of learning. It is a game they will be happy to play. The instructor or parent can adapt it easily based on the desired objectives or modify the words to be learnt.

<b>Start</b>	Orally correct the mistake in the following sentence : <b>They eated the cake.</b>	Write a word chosen by the person next to you and move forward by as many spaces as there are letters in the word.	Select the correct spelling : <b>receive / recieve.</b> Move back one space if you get it wrong.	Correct the mistake in this word and write it in the air : <b>bizzare.</b>	Find a homophone for <b>stare</b> and spell it.
Find a homophone for <b>ough</b> and spell it.	Correct the mistake in the following word and write it in the air : <b>knowlege.</b>	Select the correct spelling : <b>independent / independant.</b>	Find as many words as you can that start with a silent <b>W</b> and move forward one space for each one you find.	Write the correct spelling of the word that is pronounced <b>fizis.</b>	Spell as many of the following homophones correctly and move forward one space for each one you get right : <b>for / four / fore.</b>
Write a word chosen by the person next to you and move forward by as many spaces as there are letters in the word.	Write in the air the word that is pronounced <b>forruhn.</b>	How many mistakes can you count in this sentence ? <b>She tried to through the bawl.</b>	Find the mistakes in this sentence and move forward one space for each one you find : <b>She telled me that she don't want to go.</b>	Find the mistakes in this sentence and move forward one space for each one you find : <b>dikshunery.</b>	
Select the correct spelling : <b>akward / awkward.</b> Move back one space if you get it wrong.					Find the mistakes in this sentence and move forward one space for each one you find : <b>You knead to where you're coat.</b>
Write the correct spelling of the word that is pronounced <b>invizibal.</b>	Which of the following is the correct spelling : <b>object object objct.</b>	<b>Finish</b>	Write the correct spelling of the word that is pronounced <b>thuhruh.</b>	Find a homophone for <b>draught</b> and spell it.	Write a word chosen by the person next to you and move forward by as many spaces as there are letters in the word.
Find as many words as you can that end with a silent <b>N</b> and move forward one space for each one you find.					Orally correct the error in this sentence : <b>He want to go outside.</b>
Find the two possible spellings for these homophones : <b>choose / flew / new / blue.</b>	Find the mistakes in this word and move forward one space for each one you find : <b>obveeus.</b>	Correct the mistake in the following word and write it in the air : <b>approve.</b>	Find a homophone for <b>through</b> and spell it.	Orally correct the mistake in this sentence : <b>I maked a sandwich.</b>	Select the correct spelling : <b>schol / school.</b>

### ★ Exercise no. 4

Like the previous exercise, this adopts the principle of a game. In this case, it is happy families, but it is used to practice conjugation.

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FUTURE TENSE Family

**(I) WILL GO**

Family members :

(I) will go	(You) will do	(He) will put
(We) will love	(They) will be	

FUTURE TENSE Family

**(You) WILL DO**

Family members :

(I) will go	(You) will do	(He) will put
(We) will love	(They) will be	

FUTURE TENSE Family

**(He) WILL PUT**

Family members :

(I) will go	(You) will do	(He) will put
(We) will love	(They) will be	

FUTURE TENSE Family

**(We) WILL LOVE**

Family members :

(I) will go	(You) will do	(He) will put
(We) will love	(They) will be	

FUTURE TENSE Family

**(They) WILL BE**

Family members :

(I) will go	(You) will do	(He) will put
(We) will love	(They) will be	

PERFECT TENSE Family

**(I) HAVE GONE**

Family members :

(I) have gone	(You) have done	(He) has put
(We) have loved	(They) have been	

PERFECT TENSE Family

**(You) HAVE DONE**

Family members :

(I) have gone	(You) have done	(He) has put
(We) have loved	(They) have been	

PERFECT TENSE Family

**(He) HAS PUT**

Family members :

(I) have gone	(You) have done	(He) has put
(We) have loved	(They) have been	

PERFECT TENSE Family

**(We) HAVE LOVED**

Family members :

(I) have gone	(You) have done	(He) has put
(We) have loved	(They) have been	

PERFECT TENSE Family

**(They) HAVE BEEN**

Family members :

(I) have gone	(You) have done	(He) has put
(We) have loved	(They) have been	

# Module 10 :

## HOW NEUROSCIENCE CAN IMPROVE OUR EVERYDAY LIFE

PAST TENSE Family

**(I) WENT**

Family members :

(I) went	(You) did	(He) put
(We) loved	(They) were	

PAST TENSE Family

**(You) DID**

Family members :

(I) went	(You) did	(He) put
(We) loved	(They) were	

PAST TENSE Family

**(He) PUT**

Family members :

(I) went	(You) did	(He) put
(We) loved	(They) were	

PAST TENSE Family

**(We) LOVED**

Family members :

(I) went	(You) did	(He) put
(We) loved	(They) were	

PAST TENSE Family

**(They) WERE**

Family members :

(I) went	(You) did	(He) put
(We) loved	(They) were	

IMPERFECT TENSE Family

**(I) WAS GOING**

Family members :

(I) was going	(You) were doing	(He) was putting
(We) were loving	(They) were being	

IMPERFECT TENSE Family

**(You) WERE DOING**

Family members :

(I) was going	(You) were doing	(He) was putting
(We) were loving	(They) were being	

IMPERFECT TENSE Family

**(He) WAS PUTTING**

Family members :

(I) was going	(You) were doing	(He) was putting
(We) were loving	(They) were being	

IMPERFECT TENSE Family

**(We) WERE LOVING**

Family members :

(I) was going	(You) were doing	(He) was putting
(We) were loving	(They) were being	

IMPERFECT TENSE Family

**(They) WERE BEING**

Family members :

(I) was going	(You) were doing	(He) was putting
(We) were loving	(They) were being	

## HOW NEUROSCIENCE CAN IMPROVE OUR EVERYDAY LIFE

PLUPERFECT TENSE Family

**(I) HAD GONE**

Family members :

(I) had gone	(You) had done	(He) had put
(We) had loved	(They) had been	

PLUPERFECT TENSE Family

**(You) HAD DONE**

Family members :

(I) had gone	(You) had done	(He) had put
(We) had loved	(They) had been	

PLUPERFECT TENSE Family

**(He) HAD PUT**

Family members :

(I) had gone	(You) had done	(He) had put
(We) had loved	(They) had been	

PLUPERFECT TENSE Family

**(We) HAD LOVED**

Family members :

(I) had gone	(You) had done	(He) had put
(We) had loved	(They) had been	

PLUPERFECT TENSE Family

**(They) HAD BEEN**

Family members :

(I) had gone	(You) had done	(He) had put
(We) had loved	(They) had been	

FUTURE PERFECT Family

**(I) WILL HAVE GONE**

Family members :

(I) will have gone	(You) will have done	(He) will have put
(We) will have loved	(They) will have been	

FUTURE PERFECT Family

**(You) WILL HAVE DONE**

Family members :

(I) will have gone	(You) will have done	(He) will have put
(We) will have loved	(They) will have been	

FUTURE PERFECT Family

**(He) WILL HAVE PUT**

Family members :

(I) will have gone	(You) will have done	(He) will have put
(We) will have loved	(They) will have been	

FUTURE PERFECT Family

**(We) WILL HAVE LOVED**

Family members :

(I) will have gone	(You) will have done	(He) will have put
(We) will have loved	(They) will have been	

FUTURE PERFECT Family

**(They) WILL HAVE BEEN**

Family members :

(I) will have gone	(You) will have done	(He) will have put
(We) will have loved	(They) will have been	

# Module 10 :

## HOW NEUROSCIENCE CAN IMPROVE OUR EVERYDAY LIFE

### ★ Exercise 5

For this exercise, you need a pack of 50 cards. Each card needs to have two numbers on it, represented in two different ways:

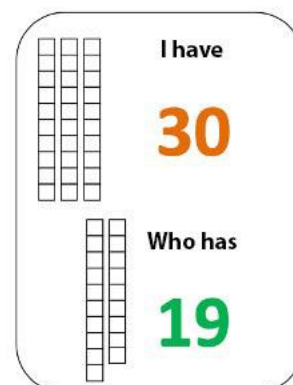
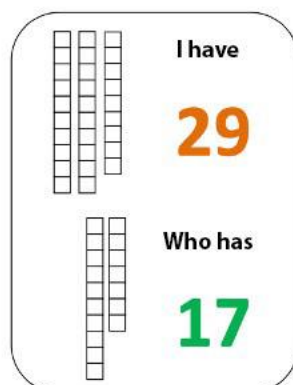
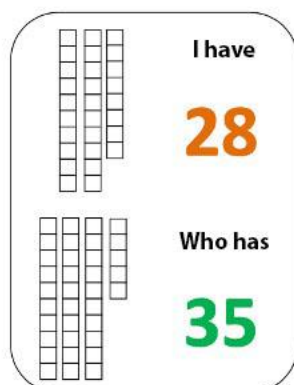
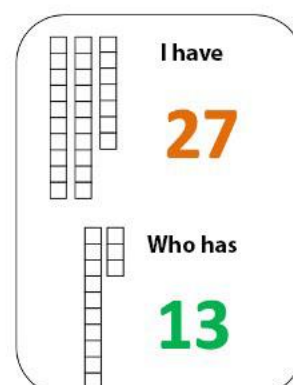
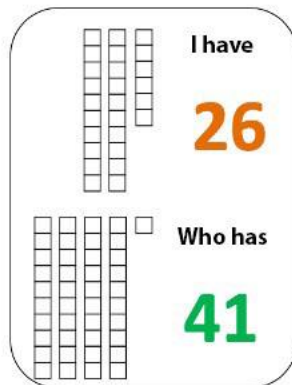
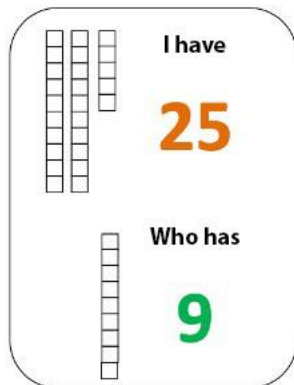
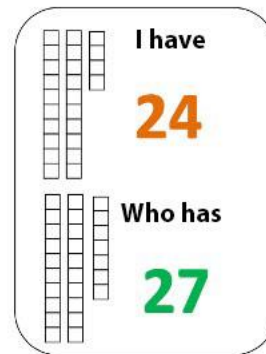
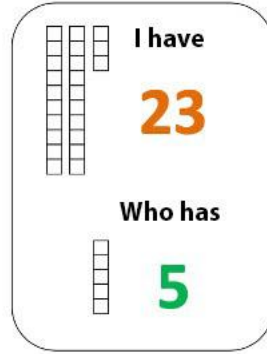
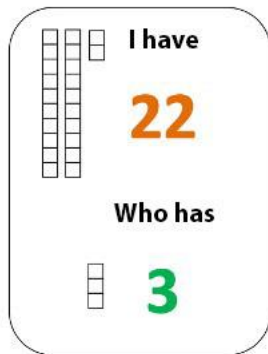
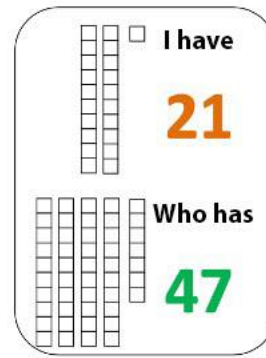
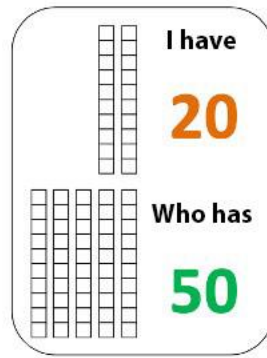
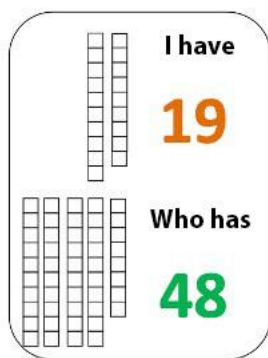
- as a figure,
- as a visual representation (tens + units).

The cards are arranged in a 4x3 grid. Each card has two sections: 'I have' and 'Who has'. The 'I have' section shows a number in orange with a visual representation of that number using blocks. The 'Who has' section shows a number in green with a visual representation of that number using blocks.

<b>I have</b> 1 <b>Who has</b> 12	<b>I have</b> 2 <b>Who has</b> 14	<b>I have</b> 3 <b>Who has</b> 45
<b>I have</b> 4 <b>Who has</b> 18	<b>I have</b> 5 <b>Who has</b> 20	<b>I have</b> 6 <b>Who has</b> 37
<b>I have</b> 13 <b>Who has</b> 36	<b>I have</b> 14 <b>Who has</b> 38	<b>I have</b> 15 <b>Who has</b> 24
<b>I have</b> 16 <b>Who has</b> 42	<b>I have</b> 17 <b>Who has</b> 44	<b>I have</b> 18 <b>Who has</b> 46

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# Module 10 :

## HOW NEUROSCIENCE CAN IMPROVE OUR EVERYDAY LIFE

I have **31**

Who has **21**

I have **32**

Who has **23**

I have **33**

Who has **49**

I have **34**

Who has **7**

I have **35**

Who has **29**

I have **36**

Who has **31**

I have **37**

Who has **43**

I have **38**

Who has **4**

I have **39**

Who has **6**

I have **40**

Who has **8**

I have **41**

Who has **10**

I have **42**

Who has **33**

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I have  
**43**

Who has  
**15**

I have  
**44**

Who has  
**22**

I have  
**45**

Who has  
**39**

I have  
**46**

Who has  
**1**

I have  
**47**

Who has  
**2**

I have  
**48**

Who has  
**16**

I have  
**49**

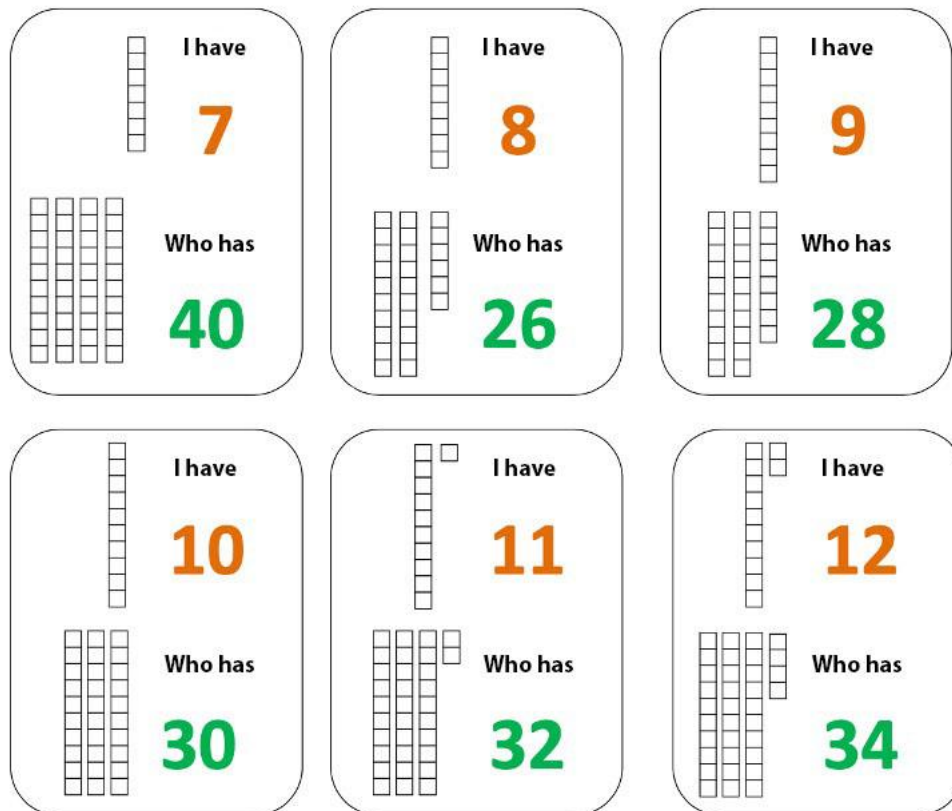
Who has  
**11**

I have  
**50**

Who has  
**25**

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### ➔ Rules of the game

The top part of the card indicates the starting number and the bottom part indicates the desired number. Each time a player puts a card down, they need to verbalize the number they have and the number they want to obtain. The visual representations help children to find the number by adding tens and units if they forget.

The game can be played by a minimum of two players, but the ideal is three or more players.

Each player is dealt 10 cards and the rest are placed in a pile to draw from. Make sure to always deal the card that reads "I have 1, who has 12".

The player who has the card with 1 on, starts. They place their card on the table and say: "I have 1, who has 12?"

The player who has the card says "I have 12, who has 34" puts their card down on top of the card with 1 on and says "I have 12, who has 34?" and so on.

The same player may have several cards that can be put down in a row.

The winner is the first player to have no cards left.

### ★ Exercise 6

This is a word fishing game. The aim is to form words from syllables and letters. This exercise helps to fulfil several objectives:

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- improving phonology;
- improving reading;
- improving writing;
- improving spelling and vocabulary;
- improving conjugation.

For this game, you need word cards, letter cards, paper and pencils.

- ose	rea -	P	R	D
- age	st-r	D	T	S
- one	sa -	S	F	E
- ort	- arts	A	O	I
s - n	R	S	P	D
ti-e	J	M	T	M
sa-	B	S	G	P

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traï -	B	P	C	R
V	L	N	L	S
T	E	A	N	I
E	C	S	O	A
I	T	I	N	L
U	- ears	S	B	D
N	- one	T	Z	C

The word cards have words written on them that are missing a letter: the first letter (for example on the cards with -one, -ears, -ose, -age), one letter in the middle of the word (for example on the cards with st-r, ti-e) or the last letter (for example on the cards with trai-, rea-, sa-). With each of these cards, it is possible to create several words (for example for the card with sa-: sat, sad, sap, or for the card with -ose: dose, rose, pose).

The letter cards are to be used to form the words written on the word cards.

The principle of the game is as follows. To start, each player is given six word cards (or fewer for very young players who are just starting to read). The rest of the word cards are placed in a pile to draw from.

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The first player draws a card from the pile of letter cards. They place it face up on the table and look at their six word cards to see if they can make a word using the letter they picked up. If they can, they announce the word they have found, show their word card and write down the word on their sheet. The word card is then placed at the bottom of the pile and the player draws a new one.

The next player then draws a letter card. If they cannot use it to make a word, they miss a turn and the next player gets to try to find a word, and so on.

The winner is the player who manages to find the most words after a set amount of time decided beforehand, or who manages to find a certain number of words first, with the number having been determined at the start of the game.

There are many different exercises like those we have just seen that help us to answer the question posed earlier: how is neuropedagogy useful for students? This question leads to another: what is the cause of most cases of academic underachievement? There are two major causes: a lack of understanding and a lack of motivation. These factors remain the same even in adults.

If the student does not understand the subject they are being taught or if it is extremely complex and demands a great deal of effort on their part, they will tend to give up as quickly as possible. Exercises like those set out here help the subject to study without stress. Starting by using games or helping them to improve their cognitive capacities will encourage them to get more involved in the process.

This is the most effective way of overcoming the feeling of inevitability that some students get when they are unable to assimilate the material they are given. This approach also helps students to become aware of their own strengths and optimize their efforts. As the saying goes, where there's a will, there's a way. Once the child or adolescent is confident of their capabilities, they will want to achieve them and will take action to succeed.

The use of neuroscience in pedagogy is not only beneficial for students. It also makes teachers' task easier. Indeed, understanding the student's vision and the causes of all their difficulties will help the teacher to implement a more effective action plan. Neuroeducation gives the teacher the opportunity to familiarize themselves with the factors that make learning more difficult or easier in children, adolescents and adults.

Neuroscience does not go against teachers' empirical knowledge. A lot of information they are given corresponds to their own vision and does not require any modification. Other information allows them to fine-tune the conventional approach they had or modify it if it was incorrect.

However, teachers should not get carried away by the myth of pedagogical innovation. Researchers are conducting studies regularly and, even if their results are positive within the framework of neuroscience, they cannot all be applied to education. There are many pedagogical myths that die hard.

## Examples of pedagogical myths

There are so many of these that we will limit ourselves to the most popular ones.

## HOW NEUROSCIENCE CAN IMPROVE OUR EVERYDAY LIFE

### ✦ Myth no. 1: The best way to teach is to always apply all innovations

This idea might seem fantastic, but this is only the case at first sight. First, we should start from the premise that the results of all the studies carried out in cognitive neuroscience do not necessarily have a practical application in pedagogy. Moreover, there is no real innovation in the field. Very often, the effective 'innovations' proposed are already known techniques, albeit improved. It is therefore pointless to be constantly looking for 'exceptional methods'.

The neuroscientific model of motivational processes suggests there are several pedagogical implications that can be used to increase motivation to learn. For example, reward is an essential driving force in a learning environment, because of the approach that behavior would not occur without a reward.

For someone to be motivated, the learning process needs to be rewarding and interesting. The rewards do not necessarily need to be tangible. In a classroom, the reward can be any kind of stimulus that has the expected positive values, including positive feedback, praise, an interesting activity, usefulness, relevance, social support and a relationship.

It is important to find and put together a list of attractive stimuli, including a variety of compliments, enjoyable activities, interesting materials, positive feedback and various new learning contexts that can activate the reward circuit in children and adolescents.

Neuroeducation (or neuroscience of education) is an interdisciplinary area of research that establishes a connection between education and developmental, cognitive, emotional and social neuroscience. It aims to develop curriculums, learning strategies, teaching methods, learning material and intervention programs to improve various types of learning and ultimately provide optimal learning environments.

### ✦ Myth no. 2: It is important to take learning styles into consideration

This myth is one of the oldest and most stubborn. In the UK education system, for example, many teachers still rely on the famous concept of learning styles. It emerged in the 1970s and states that humans learn in different ways. People can be auditory, visual or kinesthetic learners, etc.

To improve learning abilities, the teacher first needs to determine the style that suits the student. It would be inaccurate to say that the theory is fundamentally wrong; this is far from being the case. Individuals have different characteristics and some people retain information more effectively by reading, listening or watching. However, this does not mean that the sense they use most should be prioritized during learning.

In reality, to promote learning, it is important to use as many senses as possible. It does not matter whether the individual is a visual or auditory learner; if they are prompted to assimilate information by being encouraged to use all their sense organs, they will not be likely to forget it.

First, this technique forces the individual to create as many associations as possible and therefore to expand the network of neurons and synapses that are involved in learning. Second, the individual will establish points of reference more easily. The principle of learning styles is not only inefficient but also limits the student's possibilities.

## HOW NEUROSCIENCE CAN IMPROVE OUR EVERYDAY LIFE

### ✦ Myth no. 3: After a certain age, learning becomes difficult

This myth is so persistent that there are still thousands of articles written about it by 'specialists' to this day. The one factor that has absolutely no impact on the ability to learn is age. Several studies have shown that young children and adults aged under 25 years assimilate information more quickly. Nevertheless, the brain retains its ability to learn until the very end.

### ✦ Myth no. 4: Women learn more easily than men because they are better at multitasking

Women are indeed better at multitasking than men; several studies have proven this to be true. However, it would be incorrect to think that this ability is an advantage, particularly in the sphere of learning. All the studies that have been carried out to this day have proven that completing a task efficiently demands total concentration of the brain. Being able to multitask therefore hinders learning.

### ✦ Myth no. 5: People use one of the brain hemispheres more than the other

This myth states that individuals who have strong artistic capacities make greater use of the right brain hemisphere, whereas those who are more logical and analytical use the left hemisphere. This is a false premise that is nevertheless based on a scientific reality. The left and right hemispheres fulfil different functions. However, every individual, regardless of their capacities, uses all of their brain.

Innovation does not necessarily equate to improvement. Nevertheless, neuroscience will be a great help in the sphere of education, just as it is in managing stress and memory and improving understanding.

## Application of neuroscience in business

Companies have been partly responsible for stimulating the development of cognitive neuroscience. The latter has made a significant contribution to improving the working environment and modifying corporate management. In other words, neuroscience has numerous practical applications in business. It can be used in many different areas, including:

- the different decision-making mechanisms;
- methods of interpersonal communication;
- ways of improving employee cohesion;
- techniques for reducing stress in the workplace;
- techniques for improving employee productivity.

Since the second half of the 20<sup>th</sup> century, interest in neuroscience has continued to grow. Several researchers focus or have focused primarily on its application in business. As a result, we have seen the emergence of disciplines like neurofinance and neuroeconomy, and several studies in cognitive neuroscience have found an application in the professional domain.

Neuroscience offers business owners the objective and scientific tools they need to understand consumers and employees and use this information to make better business decisions.

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# HOW NEUROSCIENCE CAN IMPROVE OUR EVERYDAY LIFE

### ★ Neuroscience as a way of improving the working environment

This phenomenon is observed infrequently in France, where just 9% of employees, according to the latest statistics, consider that they are fully engaged in their work. In the Anglo-Saxon countries, however, this percentage is much higher. This is not surprising considering that many companies invest huge sums in conducting research in this area and applying the results of these studies.

Everything starts by creating a healthy working environment in which employees will not feel stressed. Having offices with relaxation areas or open spaces where employees can move around freely, without the weight of hierarchy, can help to achieve this objective.

This simple idea is rooted in neuroscience and helps employees to improve their brain fitness and what we refer to as “neuroagility” (the ability of all the areas of the brain to function as one integrated cerebral system).

When people are neuroagile, they have the flexibility required to learn new skills, mindsets and behaviors quickly and easily, and to quickly unlearn old behavioral patterns. Developing employees’ mental aptitude enables everyone to think, learn, create and perform better.

Neuroscience proves that every individual’s brain has unlimited potential for learning. Mental aptitude allows people to measure and monitor this potential and unlock more of it. From a personal development perspective, improving performance starts by understanding a person’s neurological conception. It is essential to know the factors that influence this conception in order to ensure the brain remains ‘in motion’ and agile.

A few examples are given below.

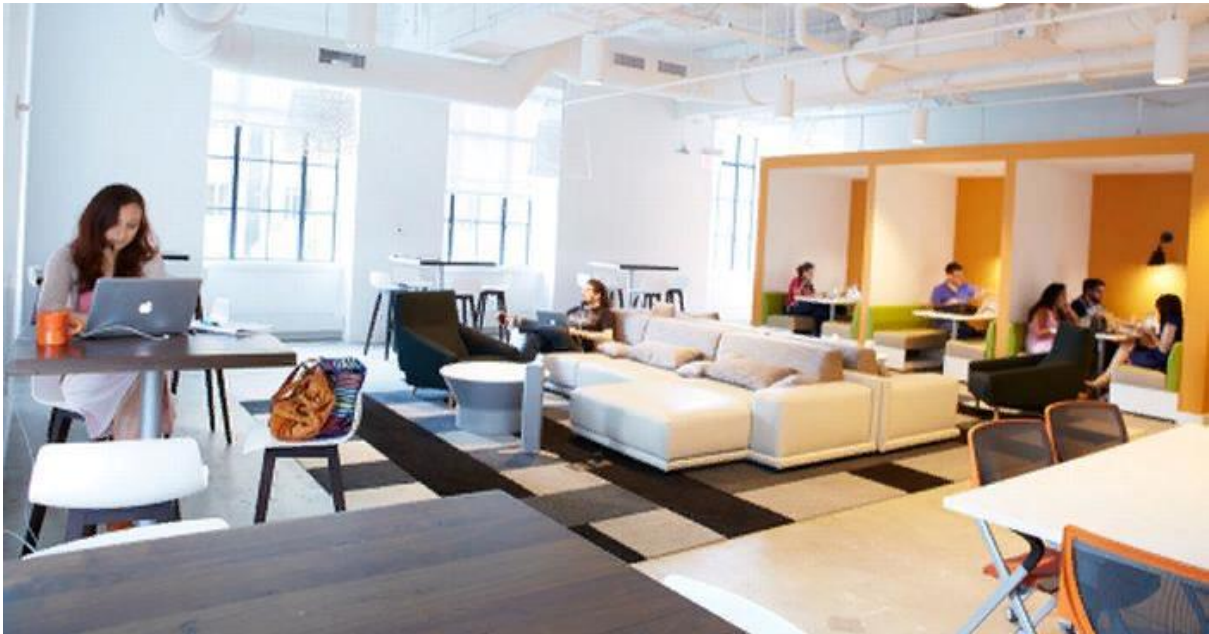


The working environment above encourages team cohesion. The one below does too, as well as creativity and cooperation/teamwork.

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The environment below is intended to reduce stress and offer employees an environment that is more reminiscent of their own home.



The same is true for this one...

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And this one.



However, what is possible in a software development, cybersecurity, design, architecture or real estate firm will not necessarily be feasible in a firm that produces high-tech devices or a bank. This is why more focus is placed on management. An efficient team is a productive team. As a result, the manager needs to make every effort to encourage them to surpass themselves and succeed.

To achieve this, the managers need to learn to trust their team, give them more autonomy and limit themselves to overseeing at most. Motivating the team while giving them a sufficient amount of

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autonomy will gently push each member of the team to prove themselves to maintain the manager's trust. The manager will also garner their sympathy and strengthen their position as a leader. This approach is even more effective in the event of conflict, because the employee will be fully aware that the comment being made to them is completely justified.

This approach also helps to reduce stress levels. By establishing clear objectives and precise deadlines and allowing a certain amount of room for maneuver, the employee is given the flexibility to organize their workflow themselves. The absence of a superior constantly hovering and on their back limits emotional pressure and reduces stress.

Another useful approach is team cohesion. This is only possible when employees are encouraged not only to get involved individually, but also to cooperate. The result is a team where exchanging ideas is the norm. This helps to boost creativity and productivity.

According to recent studies, the introduction of cognitive neuroscience into corporate management increases companies' competitiveness considerably: "Unhappy employees take twice as many sick days, are absent six times more often, and are half as creative, which represents an estimated additional cost, in France, of almost 60 million euros. Happy employees, meanwhile, are nine times more loyal, and far more productive (from 12% to 31%...)."

However, even if neuroscience has a truly positive impact on the proper functioning of companies, neuromyths have the opposite effect.

### When neuroscience veers towards the farcical

Interest in neuroscience has slowly turned into a farce. Scientists are constantly criticizing the quest for a "neuro miracle", but to no avail. The now famous 'dead salmon' study demonstrated this. At a scientific congress in 2009, Craig Bennett presented pictures of brain imaging that were used to show that 'sociability neurons' exist. This could have been the discovery of the century had it not been for the fact that the images were of a dead salmon.

The young scientist had captured images of the fish and manipulated some of the data. He realized that if he made certain aspects of the methodology vague, he would be able to fool all the attendees, and he wasn't wrong. His joke had a positive effect, however. It helped to reveal the limits of functional brain imaging.

Indeed, for a long time, researchers "discovered" all kinds of "interesting" areas thanks to this technique. Starting from the premise that each area of the brain is responsible for a particular activity, some researchers made discoveries that are now considered absurd.

One such example is the famous 'math bump'. Many companies, particularly in Anglo-Saxon, invested huge amounts of money to understand which area of the brain needed to be 'activated' to encourage individuals to make purchases or help employees to increase sales. The logic was that brain imaging could identify the brain's reactions beyond any doubt.

Admittedly, Bennett's experiment only really impressed scientists. Many multinational companies continue to invest large amounts of money in the hope of understanding whether the customer prefers such a product over another. This is precisely where the crux of the problem lies. We tend to view neuroscience as a supreme tool that can 'read' clients' needs.

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One of the 'studies' to have made a lasting impression compared Coca-Cola and Pepsi. It claimed that Pepsi creates a 'surplus' of pleasure. Thus, consumers preferred Pepsi if they drank both drinks 'blind', but moved towards Coca-Cola if they knew what they were being given.

Another study examined sports cars that might be able to activate the 'pleasure center' in men. All these studies have no real connection to science. They are used solely for marketing purposes to encourage consumers to buy a product. As wary as a consumer may be, they will always give in when faced with scientific 'evidence'.

The same trend can be observed in personnel management. Many 'scientific studies' are only scientific in name. They limit themselves to supporting certain received ideas, or sometimes conveying completely far-fetched ideas about noteworthy innovations.

## Conclusion

Despite all the studies that have been conducted thus far, the brain remains a real labyrinth to scientists. Neuroscience seeks to decode this complex organ. Throughout the 20th century, several discoveries not only contributed to improving our understanding of how the brain works, but also developed the treatment of neurodegenerative diseases, psychiatric disorders, and many other conditions.

For a long time, neuroscience was restricted to its basic domain: biology. However, in response to multiple expectations, it has ended up stepping outside of the traditional framework and dealing with other equally important aspects: psychology, pedagogy and even economics. This trend, and particularly the popularity neuroscience is currently experiencing, is partly due to an unprecedented media movement.

This media movement has brought about many positive effects. The improved understanding of how the brain functions and how individuals behave has helped to stop people suffering from depression, stress, aggression and other disorders from being ostracized. This is particularly evident in the case of post-natal depression.

For a long time, the concept of 'post-natal depression' was inconceivable. A woman who had just given birth was expected to be glowing. Thus, any women who did not feel a sense of extreme bliss and fulfilment resented themselves because they felt like they were bad mothers. This feeling exacerbated their psychological state.

The same is true for the treatment of conditions like Alzheimer's disease. For much of the 20th century, patients lost all contact with the outside world as their condition deteriorated. Now, most patients are able to lead a less isolated life, even in the relatively advanced stages of the disease. It goes without saying that neuroscience has also made a significant contribution to improving conditions at work and in education. Children with psychological and psychiatric disorders can now benefit from better support than what was available a few decades ago.

This popularization of neuroscience has also had significant negative consequences. The first of these is the fact that what were purely scientific disciplines to some have been transformed into quackery. Neuroscience finds itself in the same situation as electricity was in the 19<sup>th</sup> century. It is very often granted powers it does not have, and unscrupulous individuals take advantage of this. Nevertheless,

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this discipline, whether cognitive, cellular or otherwise, has a bright future. The brain is a complex organ that will never cease to surprise us.