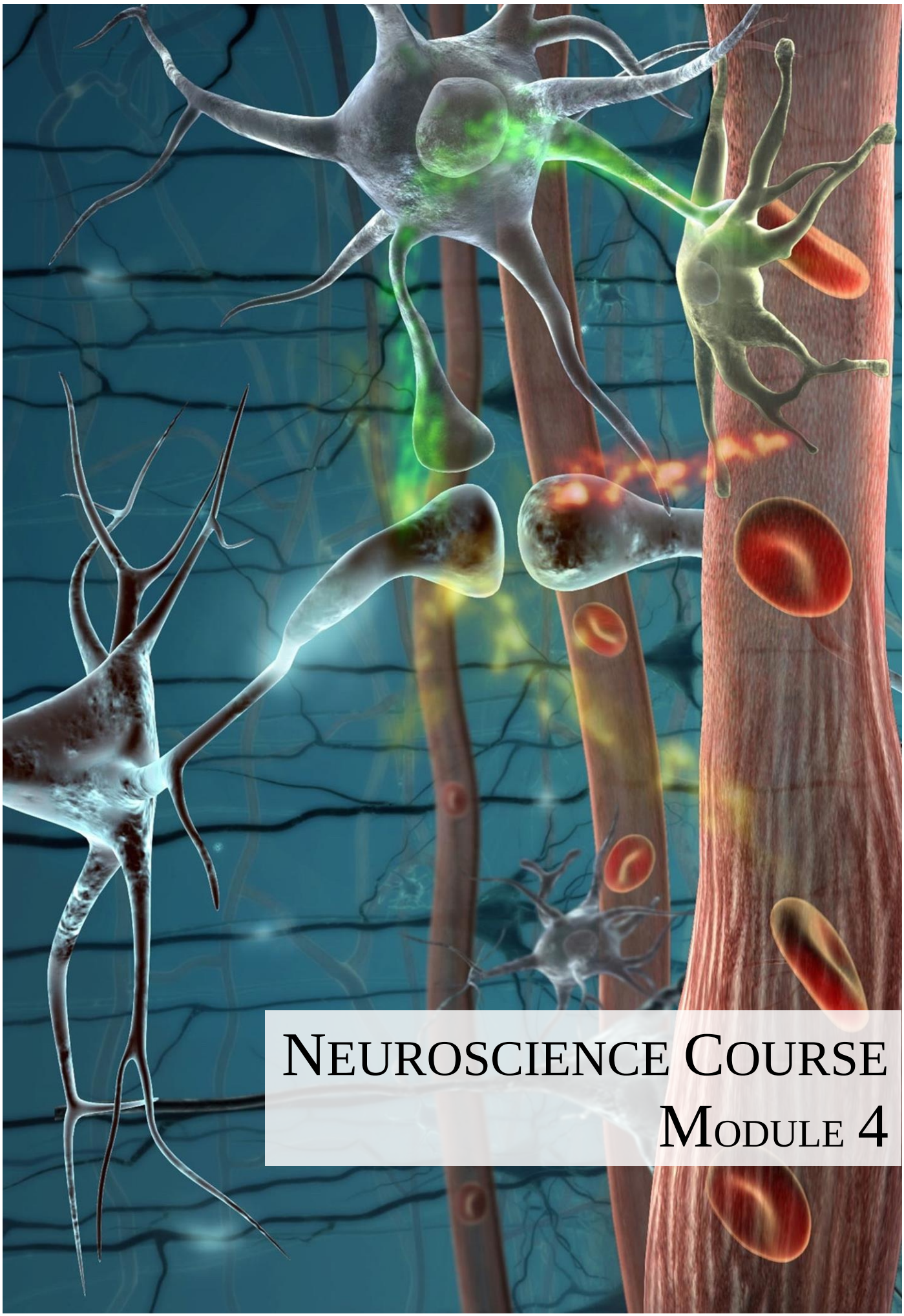


Neuroscience Course
Module 4

Module 4 :
ATTENTION

The word 'attention' comes from the Latin *attentio*, which translates as 'act of turning one's mind towards'. To gain a better understanding of this concept, we can also use the definition given by American psychologist William James. In his book that was published in 1890, *The Principles of Psychology*, he describes attention as being "the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought".

For neuropsychologist Eric Sieroff, attention "allows the individual to direct their actions towards specific objects in selected locations, and to keep certain information or certain objects at a high level of processing, in the working memory or in the mind".

The perspective from which we examine the issue does not matter. If we were to compare this concept to an object, it would probably be a beam of light: at a given moment, it illuminates a surface and highlights it in relation to the rest of the environment. In short, attention is the ability to focus on a subject, action or concrete thought for a given amount of time.

Attention is an ad hoc phenomenon. We can only concentrate on something for a certain amount of time. After this, the attention is drawn elsewhere. The transient nature of attention is a necessity, not a flaw. Indeed, continued focus on just one thing will quickly lead to overexploitation and overloading of the neural circuit; like an electrical circuit, this overloading will cause it to be destroyed.

The brain mechanisms that control attention rely on a network of areas involving the two hemispheres. This process is controlled by three regions.

- **The thalamus:** along with the reticular system, it forms the vigilance system. This is involved in filtering of information and the alertness mechanism.
- **The posterior cortical regions:** with the occipital, temporal and frontal regions, they make up the posterior network. This responds to selection of information, as well as unconscious direction of attention.
- **The prefrontal areas:** these create the anterior network and control the deliberate alteration of attention, its direction, shared attention and the sorting of relevant information.

Multidimensional aspect of attention

Attention plays an important role in the integral functioning of the body. Although this statement might seem presumptuous, it is not. In order to understand this, we simply need to analyze its importance. We would not be able to memorize information without paying attention to it. The entire learning process is built on humans' ability to pay attention to what is going on around them.

Attention is one of the body's survival functions. It can be directed towards a specific target or split between several objects. It is also an evolutionary principle. A newborn's abilities are far weaker than those of a 2- or 3-year-old child. In the same vein, adults will display a greater ability to concentrate. Like many of the body's functions, it deteriorates with age. The capacities of people of advanced age are weaker than those of an adult in full possession of their faculties.

Attention can be improved using appropriate exercises. However, it is important to understand that it is not infinite. For example, it is impossible to focus your attention on all the spectators in a stadium.

Furthermore, the more the scope of action widens, the weaker attention becomes. It is also selective and restrictive: it is possible to focus on either a specific target or a global target, but not on both at once. It is impossible to find a compromise or middle ground between these extremes.

With regard to the limitations of attention, it is important to differentiate mental attention (internal) and attention to our surroundings. We can concentrate on mental images for longer than physical ones. However, it would be impossible to follow a math, physics or history lesson, or indeed any other subject, for more than 4 or 5 hours in a row with the same level of attention retained throughout.

Generally, after 45 minutes, the brain needs to take a break, if only for a few minutes, and direct the attention to other activities (looking out of the window, talking to a neighbor, doing some physical exercise: anything goes when it comes to distracting the mind for a few moments).

The maximum duration of attention and that of the relaxation phase depends on the subject's capacities, but also the amount of interest they have in the activity in question. On television, we often see people who have fallen asleep or who are playing with their phone during official ceremonies, especially if long speeches are being given. The greater the amount of interest in the activity, the greater concentration will be, and vice versa. When we have to focus our attention on a challenging or unappealing activity, we get tired more quickly.

Attention is based on several pillars: a deliberate choice and a mandatory selection.

✪ A deliberate choice made by the subject

Although we sometimes focus our attention on a situation involuntarily, this phenomenon is generally intentional. Moreover, even unwanted attention is very often the result of the subject's prior experiences. Involuntarily or not, a member of the special forces and a mere civilian will never have the same perception of the environment. In the same vein, architects, engineers, doctors and journalists will always have a different perception of the world, even if they experience the same event at the same time.

✪ A mandatory selection

The environment in which we develop is constantly sending the nervous system a wealth of signals and information that it is important to analyze. However, the body would be devoid of all its functional capacities if it were to focus on all the information it received. Sorting is required, and attention makes it possible to eliminate any information the brain deems to be superfluous and thus concentrate on the important data.

People who have lost the use of a sensory organ are faced with huge difficulties, at least for a few hours, when they regain it. It is not uncommon to hear people who were previously deaf complain after getting their hearing back because their body does not have the ability or has lost the capacity to sort through sounds.

Attention is a phenomenon whereby the body distributes its processing resources effectively. Let's look at an example to illustrate this.

What is the answer to the following operation: 2 + 2?

What is the answer to the following operation: 367930267490629 x 12?

Solving the first operation will not require an adult to engage their full attention. It is a problem they have solved many times and that their brain can solve automatically. Even upon awaking from a deep sleep, they will be able to give the answer with ease.

Solving the second operation is much more complex. If the subject is given the exercise on a sheet of paper, they will have to make do with trying to solve it, then check that their answer is correct. On the other hand, if the operation is read out to them, the first thing they will have to do is concentrate in order to remember the number: to do this, they should not pay attention to the figure as a whole (which they are unlikely to remember), but rather concentrate on groups of numbers. This gives the following options for associations:

367930267490629 à 3 67 93 02 67 49 06 29

367930267490629 à 367 930 267 490 629

367930267490629 à 3679 3026 7490 629

After this, it all depends on the subject's memory capacity.

Selective attention

The previous example easily illustrated what selective attention (also known as "focused attention") is. Selective attention is the ability to draw up a list of priorities. The body can do this automatically, unbeknownst to the subject (this is the case when processing sensory information), or deliberately (during a lesson at school or a meeting at work).

The state of focused attention is not easy to reach, especially when it is voluntary. People who suffer from extreme distractibility or hyperactivity struggle to direct their attention towards a specific objective. Their attention is often disturbed by sensory stimulations (these are very often auditory or visual stimuli). To focus their attention, these people often have to get rid of as many disruptive factors as they can.

For a writer, this might mean setting up in a room that only contains a desk and a chair. All the windows on their computer will be closed apart from those that are genuinely useful for their work. They will also keep away from their phone and have it on flight mode or silent mode beforehand. Selective attention is always intentional.

There are two main models of selective attention: the early selection model and the late selection model.

Early selection models

There are several early selection models: the Broadbent model, the Treisman model, Posner's spotlight model, Eriksen's zoom lens model and LaBerge's model.

✪ The Broadbent model

Also known as the *selective filter*, this selection model suggests that our ability to process information is limited in terms of capacity and that our selection of the information to be processed takes place early on in the perceptive process.

The Broadbent model can be outlined as follows:

Incoming information > Sensory data > Selective filters > Detection > Conceptual processing models > End of processing

✪ The Treisman model

Treisman proposed that attention functions by means of an attenuator and not a filter. This attenuator identifies a stimulus based on physical properties or meaning. Schematically speaking, the Treisman model is set out as follows:

Incoming information > Sensory data > Attenuator filters > Detection > Conceptual processing models > End of processing

✪ Posner's spotlight model

This model relates primarily to visual stimulations. The principle is the same as that of a spotlight. The eye follows a host of events and only lingers on the event or events that are noteworthy. The spotlight in question can potentially be adjusted. The subject makes a voluntary choice as to whether to direct it over a large surface or focus it on one concrete point.

✪ Eriksen's zoom lens model

This model complements Posner's spotlight model. The zoom lens implies focusing the attention on a given object. It might involve focusing one's attention on a small dirty mark on the underside of a pair of dark-colored shoes. The subject has the flexibility to focus their attention as much as possible on a detail that most people would not even have noticed.

✪ LaBerge's model

This model alludes to a river with several branches, one of which suddenly becomes vast and floods all the others.

Late selection models

The principle remains largely the same as that of the early attention models. There is just one difference: the selective filters or attenuators are found in the short-term memory.

✪ Divided attention

Divided or shared attention is the ability to focus the attention on several targets without it being reduced. For everyday tasks or tasks in which the subject has a high level of expertise, the state of divided attention is relatively easy to reach. Sharpening a pencil while watching television, eating while listening to music, or tying shoelaces while talking to someone are not difficult tasks.

Things become more complicated when there are several complex tasks that need doing, or tasks that we struggle with. Speaking in a foreign language in which you only know the very basics while writing in another language (whether your mother tongue or another foreign language) will be extremely difficult. The subject will be forced to stop one activity in order to focus on the other because splitting their attention equally between several objects will require a large attentional capacity.

Sustained attention

It isn't uncommon for people to see sustained attention and vigilance as the same thing. In reality, however, they are two different concepts. Sustained attention implies the need to focus on a concrete situation or activity for a long time, thus calling upon different sensory modalities such as the auditory and visual modalities.

During this phase, the subject focuses their attention on one task. Piloting a plane, typing a text on a computer or driving a car are all activities that require sustained attention. This process involves engaging vast attentional resources.

Vigilance is part of another register. Although it also requires sustained attention, it is aimed more at maintaining a certain state of alertness in relation to an event or certain events, for example keeping an eye on a baby while doing the ironing or watching traffic lights, waiting for them to change to green. However, we have to recognize that in some cases (in the event of danger or in dangerous situations), vigilance requires the mobilization of a great deal of relational resources.

Joint attention

This form of attention involves several people. Take the example of a child who follows their mother's finger with their eyes and looks in the same direction as her when she attracts their attention to an activity or event going on around them. The notion of joint attention involves a phenomenon of discovery, of awareness of one's body and environment. This is one of the fundamental concepts of language development as it makes it possible to connect objects to words.

Attentional alertness

This form of attention takes into consideration both environmental (external) factors and internal factors (priorities, interest in the activity going on, motivations, etc.). Attentional alertness is split into two subgroups: tonic alertness and phasic alertness.

Tonic alertness

This is comparable to waking and translates into gradual, generalized and involuntary modifications of attention. This state is observed primarily in the morning, or at most in the first part of the day. Combined with sustained attention, it helps the subject to start the day in full possession of their faculties.

Phasic alertness

This type of attention is geared towards time. It is the sudden, transitory modification of alertness caused by a warning signal that evokes a more rapid response to a given stimulus.

Spontaneous attention is described as exogenic while intentional attention is described as endogenic. The former is an automatic process that takes place sometimes unbeknownst to the subject (for example suddenly noticing someone's bag in the middle of a huge crowd simply because it has a funny badge on it). Intentional attention is a fully thought-out action.

Development of attention from birth to adulthood

The development of the human brain is a process that begins during the third week of the gestation period with the differentiation of the neural progenitor cells. It continues until the end of adolescence at least, and likely throughout life.

The evidence of the development of attention in infancy stems from several behavioral paradigms, based mainly on analysis of babies' eye gaze. Indeed, the behavioral and physiological signs that mark the development of attention can be identified very early on in life.

The work of Jean Piaget, a specialist in the study of cognitive development, helps us to understand the development of attention from the fetal stages to adulthood. He proposes a detailed approach to the process, taking into consideration both the specific characteristics of the child and the environment in which they develop.

According to Piaget, the cognitive evolution of all living things rests on two complementary pillars: accommodation and assimilation. Accommodation is a form of adjustment of the individual to the environment. It is always accompanied by a reorganization of the individual's internal resources. Accommodation is a forced process that the subject has no choice but to undergo. Assimilation describes the process during which the individual adapts their environment to their needs.

Ultimately, cognitive development is a balancing exercise during which the individual progresses gradually through learning. This process is divided into four main phases:

- **From 0 to 2 years**: this phase is known as the sensorimotor stage. It could actually start being evaluated prior to birth, from the third trimester of pregnancy. The child learns to perceive the world using their sense organs and motor skills. They pay attention to sounds, focus on colors and their variations, flavors, and the different tactile sensations. They slowly process causal and spatiotemporal relations between the elements around them.
- **From 2 to 6 years:** this is the preoperational stage. The child, who already has a certain grasp of language, discovers the concept of quantification. They learn to pay attention not only to the objects around them, but also to their number.
- **From 6 to 10 years**: this is the concrete operational phase, during which the child develops a sense of physical property.
- **From 10 to 16 years**: this is the formal operational stage. The child is no longer content to use or copy the reasoning of those around them. They also no longer limit themselves to taking a logical approach to facts. They now propose ideas and hypotheses that they consider coherent, drawing on personal observations and thus using reasoning. This is the hypothetico-deductive approach.

To Piaget, the cognitive development of all individuals cannot be identical given that each phase forms the foundation for the next. It is impossible to skip or anticipate one of the stages. This approach has been taken up but also supplemented by certain scientists. Case, for example, notes that Piaget's vision is only possible if the environmental conditions in which the child finds themselves allow it.

Siegler, meanwhile, starts from the fact that the child has a variety of cognitive strategies that enter into competition. He proposes a principle of *overlapping waves*, which suggests that every child has several development scenarios. Each one adopts the appropriate strategy (or strategies) based on the circumstances.

Cognitive development (and the development of attention along with it) takes place in parallel to brain maturation. The primary, visual and auditory somatosensory regions, as well as the reticular system and all the structures associated with it, only mature at the end of the first year of the child's life. The association cortex only reaches its optimal state at the end of the fifth year. Maturation of the temporo-parieto-occipital junction only occurs at the end of the eighth year. The prefrontal cortex is the latest to develop: it is only complete by the age of 24.

These significant discrepancies are due to the state of the brain itself. Several studies have revealed considerable differences between the consistency of white matter in a child's brain and in an adult's. Development is both qualitative and quantitative. From a qualitative perspective, in adults, the white matter is organized in an optimal manner, the myelin thickens, and the axons increase in diameter.

Quantitatively speaking, the mass of white matter increases in a linear manner: from birth to the age of 22, it increases by around 12%. In parallel, a significant reduction in grey matter occurs. However, it is important to note that the increases and losses are not uniform across all the areas of the brain.

In the occipital region, for example, the percentage of grey matter increases. In the temporal, frontal and parietal lobes, the percentage of grey matter varies. It changes and peaks during adolescence before falling again.

Most of the changes occur in the very first few years after birth, but overall maturation is a slow process. Each lobe has its own rhythm. The posterior areas mature more quickly than the anterior zones.

Why is it important to consider brain maturation when discussing attention? Behavioral and cognitive development are conditioned by brain maturation. Studies conducted on selective visual attention in adolescents have shown that there is a direct relationship between the maturation of the areas of the brain that control this zone and the process in question.

From birth, children pay attention to those around them. However, the subject of this attention varies with age. From the first few days after birth, babies focus exclusively on the faces of the people around them. It is not until the second month of their life that they start giving attention to the rest of the body.

Interest in objects and the environment arises from the beginning of the third month. At this age, babies take just as much pleasure from looking at a corner of their room (or of the room they are in) as they do from a toy being given to them. From the sixth month, their interest in objects increases significantly, even if the level of interest in their environment and surroundings does not decrease.

From the age of 3, children develop their own selective attention strategy, which then improves with time. We note two clear phases of development: at the age of 5 and after the age of 9. The last phase (from 9 years and onwards) is a crucial step in the development of selective visual attention.

Several researchers have observed that there is a fundamental difference between perception of global and local shapes after the age of 5. There is a marked improvement in the perception of local

shapes from the age of 6, and the same phenomenon then occurs for global shapes after the age of 8. The selective, auditory and visual attention of children aged 10 and over are far better than those of younger children.

Studies conducted by a team led by Schul, Townsend and Stiles showed that subjects' attentional orientation improved with age. The study group was made up of individuals with a minimum age of 7. This could be put down to experience acquired by the older subjects, but this would be incorrect. Studies carried out into serial research processes, for example, have shown that the capacities of children aged 7 and older are exactly the same as those of adults.

It is impossible to deny the correlation that exists between the subject's experience and their cognitive capacities. However, the improvement of cognitive abilities in general and overall attentional abilities is largely the result of maturation of the regions of the brain that control the different attentional processes.

The difference between concentration and attention

Concentration and attention are two completely different concepts! This statement is both true and false. Attention and concentration are indeed different concepts.

Attention focuses the senses on an internal or external reality. In addition, it guarantees optimal perception of the information received. It is a process that is sometimes difficult and that can be directed, but which is always followed by engagement of all the body's attentional capacities. In short, attention contributes towards the body's openness to its environment.

Concentration has an opposite objective: to close the body off to external stimuli completely and incite it to isolate itself. The goal of concentration is to push the individual to focus all their attentional resources on processing one specific piece of information over the rest. Concentration makes maximal use of the working memory.

From this perspective, concentration and attention are different. However, when we compare concentration and sustained attention, there are some similarities. Both principles involve the convergence of all the attentional resources towards one clear objective. Furthermore, both unfold over a large period of time. In short, concentration is a heightened form of attention.

Cognitive attentional disorders

Attentional disorders and problems have various origins. They may be linked to age or result from conditions and injuries. There are two main categories of attentional disorders: primary and secondary disorders.

Primary disorders are significant neurodevelopmental conditions. These include attention deficit disorder (ADD) or attention deficit hyperactivity disorder (ADHD). Secondary disorders, meanwhile, are affective disorders. Let's take the example of an anxious or stressed individual. A state of

inattention or impulsiveness will be a normal reaction to environmental pressures. However, these secondary disorders sometimes represent more significant conditions.

✪ Ageing

With age, it is normal for attentional capacities to decline. The whole body suffers from degenerative issues. From the age of around 65, people have to make more of an effort to remember things because their attentional faculties diminish. They forget things more often. Getting lost in the street, forgetting someone's name or face, losing things or not remembering where they put them and not being able to carry out several tasks simultaneously all become more frequent occurrences.

✪ Inattention

Inattention is the inability to focus one's attention in order to complete a task. At first sight, inattention seems like a relatively unimportant phenomenon that does not merit being considered a problem. We all experience periods of inattention linked to stress or fatigue. However, sometimes this state occurs frequently, and the subject is not able to bring it under control.

✪ Impulsiveness

Impulsiveness translates as a difficulty controlling oneself and maintaining attention. It manifests as excessive and impulsive reactions and is classified in the same register as inattention. It is an insignificant issue if it does not arise frequently, but if it recurs and is associated with other mild problems, this may indicate that the subject is suffering from a severe attentional disorder.

✪ Attention deficit

✦ ADD

ADD, or attention deficit disorder (without hyperactivity), is a neurological condition that manifests as a deep state of inattention. Children who have this condition have a poor short-term memory. They are lazy, shy, withdrawn, virtually invisible at school and experience huge difficulty forging connections with those around them. They may also have trouble sleeping.

✦ ADHD

ADHD is attention deficit hyperactivity disorder. Individuals who have this condition, like those with ADD, are not able to focus their attention. However, their state is different. They are restless, aggressive, tyrannical, irritable and challenging. They forge relationships with others easily but are unable to maintain them.

The causes of ADD and ADHD are the same. The condition can be genetic, or the result of the mother's poor lifestyle during pregnancy (smoking, excessive alcohol consumption), exposure to harmful chemical substances during pregnancy, or a traumatic brain injury.

✪ Delirium (CMI 10)

The organic brain syndrome is characterized by the appearance of problems with consciousness and attention. This condition also alters the memory, emotions, perception, etc.

✪ Injuries, degenerative processes and brain damage

These three factors can cause attentional problems. Injury (or trauma) to the frontal lobe can lead to problems with attention, which will manifest as increased distractibility and an extreme inability to

concentrate. These processes are irreversible. Nevertheless, it is possible to relieve the most bothersome symptoms through rehabilitation.

Attention tests

The attention tests chosen for use during an assessment depend on several factors. These include the individual's age, the type of attention being assessed, and the reasons for them being taken.

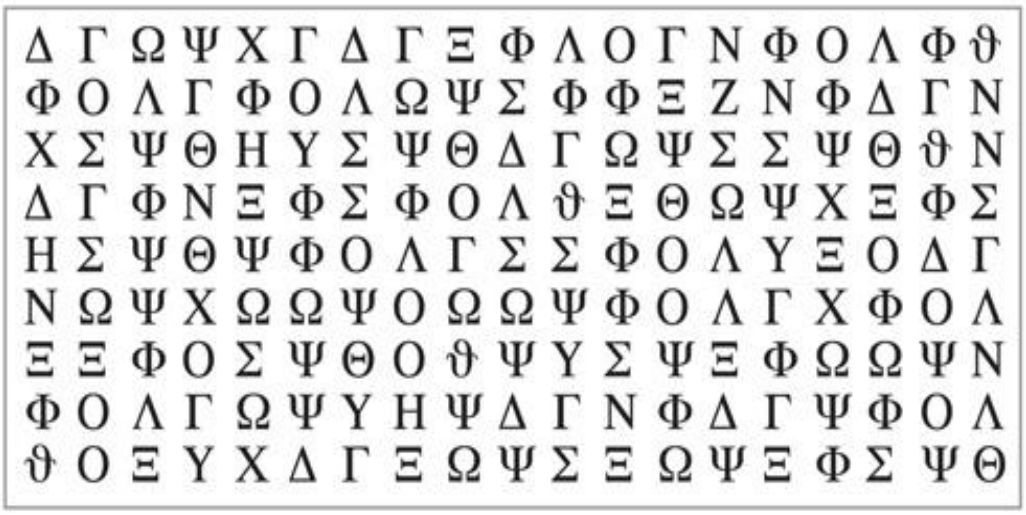
The tests for young children are different to those for adults. The same is true for the tests that are taken during a job interview or to get a driving license. Nevertheless, some tests can be used in all circumstances and adapted to the needs and skills of the person being tested. This is true of the Wechsler test which, despite assessing intelligence, also evaluates the subject's cognitive faculties, including attention.

Below, we will look at a few examples of attention tests. They cover the evaluation of several types of attention.

✪ Test 1

There are two of each item, with the exception of 5 objects. Which ones?

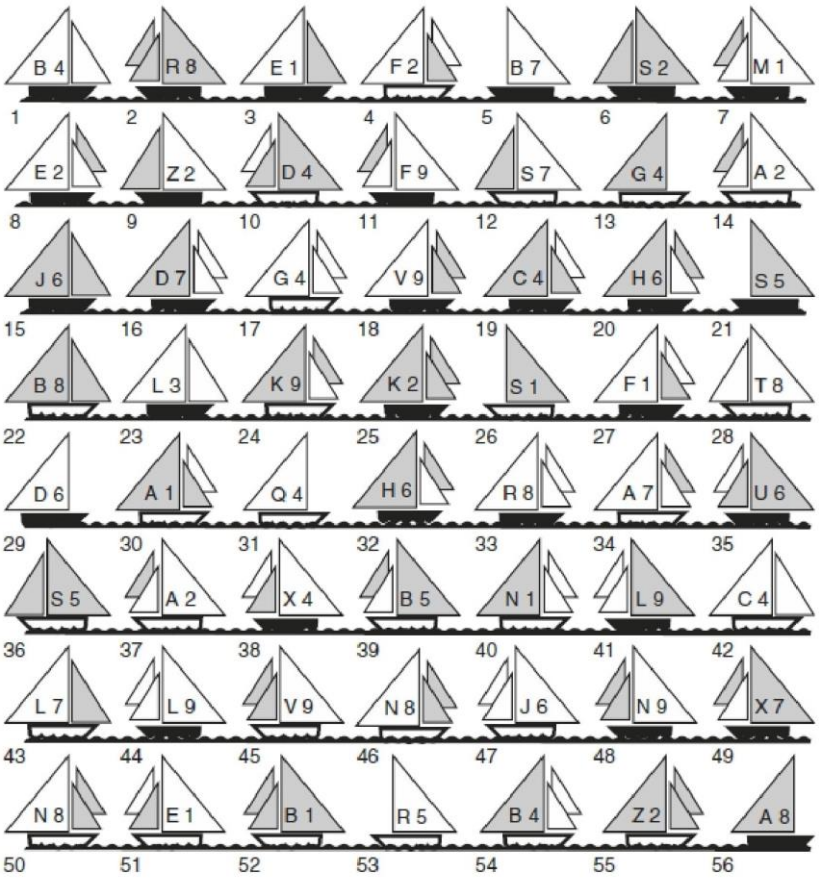
✪ Test 2



A. Δ Γ B. Ξ Φ C. Ω Ψ

How many times do the pairs of letters that indicate A, B and C appear in the grid?

✪ Test 3



How many boats with a light-colored hull and at least two dark-colored sails are facing towards the left?

a. 1 b. 2 c. 3 d. 4 e. 5

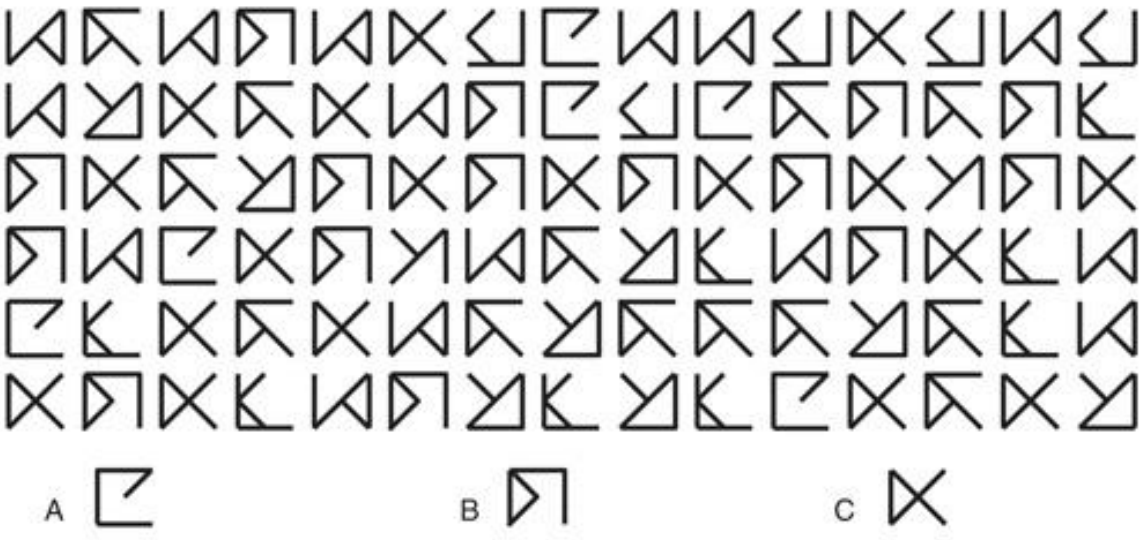
How many boats with sails in identical colors have a number higher than 5?

a. 9 b. 10 c. 11 d. 12 e. 13

How many boats with a dark-colored hull have only light-colored sails, or vice versa?

a. 9 b. 10 c. 11 d. 12 e. 13

✪ Test 4



Count how many times the three signs appear in the grid.

✪ Test 5

This test primarily seeks to assess the subject's sustained attention.

Below is an extract from a text by Honoré de Balzac.

"The little boys and the smallest of all, for lack of a mother's care, were martyrs to chilblains and chaps so severe that they had to be regularly dressed during the breakfast hour; but this could only be very indifferently done to so many damaged hands, toes, and heels. A good many of the boys indeed were obliged to prefer the evil to the remedy; the choice constantly lay between their lessons waiting to be finished or the joys of a slide, and waiting for a bandage carelessly put on, and still more carelessly cast off again. Also it was the fashion in the school to gibe at the poor, feeble creatures who went to be doctored; the bullies vied with each other in snatching off the rags which the infirmary nurse had tied on. Hence, in winter, many of us, with half-dead feet and fingers, sick with pain, were incapable of work, and punished for not working. The fathers, too often deluded by shammed ailments, would not believe in real suffering."

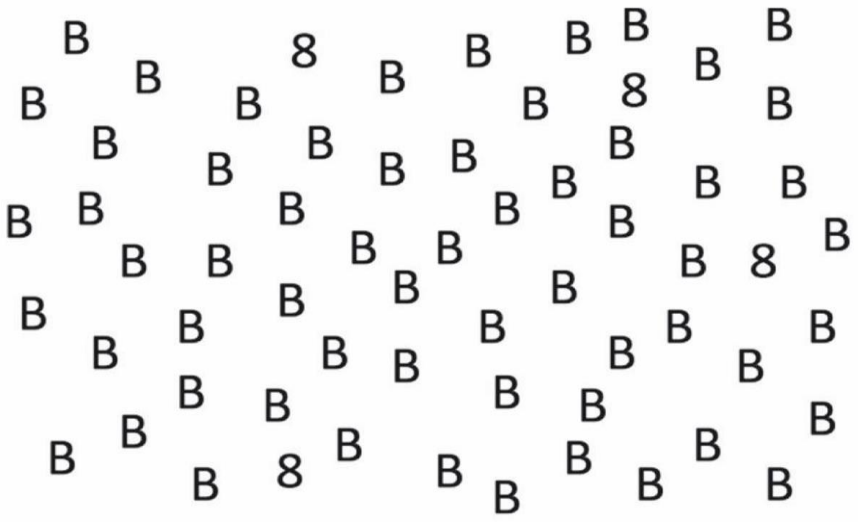
Write down how many times the letter "L" appears in the text.

Write down how many times the letter "C" appears in the text.

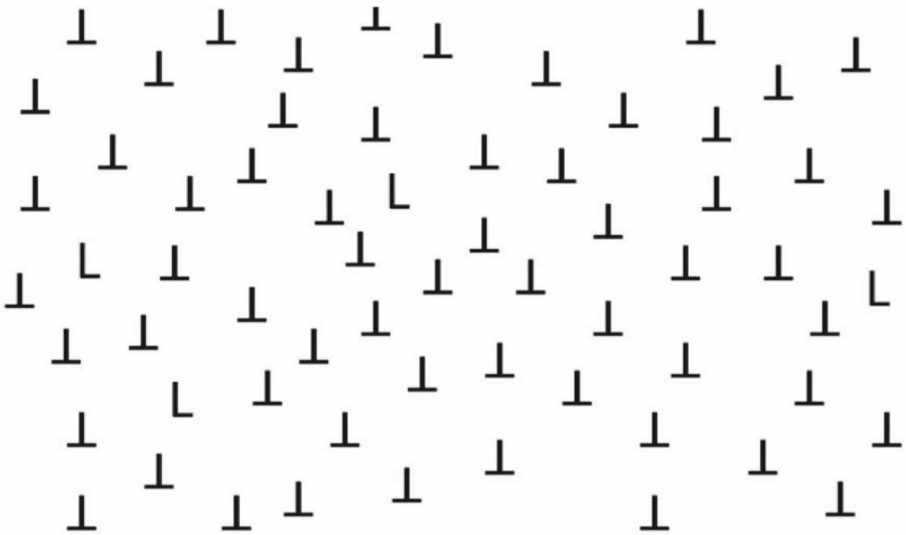
✪ Test 6

This type of test is also known as a barrage test. It assesses both visuospatial and sustained attention. This test is made up of two boards.

The first board is presented to the subject for 30 seconds. The subject has to find and circle (or cross out) the four number 8s they see in the image as quickly as possible. They are given instructions before being shown the board. The image is made up of 60 letter Bs and four number 8s.



The second board is made up of 60 inverted letter Ts and four letter Ls. The principle of the exercise remains the same as for the first board. The subject has to circle (or cross out) the four letter Ls. As in the first test, the instructions are given beforehand, and the subject can only look at the board for 30 seconds.



The outcome of the assessment will be the result of both tests. The examiner will need to analyze the subject's ability to find all the letters and numbers, as well as the speed at which the exercise was completed.

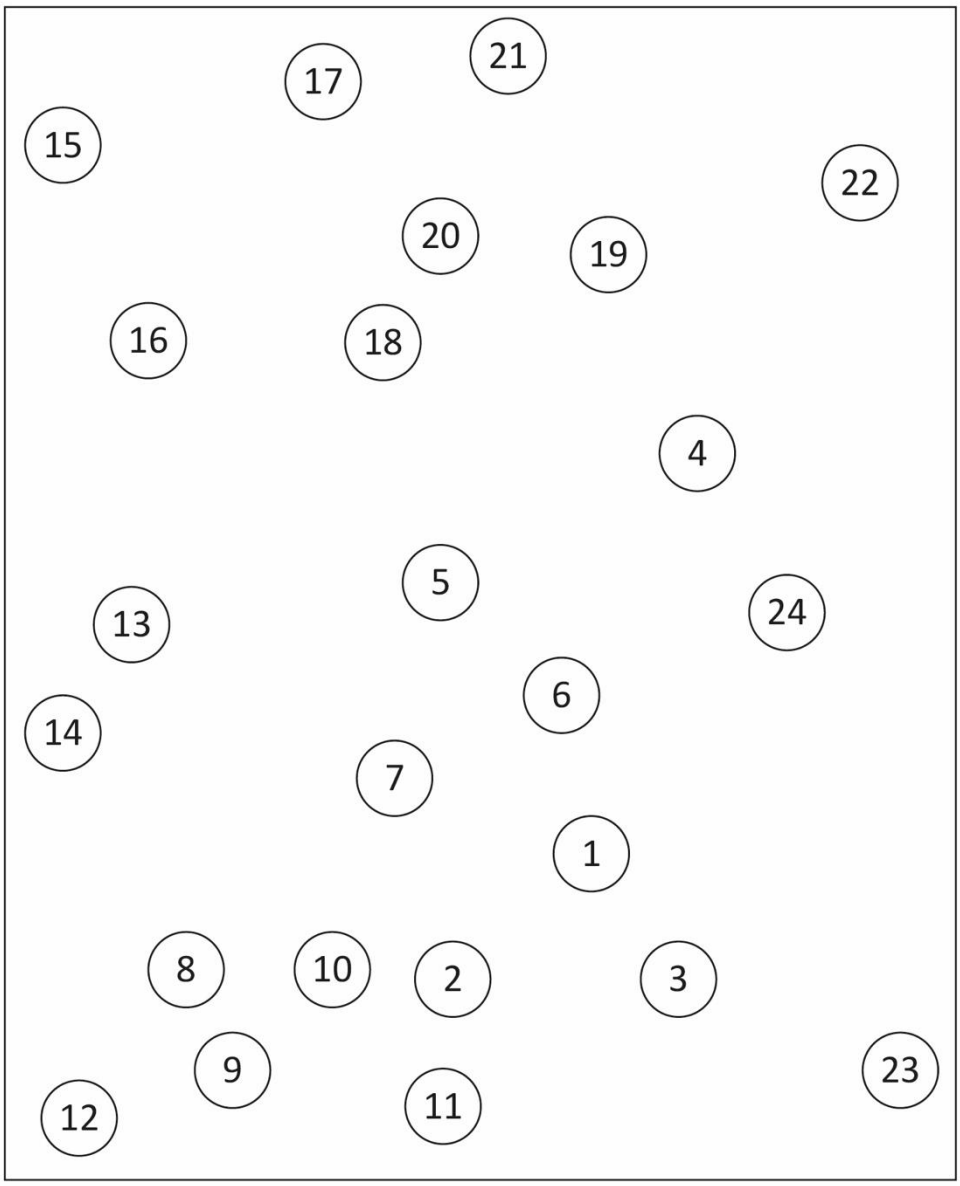
✪ Test 7 – Trail making test

This test is used to assess divided attention. Like the barrage test, it is made up of two parts. However, the way it works is a little more complex than the latter.

In these two tests, the examiner refrains from correcting the subject if they make a mistake. They simply point out their error and let them correct it themselves.

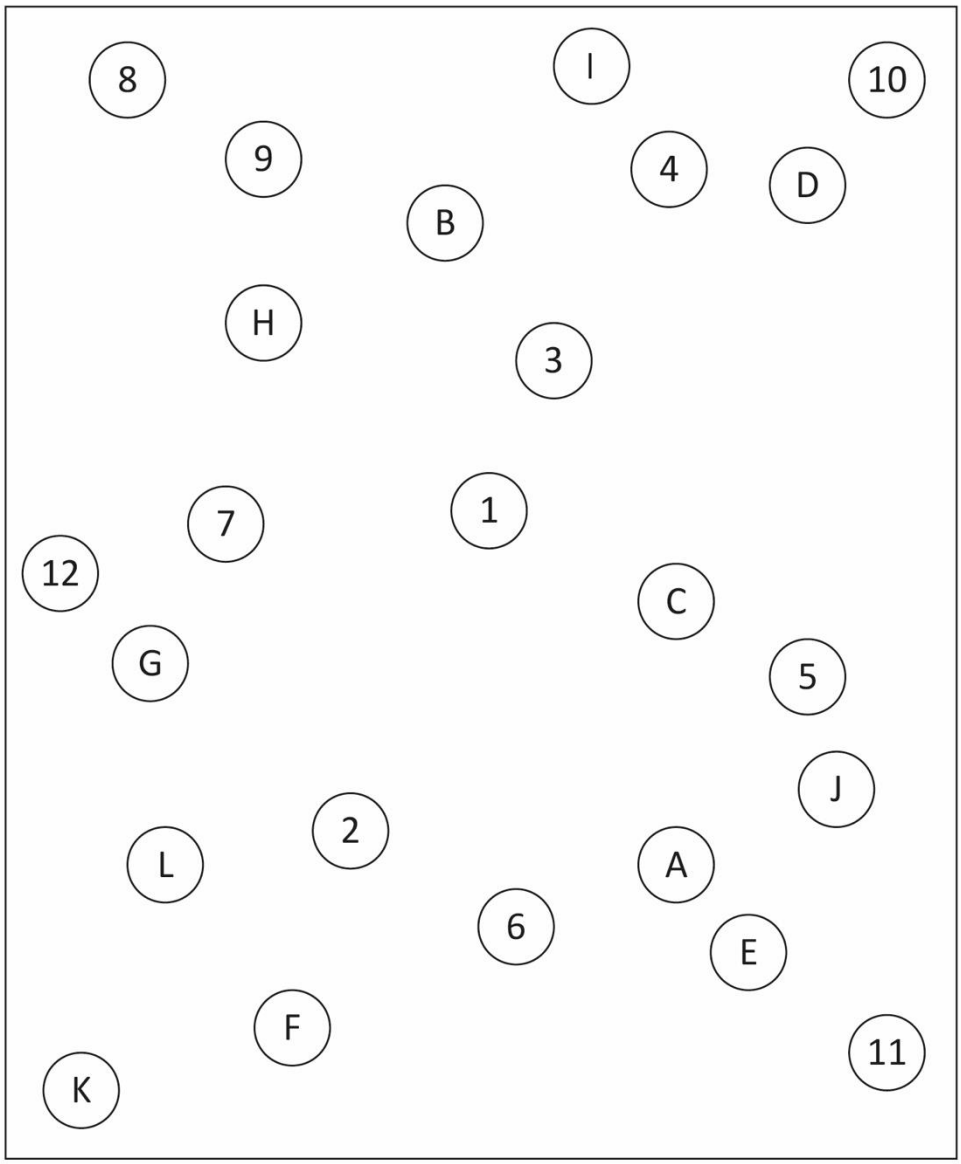
First board

Take a pencil and connect the 24 numbers on the list in ascending order as quickly as possible.



Board 2

This board contains 12 numbers (from 1 to 12) and letters (from A to L). The subject has to connect them, both in ascending order and alphabetical order (1-A-2-B-3-C-4-D, etc.). They need to complete the exercise without lifting their pencil off the paper.



Test 8 – Stroop test

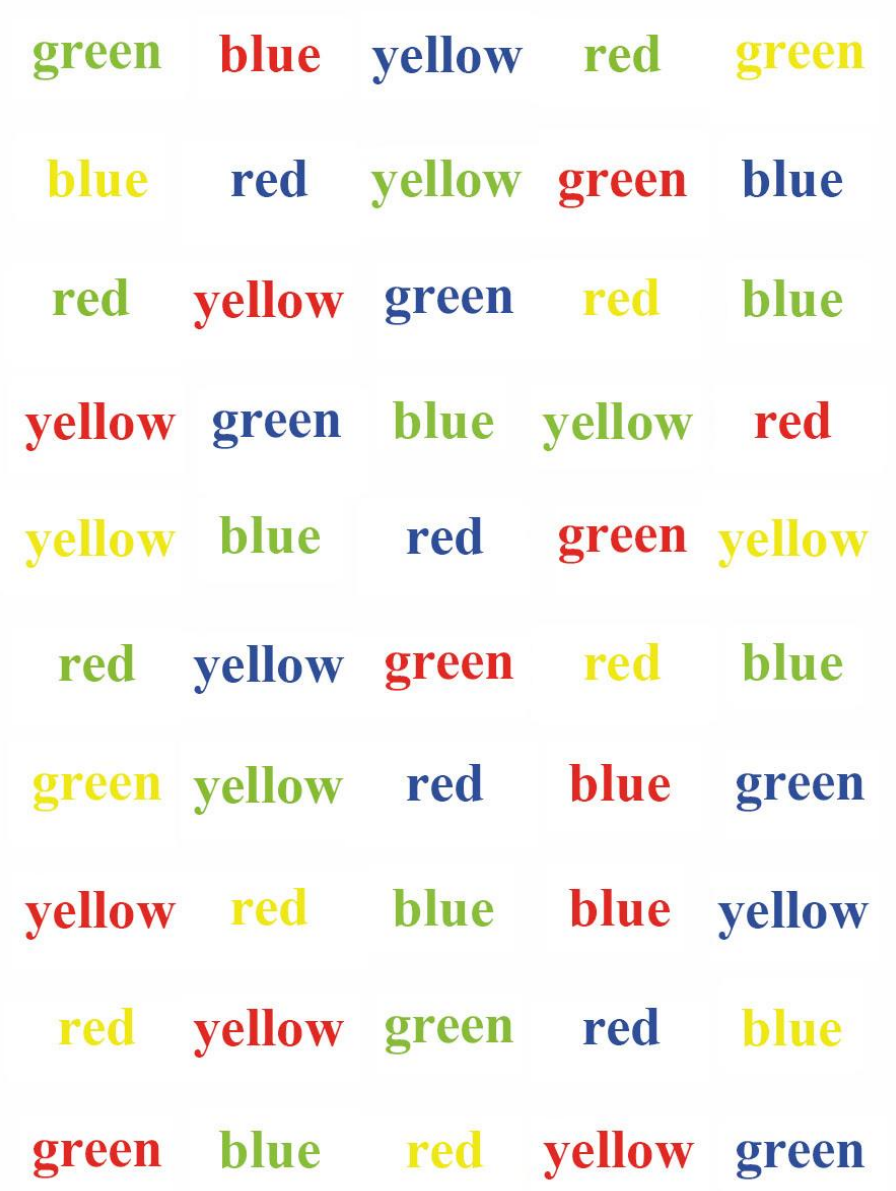
The Stroop test is divided into several tests. Its aim is to assess the selective attention capacities. There are also several variants of this test.

Variant 1 - Test 1

During this first test, the subject is presented with a board on which the names of colors are written in black. The subject simply has to read them.

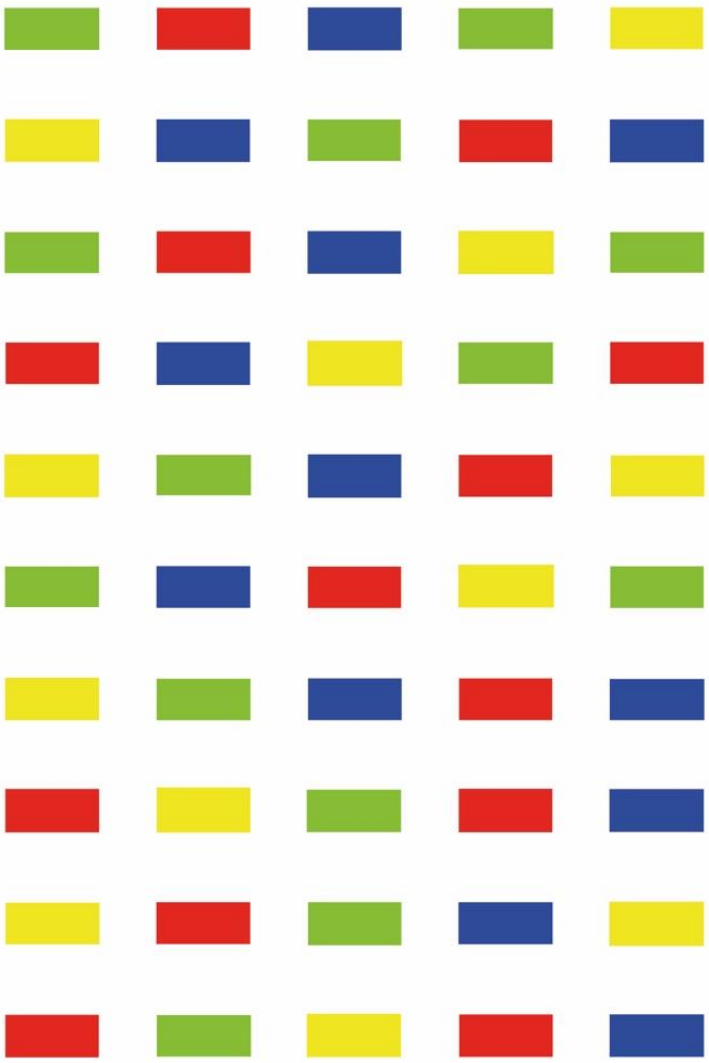
Test 2

The subject simply has to read the words in the following list.



Test 3

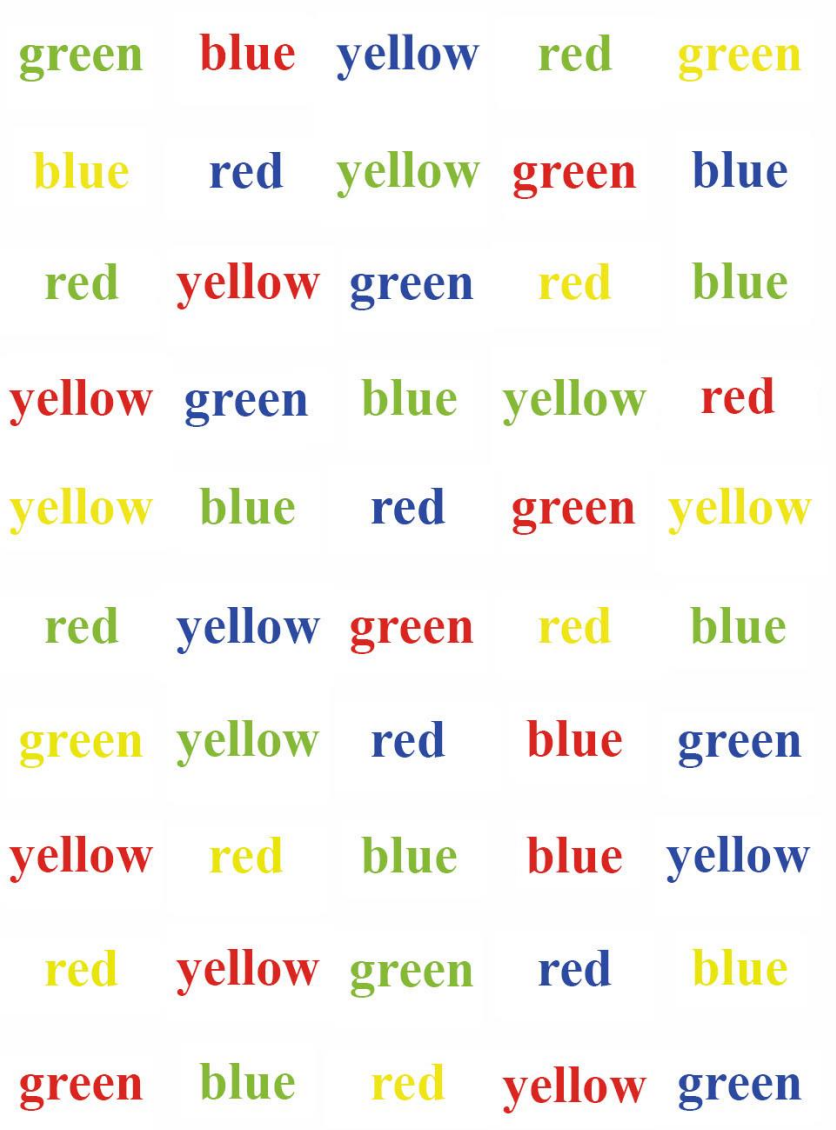
The subject has to state the colors of the different rectangles.



Test 4

The subject has to state the color of each word.

Difficulties involved in the test: although it might seem easy, this test is extremely complex because the subject is faced with a mismatch. It will not be easy to read “red” when the word in question is written in green. Thus, the subject will have to demonstrate extremely selective attention to accumulate as many points as possible in the test.



Variant 2 - Test 1

Write the first letter of the color of the word in the corresponding box, from top to bottom and left to right.

1	2	3	4	1	2	3	4
Red	Green	Yellow	Blue	R	G	Y	B
Yellow	Blue	Green	Red				
Green	Red	Blue	Yellow				
Yellow	Green	Blue	Red				
Green	Red	Yellow	Blue				
Yellow	Blue	Red	Green				
Blue	Green	Red	Yellow				
Red	Yellow	Green	Blue				
Red	Blue	Green	Yellow				
Blue	Red	Yellow	Green				
Green	Blue	Yellow	Red				
Green	Red	Blue	Yellow				
Yellow	Blue	Green	Red				
Blue	Yellow	Red	Green				
Red	Green	Blue	Yellow				
Blue	Yellow	Green	Red				
Green	Red	Yellow	Blue				
Blue	Green	Yellow	Red				
Yellow	Blue	Red	Green				
Green	Red	Yellow	Blue				
Red	Green	Blue	Yellow				
Yellow	Red	Green	Blue				
Blue	Yellow	Red	Green				
Yellow	Green	Blue	Red				
Red	Green	Yellow	Blue				

Test 2

The exercise is the same as it was for the first test. The subject has to write the first letter of the color of the word in the corresponding box, from top to bottom and left to right.

1	2	3	4	1	2	3	4
Blue	Yellow	Green	Red	R	G	Y	B
Red	Blue	Green	Yellow				
Green	Yellow	Blue	Red				
Blue	Green	Red	Yellow				
Green	Red	Blue	Yellow				
Yellow	Blue	Green	Red				
Red	Yellow	Blue	Green				
Red	Green	Yellow	Green				
Blue	Yellow	Red	Green				
Red	Blue	Green	Yellow				
Green	Red	Yellow	Blue				
Green	Red	Blue	Yellow				
Yellow	Blue	Green	Red				
Red	Yellow	Green	Blue				
Blue	Yellow	Red	Green				
Red	Blue	Yellow	Green				
Green	Blue	Red	Yellow				
Yellow	Green	Red	Blue				
Yellow	Blue	Green	Red				
Blue	Green	Yellow	Red				
Red	Yellow	Blue	Green				
Yellow	Blue	Green	Red				
Yellow	Red	Blue	Green				
Blue	Red	Yellow	Green				
Blue	Yellow	Green	Red				

Note: The difficulties remain the same as those encountered in the first variant. In test 1, the subject will have no trouble writing the correct letter, because the word matches the color in which it is written. In the second test, however, they will need to tackle the same mismatch as before.

We could also add the MoCA test, Wechsler test, de la Tour test or Wisconsin Card Sorting Test to this list. However, they all have the distinction of not being limited to evaluating attention. They also

assess the memory and visuoconstructive capacities, as well as conceptual change. The length of all the tests presented above is strict and limited. The subject must complete them within a given time.

Techniques to improve attention

There are many techniques that can be used to improve attention, but they should be selected on an individual basis. The ideal method needs to take into account the subject's age, and their physiological and psychological state. However, it is important to recognize that certain options work just as well with adults as they do with children.

✪ Healthy subjects

Under 'healthy subjects', we include people who have mild attentional problems, but also those who simply need to increase their attentional capacities. These techniques can also be used as complementary options during intensive therapies.

Board games

Board games are excellent for developing attention. In fact, they not only develop attention, but also memory and concentration. The choice of game or games will of course depend on the subject's capacities. Puzzles are suitable for all ages. The same is true for construction sets and chess, sudoku, crosswords, arrow-words, battleships, happy families, etc.

Games on the computer or phone

We will focus mainly on those that are versions of board games, but also arcade, simulation and role-playing games. In addition to improving memory, the latter encourage the subject to interact with other internet users. This is beneficial, providing that time spent playing games is restricted and does not prevent the subject from having a social life outside of the virtual world.

Mazes

Mazes are primarily strategy games, and it is not possible to talk about strategy without alluding to the attentional capacities. The approach the subject takes is important, especially when they tackle the task for the first time. Some people quickly spot lots of dead ends and choose an entrance that allows them to avoid as many of them as possible. Others always choose the same entrance, even after failing several times.

Regardless of the approach taken, in the long term, these games allow the subject to detect dead ends instinctively, even if they are tackling the task for the first time. They are just as suitable for children as they are for adults.

Visual-haptic training

This type of game is generally used to improve children's attentional capacities, but it can also be used with adults. The principle of the game is to get the subject to recognize the objects they are presented with, without using their sight. The examiner can hand them to the subject, place them on a support the subject can access, or encourage them to explore further by presenting them in a bag.

The objects to be identified can differ completely in terms of shape, size and structure. However, they can also be items that are difficult to distinguish between, which pushes the subject to make a

considerable effort. The subject can also be guided to put puzzles together or embed objects based on their shape.

Furthermore, the subject can play on their own or with others. The second option helps them to push themselves further, as they have to compete with the members of their group. The examiner will assess not only the subject's ability to complete the different exercises, but also the speed at which they do so.

Visual-haptic training is not limited solely to recognizing objects. It can also involve identifying letters and words. It is important to choose the letters to be studied and the distractor letters with great care, as well as how the whole process will unfold, on a case-by-case basis. Below is an example of an exercise for young children.

Exercise - Exploration and discovery of the letter R

We limit ourselves to choosing one letter during each exercise so the child can discover and assimilate it fully. The first step involves letting the child discover the letter calmly. To achieve this, they are given 3D models of the letter or invited to write it themselves slowly. The instructor can also blend the two approaches.

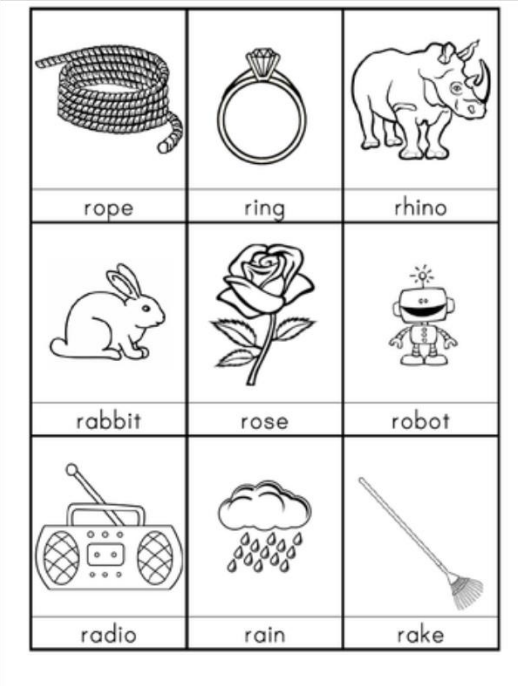
It is not impossible that the child will not be really interested and will try to use all the time required to explore rather than to complete the task they are given. In this case, they need some gentle coercion. The instructor can watch the child, calmly helping them to follow the shape of the letter.

The second step is to choose distractor letters. The principle of the game is to identify the correct elements among a host of distractor elements. As such, the distractor letters are obligatory. The choice of letters needs to be closely linked to the child's knowledge. However, they must comply with certain rules.

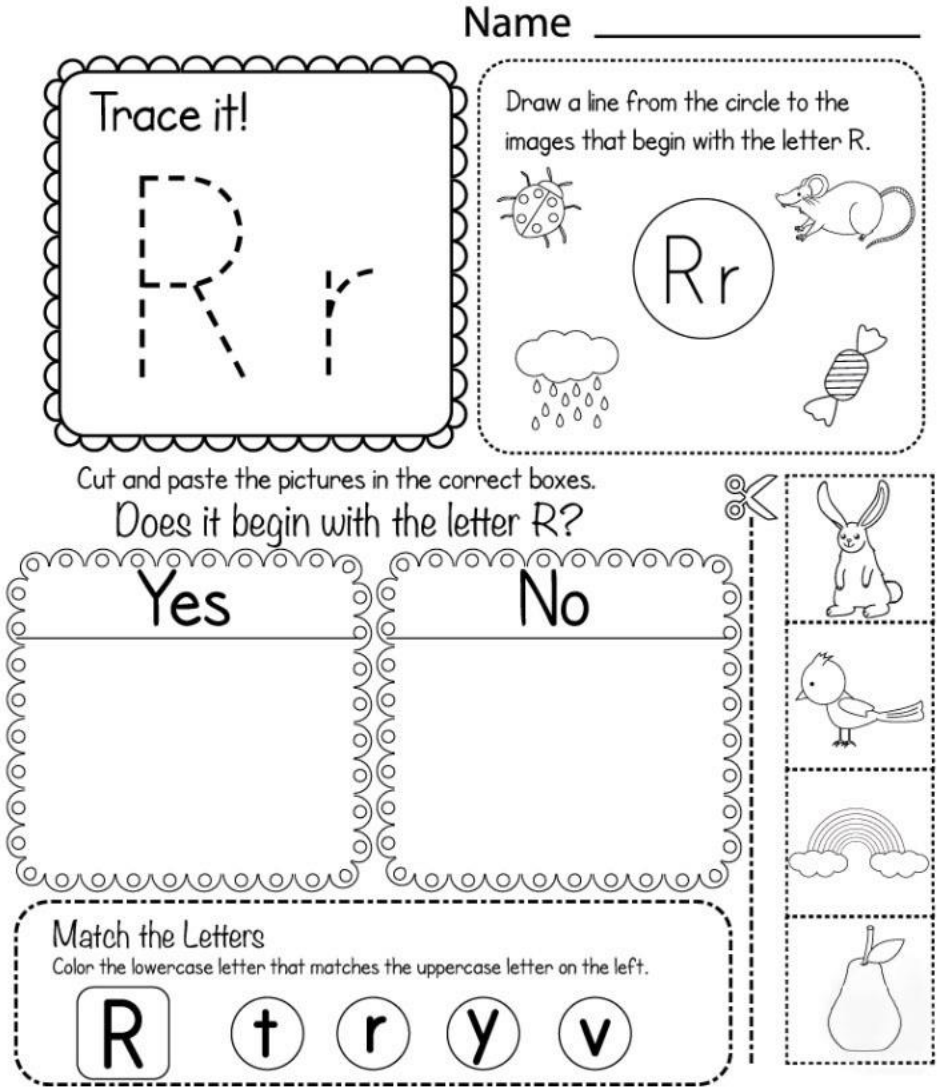
First, they need to be completely different in terms of structure. Second, it is advisable to offer as many distractor letters as possible (out of those the child knows, of course). Furthermore, these letters need to vary over the sessions, even if the main letter remains the same.

To improve the child's assimilation of the target letter, it is advisable to use nursery rhymes or little songs that encourage the child to repeat the target letter constantly. It goes without saying that the number of phases spent discovering and learning the letter must not last an unlimited amount of time; a few minutes will suffice. After this come the exercises themselves.

Words starting with "r":



Words finishing with "r":



The instructor should offer the child several exercises. They can be offered up to 9 exercises based on the individual case; it all depends on the child's age and cognitive state. Although the exercise takes place in a group, the instructor needs to invite the whole group to check themselves and each other. This means that, if one of the children makes a mistake, the group will be encouraged to point out the error and correct it.

Riddle/word to find

This game is a bit like a rebus. It is a strategy game: the individual needs to choose the option that will help them to achieve their objective as quickly as possible.

Situation 1 - The group is made up of 6 to 8 individuals, as well as the examiner. One of the subjects and the examiner choose the hidden word. The rest of the group has to guess what it is by asking questions that can only be answered with a "yes" or "no".

At the start of the exercise, the subject will give the group a clue: for example, it's a fruit, an animal, a sport, etc. The object or person in question can be in the same room as the participants. Here, the group member proposes an exercise to the rest of the group.

Situation 2 - The principle of the exercise remains unchanged, but the way it is carried out does not. This time, it becomes a team game. Each group will propose their riddle. The instructor can decide whether the winner is whoever solves the riddle fastest, or the group who manages to solve the most in a limited time.

The time spent on the exercise never exceeds 10 minutes. If the groups still have not completed the task given to them after this amount of time has passed, the instructor will decree that none of the groups won.

Mandala

Coloring mandalas is an excellent exercise for both young and older children alike. It does not only help to develop attention, but also reduces stress significantly.

Tactile games

These are perfect for younger children, especially when learning language. They involve drawing letters or objects with a finger on the child's body (back, hand or leg) and the child has to guess what object or letter it is.

Kim's game

This mental exercise, also simply known as a memory game, is very often used for children. The process is relatively simple and there are several steps.

It is important to mention that the number of objects needs to be reasonable: no more than four objects at once! The amount of time allocated for the description, analysis and memorization also needs to be reasonable: no longer than 30 seconds per object!

First step – The instructor invites the children to name the objects they take out of the bag. These will be objects the children recognize. The children have to not only name them, but also state what each object is for. If the instructor is working with very young children, they can start with a learning session during which they explain the function of each of the objects they plan to use for the game.

Second step – The instructor uses the same exercise, but this time without getting the object out of the bag. They describe it to the children, and they have to guess which object it is. It goes without saying that, during the first step of the previous exercise, the instructor must not rush. The children taking part must feel that there is real interaction between them and the adult.

Third step – This time, the child is given the central role, after being blindfolded or asked to close their eyes. The instructor can also hide objects under a sheet and ask the children if they notice which ones have disappeared.

Fourth step - Here, cards are used to replace the objects. The instructor no longer uses precise objects and instead uses photos, then drawings. Like in the first two steps, the exercise involves naming the object and describing its function.

✪ People with cognitive disorders

As mentioned above, all the techniques outlined previously can be used as part of a complex therapy, but more as complementary measures. For people with severe conditions, CBT (cognitive behavioral therapy) is used. The form used depends on the patient's cognitive disorders. For patients with ADHD, mindfulness-based therapy, cognitive remediation and many others can be used.

Individualised cognitive intervention

This method is used to overcome serious attentional problems and distressing situations caused by auditory hallucinations. It is based on traditional dichotic listening. The subject is played a recording (in one ear and then the other), then asked to repeat back what they heard.

Responding to requests

This method aims to get patients to come out of their shell. Therapists use it when all previous attempts to make the patient react have failed. It is a group therapy, during which the therapist sets an objective that must be achieved at all costs. It is generally something insignificant, for example repeating a word or phrase while looking at the therapist.

The crucial aspect is not so much repeating the phrase or word, but the ability to remain focused on the exercise from start to finish. It is very important to encourage patients to achieve the objective set by giving them praise (or through other means).

Shaping and practising skills

This involves offering the patient comprehensive care and support. First, the therapist detects the behavior that is most seriously lacking in attention and focuses the exercise on correcting (at least partially) this fault. The process is relatively long and based on the individual. The basic objectives need to be set extremely low so patients can achieve them easily. Once they do, the intensity and complexity of the exercises can be increased gradually.

Other forms of CBT

These are not always linked to attention, but they can be used as complementary techniques regardless of the individual's psychological and cognitive state.

- **Exposure:** this is a form of learning that contributes to the development of other cognitive functions. The individual adopts habits that will lead them to develop their attentional faculties.
- **Behavioral relaxation:** behavioral relaxation can take the form of sensory isolation, relaxation, verbal repetition or visualization of mental images. They encourage the subject to look inwards to find all the attentional resources inside them.
- **Cognitive restructuring**: through this form of therapy, a subject who is struggling with a flawed cognitive pattern is encouraged to rectify the problem by configuring their perception of things.

It is also possible to draw on certain methods for improving memory: adopting a healthy lifestyle (getting enough sleep, eating well, doing enough exercise and spending time outside, etc.) and doing cognitive exercises. Irrespective of the technique or techniques used, the key is that it suits the individual's needs.

Conclusion

Memorization and learning would be impossible without attention. Attention allows the body to evolve and adapt gradually to the environment from birth to adulthood. It is a cognitive function that is built on three axes: mobilization, mobilization of attentional resources and the rewards obtained after the efforts made.

Studies have shown that attention has several characteristics. On one hand, the reaction time is linked to the number of distracting factors. On the other, attention is a sequential concept; the information retrieved can only be dealt with in a precise order. Despite its sequential aspect, it unifies several sets of data to create a logic, compact whole. In automatic mode, it extracts the important information with ease, ignoring the distracting factors.

Furthermore, attention improves readiness skills by providing indications to help get started. Automatic attention mainly deals with general processes that do not require any special control, whereas voluntary attention handles all important elements and events. Contrary to popular belief, attention is not affected in any way by gaze direction. It is not uncommon for people to use their peripheral vision to linger on something visually.

Attentional capacities and resources evolve slowly. At birth, they are extremely weak. Humans pay attention primarily to actions that are important for their survival. Over time, their behavior changes, and for good reason: although attention conditions the individual's psychological development, it is also conditioned by the psychological state of those around them, from birth to adulthood.