

Handwriting is Brainwork

introduction

Writing by hand remains important

In this piece we tell what happens in the brain when written by hand. Writing by hand does more than we think! We live in a digital world. Writing is communication and that is fine by hand and keyboard. Handwriting stimulates our personal computer for a lifetime: our brain. The choice to continue to learn a flexible and readable handwriting can be made responsibly if all arguments are known. By also passing on the brain arguments, we hope to motivate you.

Hand-writing stimulates our brain

Writing promotes brain development. The brain needs stimuli to develop. Enrichment of the brain is possible from birth to old age! Today's brain function is the result of millions of years of learning to adapt and evolution. (14)

Things that cost effort stimulate the expansion and quality of the 'white fabric'. Writing by hand requires more effort from the brain than typing, because when writing, a nerve cell is always stimulated in a different way, making it stronger. (17) The history of scripture is similar to human possibilities for communication; from cave drawings to the connected script. Every child goes through these phases while playing and learning.

Writing by hand is a miracle

Writing is one of the most difficult neuromuscular tasks. (11) What is involved in writing? We mention motor skills, the cooperation between left and right hemispheres, motor planning, depth, visual perception, concentration and sensory awareness of the fingers. (31) It is a miracle that all these parts of the brain learn to work together so quickly that, as we write, we can give our attention to the spelling and content of the text and process what the text does to us. Below we take a closer look at the following areas: left and right hemispheres, neural connections, motor skills, spatial orientation, seeing, reading and language, emotion. ¹

In the follow-up to this article, 'writing' means writing by hand and in parentheses is the reference to the number of the literature list.

Left and right hemispheres

The introduction shows that many brain regions are active in order to perform the writing act. The connections between these areas must work well, because the data is constantly flashing back and forth. In it, the brain bar (corpus callosum) between the left and right hemispheres occupies an important place. In children who are able to write well, the white matter-coated brain pathways are more developed than in children who have difficulty writing. These two job systems play a role in many cognitive functions. The brain works asymmetrisch; de linker- en rechterhemisfeer spelen een verschillende rol bij het combineren van letters tot taal.

Lateralisatie

Lateralization occurs when the brain divides its functions to the right or left, and then one side develops dominantly over the other. Hereditary predisposition not taken into account. Fine motor skills play an important role in stimulating lateralisation. Handwriting is not just a motor skill. It requires the brain to process understanding and language by moving in agreed forms; the letters. With good lateralization, impulse control also increases, which finds its origin in the right side of the brain. If the left side can counterbalance logical reasoning, there will be more considered behavior. (35)

Dr. David Sortino recommends writing to stimulate the synchronicity of the brain. The right part, the visual, with the left part, containing the verbal and spatial areas of the brain. (7, 8) In particular, connected writing improves the dynamic interaction between the left and right hemispheres of the brain. (10, 12)

practice:

The right hand is controlled by the left hemisphere and the left hand by the right hemisphere. Therefore, let preschoolers work a lot of two-sided and two-handed (32) – both motorily and on paper to activate both hemispheres of the brain.

When learning to write, the collaboration between the two hemispheres of the brain can be promoted by, among other things, making the lemniscate; the lying eight. Every movement of the writing letters (up, down, right, left, diagonal) is discussed when creating the lemniscate. (18, 32)

8-year-old girl. right-handed

She worked with two damp sponges two-handed on a hanging chalkboard (to music).

Neural connections

In a healthy brain, the nerve pathways are strengthened and even new neural pathways are built, partly due to learning to write. As a result, data is transported, coordinated and stored faster. It presents the brain with new challenges. The brain likes that! Neuroscientific studies show that twelve brain regions actively cooperate in writing. (21, 32). By continuing to offer the writing, we give every child this development opportunity!

More than 3,000 nerve endings in each fingertip, which are directly connected to the brain, are activated when connected writing. The movement of the writing act leaves a trace in the brain and that in turn ensures that we remember letterforms better.

An fMRI study with children at the University of Washington showed that moving the fingers activates thinking (4). This confirms the connection between motor skills and the words and phrases we put on paper. The same source mentions that connected writing helps to keep the focus on the assignment and the content of the text.

The connection of cerebral cortex and spinal cord – which reaches the fingertips and affects fine motor skills – is not fully developed until the age of ten. That's something to take into account. Writing is a fine-motor skill and therefore practicing it must continue to feed that brain activity. (23)

Writing training has a lasting impact on particularly important parts of the brain (6)

Two-handed working stimulates the development and maintenance of the neural connections between the two hemispheres of the brain

Locomotion

EXERCISE is necessary for a healthy life. Writing is moving over paper or other surfaces. The brain must have matured far enough through exercise to be able to put a letter shape on paper with a consciously controlled movement. The small motor skills are necessary to actually create letters, with which a word can be made. (9) It is important to start with the shape of the letters only if the student can steer the writing material in the desired direction. If one starts too early, it encourages cramping and frustration, literally and figuratively.

Brain functions can be organized in front, posterior, left and/or right areas. Motor functions are mainly attributed to the anterior brain regions, the sensory processes to the posterior brain regions. (14)

Motor skills are divided into large and small motor skills. Both are important for learning to write. They can be practiced independently of each other. The large body motor skills (proximal) are very important as a basis! Walking, running, maintaining balance, throwing, catching and estimating space are indispensable as a good motor and spatial basis for learning to write.

Healthy kids like to exercise. Writing is a small- motor exercise, which requires a lot of physical coordination. In the hand alone, 29 joints and 35 muscles must work together. Due to the sitting position, the pen grip and the movement, the whole body is involved in writing in order to achieve an optimal result. **Writing is top sport**: a unique human skill, acquired through a lot of practice and automated and refined by a lot of training. (25)

By learning the shape of the letter movingly, the letter form appears to be recognized faster and its memorization is better than typing. (22) This contains the added value of writing. Each letter has its own movement pattern. (21) This is in contrast to pressing a key, where the same movement is made for the 'a' and the 'h'.

Neuroscientific research with fMRI (functional Magnetic Resonance Imaging) has shown that the recognition of letters learned by the motor action activates the motor brain regions more strongly. For letters learned by typing on a keyboard, this does not appear to be the case. (6,7)

Practicing small motor skills, the preparatory writing movements (32) (often called writing patterns due to the repetitive movement) contribute to the learning of letters. It also

improves thought formation and expression. (24) By practicing motor skills, scientists found that knowledge was stored more sustainably. (8)

The physiological benefits of movements (tightening muscles, relaxing muscles) in connected writing helps to establish connections in the brain and thereby increases cognitive effectiveness. (10) Multi-sensory instruction is important when instructing the writing lesson; a combination of auditory phrasing, visual examples and kinesthetic exercise or muscle movement.

Readable, fluent and well-groomed paper writing requires good motor skills. Most writing problems are caused by inhibitions in sensory integration, which hinders coordination and integration of the many brain structures and brain systems involved in the writing process. (11) Not only what we write matters, but how we move on paper and organize space is just as important. (13)

Spatial orientation

A written text consists of letters, words and sentences, which we divide over the available space. Each one does that differently. Ranging from leaf-filling to a few small phrases in the upper left corner. We estimate whether a word still fits the rule. We make sure that the letters of a word form a whole. We write the letters in their own zone. We distinguish: upper, middle and lower zone. The letter-f is the only letter, covering all three zones. Margins are observed above the text, to the left and right of the text and below the text, which also differ per person. Similarly, the line, word, and letter spacing differ. Regularity when classifying increases readability. While writing, we learn to organize the letters and independently organize the space. In addition, it is very important that spatial orientation is practiced as a writing condition from an early age.

When **typing**, the machine organizes the text and sets margins automatically. Convenient and neat, but we don't learn from dividing the space ourselves. The personal character of the text is therefore gone and our brain misses the challenge.

In multiple activities, spatial insight is of great importance: driving, how much force to put to jump over a ditch, precision work by surgeon and clockmaker, etc. Playing outside is very important for developing spatial insight!

The **hippocampus** is an important brain region. The hippocampus is present in both hemispheres of the brain. The name comes from the Greek word for seahorse. It has a curved shape, which is a bit reminiscent of a seahorse. The hippocampus plays an important role in the storage of information and memories in memory and spatial **orientation**.

Seeing

The most important element of looking turns out to be the underlying visual-spatial integration. Looking and spatial orientation influence each other to get a good picture. It seems so obvious that you have to be able to see well to write, but still it is often forgotten to look at the eye fupmetrist. The optometrist not only pays attention to 'sharp looking',

but also whether sharp looking leads to vision. He investigates how the eyes work separately and how they work together. His 21-point test also provides clues regarding the large and small motor skills.

Example: If a student can only make both eyes work together for a short time, it is understandable that texts are not caught, rules are not overlooked and words are missed. Just because you can read what's on the board from behind the classroom doesn't mean you can see letters, words and text from 30cm.

Important **visual skills**, which are indispensable when writing are: focus, eye movement, the cooperation of both eyes, eye-hand coordination, visualization and visual memory.

As with the hands, the information to and from the eyes also **crosses** through the brain and from front to back, finding its way into our brain. Even more ingenious is that the information is transported from the left part of both eyes to the right hemisphere.

The right retinal parts of both eyes send their information through the left hemisphere.

In a split second, the retina converts the light into millions of electrical signals that are routed through the optic nerve to the brain. Only in the brain are the signals converted into conscious images. We don't really see anything until our brains get involved. We can see depth because we have two eyes. From an object, the brain receives two recordings that are a bit different from each other. They use this difference to determine the position of the object. Because we see depth, we can also estimate distances that are indispensable when writing. This has already been discussed in the spatial orientation section.

The eyes transmit signals to the brain three to five times per second. This seems like a lot, but a simple movie camera already takes more images per second. Then how come we're seeing sharp? When seeing, the brain uses more information than just the signals that come in through the eye. The visual center is connected to other parts of the brain that are in turn connected to other parts. All these parts provide information that the brain uses to build an image. For example, information that is formed by what we hear, feel and smell, but also by our memories and expectations. The brain combines all these components. (27)

It is a wonderfully complex whole and only one of the skills to write a single letter. Let alone writing a message, which brings us to the following part -language-.

Reading and Language

Now we come to the ultimate goal of writing: **communication** on paper or other script carrier. Think of how stone, palm leaf or birch bark were used as a substrate in the past. The goal may be, for example, to preserve information, record sales contracts, but also to express your own thoughts or to come up with fantasy stories. If after a lot of practice the writing act is automated, the language center can be addressed extra and we can write stories and poems without the writing movement hindering that. Then all attention can go to composing and the content of the text. We link a sound to a sign that we shape by hand in a form that we have agreed upon. This makes the message understandable to others. Handschrift is een culturele vaardigheid, waarbij alle bovenstaande vaardigheden een rol

produce an understandable text in a smooth, readable handwriting. Why does the hand play such a big role in this? By manually shaping, we're snatching a trail in our brain that's permanent.

In 2005, Mr. Longcamp and her collaborators investigated the effect of writing and typing on letter memory. The children who wrote the letters remembered them better than the children who typed the letters. This could be due to the difference in motor action in writing and typing. Remembering the letterforms (cognitive) requires a different kind of feedback from the brain. (9) It happens so fast, we don't even notice. Connected learning to write improves brain development in the areas of thinking, language and working memory. (14)

"Children in China are less able to remember characters when they learn them on the computer. You have to make them with your own hands. Then you remember them! That's how our brain works." (28)

Scientists measure increased activity in three areas of the brain, which are activated in adults when they read and write: the left fusiform lobe, the inferior frontal lobe, and the posterior parietal cortex. (13)

The left fusiform area is more active when seeing letters learned by writing than when they are learned by typing. So it is specifically writing letters by hand that activates this brain region (29)

Learning letters by writing them by hand leads to better recognition of the new letters, both in adults and in children who are not yet able to read. This indicates that letter-specific motor programs are not only involved in writing, but also in reading and language. It has been definitively demonstrated that the act of writing with pen on paper helps children learn and read faster. It also helps to organize and put thoughts in writing and to express ourselves in a differentiated way. "The pen on paper will lead to much more creative ideas and innovation". (14)

The advantage of writing is that it is a slow, coordinated visual and motor process that requires full concentration and sustained attention to what happens at the tip of the pencil to get a result that is readable to others. During this process, a child also learns pattern recognition. (15)

This pattern recognition and the fact that written letters are more strongly etched in our brains are not only the basis for reading, but also for many higher-level language skills. (essay, poetry, etc.)

Learning to read is promoted and supported by writing the letters to be learned.

Children who learn to write in italics have an advantage. They understand a word image faster, because they write it as a whole and read it back. They acquire better writing motor skills related to language processing. (12)

Connected writing requires more effort and exercise from the brain. The time we put into it as a teacher is worth it.

What is important for the teacher to know and to be able to take into account in the lessons: Girls are about nine months ahead in their language skills on boys. That's because the beam that separates our two hemispheres of the brain is larger in girls than in boys, which makes their brains more capable of interplay (crosstalk).

The children who now grow up with a tablet and smartphone have the writing track and therefore the letter forms, not yet as an etched trace in their brain. This slows down learning, reading and spelling development. The fine-motor structures make connections in the brain so that we can think, speak, write prose and poetry. In short, performing higher cognitive functions, for which the handwriting - while moving - lays a lasting foundation.

emotion

An emotion is a reaction of our entire organism to a stimulus, which is unconsciously and automatically sent out and directed outwards. An emotion stirs something, in turmoil. This can be seen in behaviour, cognition and physiology.

For writing, the most important thing is the physical expression: the muscles are tightened too much or too little during writing. You can almost "read" whether there is a lot of emotion. A writing teacher and a graphologist can recognize the emotion. By looking closely at the writing, the teacher can benefit pedagogically.

The emotion manifests itself in the script and influences the way of writing. Shadmehr and Holcomb of John Hopkins University published a study in Science Magazine, showing that their subjects' brains changed in response to physical instruction such as lessons in light-healing connected writing. The researchers did PET (Positron Emission Tomography) scans as evidence of these changes in brain structure. Moreover, they also proved that these changes made the script smoother, which later led to the development of neural pathways.

Connected writing helps to calm the emotional part of the brain. Emotional involvement of a writer who entrusts handwritten stories to the paper makes diaries something more than just knowledge transfer.

Writing is a special, personal, expressive means of communication, which shows the sensual and emotional involvement of the writer.

conclusion

The evidence gathered here shows that in 2020 the writing does not have to pay in value. The means of communication practiced for centuries connects past, present and future. The writing strengthens our brain. It can coexist independently in addition to typing because it allows students to understand and process the structure in other subjects, which ultimately leads to a better performance. When learning to write, children learn more than just taking notes! Those who write by hand must plan accurately what they want to write. This encourages students and students to learn to draw conclusions and think logically. (21)

Handschrift is zo belangrijk. Het kan tot leerproblemen leiden als het uit het curriculum verwijderd zou worden. (35)

The luggage we give students is not complete without its own readable handwriting. Just because of what learning it did to the brain and continues to practice it. Writing by hand is a training to grow and strengthen our brain; brain gymnastics!

Writing by hand and working with a keyboard are necessary.

If both skills are given to our children, then in later life they can decide autonomously which situation is best to use and they are never left empty-handed.