

## Interview with Prof. Gertraud Teuchert-Noodt

### What does brain research say about the digitalization of children and young people's learning?

Prof. Gertraud Teuchert-Noodt was head of the Department of Neuroanatomy and Human Biology at Bielefeld University and researched the consequences of sensory overload, addiction mechanisms and the connection between movement, learning and the brain. She is one of the strongest critics of the digitalization of education due to her own research results. Why digitalization is having an irreversibly detrimental effect on the development of children's brains, she explains to us in the interview. The term "media" is used in the interview in the sense of digital media, although media naturally includes much more.



Prof. Dr. Gertraud Teuchert-Noodt - Foto: Sarah Jones

“... even half an hour is too much for the child!”

**KOMPAKT: Prof. Teuchert-Noodt, countries such as Sweden and the Netherlands have decided to reverse the digitalization of preschools. Does that make you optimistic?**

TEUCHERT-NOODT: Well, only if it can be seen as a wake-up call that will be followed by further steps, and definitely in this, in our country as well. After all, this hesitant measure is based on a comprehensive scientific study conducted by professors of psychology

and cognitive neuroscience and presented to politicians with a statement from the entire Karolinska University. We therefore expect more far-reaching measures than this banal concession "Screens have no place in preschools", which, for someone with a relevant background, sounds like "tomorrow morning the night will be over". One wonders how much lack of understanding it takes to introduce tablets into preschools in the first place. Sooner or later, this step would inevitably have been taken back without a recommendation from a university, because such a deviant field trial would have revealed its consequences all by itself and is already doing so.

**KOMPAKT: The newly published guideline on screen media use is now generally in favor of using tablets as late as possible, but follows the concept of media supervision: no use up to the age of 3, a maximum of 30 minutes from the age of 3 and 30-45 minutes from the age of 6-9. What do you think of this?**

TEUCHERT-NOODT: If tablets are to be used as late as possible, that would be an important step in the right direction. It remains that the new guidelines should first be coordinated with scientific findings on learning in adolescence. So far, pedagogy has not done this, even though the decade of brain research with important messages on learning development suggests that it should. In the media age, how is it possible to pursue sensible school pedagogy at all without knowledge of the subject that everything revolves around, the human brain in its development? Surely word must have gotten around that neuronal

development and learning go hand in hand. The concept of media guidance for young children, and then even with small-minded regulations.

The concept of media guidance for small children, and then even devised with petty regulations, is like a bad joke. It can only be a concept of complacency that plays into the hands of companies that shovel tech toys and children's tablets onto the market and systematically prepare children for digital surveillance, as in China. The fact of the matter is that children's brains are fundamentally overtaxed by all media use because the maturing brain is immediately damaged and the child develops a digital addiction; even half an hour is too much for the child.

### KOMPAKT: What basic skills will these children not develop?

TEUCHERT-NOODT: Even short periods of screen use neglects social



communication, which makes it difficult to learn to speak. And the unstoppable childhood urge to be physically active in a variety of ways, which is normally benefited from for the rest of our lives, is blocked here. All this to the fact that in the child's brain, senso-motoric and emotional-limbic circuits are in the starting blocks (are ready to be developed), but in the digital environment - even when mom is surfing while

feeding her toddler - the countless nerve cells cannot be adequately connected. Only analog activities can trigger and promote the maturation of synaptic circuits. Why do humans bring such complex sensory organs into the world if they are prevented from bringing this world into the vastness of the cerebrum just by the use of the media? The all-dominant sense of balance in particular conveys a large proportion of influential activities in early childhood for space-related and intelligent brain development through crawling, climbing and communicating. But it immediately loses these vitalizing powers when a child's eyes stare at a screen. The child's behavioral development is then steered in the wrong direction. Dependence and learning disabilities are the first and, through no fault of their own, the child, who actually has a wonderful disposition, becomes a therapy case.

### KOMPAKT: You postulate that no digital learning can exist. Why does nothing stick in the mind when you swipe your finger across a display?

TEUCHERT-NOODT: "Digital learning" is just as non-existent as the much-praised so-called "artificial intelligence", and there will never be either, even if certain strategists are hoping to capture young children for digital technologies through half-hour daily programs. They will indeed succeed, but with negative consequences for the child's mental development. This is because technical devices function one-dimensionally, but biological systems are created space-dimensionally. This does not mean that the neural framework in the embryonic brain automatically develops spatially. Rather, the genetically designed framework only becomes truly spatial by using all of the available senses and brought to performance. When children swipe their finger across a display, they are merely operating one switching level in

the already genetically constructed framework of possibilities, a comprehensive maturation of contacts is left out of the cerebellar and cerebral cortex. This is irretrievably reflected in behavioral deficits.

**COMPACT: Please explain to us in more detail why this can lead to further irreversible damage, and what kind of damage!**

TEUCHERT-NOODT: The keyword is "adaptive neuroplasticity": Back at the end of the 1990s, neuroscientists in Bremen used imaging analysis technology to show that the representation of the thumb in the motor cortex of the cerebral cortex was neuroplastically enlarged in students who used their cell phones a lot. Of course, this happens at the expense of neighboring fields that should actually be available for other motor-associative skills - perhaps for playing the piano. This experiment has proven that nerve networks, just like the physical movement muscles, respond to active sensory-motor training with structural expansion. Conversely, just as a broken arm in plaster soon thins its muscles, "digital learning" will also organize cognitive networks in the student's cortex correspondingly less. Also those who use digital life and household aids in their private lives will soon suffer from general cognitive deficits. Navi-dependent drivers will feel it directly as soon as the connection doesn't work.

**KOMPAKT: And with children?**

TEUCHERT-NOODT: In children, digital stress on maturing cortical fields generally has more serious consequences than in adults. Swiping and typing in the senso-motoric fields of the cerebellar and cerebral cortex only allows one-sided contacts to mature, this also leads to an undersupply of associative areas. It is predictable that learning to speak and write will only develop slowly as a result, and that access to mathematical thinking will remain completely blocked. The earlier the child is introduced to the technology, the more dramatic the damage will be.

And there is something else to be said about this: there is a general demand, at least in the advanced school years, to switch learning to e-learning and tablets. This also contradicts the scientific findings on neuroplastic brain maturation: the adolescent cortex is still undergoing a very specific restructuring and development of cognitive fiber tracts. In early childhood, the frontal brain works increasingly via deep and short associative fiber tracts; from adolescence onwards, these are replaced by maturing long horizontal tracts in the higher cortex. This late and significant reorganization and expansion makes it possible to build and enlarge memory storage and train the ability to think. Traditionally this is taught in lessons in the upper grades as in philosophy and higher mathematics. And learning to understand also dominates practically all other school subjects, at least cramming (intensive learning) was frowned upon in our advanced school days.

The fact remains that learning and development go hand in hand. A generally digitally organized middle and high school curriculum will significantly hinder the necessary neuroplastic restructuring and expansion of the cerebral cortex. Learning by conditioning, which has been predominantly childlike up to this point, cannot be sufficiently replaced by learning through insight; long-term memory and in-depth thinking skills fall by the wayside.

## Graphic

Study result: Children who use their cell phones frequently have an underdeveloped space-time coordination (Supper / Teuchert-Noodt, 2021)



*Figure. 1a.* In this handwriting sample, both students try to fit the word "Schneeballschlacht" [snowball fight] into the assigned rectangle.

**KOMPAKT: In a study with the psychologist Angelika Supper, you investigated how their spatial imagination develops in children who do not play with their smartphones compared to those who use it a lot. In a nutshell, what was the result?**

TEUCHERT-NOODT: This study has evolved for me from our many years of plasticity and cognition research at Bielefeld/Germany University, where I worked with a team of advanced students for over 25 years on the development of learning and psychosis in early childhood. I therefore knew that the frontal brain is of the utmost importance with regard to the development of spatial imagination, and that pre teenagers already have all the physiological requirements for the development of spatial memory. For this reason, Ms. Supper and I specifically selected third graders aged 9 for this study.

Our study has shown (see chart above) that children who do not use smartphones have a solid and well-established spatial awareness, sense of time and memory. However, these skills are already significantly poorly developed in third-graders who have intensive contact with the device (digital touch screens). This holds further dangers for the development of intelligence. It comes as no surprise that the public media have recently been complaining that primary school children's attention and concentration are declining. Our study is intended as an alarm signal for parents and teachers. Some of the tests used (note: published in *Neurology & Neuroscience*, 2021, 1 (3): 1-9) could be established in schools to therapeutically combat the maturation deficits of digitized children. In principle, children's cell phones should be banned. Then many learning difficulties would resolve themselves.

**KOMPAKT: What significance for the development of the personality does the lack of maturation of the space-time calculation have?**

TEUCHERT-NOODT: Over the last 70 years, this has been a central question in human cognition and psychosis research in institutions worldwide. Spatio-temporal behavior is also used with reliable tests - as we used in the above study - in the industrial development of psychotropic drugs in order to detect and pharmacologically treat psychological deficits in adults. Psychologists and behavioral researchers such as Jean Piaget and Konrad Lorenz first recognized in German-speaking countries in the middle of the last century that cognitive functions are controlled via the frontal brain and limbic cortex, and that mental functions are organized spatio-temporally. As a result, many sub-disciplines, such as developmental psychology and neuroscience have recognized that this also affects the formation of will, conflict resolution, control over emotions and working memory. The latter controls attention, concentration and motivation. With these enormously high demands on the forebrain, it is

easy to understand why it takes almost 20 years of life years until all of these sub-functions have almost matured. This is what makes a personality.

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In our laboratory, we found that early childhood deprivation leads to a deficient spatial maturation of individual neuronal fields in the far reaches of the forebrain, and that this results in functional disorders like - depending on the severity of the deprivation - as hyperactivity, anxiety disorder and loss of spatio-temporal memory formation.

So consider what depends on a solid infantile frontal brain maturation, and how almost impossible it is for children with a cell phone in their pocket or within their reach to concentrate on the essentials. The physiologically unstable nerve networks in the child's frontal brain would naturally much rather make friends without demands - i.e. digitally - in order to fulfil social needs and the inherent curiosity of children. And they like to use the tablet to be conditioned and to wipe away learning content without a clue. Therefore, hands away from cell phones and tablets, not only in childhood, but throughout brain maturation, which continues into adolescence.

**KOMPAKT: You need to explain that in a little more detail. In the middle of the last century, conditioning according to Skinner box learning was disqualified as the use of the so-called Nuremberg funnel (Nürnberger Trichter). Where is this funnel located and what does it do to the brain?**

TEUCHERT-NOODT: This funnel is located in the subliminal areas of our brain, i.e. in the circuits of the brain stem, thalamus and limbic system, which are all interconnected in an unclear and diverse way. In the unconscious, they carry out the preliminary work for the forebrain and associative cortical fields. Remember, this funnel is fully available from birth and naturally conditions early childhood behavior. The thalamus is the gateway to the slowly awakening consciousness, and the limbic hippocampus is the neuronal secretary for the equally slowly maturing forebrain. Until the intellect takes hold, children's behavior is bypassed by conditioned learning. This is why children are so keen on digital technology and are then unable to cut the cord as teenagers.

From a biological point of view, this gradual expansion of the brain makes a lot of sense. The frontal brain would be overwhelmed by the constant flood of sensory stimuli if it were not preceded by a secretary, which is also responsible for the spatial pre-processing of all sensory stimuli passing through it. The neuronal grids responsible for this have only recently been discovered and described at the hippocampal gateway. The gateway itself is equipped with the so-called Hebb's learning synapse, which has previously been studied both molecularly and electrophysiologically for over three decades due to its ingenious plasticity. Both structures act as very flexible gatekeepers at the entrance in order to withstand a high flood of stimuli. Digital accelerators are the perfect service providers to accept the flow of many sensory activities almost simultaneously and to reflexively condition connected switching elements.

Children are literally prevented by digital technology from seeking out learning experiences and anchoring them firmly in their cerebrum. This is why tablet schooling for children and young people is the biggest threat to the future of our society.

**KOMPAKT: Where do you derive your thesis that the smartphone is a drug which can be compared to physical drugs?**

TEUCHERT-NOODT: This question arises directly from the previous remarks, because the structural cause is hidden in the catacombs of the limbic system. Swiping across the smart plate enables the human eye to tour up the hippocampal circuitry. That alone does not yet lead to addiction, but the real problem is hidden in other circuits of the hippocampal turbulator, which is known to create short-term memory.

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It is usually played by two sides, a bypass from the amygdala with an emotional inflow, and a second bypass, which provides strong support via a dopamine-opiate axis by independently creating a certain long-term memory. The receptive and structural characteristics of this special memory have been well known to us for a quarter of a century, and we have also carried out intensive research on this and the further consequences in our laboratory. On the one hand, this subcortical memory, the so-called reward system, is ingenious because it increases our performance in dull routine tasks that we are exposed to everywhere in our professional lives. We don't even think about it, we just do the nonsense, perhaps even happily and for years. Even scientists are not immune to pursuing pointless research in the long term without thinking.

At the same time, evolution has lured us into a nasty trap. A designer drug - we have examined this in our laboratory for the amphetamine drug ecstasy - binds to the dopamine-opiate axis and this builds up a pathological long-term memory. A drug addiction develops. In the same way an over-accelerated hippocampal gatekeeper can trigger a long-term cell phone addiction. No matter, at whichever point the hippocampal circuitry overwhelms its actual short-term memory, to literally surrender it to this diabolical long-term memory it uses up the precious available transmitter budget. Then the forebrain is undersupplied, especially due to a lack of dopamine, which causes the local transmitters such as GABA and glutamate and forces them to make dysfunctional structural adaptation. Working memory and other frontal brain functions can no longer meet the growing demands of adolescence under the influence of drugs, and the functional dysfunctions can be reflected in the psychotic behavior spectrum. The current increase in mental disorders in adolescence can most likely be attributed to media overload, to which the limbic hippocampal complex is exposed, as when using a designer drug. With additional digital experiences from childhood, it becomes all the more difficult to go back.

**KOMPAKT: Why should in particular educators adopt these neurobiological basics?**

TEUCHERT-NOODT: It is essential to take scientific findings into account before issuing new guidelines. Without these findings from addiction and learning research, educators and those responsible for new guidelines on the digitalization of schools can hardly really understand the fundamental dangers of general computer learning. The current outrageous and naive field trial of schooling with tablets will only fail when it is too late for

this generation. Those in positions of responsibility are therefore obliged to orient themselves to the scientifically findings. They should understand why digitalization is so extremely dangerous for children and young people and should be abolished as quickly as possible! It would be much more appropriate to offer a media course at the end of a school like the one my students took in the 90s the 90s, when computers were first introduced at the universities. After a few weeks, they were so perfectly familiar with media technology that, at the age of 50, I quickly learned from them too.

**COMPACT: Why is digital media abstinence in childhood and adolescents the best preparation for the digitalized environment? That actually sounds paradox.**

TEUCHERT-NOODT: Yes, that actually sounds paradox, because in education we can always assume that children's natural talent for learning, should be used to offer as many skills as possible and make them learnable; only then children are well prepared for their future. But let's admit it, the future is written in the stars for every growing generation. So, what children need to be given first and foremost in their lives are general practical and mental skills in order to develop a smart life strategy and to strengthen the individual qualities that are always necessary, such as curiosity, courage and creativity. You learn all this as if by chance in everyday life, but also at school. But the use of digital media completely turns the conventional life experiences that fabulously match scientific results, completely upside down.

So if you have to proclaim the message today, that "a childhood without media is the best start to the digital age", it is because courage and creativity remain the best dowry for an ever uncertain future, a dowry that is being taken away by digitalization. Children and young people who are digitally active are denied not only physical but also mental sporting lessons. This is the real paradox in the age of digitalization.

**KOMPAKT: The social pressure that children want a smartphone from the age of 9 or even earlier is big. How can parents counteract this?**

TEUCHERT-NOODT: It's never been any different, parenting requires full parental commitment. Truly loving parents must make an effort to explain to the child why a smartphone is out of the question at this age. Why the child can even be proud not to have one, because this is at the expense of their intelligence development. Children don't understand that? I think they can understand it. The question is how you explain it to them and what they are offered to compensate. Attractive activities outside of school hours, such as physical and mental training in sporting and artistic educational facilities are particularly helpful in digital times to reduce social pressure and at the same time promote development in a wonderful way.

**KOMPAKT: Let's get back to the point. Children should not be left alone, which is why an early and supervised use of digital media is a responsible solution. The advocates of digitalization like to teach children a "sensible", "responsible" and "competent" use of the devices. Is that inconceivable for you?**

TEUCHERT-NOODT: "Reason, responsibility and competence" - these are the three qualities that shape a person's personality, but which mature last. As explained above, it takes almost the first 20 years of life to acquire these skills. Since the beginning of time, it has demanded the full commitment of parents. They do a lot, but that is exactly what the numerous digital helpers do not do for the parents. Children raised with this in mind will later gratefully pay the bill for their parents' efforts. However, if the golden rules of child upbringing are blatantly neglected by using the smartphone as a substitute for parents, they will very soon be overtaken by the most serious worries. The advocates of digitalization could

perhaps be advised to change their profession and help remedy the dramatic shortage of teachers. However, they should be converted beforehand and then want to achieve the almost impossible: to take these devices out of children's hands in order to bring schools back up to standard.

**KOMPAKT: So how should children grow up to be protected from the dangers of new technologies? Can parents even master this challenge alone?**

TEUCHERT-NOODT: When parents are willing to deal with the very difficult subject of a media-free upbringing, and spend their evenings, weekends and vacations together with their children in social harmony, then they can pass on the necessary intelligence to them. The fact is, children love their parents most of all and can learn from them how to renounce for the cell phone. How the Irish town of Greystones has solved the problem is exemplary: elementary school, parents and the town council have agreed that children should not use their smartphones. Sociologists and educators can give a lot more advice on what else is needed to overcome the enormous challenges of the media age.

**KOMPAKT: We have an education catastrophe. The basic skills of reading, calculating, writing and listening are declining more and more. Education policy is relying on even more digitalization as a way out. Are there actually any reliable studies that the digitalization of schools can be a promising undertaking?**

TEUCHERT-NOODT: If we look at the science of the past century, the answer is no. All the findings indicate that digitalization of schools can only be a total failure! We know from brain research that children are biological and non-technical individuals, right down to the neuronal and mental level, who require the utmost commitment from family and school to mature their mental and social intelligence. Pedagogy, developmental psychology and neuroscience have jointly contributed to the fundamentals for a generally sound learning development of children and to incorporate this into school concepts. After all, even the founder of cybernetics, Norbert Wiener, warned more than half a century ago that the development of technical control loops, which, like biological control loops, would presumably soon be controlled plastically, could become the greatest danger to mankind. That's what they have become.

If we ask today's school practice to what extent digitalisation of schools is promising, we come across abstentions or similarly to a no. All the latest evidence shows that this is truly an educational catastrophe. If, however, stubborn proponents of digitisation of schools ask for even more digitisation and feel that they need to train teachers better for this, then they have not yet understood the basics. They would have to be given a recommendation for further training in this sector. If a sense of responsibility is not finally in sight neither among the AI producers nor globally in society, then history will catch up with us.

**KOMPAKT: Dear colleague Teuchert-Noodt, thank you very much for these important explanations and remarks.**

The interview was conducted by Peter Hensinger