LEARNING
BRAINS

A question of striking the right balance

How do digital media influence how we think and act?

By Yee Lee Shing, Isabelle Ehrlich and Christian Fiebach

What influence do digital technologies have on human perception, thinking and action? Do computer games harm the development of young brains? And is there really such a thing as »digital dementia«, an increasing forgetfulness caused by the use of modern technologies? For some of these questions, answers are available that are empirically corroborated.

The digital revolution has changed our life fundamentally over the past years, and this trend will continue in future. Teenagers in the USA spend an average of between six and nine hours of their free time each day with digital media. Even if these figures would so far seem to be lower for Germany, with an average of around three hours per day – according to a recent report by the Federal Centre for Health Education – 12-16 year-olds in Germany also spend a great deal of time online. 22.4 percent of the young participants in the survey rated their own use of media as problematic.

In view of these figures, the following question arises for psychology: How do digital technologies influence human perception, thinking and action? In order to answer this question, it is critical to understand how the use of digital technologies affect human cognition and the human brain – positively as well as negatively. The focus here lies especially on some recent key findings in the fields of cognitive psychology, cognitive neuroscience and developmental psychology that are concerned with the impacts of computer games and media use on cognitive performance and cognitive development. To conclude, this will be contemplated in the light of current developments in the area of artificial intelligence.

Concerns about the brain's »maladaptation«

Our brain is a miracle of nature. It is capable of learning and adapting to constantly changing demands and circumstances. Neural plasticity, that is, the ability of our nervous system to continuously change its function and structure, allows us on the one hand to develop and modify all kinds of skills through training, but also to compensate them. On the other hand, the absence of sensory experiences and even excessive one-sided training can also entail adverse changes in plasticity that lead to our abilities shrinking or even being lost altogether. It is precisely this concern that is increasingly a topic of discussion in the age of smartphones and the internet.

Research is paying special attention to the effects of excessive gaming. Since the Columbine High School massacre in Colorado, USA, 20 years ago, several studies have explored the influence of computer games on aggressive behaviour as well as on cognitive skills. The results are, however, contradictory. Meta-analyses have revealed that the effects of computer games containing violence on aggressive behaviour are generally to be regarded as minimal (Anderson et al., 2010). Gaming therefore does not seem to mould the human brain in a way that would generally drive us to violent acts. It is more the

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IN A NUTSHELL

- The human brain adapts constantly to changing demands from its environment. Missing or one-sided stimuli can trigger disadvantageous changes to its plasticity. This concern is increasingly a topic of discussion in the age of smartphones and the internet.

- What cannot be proven is a strong correlation between computer games and a disposition towards aggressive behaviour. Nonetheless, computer games leave behind traces in the brain; the effects depend on a large number of factors.

- Studies show that moderate screen time among children and adolescents does not have a negative impact. Important, however, are their living conditions: Children from difficult backgrounds tend to experience social disadvantage online too. This is referred to as social media spillover.

- People who use their smartphones frequently often display a poorer cognitive performance. The relationship between cause and effect is still unclear.

- As far as artificial intelligence is concerned, psychology is still in it infancy. To meet this challenge, enhanced collaboration between computer science, technology providers and psychology is needed.

case that there are indications of complex interdependencies that are so far not fully understood.

More attention, but also greater potential for addiction

There is no mistaking that gaming has an impact on our brain. For example, a widely acclaimed study showed that playing »Super Mario 64« on a regular basis leads to an increase in the volume of brain regions associated with spatial coordination (Kühn et al., 2014). Moreover, similar structural changes could be observed in areas involved in processing rewards. This result is in line with a number of studies which corroborate that playing action games on a regular basis can bring small but noticeable improvements in attention performance (Bavelier & Green, 2019). At the same time, the morphological changes in the reward system resemble changes that can also be observed in substance addiction. Computer games are designed in such a way that they facilitate frequent and slightly rewarding experiences. Via this mechanism, frequent gaming could lead to dependency – the vastly increasing numbers of internet

and gaming addicts substantiate this correlation and are worth monitoring.

Harm or benefit – a question of many factors

Yet even if gaming does not become pathological, the tremendous appeal that emanates from these games may have negative consequences: If a large part of children's free time is spent playing computer games, their reading and writing skills may suffer and conflicts at school might increase, as has been shown (Weis, Gerankosky, 2010). At the same time, education and health care are increasingly capitalizing on the motivational potential of computer games. Consider serious gaming, which is the use of specially developed PC games to improve, for example, motor skills, multitasking or health (Gentry et al., 2019). However, this type of intervention is still in its infancy and its actual value has yet to be empirically tested. Overall, it can be stated that gaming leaves traces in our brain's plasticity. Whether these are harmful or beneficial, like any form of experience, seems to be a question of striking the right balance and of the interaction of personal and external factors.

The complex connection between media use and child development

The often cited »displacement hypothesis« assumes a correlation between media use and development, and postulates that the harms caused by technology are directly proportional to the extent of this use. However, this hypothesis has not been well supported by empirical evidence. For example, a large-scale survey with 120,000 adolescents revealed that the relationship between screen time or time spent online and mental well-being is best illustrated by a

quadratic function (Przybylski & Weinstein, 2017). According to this, positive effects can be expected in the case of media use lasting one to three hours per day. After that, a »turning point« is reached, beyond which greater media use is associated with negative effects on mental health. However, the actual effects also depend, for example, on the type of activity and the weekday. For example, video games have a later turning point than smartphones, and the turning point occurs later on weekends than on weekdays. These results support what is known as the »digital Goldilocks« hypothesis, which postulates that moderate screen time as such is not harmful (Przybylski & Weinstein, 2017), since it can also have positive effects, for example, by integrating the user in social media. It is also worth noting that the negative correlation between screen time and well-being is weak (Orben & Przybylski, 2019) and can be overshadowed by other influencing factors.

Something that is important to point out in these studies is the fact that people have different online experiences – which in turn also often reflect differences in their living conditions (e.g. relating to socio-economic background). Studies by American psychologist Candice Odgers show that adolescents who have to deal with more adversities in real life are more likely to experience negative effects from the use of smartphones and other digital devices – an observation she calls »social media spillover«. For example, adolescents who have already been victims in real life are more likely to be exposed to online bullying. Teenagers from poorer households receive less parental supervision when using the internet. In this way, a kind of digital divide emerges, such that online experiences increase the risks for precisely those young people who are already more vulnerable in analogue life.

Digital technologies and their influence on cognitive performance

The use of tools to improve our quality of life is one of humankind's main cultural achievements. Digital technology is such a tool and one that has grown far beyond the power of our imagination. It penetrates our professional and private life so deeply that the boundaries between the digital and the analogue are becoming increasingly blurred. There is growing concern that our digitally expanded environment is overloaded with information to an extent where the disadvantages resulting from it for human perception far exceed the advantages of digital media. This is in line with the fact that doing several things at once (»multitasking«) is cognitively very challenging, regardless of whether it is a matter of digital technologies or not. But is it pos-

sible to corroborate empirically the notion that digital technology has negative effects on perception in the long term?

A pioneering study in this area (Ophir, Nass, Wagner, 2009) showed that people who frequently use several media in parallel (heavy media multitaskers) are more easily distracted by unimportant input from their surroundings than light media multitaskers. Although findings of follow-up studies are heterogenous, an emerging pattern indicates that persons with »heavy media multitasking« display poorer cognitive performance. However, an important unanswered question in this context is that of causality: Does media multitasking really cause the poorer cognitive performance observed, or do individuals with behavioural tendencies that already exist, such as impulsiveness, exhibit more problematic behaviour regarding media use? Understanding these causal connections will thus be a deciding factor in the development of appropriate interventions, for example, in order to decide whether media use should be reduced or an increased awareness of the risk established as a preventive measure.

Google as »outsourced memory«

The possibility to use computers and smartphones as external memory aids also has a major impact on how our brain stores information. The example of the »Google effect« illustrates this point aptly: Information is more quickly forgotten when we are sure it can be accessed at any time on the internet. A similar finding is the »photo-taking-impairment-effect«, according to which taking a photograph of an event in comparison to its passive observation reduces our recollection of it.

Computer games have a considerable power of attraction for adolescents. Other possibilities for recreational activities are often neglected as a result.

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»Heavy media multitaskers« like to use several media in parallel. But what effects does this have on their cognitive performance?

On the other hand, positive outcomes from computer use are reported in literature too: If the computer is used as a strategic aid, this can release resources for other cognitive tasks and improve memory performance, as has been shown in earlier studies in conjunction with non-digital memory aids. Thus, the effects of digital technologies on human cognitive performance likely reflect basic principles of the human brain in interaction with its surroundings. To understand the effects of digital technologies on how we think and act, it is essential that we examine closely the basic cognitive processes of the human brain.

Artificial intelligence as opportunity and challenge

The recent development of what is known as artificial intelligence (AI) represents a particular challenge. Many processes in human decision-making – from everyday consumer decisions to investment decisions in the financial sector and medical diagnostics – are supported more and more by machine learning and predictive algorithms. Consequently, the risks of modern AI applications are coming increasingly to the forefront of social discussion. However, in view of the cognitive and neuroscientific evidence discussed to date, we do not automatically expect negative effects at the interface between human cognition and machine »intelligence«; here too, type and scale of use, mediated via the mechanisms of perception, cognition and neural plasticity, will have a differentiated impact on human thinking, acting and decision-making.

However, from a psychological perspective individual expertise in the handling of AI algorithms seems to be of critical importance. Popular examples over the last years show that even developers do not understand all the aspects of decision-making in AI systems. Understanding this »black box« and the possible intentions of its developers will be a major challenge. Will it be possible, for example, to protect adolescents from the marketing interests of commercial enterprises by means of »child-friendly« algorithms? How must educational curricula be adapted in order to allow future generations an understanding of the basic principles of AI algorithms, which they will need both in their careers as well as their private lives? Will it be possible to maintain the ability and willingness to engage intensively and critically with texts and other sources of information in the face of increasingly powerful and easy-to-use search algorithms? To meet these challenges, strengthening collaboration between computer science, technology companies and psychology is essential. In view of the particular need to protect children and adolescents, we consider that knowledge from developmental and educational psychology are especially required here, in addition to cognitive psychology.

If these objectives could be achieved, important applications developed from a psychological perceptive could contribute to improving mental well-being. For example, screening algorithms are a possibility here, which on the basis of behaviour, facial expressions or voice can support the early detection of mental problems, as well as internet-based psychotherapeutic prevention and intervention measures (keyword: E-mental health). Socially disadvantaged groups could especially profit from this. Finally, it is also important when designing such digital applications to introduce sound psychological knowledge regarding, for example, vulnerability vs. protective factors in relation to children and adolescents. ●

The authors

Isabelle Ehrlich, 30, is a research associate and doctoral researcher in the Lifespan Cognitive and Brain Development Lab (LISCO) at the Institute of Psychology of Goethe University. She studied psychology at the Paris Lodron University of Salzburg and Goethe University. In her research work, Ehrlich investigates how the brain makes predictions, how these predictive processes interact with memory systems and the relevant underlying neural basis, taking human development and lifelong neural plasticity into consideration.

ehrlich@psych.uni-frankfurt.de

Christian Fiebach, 48, studied psychology at the University of Koblenz and Landau and earned his doctoral degree at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig with a thesis on the neural principles of language. After a period as a post-doctoral researcher at the University of California in Berkeley and as head of an Emmy Noether group at the University of Heidelberg, in 2010 he became professor for neurocognitive psychology at the Institute of Psychology of Goethe University. His main research interests are concerned with the neurobiological principles of higher cognitive processes, such as cognitive flexibility, language processing and human intelligence.

fiebach@psych.uni-frankfurt.de

Yee Lee Shing, 40, is professor for developmental psychology at Goethe University and head of the Lifespan Cognitive and Brain Development Lab (LISCO). She is also a member of the IDeA Centre of the Leibniz Institute for Research and Information in Education (DIPF). Shing, who is originally from Malaysia, studied psychology in the USA. She was then a researcher at the Max Planck Institute for Human Development in Berlin and earned her doctoral degree at Humboldt University. After her time as a post-doctoral researcher at the MPI, she became a lecturer at the University of Stirling in Scotland. With a freshly acquired ERC grant, she came to Goethe University in 2018, where she continues to research the development of cognitive and neural functions along the human lifespan, with a focus on episodic memory and predictive processing.

shing@psych.uni-frankfurt.de