WHAT DO WE KNOW ABOUT CHILDREN AND TECHNOLOGY?

OECD

This brochure summarises some of the main findings from the Centre for Educational Research and Innovation's (CERI) 21st Century Children project. It was prepared by Tracey Burns and Francesca Gottschalk. Sophie Limoges was responsible for the design and providing editorial support.

FOREWORD

We are more connected than ever before. Many children have access to tablets and smartphones before they learn to walk and talk. This begs the question: What are the impacts of technology on children, and how can screens impact their growth and development?

This is an area where there is an urgent need for robust research to guide policy and practice. Shock headlines such as “Have Smartphones Destroyed a Generation?” and claims that technology is “re-wiring” children’s brains are dramatic, but to what extent do they reflect what we actually know rather than anxieties with tools we do not yet understand? This brochure brings together research from the OECD’s 21st Century Children project to summarise some of the guidelines that have been established for children’s use of screens. It also provides an overview of the research on the impact of using technologies – including television, video games and social media – on children’s developing brains and bodies. Lastly, it looks at the role of schools and teachers in supporting and guiding safe and responsible technology use.

People tend to be scared, or at least wary, of new developments in technology. Yet we live in an age where digital tools have fundamentally transformed the world, and the reality of children’s lives. We owe it to our children and youth to separate fact from fiction, and help support them to get the best start in life.

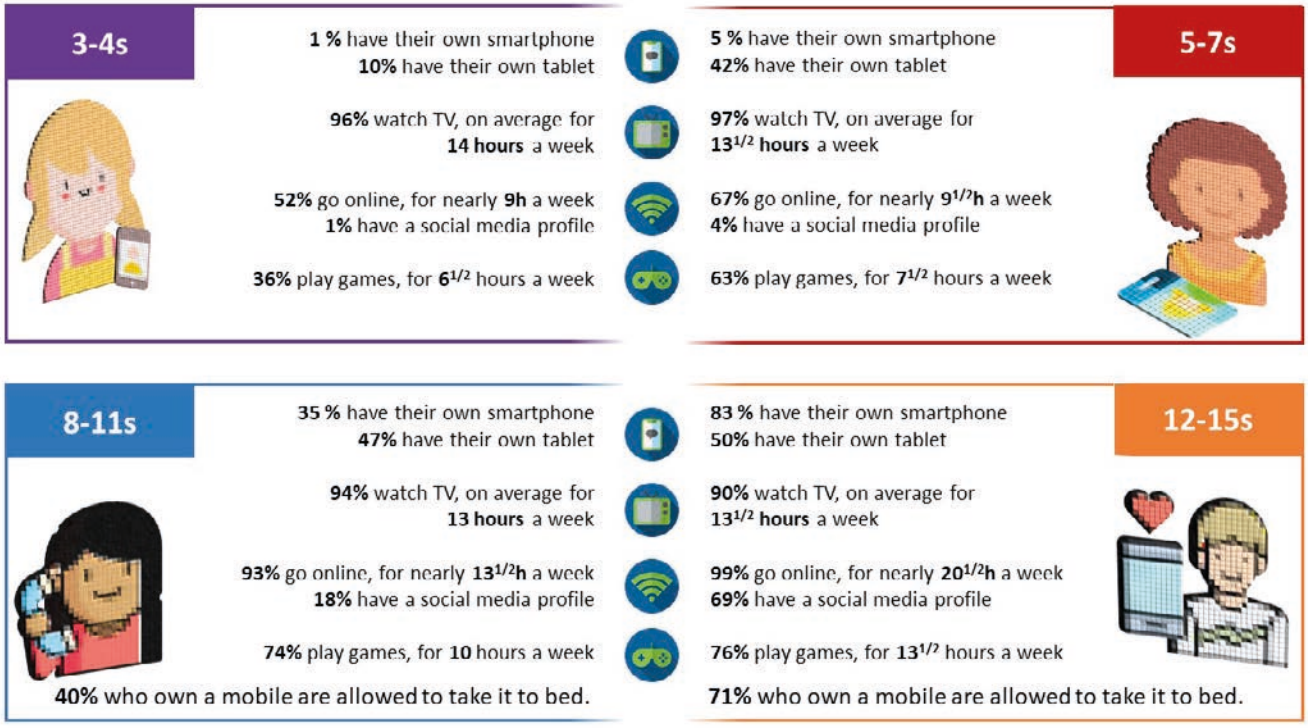
Andreas Schleicher
Director, Education and Skills, OECD

Technology trends in the 21st century

We are more connected than ever. At the end of 2017, the number of high-speed mobile subscriptions in OECD countries reached a milestone: more subscriptions than the number of people (OECD, 2019). And young people are particularly active on line. In 2015, a typical 15-year-old reported using the Internet since the age of 10 and spending more than two hours every weekday on line after school (an increase of over 40 minutes since 2012), and more than three hours every weekend day (OECD, 2017).

Not only are youth using the Internet more, they are doing so at younger ages (Hooft-Graafland, 2018). Some research suggests that preschoolers become familiar with digital devices before they are exposed to books (Hopkins, Brookes and Green, 2013). In the United Kingdom, the most recent figures show that 52% of 3-4 year-olds and 82% of 5-7 year-olds are on line (Ofcom, 2019).

Figure 1. Snapshot of children's media use in the UK



Source: adapted from Ofcom, 2019

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Over-concerned about being ?over-connected??

The rise in children's use of technology has led to growing concern about how it affects children's brains, bodies and their socio-emotional, cognitive and physical development.

Many groups concerned with children's health, including governments and medical societies, advocate for partially or fully limiting screen time for children. However, "restriction focused" guidelines are criticised by experts in the field as not being based on robust research.

Currently, scientific research:

- is not conclusive enough to support evidence-based guidelines on optimal amounts of screen use or online activities (Gottschalk, 2019); and
- does not provide evidence of a causal relationship between screen-based activities and mental health problems, although some associations between screen-based activities and anxiety or depression have been found (OECD, 2018, Orben and Przybylski, 2019).

However, it is still wise to take a precautionary approach including turning off devices when not in use, switching off screens an hour before bed, and designating times (e.g. while having dinner or driving) and locations (e.g. the bedroom) as media-free.

Most importantly, it is key to maintain a focus on the activities that are strongly associated with healthy development, such as good quality, regular sleep and quality time spent with family and friends. These and many other factors are more important than taking a hard line over screen time limits to ensure the best start in life.

Evidence-based guidelines: an example of good practice from the United Kingdom

The UK Royal College of Paediatrics and Child Health Recommendations are based on a comprehensive review of the evidence on the effects of screen time on children's physical and mental health.

Given the lack of causal evidence linking screen time to negative child health, the guidelines focus on aspects of child well-being, such as online safety (i.e. from bullying, exploitation etc.) and access to inappropriate content. The main recommendation is that families negotiate screen time with children, based on the needs of the child and on which screens are in use and how they may or may not displace other health-related behaviours or social activities.

The guide poses four questions to be used by families to examine how they use screens. If families are satisfied with their responses, it is likely they are doing well regarding screen time. The questions are:

1. Is screen time in your household controlled?
2. Does screen use interfere with what your family wants to do?
3. Does screen use interfere with sleep?
4. Are you able to control snacking during screen time?

The guide finishes with a set of recommendations on how families can reduce screen time, if they feel the need. This includes protecting sleep, prioritising face-to-face interaction and being aware of parents' media use, as children tend to learn by example.

Source: Viner, Davie, Firth (2019).

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Childhood is a time of rapid development

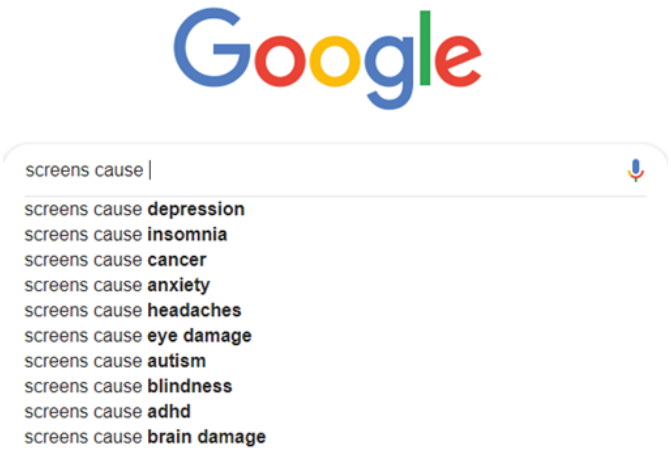
It is evident that children are spending more time on line, and at earlier ages. This may be significant because childhood is a time of rapid growth, development and maturation. One important element of the human brain is that it is "plastic", which means that it changes in response to experiences.

Childhood is a period of high brain plasticity. During the first three years of life, a child's brain may create over one million new connections per second - essential for the development of hearing, language and cognition (Center on the Developing Child, 2009). These basic capacities create the foundation for the neural networks underlying more complex activities, such as decision-making and cognitive flexibility. Brain imaging studies have shown that these changes in function are accompanied by extensive structural alterations in the adolescent brain (Crone and Konijn, 2018).

"Rewiring" children's brains takes a little more than some screen time

Due to the plasticity in childhood, there is a lot of concern about technology "rewiring" children's brains. Unfortunately, there is an abundance of misinformation on this topic that has fed into fears and misplaced anxiety about how and how much children use technology. A quick google search shows how fearful people are of screens

Fortunately, major brain changes and "rewiring" resulting from screen time is unlikely (Mills, 2014). Children's outcomes are the product of many different factors, including their experiences and environment (along with other factors such as genetics). While technology will have an impact on them, the key is to maximise the cognitive, physical and social benefits it brings while minimising the risks.



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Impacts of technology on children

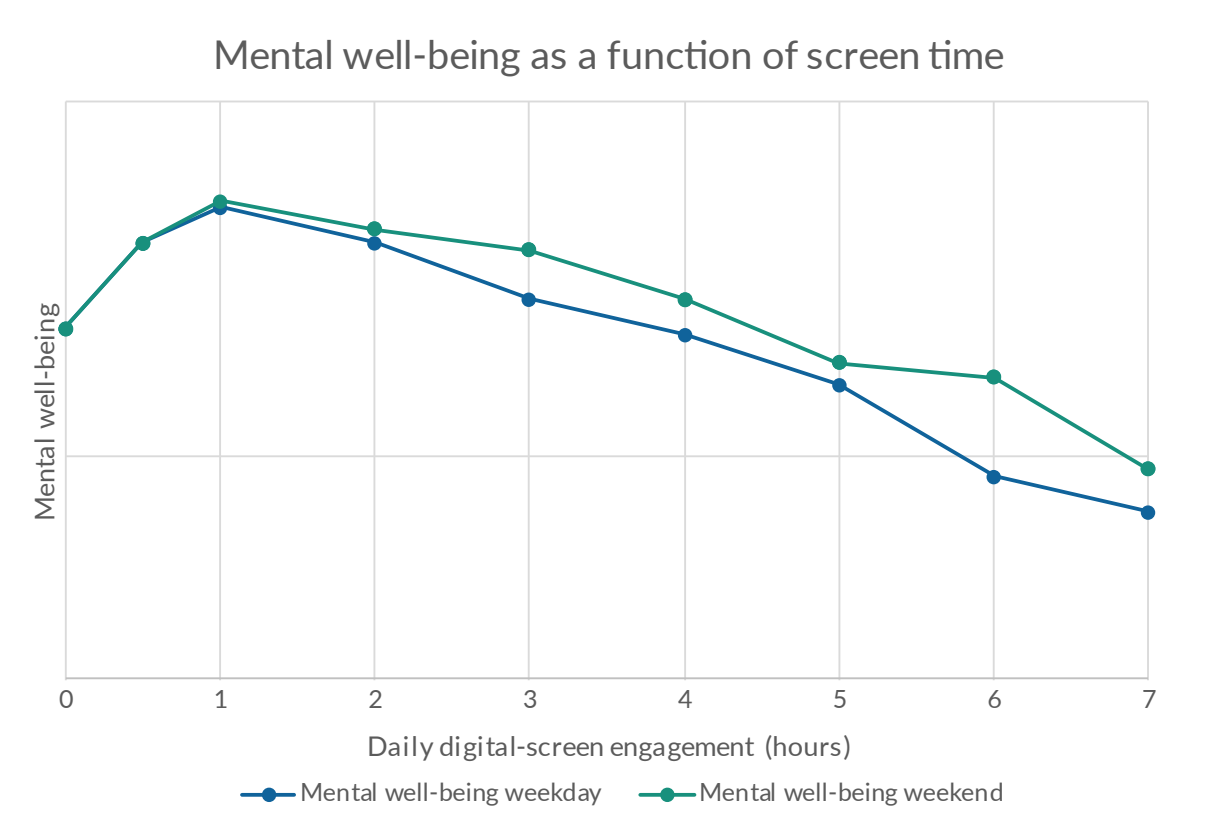
The impact of technology depends on the type of technology and what it is used for (Bavelier, Green and Dye, 2010). It is thus important to better understand how and why technology is used, and the variety of devices children choose.

Young people use the Internet for gaming, chatting and social networking. Although televisions and tablets dominate media use in children, traditional television is increasingly being replaced by services such as Netflix and Amazon Prime, and YouTube is quickly becoming the viewing platform of choice especially for 8-11 year-olds (Ofcom, 2019). Children may use computers during class time, cell phones to keep in contact with friends, a tablet to do schoolwork in the evening, and then watch an hour of television with their families to unwind. This can add up to many hours over the course of the day, although the majority of 12-15s in the United Kingdom believe they have managed to strike a balance between using screens and doing other things (Ofcom, 2019).

Spotlight on the "Goldilocks effect"

Is there a "right" amount of technology use? The "Goldilocks Effect" argues that moderate engagement in online and digital activities is beneficial in terms of subjective mental well-being and adolescent connectedness, whereas too much or too little might prove detrimental (Przybylski and Weinstein, 2017).

So how much is too much? The threshold varies and will depend on the individual activity and child. In 2015, 16% of 15 year-olds among OECD countries reported that they spent more than 6 hours on line per day outside school during weekdays, and 26% during weekends. These "extreme Internet users" reported less life satisfaction and were more likely to be bullied at school (OECD, 2017). Moreover, "extreme Internet users" performed worse across all subjects in the Programme for International Student Assessment (PISA), even after accounting for differences in socio-economic background.



Note: Screen use of computers shown. The pattern is consistent also for watching TV, gaming and streaming.
Source: Adapted from Przybylski & Weinstein, 2017.

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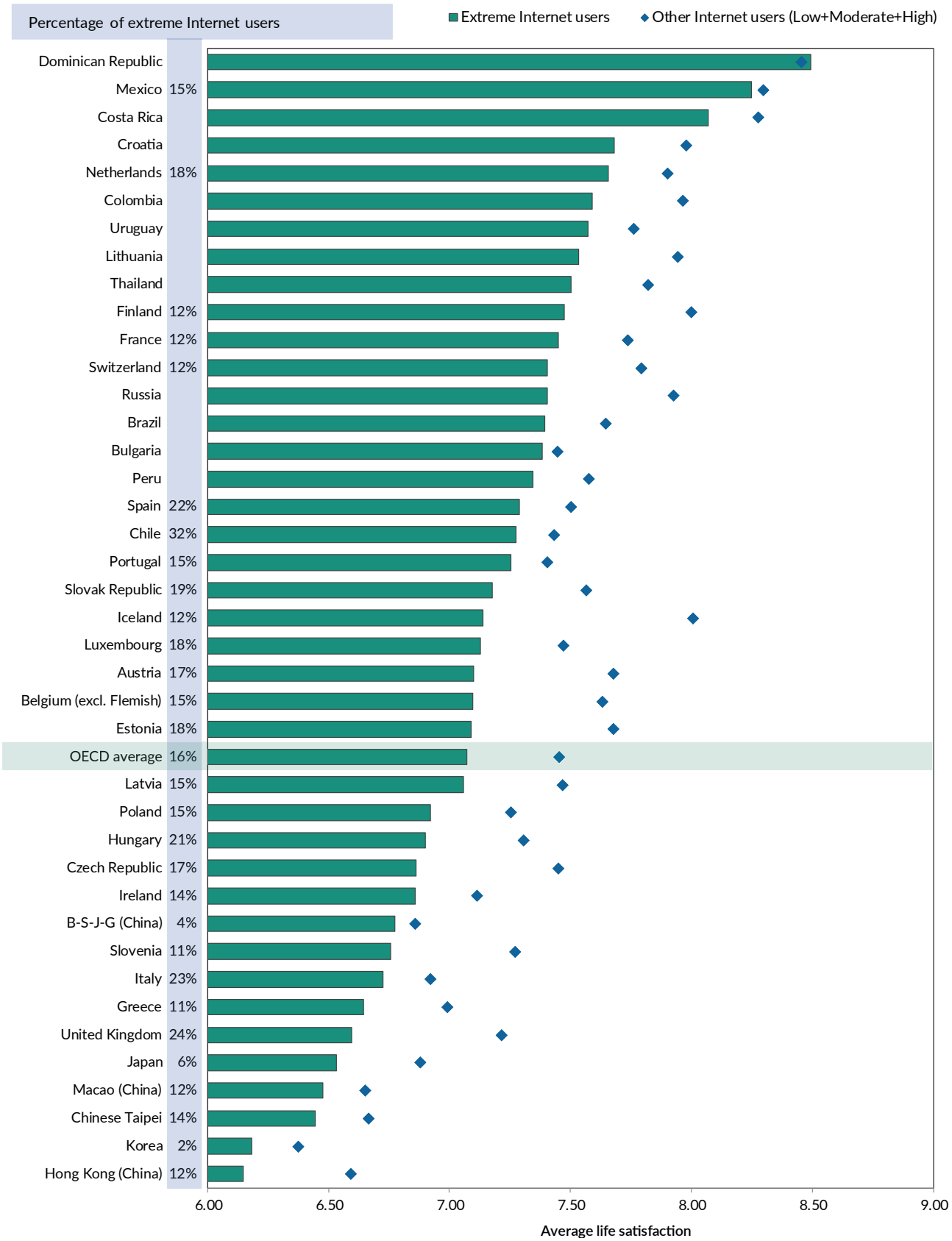
Figure 2. Life satisfaction of extreme Internet users

Average life satisfaction, by time spent on the Internet outside of school during weekend days



Notes: Categories of Internet users are based on students' responses to questions about how much time they spend on line, outside of school, during a typical weekend day. Low Internet users: one hour or less; moderate Internet users: 1 to 2 hours; high Internet users: 2 to 6 hours; extreme Internet users: more than 6 hours.

Statistically significant differences in life satisfaction between extreme Internet users and other Internet users are shown next to the country/economy name (see Annex A3 in OECD [2017]).

Countries and economies are ranked in descending order of the average life satisfaction of extreme Internet users.

Source: OECD, PISA 2015 Database, Table III.13.23.

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Highlights of Research on...

Television

There is a larger research base on television and children than most other types of technology; in part, this is because television has been around for a long time. However the research is contradictory and there is no clear impact (either positive or negative) of moderate television viewing (Foster and Watkins, 2010). The two most important elements appear to be the quality of the programming, and whether or not the child is interpreting it with a parent or other responsible viewer.

A systematic review of the literature exploring the association between television viewing and outcomes such as academic performance, language and play suggests that watching high-quality content is associated with higher academic skills and is predictive of future academic performance, whereas watching television during infancy and engaging with inappropriate content was associated with negative outcomes (Kostyrka-Allchorne, Cooper and Simpson, 2017). These findings underline the concern about equity and context as children from disadvantaged backgrounds tend to watch more television than children from advantaged backgrounds (Certain and Kahn, 2002; Rideout and Hamel, 2006).

In sum, there may be some benefits associated with engaging with child-tailored, educational content in terms of improved verbal abilities, cognitive development and neural maturity in children. However, the research also points to children learning better from live sources than from videos, despite the potential mitigation of this deficit by using socially meaningful or familiar onscreen characters.

The importance of co-viewing

"Co-viewing" (when parents watch videos with children) allows children to potentially increase their ability to learn from video content (see Gottschalk, 2019, for an overview). When parents pose questions and give descriptions and labels during viewing, this helps their children pay more attention (Barr et al., 2008). But the extent of the cognitive outcomes associated with co-viewing is unclear and it might also be that simply engaging in behaviours (screen-based or not) with a caregiver may be beneficial for child development (Lee, Spence and Carson, 2017).

A warning: Co-viewing may inadvertently be increasing the divide between advantaged and disadvantaged families. Children whose parents are able to spend time curating and mentoring screen time may reap more benefits than those in families with less financial resources and with parents who are less able to be involved in daily activities (Canadian Paediatric Society, 2017). It is thus important to encourage all parents to talk to their children about what they are watching. For children with parents whose schedule gives them less time to spend together, co-viewing perhaps can be incorporated into other health and development-promoting habits, even for infants and young children.

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Video games

The literature on video gaming and children is much more recent than that on television. The majority of the research that exists focuses on negative rather than positive outcomes (Granic, Lobel and Engels, 2013). Providing a coherent and balanced evidence base is important, especially as online gaming is becoming increasingly popular; of children aged 5-15 in the United Kingdom who play games, three quarters do so on line (Ofcom, 2019).

Parents and educators often worry about the impact of gaming on educational attainment; but as with "educational television", "educational gaming" might have positive effects on children. In general, however, there is a lack of strong evidence and the literature in this domain is contradictory.

Active video games

Video games have undergone a shift. Where we once had only sedentary, controller-based games, we now have options to engage in active video games, which require players to engage in physical movements in order to interact with the screen-based game and can elicit light, or even moderate activity (Norris, Hamer and Stamatakis, 2016).

Augmented reality games, or those that involve geotracking (or in the case of Pokémon GO, a game that uses both) are also becoming increasingly popular and are argued to promote movement. However, the evidence on whether these can be used to enhance physical fitness or promote well-being is mixed.

A systematic review of the literature on active video games as health interventions within schools found that the research was not of a high enough quality, and recommended that randomised controlled trials with larger sample sizes be conducted in order for these to be used as health interventions (Norris, Hamer and Stamatakis, 2016). In contrast, a meta-analysis including 35 articles on active video games concluded that these games can be a good alternative to sedentary behaviour, although they are not replacements for more traditional sports and physical activity in children and adolescents. The effect sizes (i.e. the size of the difference in outcomes between those who played the video games and those who did not) in most of these studies ranged from small to null (Gao et al., 2015). This highlights an important problem in this field; effect sizes are often small or even negligible.

Source: Gottschalk, 2019

Social media & communication

Since 1997, over 10 000 published journal articles have used the term "social media", with experts in fields such as psychology, economics and sociology incorporating this topic into their research agendas (Meshi, Tamir and Heekeren, 2015). This is for a good reason: in the UK about 70% of kids aged 12-15 have a social media profile (Ofcom, 2019). In the US approximately 97% of 13-17 year-olds use at least one social media platform (Ancerson and Jiang, 2018)

Similar to the "Goldilocks Hypothesis" for screen use, there is evidence to suggest that children's social relationships can be stimulated through digital technology and that moderate online communication has a positive relationship with the quality of friendship and social capital (for a review, see (Kardefelt-Winther, 2017)).

Despite the proliferation of research exploring social media use and the huge numbers of children subscribing to these platforms, empirical research on the impacts of social media on the brain is scarce. In 2015, only seven published articles explored neurosciences and social media (Meshi, Tamir and Heekeren, 2015). Furthermore, most studies focus on Facebook use, which is not as popular as other social media used by 21st-century children, such as Snapchat and Instagram.

Despite the difficulty in conducting research on rapidly changing technology, it is important to study this further.

Internalising behaviours such as anxiety and depression have risen in recent years in children and adolescents (Choi, 2018); social media often takes the blame for being one of the root causes of this trend.

Being connected to their online communities is important for children and adolescents. Half of the students who took the 2015 PISA assessment agreed with the statement "I feel bad when I am not on line". In European countries, disadvantaged students were more likely to report that they felt bad without available Internet connection, compared to advantaged students, and girls were more likely to report feeling bad when unconnected than boys (OECD, 2017).

There is some research to suggest that social media use, especially at night, might be linked to outcomes such as poor sleep quality. But relationships between screen use and levels of anxiety and depression tend to be small, and do not show the direction of the link (that is, levels of anxiety and depression could be causing more social media use, or vice versa) (OECD, 2018).

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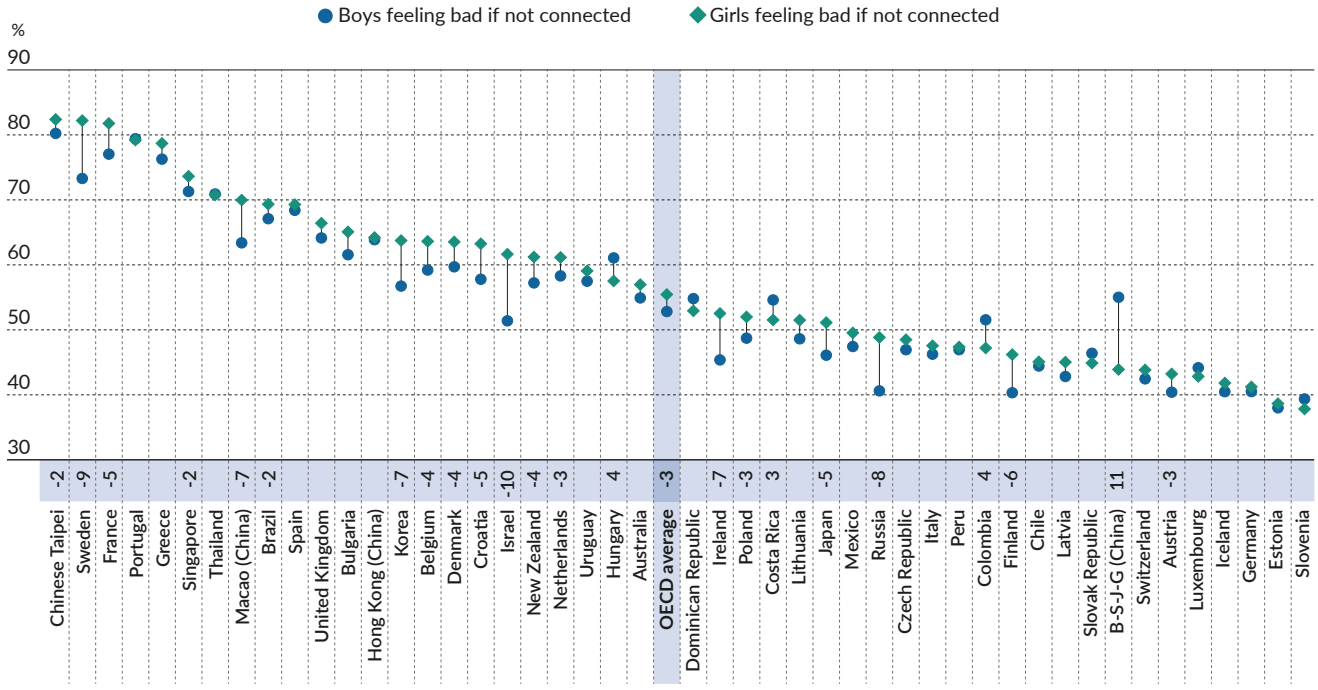
Figure 3. Feeling bad if not connected to the Internet, by gender

Percentage of students who reported "agree" or "strongly agree"



Note: Statistically significant differences between boys and girls are shown next to country/economy name (see Annex A3).

Countries and economies are ranked in descending order of the percentage of girls who feel bad if there is no Internet connection available.

Source: OECD (2017), Table III.13.16.

Controversial diagnoses: Social media, gaming and "addiction"

Policymakers, parents and the media are consistently reporting concerns about gaming and addiction. "Internet Gaming Disorder" (IGD) was recently included in the Appendix of the Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V) and as "Gaming disorder" in the draft of the 11th revision of the World Health Organization's International Classification of Diseases (ICD-11).

However, these additions are controversial [i.e. (Starcevic, 2017; Aarseth et al., 2017; Király and Demetrovics, 2017; van Rooij et al., 2018; Rumpf et al., 2018)], and the formal classification as a "disorder" is contentious in the scientific community (Turel et al., 2014). Some researchers prefer to use terms such as 'excessive Internet use' to avoid using medical classification or terminology (Smahel et al., 2012, Kardefelt-Winther, 2017). "Problematic" or "excessive" use of technology is determined by whether the use interferes with normal daily functions and is difficult to control, rather than based on the absolute quantity of exposure (Howard-Jones, 2011).

"Facebook addiction" is another term that has gained traction in recent years, and as with "gaming addiction" this label is contentious.

Even though more children are using social media than ever before, research on the effects of that activity on developing brains is still in its infancy. The use of social media has been connected to facial recognition and memory, which could prove beneficial in establishing and maintaining strong social networks both on line and off, in adolescence and later in life. However, directional causality cannot be inferred, and often the functional relevance of certain brain phenomena is unclear.

As this is a fast-moving area, the importance of using rigorous research is more necessary than ever (OECD, 2018). At present, there appears to be a disconnect between the available evidence, media and public perception. Claims that "smartphones have ruined a generation" are largely unfounded. However, it is clear that this is an area of study that will need constant updating and refinement as technology evolves.

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Implications for physical health: frequently asked questions

Does screen time impact children's sleep?

Many devices today emit short wavelength or blue light, which has an effect on natural sleep and wake cycles. As computers, cell phones and tablets have evolved over time to have larger and brighter screens, using one of these self-luminous devices in the evening has been associated with reduced melatonin, a hormone that helps signal sleep to the body.

A systematic review of the literature examining sleep patterns among school-aged children and adolescents found that the vast majority of the studies showed negative associations between screen time and sleep outcomes, such as delayed timing and shortened duration of sleep (Hale and Guan, 2015), although this reduction might be as small as 3-8 minutes per hour devoted to screen time (Przybylski, 2019). However, association, or correlation, does not imply causality, and it is hard to accurately measure sleep and screen time.

Still, it seems clear that establishing limits on when children and adolescents use technology (e.g. not in the hours immediately preceding bedtime), or providing children with protective equipment, such as blue light-blocking glasses, may help prevent sleep disruptions.

More research is needed to identify whether activating features on mobile devices, such as "night shift" or "night mode", are effective in avoiding disruption of melatonin production. These steps could be incorporated into good sleep-hygiene practices, which include avoiding excess (or any) caffeine, engaging in regular exercise, maintaining a regular sleep schedule, and eliminating light and noise from the sleeping environment (Stepanski and Wyatt, 2003).

What's the link between obesity and screens?

Over recent decades, increases in time spent watching television and using the computer have raised concerns about obesity in children. Eating while watching television, for example, has been associated with an increase in energy intake (i.e. more calories or food eaten) because it can delay the feeling of fullness. It can also obscure signals of satiety from foods that have been previously consumed (i.e. children do not stop eating, even though they are already full) (Bellissimo et al., 2007).

This can be partially mitigated by parents and caregivers limiting snacks in the home, providing children with healthy foods to snack on while watching television or playing video games, and making meal times screen-free.

Isn't screen time taking time away from children socialising, playing and doing sports?

Some literature points to the notion of a "displacement effect", whereby time spent using technology takes away from other potentially more "valuable" activities (Neuman, 1988). However, a recent review of the literature suggests that reducing screen time may not motivate adolescents and children to engage more in physical activity (Kardefelt-Winther, 2017); other research has shown that screen-based, sedentary behaviour and leisure-time physical activity are independent of one another (Gebremariam et al., 2013). Television watching may displace other activities, such as reading, but the overall evidence of the negative impact of displacement is relatively weak (Evans Schmidt and Anderson, 2009). While screens do not specifically cause myopia (short-sightedness), too much time spent indoors is associated with its onset (Dolgin, 2015). Parents and teachers should thus ensure that screen time does not take away from time spent outdoors.

Displacement effects can differ based on the extent of screen time and the activities being displaced. For example, heavy Internet use may interfere with participation in clubs and sports, whereas moderate use has been shown to encourage participation (Romer, Bagdasarov and More, 2013). This is a relatively consistent finding across the research: moderate Internet use, and shared media experiences, allow young people to build rapport with their peers (Romer, Bagdasarov and More, 2013; Romer, Jamieson and Pasek, 2009).

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What can schools do? The role of education in fostering safe, responsible Internet use

Schools and education systems play a key role in supporting safe and responsible Internet use. The challenge for schools lies in their ability to reduce the negative uses of the Internet and digital devices while maintaining their contributions to teaching, learning and social connection. In order to do this, children should be taught how to manage risks on line. Schools and education systems can adopt some of the following approaches to support students in their digital use (for the full discussion see Hooft-Graafland, 2018).

Adopt a whole-school approach to resolving online safety issues

When teachers and support staff can recognise, respond to and resolve online safety issues, this is effective in protecting and supporting students on line. Staff and teachers therefore need regular training in online risks and their implications. Parents and students can be involved to strengthen their own capacity in dealing with online issues. And don't forget the connection to the physical world: online safety also means putting screens away while crossing roads and walking!

Develop and enact online safety policies and procedures

Effective policies and procedures promote responsible and safe online practice for students and staff. Good policies will support students' online learning, without preventing or overly limiting online access, and should be integrated with safeguarding policies such as those on cyberbullying and online behaviour. Talking to children about their experiences and engaging them in the development of online safety policies is important, as children often know best what new risks they might encounter on line.

Establish coherent (cyber)bullying policies

Policies targeting cyberbullying should be incorporated into the context of traditional bullying. Given the strong correlation between the two, successful bullying interventions may also reduce cyberbullying (Livingstone, Stoilova and Kelly, 2016). Effective policies for bullying clearly describe what behaviour is and is not accepted on line and at school, and what the consequences are for violating these rules (StopBullying, 2017).

Incorporate e-safety in the curriculum

Including online safety in the school's curriculum helps children become safe and responsible users of technologies (Hinduja and Patchin, 2018), with peer-support programmes and mentoring schemes seen as effective in enhancing online safety. But e-safety is not isolated from the rest of learning. There is a growing belief that schools should teach digital citizenship as part of digital literacy, to help children engage in more positive online behaviour. This includes online etiquette and behaviour as well as on harm reduction strategies that teach children about empathy and privacy (see Hooft-Graafland, 2018).

Strengthen family-school partnerships

Online safety must continue at home. As younger children go on line and children increasingly use technology out of school environments, parents and caregivers play a more important role in educating children about technology (Duerager and Livingstone, 2012). Parents and caregivers thus need to know about adaptive ways of responding to safety incidents with children, and how best they can effectively mediate their child's exposure to online risks.

Furthermore, technology can be an important tool in parent-teacher communication, informing parents about their children's time at school and including them in activities and discussion.

Harness the power of peers

Besides seeking help from parents and teachers, children and especially adolescents turn to each other when they need support. They also learn about new opportunities on line mainly through their peers: Peer mediation can positively affect children's digital literacy and the type of activities they engage in on line. It is thus important to foster an open culture of e-safety in schools so that peers can also provide helpful advice and access to resources.

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Making e-safety work

Even though children often seem to understand technology better than adults do, they need guidance on how to use technology in a responsible and positive way. The following set of messages are important to consider when developing school policies:

- Adults who understand online safety and are able to use technology are more successful in guiding children's digital use. Therefore, it is crucial that parents and teachers receive information on online safety, and advice on how to help children manage online risks (Livingstone, Davidson and Bryce, 2017).
- Take a look in the mirror: teachers and parents need to be mindful of their own online behaviour and what they are modelling for the youth around them. Parents (and grandparents) should never assume that children are happy to have their images and news about their lives shared on line without their permission.
- Children and adolescents need to be stimulated to become content creators and not just receivers (Livingstone, Davidson and Bryce, 2017). Most students still use the Internet for ready-made, mass-produced content, such as watching online video clips or listening to music.
- The second digital divide is real: students from more advantaged backgrounds tend to have higher digital skills. Special efforts should be made to overcome these inequalities and ensure that disadvantaged children receive the support and guidance they need to succeed in a digital world (Hatlevik, Gudðmundsdóttir and Loi, 2015).

One last note: Policy solutions should be based on robust evidence. The speed of change of technology means that research on the impact of technology on children is more, not less, important. Although seemingly self-evident, fears that technology is harmful for children have resulted in a disconnect between the policy, public discourse and the body of evidence. This topic will need constant updating and refinement as technology and its uses evolve.

The OECD's Directorate for Science, Technology and Industry is currently revisiting and updating the OECD (2012), *Recommendation of the Council on the Protection of Children Online*. The Recommendation includes principles for all stakeholders involved in making the Internet a safer environment for children and educating them to become responsible digital citizens. The conclusions of this process will be available in the coming months.

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