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How technology use is changing adolescents' behaviors and their social, physical, and cognitive development

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The rapid spread of Information and Communication Technologies (ICTs) in recent decades has pushed the use of smartphones, tablets, and their applications to become pervasive tools used in everyday life, especially among adolescents (Khang et al., 2013; Odaci & Çıkrıkçı, 2014). The possibility of being constantly connected significantly increases the amount of time adolescents spend online, and Web and mobile applications are ubiquitous in many adolescents' lives (Durak, 2018). Research has shown that adolescents use the Internet more frequently (compared to adults) than other generations and in a more multipurpose context (Cain & Gradisar, 2010; Livingstone et al., 2011; O'Keeffe et al., 2011; Tzavela et al., 2015, Casaló & Escario, 2018). The use of digital applications has also dramatically changed the way adolescents relate to their peers, access information, and engage in social relationships, and has also had a profound influence on their health, including their well-being (e.g., the impact of smartphone uses on the sleep-waking cycle), and on their cognitive development (e.g., level of attention in carrying out a task). Given the importance of considering technology use as having a profound role in adolescent development, one key question many scholars are now attempting to answer concerns how adolescents' online presence shapes their offline lives; this question could be encapsulated as follows: "*Is technology use changing adolescents' behaviors, their social, physical, and cognitive development?*"

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Our principal focus in this special issue is on adolescence and digital natives. In this regard, we consider adolescence as the transition between childhood and adulthood, characterized by biological, cognitive, social, and psychological changes (Berk, 2017). Adolescents are also commonly referred to as "Digital Natives" (Prensky, 2001), meaning that they were born into a world where technology is central to daily life, they are learning and adopting technology from infancy, and as a result they think and process information in fundamentally different ways when compared to their predecessors, referred it as "digital immigrants". Considering this definition, it is also important to note that the duration of adolescence, its demands, and pressures vary substantially between cultures (Berk, 2017). Most tribal and village societies have only a brief intervening phase between childhood and the full assumption of an adult role (Berk, 2017). On the other hand, young people in Western societies (e.g., Europe and North America) face a prolonged dependence on their parents and the postponement of sexual gratification while they prepare for a productive working life. As a result, adolescence is often greatly extended in these countries. In this regard, according to Berk (2017), for this special issue, we consider a wide range of the meaning of adolescence, which is reflected in the included papers that considered the following groups: *Early Adolescence* (11–12 to 14 years): this is a period of rapid pubertal change; *Middle Adolescence* (14 to 16 years): pubertal changes are now almost complete; *Late Adolescence* (16 to 18 years): the young person achieves their full adult appearance and begins to take on more adult roles. Then, considering all these aspects, the main goal of this special issue is to include papers on the impact of technology on adolescent development. Papers published consider different fields of research (e.g., psychology, sociology, health, data science, cognitive science) that describe the impact of technology on behavioral, social, physical, and cognitive changes during adolescence, and how technology may influence these changes in both positive or negative ways throughout adolescent development

(psychological, sociological, physical, and cognitive). With this wide range of topics described across the included contributions, then we can ideally divide these papers into three macro sections.

Section 1: Behavioral and psychological changes during adolescence using technology

Around 71% of young people worldwide are internet-users compared to 48% of the world's population. The highest reported percentage of internet users in this age group is in Europe where 97% of 15 to 24 year-olds are internet users.

Around 71% of young people worldwide are internet-users compared to 48% of the world's population. The highest reported percentage of internet users in this age group is in Europe where 97% of 15- to 24-year-olds are internet users[1]. Similarly, in many lower resource countries globally, use of technology among adolescents is increasing rapidly, with smartphones, mobile apps, and social media platforms featuring prominently in the daily lives of many adolescents. Therefore, the internet provides teens with various opportunities, including the formation and maintenance of peer relationships, entertainment (e.g., watching videos and movies), access to information for schoolwork, and fast communication with parents, friends, and other individuals (Lenhart, 2015). Complicating the "picture" of teens' online behaviors is that they often coordinate this activity simultaneously with spending time with their friends online and offline (Lenhart et al., 2015). Research suggests that many teens "hang out" with their friends online and "hang-out" with their friends in person too (Lenhart et al., 2015). Despite these opportunities, teens are potentially exposed to harmful or disturbing content, experience internet victimization or online hate, and are exposed to identity theft, unwanted sexual solicitation, and sexual predation (Kuss et al., 2013; Weaver et al., 2011; Yakovlev & Kinney, 2008). Teens who are low-income, have a history of maltreatment, and disclose more personal information online are more likely to experience these online risks (Noll et al., 2013). Researchers, educators, and clinicians are also particularly concerned with the psychological risks and addictive potential of excessive internet use among teens. Prevention efforts have focused attention on promoting digital literacy skills, training parents and educators on teens' exposure to online risks and promoting kindness online through various social awareness campaigns. Papers that refer to this section come from different cultures and social contexts and analyze the behavior of adolescents in the use of technologies. Summarizing the results of these research, it is highlighted how the time and way of using the internet (in general) and specific technologies influence adolescents' behavior (development and application), and how this affects their personality, their social relationships, and their relationship with family and with peers.

Section 2: Cognitive and physiological development as well as impacts on health, mental health, and wellbeing

Having near constant access to technology and internet might affect teens' cognitive development. The constant access to the internet might hinder teens' memory abilities or the ability to engage in effortful thinking (Nasi & Koivusilta, 2012). Research indicates that near-constant access to the internet influences the kind of information people choose to remember (Sparrow et al., 2011). Such a finding might suggest an adaptation to the online environment where it is more efficient to remember where to access information easily than remembering specific information. Another concern is that teens' ability to multitask between various activities, those online and offline, could shorten their attention spans. Furthermore, multitasking might include simultaneously accessing digital media and the internet while also engaging in other activities, like household chores (Common Sense Media, 2015). Social interactions online might also occur simultaneously with socializing offline, as teens might play consoles or mobile phone games, surf social media, and video chat others while a friend is present. Findings from one study revealed that heavy media users were much better at switching between tasks than light media users (Alzahabi & Becker, 2013). By focusing attention on the function for which a technology is built and reasoning from the adolescent development perspective, it is possible to say that when the use of a technology supports an adolescent activity (or compensates for its shortcomings) to reach a goal or to facilitate its achievement, then this technology is functional to the adolescent development. On the contrary, when this does not happen the technology is dysfunctional and can lead to problematic use. Papers in this section highlight the results of research that show the effects and potential of technologies in the development of adolescent well-being, with a focus also on risk prevention, gender differences and gender equality.

[1] https://www.wish.org.qa/wp-content/uploads/2022/04/WISH-Digital-Technology-and-Child-Wellbeing.12.04.22-V06.pdf.

Section 3: Explores potential for digital health interventions (DHIs) to have positive effects on promoting adolescent health/wellbeing, adoption of positive health behaviors, cognitive development, and positive impact on other important aspects of adolescent development

Digital health interventions (DHIs), involving computer-assisted therapy, smartphone apps, online interventions, and wearable technologies, have been developed for a wide variety of adolescent mental health outcomes such as anxiety, depression, loneliness, autism, psychosis, attention deficit hyperactivity disorder, eating disorders, and post-traumatic stress disorder (Alvarez-Jimenez., et al. 2014; Hollis et al., 2017; Lim et al., 2019). According to a systematic and meta-review, modest clinical benefit of DHIs was found mainly for depression and anxiety and particularly for computerized cognitive behavioral therapy (cCBT; Hollis et al., 2017). In short, anxiety and depression symptoms were found to improve through cCBT. However, the evidence was mainly relevant to late adolescents (16–18 years old) with mild to moderate symptoms, though for other mental health outcomes (e.g., psychosis, ADHD, eating disorders) the evidence is limited. Moreover, the review concluded that DHIs were not necessarily favored by adolescents' over face-to-face contact. This suggests that the commonly held assumption that DHIs are preferred among adolescents may not accurately portray their views or perceptions, and explorative qualitative research could inform this issue (Hollis et al., 2017). Methodological issues abound in this field: there is great heterogeneity among DHIs, and a taxonomy does not exist to specify components of DHIs making comparison across studies difficult; studies are generally under-powered and poorly controlled. Hollis et al. (2017) suggested that more research should be conducted on how DHIs should be tailored to personal requirements, what the active components or ingredients in DHIs are (i.e., what is driving change?), cost-effectiveness, investigation of how much human facilitation/support is necessary, DHI effects in the offline world, and the use and effectiveness of mHealth smartphone/tablet apps. Additionally, most studies rely on self-reported data from subjects, making it difficult to fully explore the effects of technology use on different changes in physiology and behaviors (George & Odgers, 2015). Results described in the papers referring to this section show how DHIs are extremely relevant for adolescents, and how they can positively support the changes that occur in this age, considering the uncertainties, changes and physical exploration and different stages of adolescence.

Conclusion

In this special issue we have tried to collect the latest research that addresses the most relevant issues for adolescents, taking into consideration a broad spectrum of cultures and populations of adolescents. Future research on these issues should take into consideration some aspects that may be relevant in the future for adolescents, who will later become adults in the future. A very relevant aspect is certainly their well-being, an in-depth study on the use of technologies and well-being could lead to results and the formation of educational and psychological paths, that can help adolescents to face the challenges that this difficult phase of development offers. A second aspect concerns the importance of monitoring the development of changes in interpersonal relationships, both at the family level and with peers. The relevance of building relationships in adolescence is fundamental for a positive physical and psychological development. The significance of online relationships is linked to this aspect. In the teenagers of tomorrow, now digital natives, there is no longer the difference between online relationships and offline relationships, there is a concept of onlife: their relationships merge into a unique dimension. The value of focusing on managing these relationships is also fundamental for handling the use of social networking sites (SNSs) and adolescents' online reputation (What place and with whom). Finally, we want to emphasize the meaning of research that can include multiple scientific, interdisciplinary sectors that can create ideas for the new challenges of the future, and that can keep pace with the social, cultural, and behavioral changes of future adolescents worldwide.

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