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***Research article***

# The impact of digital technologies on sleep and learning: An overview of recent research and neuroscientific analysis

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***Abstract***

This article examines the neuroscientific underpinnings of how new technologies impact sleep — an essential component for development, memory and learning

We will look on the implications of proper rest on development and education by reviewing recent research on smartphone use, social media engagement, and the role of computer games and reading habits in digital literacy.

A growing body of evidence highlights the role of brain systems associated with the default mode network (DMN), essential for introspective processes such as self-awareness, reflection, autobiographical memory retrieval, future planning, socioemotional reasoning, and moral judgements. This paper explores how technology-induced habits disrupt these neural processes, subsequently affecting sleep architecture, attentional control, and learning efficiency. During sleep, the brain actively reprocesses daily experiences, discarding irrelevant information and consolidating meaningful memories into long-term storage. By analyzing the impact of technology on this restorative process, this review aims to provide insights that can inform pedagogical strategies.

***Keywords:*** neuroscience, education, technology, sleep, learning, smartphones, computer games, social media, digital reading

*Научная статья*

# Обзор последних исследований и анализ на нейробиологической основе влияния новых технологий на качество сна и обучения

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***Аннотация***

В статье описываются неврологические проблемы, связанные с влиянием новых технологий на важнейший элемент развития, памяти и обучения, — сон.

Рассматривается влияние отдыха на развитие и образование с учетом последних исследований, посвященных использованию смартфонов, влиянию приложений и социальных сетей, а также роли компьютерных игр и чтения в достижении цифровой грамотности.

Накопленные данные демонстрируют важность изучения систем мозга, связанных с режимом бодрствования и отдыха, которые имеют решающее значение для активности ментальных и психосоциальных процессов. Эти процессы задействованы в таких видах деятельности, как самосознание и рефлексия, воспроизведение личных воспоминаний, представление сценариев будущего, формирование моральных суждений, переживание эмоций, связанных с психологическим воздействием социальных ситуаций. В рамках этой темы стоит кратко рассмотреть, как появление новых привычек, связанных с использованием современных технологий, существенно влияет на режим сна, концентрацию внимания и общую способность к обучению.

Сон — это время, когда мозг перерабатывает и систематизирует впечатления и информацию, собранные в течение дня. Во время сна большинство чувств и переживаний «отбрасываются», а важная информация закрепляется в «долговременной» памяти. Обзор последних исследований, в которых анализируется влияние новых технологий на отдых, может стать полезным инструментом для совершенствования педагогической деятельности.

***Ключевые слова:*** неврология, образование, технологии, сон, обучение, смартфоны, компьютерные игры, социальные сети, цифровое чтение

## Introduction

This article is structured into four distinct sections, preceded by an overview of research methodology. The sections present the core analytical content and could be published as separate papers as each examines a different facet of technology's impact.

The first analytical section explores the critical implications of rest and sleep for development and education. It outlines the neuroscientific evidence demonstrating how sleep actively optimizes learning processes.

A key modern rest disruptor, especially among school-aged children, is pre-sleep exposure to electronic screens (e. g., smartphones, tablets). Thus, section two delves into the neuroscientific mechanisms through which such digital overexposure negatively impacts sleep architecture. Beyond the school environment, children are increasingly immersed in digital realities. The second analytical section, entitled 'The effects of intensive app and social media use', investigates this pervasive 'space of existence'. It offers the analysis of how a digitally saturated life influences cognitive processes, learning activities, and social relationships.

The final section reviews recent neuroscientific studies on the roles of digital gaming and reading. Digital gaming extends beyond dedicated leisure time — which can itself hold pedagogical value — to fill interstitial moments such as short breaks and daily commutes. The section examines the cognitive impact of these activities on the development of digital literacy. Understanding the combined

influence of these digital engagements is vital for shaping effective strategies. This knowledge is crucial not only for refining pedagogical approaches but also for guiding broader efforts to promote mindful and productive use of technological tools.

## Methodology

### Eligibility Criteria

The following eligibility criteria were applied for the selection of articles:

— systematic research articles published in English;
— research involving student populations;
— research published in journals between 1994 and 2024.

### Sources of information

A comprehensive search was conducted across several major electronic databases, including PubMed, PsycInfo, and MEDLINE. Additionally, a manual search was performed to identify further relevant publications.

### Search strategies

An electronic search was carried out from December 2023 to June 2024 using the databases MEDLINE, PubMed, PsycInfo, and SciELO. The search was restricted to peer-reviewed journal articles available online and published in English. To ensure the relevance of the literature, the publication date was limited to the past 25 years.

### Selection procedure

In accordance with PRISMA guidelines (Moher et al. 2009), inclusion and exclusion criteria were defined a priori. During the initial screening phase, articles were assessed based on their abstracts according to the following inclusion criteria: (I) study samples aligned with the populations under review; (II) conditions of interest were explicitly evaluated; (III) publications were peer-reviewed.

Exclusion criteria were as follows: (I) single case studies without a rigorous methodological design; (II) studies unrelated to education and learning.

In the second phase, full-text articles that met the initial criteria were thoroughly reviewed. The following aspects were considered: (I) availability of replication or validation; (II) detailed description of assessment methods applied to participants; (III) clear specification of subject characteristics.

### Key findings, interpretation, and implications

The selection and analysis yielded several systematic reviews, which were organised thematically. Below is a summary of the examined topics along with interpretations of the results and their implications:

— implications of sleep-quality on development and education;
— smartphone use and sleep;
— the effects of intensive app and social media use,digital gaming and reading attitudes in digital reading performance.

## Implications of sleep quality on development and education

Recent insights into brain functionality reveal the dynamic interplay between neural networks responsible for externally directed attention and those governing the brain's default mode (DM). This default mode network activates during states of rest, daydreaming, and reduced external focus while being awake (Smallwood et al. 2003). Increasing evidence underscores the crucial role of brain systems linked to the DM in supporting internally related psychosocial processes, namely, self-awareness, introspection, autobiographical memory retrieval, prospective thinking, empathy, emotional evaluation of social contexts, and moral reasoning (Buckner, Carroll 2007; Buckner et al. 2008; Spreng et al. 2009; 2010). A growing body of evidence suggests that reduced opportunities for unstructured play, quiet reflection, and mind-wandering — especially during adolescence — may impair cognitive and emotional development. While lapses in attention due to daydreaming may momentarily hinder task performance, periods of reflection and intentional mind-wandering are crucial for long-term learning, emotional regulation, and psychological well-being (Brown, Vaughan 2009; Doyle 2016; Scott, Panksepp 2003; Siviy, Panksepp 2011; Thernstrom 2016; Walker 2015). Attention is not a unitary function but arises from the integration of three distinct neural systems: alertness, orientation, and executive control (Corbetta, Shulman 2002). Moreover, the networks supporting externally focused ('looking out') and internally focused ('looking in') cognition are interdependent. Their coordinated regulation is essential for optimal functioning across both short-term and longer-term tasks. As stated in (Immordino-Yang et al. 2012), 'the quality of default mode activity during restful states correlates closely with the quality of subsequent neural and behavioral responses to external stimuli. Therefore, fluctuations in these networks are integral to perception, attention, and goal-directed cognitive processes' (Northoff et al. 2010; Spreng et al. 2010). Research conducted in educational settings supports these insights. For example, primary school

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students show improvements in emotional well-being, self-confidence, and academic performance when encouraged to engage in 'metamoments' — pausing to reflect on emotions, envision their ideal self, and plan future actions accordingly (Brackett et al. 2012). Such practices align with DM research emphasizing the role of introspection and reflection in knowledge consolidation. The ability to modulate between internal reflection and external focus is critical for academic engagement, well-being, and performance on tasks requiring sustained attention. As argued by (Immordino-Yang et al. 2012), 'Both neural and psychological research reveal the significance of equipping individuals — adolescents in particular — with opportunities to refine their capacities for effective attention diversion'. Strengthening these capacities supports high-quality introspection and healthier outwardly-directed cognition. These processes are essential not only for task performance but also for overall well-being and the interdependent enhancement of internal and external attentional states. A related and increasingly urgent concern is the impact of smartphone use on adolescent sleep patterns with significant implications for both cognitive performance and emotional health.

## Smartphone use and sleep

Smartphones have become deeply embedded in the daily routines of adolescents, often used from morning until late at night. A recent study by (Siebers et al. 2024) investigated how smartphone usage at different times of day — particularly before sleep — affects sleep quality, distinguishing between passive consumption ('lean-back' apps) and active interaction ('lean-forward' apps). Sleep is essential for maintaining a balanced lifestyle, especially during adolescence — a critical developmental stage where establishing healthy sleep habits is crucial (Dregan, Armstrong 2010). Despite this, many adolescents experience poor sleep quality, with 50 % to 66 % reporting difficulties falling asleep, frequent nighttime awakenings, or non-restorative sleep (Akçay, Akçay 2018; Amra et al. 2017; Gradisar et al. 2013). These sleep disturbances are linked to adverse mental health outcomes, including depression (Alonzo et al. 2021; Gradisar et al. 2022; Orchard et al. 2020), anxiety (Alonzo et al. 2021; Orchard et al. 2020), and increased negative affect (Triantafillou et al. 2019). The relationship between smartphone use and adolescent sleep has been widely examined. At least five meta-analyses (Chu et al. 2023; Han et al. 2024; Yang et al. 2020), two focusing specifically on adolescents (Carter et al. 2016; Sohn et al. 2019), and seven systematic reviews (Brautsch et al. 2023; Cain, Gradisar 2010; Hale et al. 2019; LeBourgeois et al. 2017; Mac Cárthaigh et al. 2020; Silva et al. 2022) detailed the impact of smartphone use among adolescents on sleep. Numerous empirical studies (e. g., Burnell et al. 2022; Cabré-Riera et al. 2019; Caumo et al. 2020) have consistently indicated that excessive smartphone use by adolescents — particularly at night — is associated with poorer sleep quality. However, they also identified gaps in the existing body of literature. Siebers (Siebers et al. 2024) contributed to this literature by examining within-person effects of smartphone use across different times: daytime, pre-bedtime, and after sleep onset. Interestingly, the study found no significant effects for daytime or pre-sleep smartphone use. Instead, phone use after falling asleep was strongly associated with reduced sleep quality. Individual differences appear to moderate these effects. The Differential Susceptibility to Media Effects Model (DSMM; Valkenburg, Peter 2013) highlights factors such as gender (McManus et al. 2021), chronotype (Fossum et al. 2014), social media stress sensitivity (Wolfers, Utz 2022), and self-regulation (Kroese et al. 2016; Li et al. 2015) as key variables influencing how smartphone use throughout the day impacts sleep.

By utilizing real-time smartphone data, Siebers and colleagues provide a nuanced, within-person analysis of how nighttime smartphone usage impacts adolescent sleep. Their findings critically underscore that the greatest harm is not necessarily from pre-sleep use, but from engagement *after* the sleep period has begun. This negative relationship appears to be driven by three interconnected mechanisms. First, smartphone use after bedtime can induce cognitive and emotional arousal at a time when the nervous system should be descending towards rest, directly impairing sleep onset and quality. Second, such nocturnal use directly encroaches on total sleep time and can distort the subjective perception of rest received. Finally, and perhaps most disruptively, push notifications and alerts can fragment the sleep architecture itself, causing micro-arousals and awakenings that lead to shallow, non-restorative sleep (Fobian et al. 2016; Van Den Bulck 2003). This often creates a vicious cycle: adolescents suffering from insomnia may turn to their phones as a distraction, a coping strategy that inadvertently exacerbates the very sleep difficulties they aim to escape (Bartel, Gradisar 2017; Eggermont, Van Den Bulck 2006). By utilizing real-time smartphone data, the study by Siebers is one of the first investigations into the day-to-day connections between nighttime smartphone usage and adolescent sleep outcomes. The findings highlight the particular harm associated with smartphone engagement after sleep onset.

This negative relationship can be explained through three key mechanisms. First, engagement with smartphones after going to bed may increase arousal at a time when the body should be preparing for rest, thereby undermining sleep quality. Second, prolonged phone use during the night intrudes on vital sleep time and can negatively influence the subjective evaluation of sleep. Third, push notifications and other device alerts can disrupt sleep cycles by causing awakenings (Fobian et al. 2016; Van Den Bulck 2003). Fragmented and shallow rest results in individuals feeling less rejuvenated upon waking, further lowering perceived sleep quality. It is also important to note that some adolescents may wake during the night and turn to their smartphones as a coping mechanism for insomnia, a behavior that can create a cyclical pattern and worsen sleep outcomes over time (Bartel, Gradisar 2017; Eggermont, Van Den Bulck 2006). The research also underscores the significant influence of application type on sleep outcomes. The use of interactive 'lean-forward' apps, such as social media platforms before bed or gaming apps after bedtime, is linked to poorer sleep quality. In contrast, passive 'lean-back' apps, like video streaming services, appear to lack these same detrimental effects. This important distinction challenges the displacement hypothesis, which posits that any screen time uniformly reduces resting opportunities. Instead, it suggests that the specific nature of the activity is a critical factor in determining the relationship between phone usage and sleep. The connection between smartphone use and diminished sleep quality is further elucidated by the arousal-before-sleep hypothesis. This theory suggests that heightened cognitive or emotional activation prior to bedtime negatively affects perceived sleep quality, a claim supported by existing evidence (Tang, Harvey 2004; Tkaczyk et al. 2023; Wuyts et al. 2012). Different smartphone apps induce varying levels of arousal; interactive 'lean-forward' apps such as social media and gaming are more likely to disrupt pre-sleep calmness due to their engaging nature. Previous findings confirm that such interaction can harm sleep quality (Gradisar et al. 2013). For adolescents, social media use before bed can heighten alertness through a sensitivity to social validation — such as likes, comments, and notifications — and the associated pressure to respond quickly, thereby interfering with the necessary wind-down process (Scott, Woods 2018). Similarly, gaming requires heightened focus and vigilance, which can delay sleep onset (Ivarsson et al. 2013; Weaver et al. 2010; Wolfe et al. 2014). Conversely, 'lean-back' applications like video streaming may promote relaxation and help lower arousal levels, potentially preparing the body for sleep (McNally, Harrington 2017). Although direct measures of pre-sleep arousal were not included in the study, the observed differences in sleep quality associated with various app types strongly point to arousal as a central mechanism linking smartphone usage to sleep disturbances. Empirical findings further emphasize how app usage patterns shape sleep outcomes. Adolescents who spent more time watching videos in the hour before bed reported better sleep quality compared to peers who engaged more with interactive apps. This pattern suggests that integrating passive video watching into bedtime routines may serve as a relaxing transition into sleep, a notion supported by qualitative research on adolescent wind-down practices (Toh et al. 2019). Furthermore, longitudinal data from studies utilizing daily diary surveys and smartphone monitoring indicate that young adults who allocated more evening time to watching videos experienced longer sleep durations (Sumter et al. 2024).

## The effects of intensive app and social media use

The proliferation of digitally mediated communication platforms and digital entertainment has fundamentally reshaped social interaction, with texting and messaging largely supplanting traditional face-to-face communication among adolescents (Pew Research Center 2010). This rapid shift has elicited considerable concerns regarding its developmental implications, particularly whether extensive digital communication undermines youths' ability to navigate in-person social dynamics and how such potential deficits manifest psychologically. Evidence suggests that excessive social media use and persistent interruptions by messaging may orient adolescents toward concrete, immediate aspects of their environment at the expense of abstract and morally reflective thinking. Specifically, sustained engagement with digital communication appears to diminish attention to the broader moral, emotional, and long-term implications of behavior. A study by Trapnell and Sinclair (Trapnell, Sinclair 2012) examined this hypothesis in a sample of 2,300 Canadian university students aged 18–22. The results revealed weak but consistent associations between high texting frequency and increased materialism, out-group bias (e. g., more negative attitudes toward Indigenous Canadians), and greater emphasis on physical appearance. Furthermore, heavy texting was negatively correlated with moral reflexivity, including reduced motivation to promote social equality, weaker commitment to social justice, and diminished valuation of personal integrity. These effects intensified over the five-year study period,

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with rising texting frequency paralleled by a marked decline in ethical reasoning. This pattern underscores the nuanced yet meaningful influence of digital communication tools on cognitive, social, and ethical development in young people. Further research is needed to clarify these dynamics and develop strategies that promote balanced technology use in support of social well-being and cognitive growth.

Complementing these findings, A. Abraham et al. (Abraham et al. 2012) observed that participants who drew and described their mobile phones reported a temporary decrease in prosocial behavior — operationalized as willingness to donate time or resources to a homeless charity — alongside an increase in perceived social connectedness. Similarly, Angster et al. (Angster et al. 2010) found that frequent texting among young adults was associated with less satisfying friendships. These findings underscore the possibility that sustained engagement with external stimuli, particularly through media-driven distractions or habitual reliance on brief, digitally mediated communication, might diminish opportunities for introspection regarding the moral, social, and emotional dimensions of interpersonal interactions. Over time, this dynamic can inhibit the development of personal values and impair the capacity to form meaningful relationships, potentially narrowing identity formation toward superficial traits at the expense of broader emotional and social awareness. However, the impact of technology is not inherently negative but depends on its application. For example, when used intentionally — such as in targeted behavioral interventions (e. g., health reminders) — technology can yield substantial benefits (Cole-Lewis, Kershaw 2010). Similarly, digital tools can enhance social reflexivity and moral engagement by facilitating communication across geographic and cultural divides, thereby fostering empathy and perspective-taking. The central issue, therefore, lies not in the technology itself, but in how it is leveraged. Judicious use that promotes social development and meaningful interaction is essential.

A recent Italian study, EYES UP (Respi et al. 2025), offers an in-depth analysis of the relationship between early digitalization, academic performance, and educational inequality. This study estimated the effect of the age at which children open a social media account on academic achievement — a novel contribution to the literature. The study found a negative association between early access to smartphones and social media and school performance, whereas the use of PCs, tablets, video game consoles, and instant messaging showed no significant effects. A pronounced performance gap emerged in the third year of lower secondary school, to the detriment of early adopters of social media. This study represents the first rigorous identification of such an effect in Italy, confirming widespread concerns about the negative interference of early digital adoption on learning and underscoring the need for a critical approach to technology diffusion among minors.

The study also examined social differentials (gender, social origin, migrant background) in early digital exposure. Boys appeared to suffer more pronounced academic consequences from early social media access than girls. Moreover, early access to digital media was more common in socially and culturally disadvantaged contexts, where children often use devices more intensively and with less educational guidance from families. Although no greater negative effect was detected among these groups, the higher prevalence of early digital use in vulnerable contexts risks exacerbating existing educational disparities. This was further supported by the third research question and analyses of 'educational poverty', which linked early and pervasive use of smartphones and social media to reduced cultural consumption and lower academic self-efficacy.

## Digital gaming and reading attitudes in digital reading performance

W. Zhang and L. Gu (Zhang, Gu 2023) conducted an in-depth analysis of the interplay between digital reading outcomes, computer gaming, and reading attitudes using data from Hong Kong in the 2018 Programme for International Student Assessment (OECD 2019). Their study elucidated several critical relationships: digital reading achievement correlated negatively with computer gaming but positively with reading attitudes. Importantly, reading attitudes mediated the adverse effects of gaming on digital reading performance. When controlling for gender, the initially pronounced negative impact of gaming diminished, suggesting that gender-related differences significantly influence these dynamics. The study highlights three key insights: first, excessive gaming can impair digital reading performance; second, positive reading attitudes buffer these detrimental effects; and third, gender differences in reading attitudes meaningfully shape the relationship between gaming and reading outcomes, to the extent that the negative impact of gaming diminishes in specific contexts. These findings contribute valuable empirical evidence to the understanding of how gaming behavior,

literacy skills, and attitudinal variables intersect — a topic often discussed anecdotally rather than systematically.

The negative association between computer gaming and digital reading aligns with earlier research on the deleterious academic effects of intensive gaming. For instance, findings from C. P. Barlett (Barlett et al. 2009) and A. Drummond and J. D. Sauer (Drummond, Sauer 2014) support the notion that prolonged video gaming adversely impacts academic performance. However, the results from W. Zhang and L. Gu contrast with those of Rasmusson and Åberg-Bengtsson (Rasmusson, Åberg-Bengtsson 2014), who found a positive correlation among Swedish adolescents, and with F. Borgonovi (Borgonovi 2016), who observed that moderate gaming may support learning while excessive use is harmful. These inconsistencies suggest that contextual factors (cultural norms, learning environments, etc.) may mediate the relationship between gaming and educational outcomes.

A salient contribution of Zhang and Gu's work is its emphasis on reading attitudes as a potent predictor of digital reading performance — more influential than gaming behavior itself. This reinforces prior scholarship identifying positive reading attitudes as critical for literacy development (Lim et al. 2015; Logan, Johnston 2009; Martinez et al. 2008; Sainsbury, Schagen 2004). Nevertheless, the literature remains contested, with some studies reporting negative or inconclusive associations between reading attitudes and performance (Kush, Watkins 1996; Martinez et al. 2008; McKenna et al. 1995; 2012; Sölpük 2017), underscoring the need for further nuanced investigation.

The study also identified a significant inverse relationship between computer gaming and reading attitudes. This may be explained by the displacement of study-related activities, including reading, in favor of gaming, leading to less favorable attitudes toward literacy. These findings highlight the importance of promoting both responsible gaming habits and positive reading cultures in educational and familial contexts.

Using structural equation modeling, Zhang and Gu demonstrated that computer gaming affects digital reading both directly and indirectly through its impact on reading attitudes. Specifically, students who engage extensively in video games are more likely to exhibit lower levels of achievement in digital reading tasks and harbor more negative perceptions of reading as an activity. This aligns with research linking excessive gaming to poorer academic outcomes (Ferguson, Olson 2014; Kowert et al. 2015; Swing et al. 2010) and studies affirming the intrinsic link between positive reading behaviors and favorable attitudes (Logan, Johnston 2009; Martinez et al. 2008; Sainsbury, Schagen 2004). In summary, while gaming exhibits a modest negative effect on digital reading, the influence of reading attitudes is substantially greater. By situating their findings within wider scholarly discussions on education and technology, Zhang and Gu underscore the strategic value of fostering meaningful literacy experiences while proactively managing the challenges associated with frequent digital entertainment use. Their analysis indicates that while online video gaming exerts a modest adverse effect on digital reading performance, the role of reading attitudes is substantially more influential. This implies that the more pronounced negative correlation often observed between gaming and reading performance likely arises when the mediating role of reading attitudes is not accounted for. Fundamentally, a positive orientation toward reading can counteract the detrimental effects of video gaming, as constructive reading attitudes contribute more strongly to digital reading outcomes than gaming behaviors do. These results point to a significant pedagogical opportunity: through targeted efforts to cultivate positive reading dispositions, educators can mitigate the potential disruptions caused by computer gaming and support students' digital literacy development.

Moreover, gender-based analysis indicates that girls demonstrate a stronger inclination toward reading than boys, even when controlling for time spent playing video games. This finding aligns with the PISA 2018 report (OECD 2019), which noted that while both genders show declining rates of leisure reading, girls consistently maintain more positive attitudes toward reading. These results corroborate previous studies documenting girls' generally higher reading enthusiasm. Interestingly, video gaming may provide girls with supplementary cognitive benefits beyond visual-spatial skills — an area warranting further investigation regarding specific reading strategies acquired via gaming. In light of the documented gender gap in digital reading performance identified by Zhang and Gu, targeted interventions to enhance boys' literacy skills appear particularly urgent. One promising approach involves encouraging frequent, interest-driven online reading experiences specifically designed to appeal to male students' preferences and motivations.

## Conclusions

Sleep constitutes a vital neurophysiological process during which the brain consolidates and organizes daily experiences and information. Research demonstrates that sleep facilitates the elimination

 https://www.doi.org/10.33910/2686-9527-2025-7-3-408-419

of sensations and experiences while strengthening the retention of crucial information in long-term memory. This overview of current research underscores the importance of understanding how modern technologies impact sleep and subsequent cognitive functioning, with significant implications for educational practice. Contemporary digital media substantially affect attentional capacities through both the structure of texts and hypertexts and prolonged exposure to artificial light emitted by screens. The constant interruption from notifications, messages, and pop-ups further disrupts cognitive continuity throughout the day, impairing deeper reflection, analysis, and knowledge integration. Evening screen exposure compounds these effects by disrupting circadian regulation through the suprachiasmatic nucleus, exacerbating sleep disturbances that surpass those observed in earlier media environments, namely, TV. These challenges are amplified by modern societal pressures, including demanding work schedules and relentless pace of society, which contribute to elevated stress levels in daily life.

As indicated by recent research (Di Salvo 2025), chronic stress — particularly that associated with traumatic experiences — can induce structural alterations in brain regions critical for memory, including the amygdala and hippocampus. Such neurological changes impair memory function by disrupting protein synthesis essential for neuroplasticity, potentially leading to false memory formation, memory suppression, emotional dysregulation, and other cognitive symptoms often misattributed to non-neurological causes. Further investigation is necessary to elucidate how these mechanisms disrupt fundamental cognitive processes and neural circuitry.

Regarding intensive social media and application use, evidence confirms negative associations between early digital technology adoption and learning outcomes, highlighting the need for more critical approaches to technology dissemination among youth. Gender differences are particularly noteworthy, with boys appearing more susceptible to the academic consequences of early social media access than girls, while digital gaming exhibits distinct gender-specific impacts. Furthermore, early and pervasive smartphone and social media use correlates with reduced cultural engagement and diminished academic self-efficacy.

These collective findings suggest several actionable recommendations, including promoting mindful, purposeful, and moderated digital technology use, implementing educational initiatives fostering critical digital literacy, and encouraging reduced screen exposure during evening hours. Concurrently, priority research directions should investigate technology's direct effects on memory consolidation, sleep quality, and stress response systems; examine whether proficiency with one medium diminishes capacity for learning through others (evaluation of multimodal learning); and conduct cross-cultural analyses to determine how contextual factors moderate digital technology effects.

## Conflict of Interest

The author declares that there is no conflict of interest, either existing or potential.

## Конфликт интересов

Автор заявляет об отсутствии потенциального или явного конфликта интересов.

## References

Abraham, A., Pocheptsova, A., Ferraro, R. (2012) *The effect of mobile phone use on prosocial behavior*. [Online]. Available at: https://www.academia.edu/55138727/The_effect_of_mobile_phone_use_on_prosocial_behavior (accessed 13.06.2025). (In English)

Akçay, D., Akçay, B. D. (2018) The influence of media on the sleep quality in adolescents. *The Turkish Journal of Pediatrics*, vol. 60, no. 3, pp. 255–263. https://doi.org/10.24953/turkjped.2018.03.004 (In English)

Alonzo, R., Hussain, J., Stranges, S., Anderson, K. K. (2021) Interplay between social media use, sleep quality, and mental health in youth: A systematic review. *Sleep Medicine Reviews*, vol. 56, article 101414. https://doi.org/10.1016/j.smrv.2020.101414 (In English)

Amra, B., Shahsavari, A., Shayan-Moghadam, R. et al. (2017) The association of sleep and late-night cell phone use among adolescents. *Jornal de Pediatria*, vol. 93, no. 6, pp. 560–567. https://doi.org/10.1016/j.jped.2016.12.004 (In English)

Angster, A., Frank, M., Lester, D. (2010) An exploratory study of students' use of cell phones, texting, and social networking sites. *Psychological Reports*, vol. 107, no. 2, pp. 402–404. https://doi.org/10.2466/17.PR0.107.5.402-404 (In English)

Barlett, C. P., Anderson, C. A., Swing, E. L. (2009) Video game effects—confirmed, suspected, and speculative: A review of the evidence. *Simulation & Gaming*, vol. 40, no. 3, pp. 377–403. https://doi.org/10.1177/1046878108327539 (In English)

Bartel, K., Gradisar, M. (2017) New directions in the link between technology use and sleep in young people. In: S. Nevšímalová, O. Bruni (eds.). *Sleep disorders in children. Cham*: Springer Publ., pp. 69–80. https://doi.org/10.1007/978-3-319-28640-2_4 (In English)

Borgonovi, F. (2016) Video gaming and gender differences in digital and printed reading performance among 15-year-olds students in 26 countries. *Journal of Adolescence*, vol. 48, no. 1, pp. 45–61. https://doi.org/10.1016/j.adolescence.2016.01.004 (In English)

Bracket, M., Rivers, S. E., Reyes, M. R., Salovey, P. (2012) Enhancing academic performance and social and emotional competence with the RULER feeling words curriculum. *Learning and Individual Differences*, vol. 22, no. 2, pp. 218–224. https://doi.org/10.1016/j.lindif.2010.10.002 (In English)

Brautsch, L. A., Lund, L., Andersen, M. M. et al. (2023) Digital media use and sleep in late adolescence and young adulthood: A systematic review. *Sleep Medicine Reviews*, vol. 68, article 101742. https://doi.org/10.1016/j.smrv.2022.101742 (In English)

Brown, S., Vaughan, C. (2009) *Play. How it shapes the brain, opens the imagination, and invigorates the soul*. New York: Avery Publ., 240 p. (In English)

Buckner, R. L., Andrews-Hanna, J. R., Schacter, D. L. (2008) The brain's default network: Anatomy, function, and relevance to disease. *Annals of the New York Academy of Sciences*, vol. 1124, no. 1, pp. 1–38. https://doi.org/10.1196/annals.1440.011 (In English)

Buckner, R. L., Carroll, D. C. (2007) Self-projection and the brain. *Trends in Cognitive Sciences*, vol. 11, no. 2, pp. 49–57. https://doi.org/10.1016/j.tics.2006.11.004 (In English)

Burnell, K., George, M. J., Jensen, M. et al. (2022) Associations between adolescents' daily digital technology use and sleep. *Journal of Adolescent Health*, vol. 70, no. 3, pp. 450–456. https://doi.org/10.1016/j.jadohealth.2021.09.033 (In English)

Cabré-Riera, A., Torrent, M., Donaire-Gonzalez, D. et al. (2019) Telecommunication devices use, screen time and sleep in adolescents. *Environmental Research*, vol. 171, pp. 341–347. https://doi.org/10.1016/j.envres.2018.10.036 (In English)

Cain, N., Gradisar, M. (2010) Electronic media use and sleep in school-aged children and adolescents: A review. *Sleep Medicine*, vol. 11, no. 8, pp. 735–742. https://doi.org/10.1016/j.sleep.2010.02.006 (In English)

Carter, B., Rees, P., Hale, L. et al. (2016) Association between portable screen-based media device access or use and sleep outcomes: A Systematic Review and Meta-analysis. *JAMA Pediatrics,* vol. 170, no. 12, pp. 1202–1208. https://doi.org/10.1001/jamapediatrics.2016.2341 (In English)

Caumo, G. H., Spritzer, D., Carissimi, A., Tonon, A. C. (2020) Exposure to electronic devices and sleep quality in adolescents: A matter of type, duration, and timing. *Sleep health*, vol. 6, no. 2, pp. 172–178. https://doi.org/10.1016/j.sleh.2019.12.004 (In English)

Chu, Y., Oh, Y., Gwon, M. et al. (2023) Dose-response analysis of smartphone usage and self-reported sleep quality: A systematic review and meta-analysis of observational studies. *Journal of Clinical Sleep Medicine*, vol. 19, no. 3, pp. 621–630. https://doi.org/10.5664/jcsm.10392 (In English)

Cole-Lewis, H., Kershaw, T. (2010) Text messaging as a tool for behavior change in disease prevention and management. *Epidemiologic Reviews*, vol. 32, no. 1, pp. 56–69. https://doi.org/10.1093/epirev/mxq004 (In English)

Corbetta, M., Shulman, G. L. (2002) Control of goal-directed and stimulus-driven attention in the brain. *Nature reviews Neuroscience*, vol 3, no. 3, pp. 201–215. https://doi.org/10.1038/nrn755 (In English)

Di Salvo, M. (2025) Psicoterapia e plasticità cognitiva e neuronale. Cervello sociale e disturbo post-traumatico da stress. Note a L'interprete di M. Gazzaniga [Psychotherapy and cognitive and neural plasticity. the social brain and post-traumatic stress disorder. Notes on M. Gazzaniga's The Interpreter]. *Ricerca Psicoanalitica*, vol 36, no. 1, pp. 79–95. https://doi.org/10.4081/rp.2025.854 (In Italian)

Doyle, W. (2016) How Finland broke every rule — and created a top school system. *Hechinger Report*, 18 February. [Online]. Available at: https://schoolleadership20.com/profiles/blogs/how-finland-broke-every-rule-and-created-a-top-school-system-by-w (accessed 15.06.2025). (In English)

Dregan, A., Armstrong, D. (2010) Adolescence sleep disturbances as predictors of adulthood sleep disturbances — a cohort study. *Journal of Adolescent Health*, vol. 46, no. 5, pp. 482–487. https://doi.org/10.1016/j.jadohealth.2009.11.197 (In English)

Drummond, A., Sauer, J. D. (2014) Video-games do not negatively impact adolescent academic performance in science, mathematics or reading. *PLOS One*, vol. 9, no. 4, article e87943. https://doi.org/10.1371/journal.pone.0087943 (In English)

Eggermont, S., Van den Bulck, J. (2006) Nodding off or switching off? The use of popular media as a sleep aid in secondary-school children. *Journal of Paediatrics and Child Health*, vol. 42, no. 7–8, pp. 428–433. https://doi.org/10.1111/j.1440-1754.2006.00892.x (In English)

Ferguson, C. J., Olson, C. K. (2014) Video Game violence use among "Vulnerable" populations: The impact of violent games on delinquency and bullying among children with clinically elevated depression or attention deficit symptoms. *Journal Youth Adolescence*, no. 43, pp. 127–136. https://doi.org/10.1007/s10964-013-9986-5 (In English)

Fobian, A. D., Avis, K., Schwebel, D. C. (2016) Impact of media use on adolescent sleep efficiency. *Journal of Developmental & Behavioral Pediatrics*, vol. 37, no. 1, pp. 9–14. https://doi.org/10.1097/DBP.0000000000000239 (In English)
Fossum, I. N., Nordnes, L. T., Storemark, S. S. et al. (2014) The association between use of electronic media in bed before going to sleep and insomnia symptoms, daytime sleepiness, morningness, and chronotype. *Behavioral Sleep Medicine*, vol. 12, no. 5, pp. 343–357. https://doi.org/10.1080/15402002.2013.819468 (In English)
Gradisar, M., Kahn, M., Micic, G. et al. (2022) Sleep's role in the development and resolution of adolescent depression. *Nature Reviews Psychology*, vol. 1, no. 9, pp. 512–523. https://doi.org/10.1038/s44159-022-00074-8 (In English)
Gradisar, M., Wolfson, A. R., Harvey, A. G. et al. (2013) The sleep and technology use of Americans: findings from the national sleep foundation's 2011 sleep in America poll. *Journal of Clinical Sleep Medicine*, vol. 09, no. 12, pp. 1291–1299. https://doi.org/10.5664/jcsm.3272 (In English)
Hale, L., Li, X., Hartstein, L. E., LeBourgeois, M. K. (2019) Media use and sleep in teenagers: What do we know? *Current Sleep Medicine Reports*, vol. 5, pp. 128–134. https://doi.org/10.1007/s40675-019-00146-x (In English)
Han, X., Zhou, E., Liu, D. (2024) Electronic media use and sleep quality: Updated systematic review and meta-analysis. *Journal of Medical Internet Research*, vol. 26, article e48356. https://doi.org/10.2196/48356 (In English)
Immordino-Yang, M. H., Christodoulou, J. A., Singh, V. (2012) Rest is not idleness: implications of the brain's default mode for human development and education. *Perspectives on Psychological Science*, vol. 7, no. 4, pp. 352–364. https://doi.org/10.1177/1745691612447308 (In English)
Ivarsson, M., Anderson, M., Åkerstedt, T., Lindblad, F. (2013) The effect of violent and nonviolent video games on heart rate variability, sleep, and emotions in adolescents with different violent gaming habits. *Psychosomatic Medicine*, vol. 75, no. 4, pp. 390–396. https://doi.org/10.1097/PSY.0b013e3182906a4c (In English)
Kowert, R., Vogelgesang, J. F., Quandt, T. (2015) Psychosocial causes and consequences of online video game play. *Computers in Human Behavior*, vol. 45, pp. 51–58. https://doi.org/10.1016/j.chb.2014.11.074 (In English)
Kroese, F. M., Evers, C., Adriaanse, M. A., de Ridder, D. T. D. (2016) Bedtime procrastination: A self-regulation perspective on sleep insufficiency in the general population. *Journal of Health Psychology*, vol. 21, no. 5, pp. 853–862. https://doi.org/10.1177/1359105314540014 (In English)
Kush, J. C., Watkins, M. W. (1996) Long-term stability of children's attitudes toward reading. *The Journal of Educational Research*, vol. 89, no. 5, pp. 315–319. https://doi.org/10.1080/00220671.1996.9941333 (In English)
LeBourgeois, M. K., Hale, L., Chang, A.-M. et al. (2017) Digital media and sleep in childhood and adolescence. *Pediatrics*, vol. 140 (2), pp. S92–S96. https://doi.org/10.1542/peds.2016-1758J (In English)
Li, J., Lepp, A., Barkley, J. E. (2015) Locus of control and cell phone use: Implications for sleep quality, academic performance, and subjective well-being. *Computers in Human Behavior*, vol. 52, pp. 450–457. https://doi.org/10.1016/j.chb.2015.06.021 (In English)
Lim, H. J., Bong, M., Woo, Y. (2015) Reading attitude as a mediator between contextual factors and reading behavior. *Teachers College Record*, vol. 117, no. 1, pp. 1–36. https://doi.org/10.1177/016146811511700116 (In English)
Logan, S., Johnston, R. (2009) Gender differences in reading ability and attitudes: Examining where these differences lie. *Journal of Research in Reading*, vol. 32, no. 2, pp. 199–214. https://doi.org/10.1111/j.1467-9817.2008.01389.x (In English)
Mac Cárthaigh, S., Griffin, C., Perry, J. (2020) The relationship between sleep and problematic smartphone use among adolescents: A systematic review. *Developmental Review*, vol. 55, article 100897. https://doi.org/10.1016/j.dr.2020.100897 (In English)
Martinez, R. S., Aricak, O. T., Jewell, J. (2008) Influence of reading attitude on reading achievement: A test of the temporal-interaction model. *Psychology in the Schools*, vol. 45, no. 10, pp. 1010–1023. https://doi.org/10.1002/pits.20348 (In English)
McKenna, M. C., Conradi, K., Lawrence, C. et al. (2012) Reading attitudes of middle school students: Results of a U.S. survey. *Reading Research Quarterly*, vol. 47, no. 3, pp. 283–306. https://doi.org/10.1002/rrq.021 (In English)
McKenna, M. C., Kear, D. J., Ellsworth, R. A. (1995) Children's attitudes toward reading: A national survey. *Reading Research Quarterly*, vol. 30, no. 4, pp. 934–956. https://doi.org/10.2307/748205 (In English)
McManus, B., Underhill, A., Mrug, S. et al. (2021) Gender moderates the relationship between media use and sleep quality. *Journal of Sleep Research*, vol. 30, no. 4, article e13243. https://doi.org/10.1111/jsr.13243 (In English)
McNally, J., Harrington, B. (2017) How millennials and teens consume mobile video. In: *TVX'17: Proceedings of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video*. New York: Association for Computing Machinery Publ., pp. 31–39. https://doi.org/10.1145/3077548.3077555 (In English)
Moher, D., Liberati, A., Tetzlaff, J. et al. (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine*, vol. 6, no. 7, article e1000097. https://doi.org/10.1371/journal.pmed.1000097 (In English)
Northoff, G., Duncan, N. W., Hayes, D. J. (2010) The brain and its resting state activity—Experimental and methodological implications. *Progress in Neurobiology*, vol. 92, no. 4, pp. 593–600. https://doi.org/10.1016/j.pneurobio.2010.09.002 (In English)
OECD. (2019) *PISA 2018 Results (Vol. I): What students know and can do, PISA*. Paris: OECD Publ., 354 p. https://doi.org/10.1787/5f07c754-en (In English)

Orchard, F., Gregory, A. M., Gradisar, M., Reynolds, S. (2020) Self-reported sleep patterns and quality amongst adolescents: Cross-sectional and prospective associations with anxiety and depression. *Journal of Child Psychology and Psychiatry*, vol. 61, no. 10, pp. 1126–1137. https://doi.org/10.1111/jcpp.13288 (In English)

Pew Research Center. (2010) *Global Digital Communication: Texting Social Networking Popular Worldwide*. [Online]. Available at: https://www.pewresearch.org/global/2011/12/20/global-digital-communication-texting-social-networking-popular-worldwide/ (accessed 15.06.2025). (In English)

Rasmusson, M., Åberg-Bengtsson, L. (2014) Does Performance in digital reading relate to computer game playing? A study of factor structure and gender patterns in 15-year-olds' reading literacy performance. *Scandinavian Journal of Educational Research*, vol. 59, no. 6, pp. 691–709. https://doi.org/10.1080/00313831.2014.965795 (In English)

Respi, C., Gui, M., Abbiati, G. et al. (2025) *Report di fine progetto EYES UP (EarlYExposure to Screens and Unequal Performance). Precocita digitale, performance scolastiche e disuguaglianze: nuove evidenze e prospettive [EYES UP (Early Exposure to Screens and Unequal Performance) Project Final Report. Early Digital Education, School Performance, and Inequalities: New Evidence and Perspectives]*. Milano: EYES UP Publ., 72 p. (In Italian)

Sainsbury, M., Schagen, I. (2004) Attitudes to reading at ages nine and eleven. *Journal of Research in Reading*, vol. 27, no. 4, pp. 373–386. https://doi.org/10.1111/j.1467-9817.2004.00240.x (In English)

Scott, E., Panksepp, J. (2003) Rough-and-tumble play in human children. *Aggressive Behavior*, vol. 29, pp. 539–551. https://doi.org/10.1002/ab.10062 (In English)

Scott, H., Woods, H. C. (2018) Fear of missing out and sleep: Cognitive behavioural factors in adolescents' nighttime social media use. *Journal of Adolescence*, vol. 68, no. 1, pp. 61–65. https://doi.org/10.1016/j.adolescence.2018.07.009 (In English)

Siebers, T., Beyens, I., Baumgartner, S. E., Valkenburg, P. M. (2024) Adolescents' digital nightlife: The comparative effects of day- and nighttime smartphone use on sleep quality. *Communication Research*. https://doi.org/10.1177/00936502241276793 (In English)

Silva, S. S. D., Silveira, M. A., Almeida, H. C. et al. (2022) Use of digital screens by adolescents and association on sleep quality: A systematic review. *Cadernos de saude publica*, vol. 38, no. 10, article e00300721. https://doi.org/10.1590/0102-311XEN300721 (In English)

Siviy, S. M., Panksepp, J. (2011) In search of the neurobiological substrates for social playfulness in mammalian brains. *Neuroscience and biobehavioral reviews*, vol. 35, no. 9, pp. 1821–1830. https://doi.org/10.1016/j.neubiorev.2011.03.006 (In English)

Smallwood, J., Obonsawin, M., Heim, D. (2003) Task unrelated thought: The role of distributed processing. *Consciousness and Cognition: An International Journal*, vol. 12, no. 2, pp. 169–189. https://doi.org/10.1016/S1053-8100(02)00003-X (In English)

Sohn, S. Y., Rees, P., Wildridge, B. et al. (2019) Prevalence of problematic smartphone usage and associated mental health outcomes amongst children and young people: A systematic review, meta-analysis and GRADE of the evidence. *BMC Psychiatry*, vol. 19, article 356. https://doi.org/10.1186/s12888-019-2350-x (In English)

Sölpük, N. (2017) The effect of attitude on student achievement. In: E. Karadag (ed.). *The factors effecting student achievement*. Cham: Springer Publ., pp. 57–73. https://doi.org/10.1007/978-3-319-56083-0_4 (In English)

Spreng, R. N., Grady, C. L. (2010) Patterns of brain activity supporting autobiographical memory, prospection, and theory of mind, and their relationship to the default mode network. *Journal of cognitive Neuroscience*, vol. 22, no. 6, pp. 1112–1123. https://doi.org/10.1162/jocn.2009.21282 (In English)

Spreng, R. N., Mar, R. A., Kim, A. S. (2009) The common neural basis of autobiographical memory, prospection, navigation, theory of mind, and the default mode: A quantitative meta-analysis. *Journal of Cognitive Neuroscience*, vol. 21, no. 3, pp. 489–510. https://doi.org/10.1162/jocn.2008.21029 (In English)

Spreng, R. N., Stevens, W. D., Chamberlain, J. P. et al. (2010) Default network activity, coupled with the frontoparietal control network, supports goal-directed cognition. *NeuroImage*, vol. 53, no. 1, pp. 303–317. https://doi.org/10.1016/j.neuroimage.2010.06.016 (In English)

Sumter, S. R., Baumgartner, S. E., Wiradhany, W. (2024) Beyond screentime: A 7-day mobile tracking study among college students to disentangle smartphone screentime and content effects on sleep. *Behaviour & Information Technology*, vol. 44, no. 6, pp. 1260–1276. https://doi.org/10.1080/0144929X.2024.2350663 (In English)

Swing, E. L., Gentile, D. A., Anderson, C. A., Walsh, D. A. (2010) Television and video game exposure and the development of attention problems. *Pediatrics*, vol. 126 no. 2, pp. 214–221. https://doi.org/10.1542/peds.2009-1508 (In English)

Tang, N. K. Y., Harvey, A. G. (2004) Effects of cognitive arousal and physiological arousal on sleep perception. *Sleep*, vol. 27, no. 1, pp. 69–78. https://doi.org/10.1093/sleep/27.1.69 (In English)

Thernstrom, M. (2016) The anti-helicopter parent's plea: Let kids play. *New York Times Magazine*, 19 October. [Online]. Available at: https://www.nytimes.com/2016/10/23/magazine/the-anti-helicopter-parents-plea-let-kids-play.html (accessed 15.06.2025). (In English)

Tkaczyk, M., Lacko, D., Elavsky, S. et al. (2023) Are smartphones detrimental to adolescent sleep? An electronic diary study of evening smartphone use and sleep. *Computers in Human Behavior*, vol. 149, article 107946. https://doi.org/10.1016/j.chb.2023.107946 (In English)

Toh, S. H., Howie, E. K., Coenen, P., Straker, L. M. (2019) "From the moment I wake up I will use it... every day, very hour": A qualitative study on the patterns of adolescents' mobile touch screen device use from adolescent and parent perspectives. *BMC Pediatrics*, vol. 19, article 30. https://doi.org/10.1186/s12887-019-1399-5 (In English)

Trapnell, P., Sinclair, L. (2012) *Texting frequency and the moral shallowing hypothesis. Poster presented at the Annual Meeting of the Society for Personality and Social Psychology*. San Diego: The University of Winnipeg Publ. [Online]. Available at: https://news.uwinnipeg.ca/wp-content/uploads/2013/04/texting-study.pdf (accessed 15.06.2025). (In English)

Triantafillou, S., Saeb, S., Lattie, E. G. et al. (2019) Relationship between sleep quality and mood: Ecological momentary assessment study. *JMIR Mental Health*, vol. 6, no. 3, article e12613. https://doi.org/10.2196/12613 (In English)

Valkenburg, P. M., Peter, J. (2013) The differential susceptibility to media effects model. *Journal of Communication*, vol. 63, no. 2, pp. 221–243. https://doi.org/10.1111/jcom.12024 (In English)

Van den Bulck, J. (2003) Text messaging as a cause of sleep interruption in adolescents, evidence from a cross-sectional study. *Journal of Sleep Research*, vol. 12, no. 3, pp. 263. https://doi.org/10.1046/j.1365-2869.2003.00362.x (In English)

Walker, T. D. (2015) The joyful, illiterate kindergartners of Finland. *Atlantic Monthly*, 1 October. [Online]. Available at: https://www.bowdoin.edu/childrens-center/pdf/the-joyful-illiterate-kindergartners-of-finland.pdf (accessed 15.06.2025). (In English)

Weaver, E., Gradisar, M., Dohnt, H. et al. (2010) The effect of presleep video-game playing on adolescent sleep. *Journal of Clinical Sleep Medicine*, vol. 6, no. 2, pp. 184–189. https://doi.org/10.5664/jcsm.27769 (In English)

Wolfe, J., Kar, K., Perry, A. et al. (2014) Single night video-game use leads to sleep loss and attention deficits in older adolescents. *Journal of Adolescence*, vol. 37, no. 7, pp. 1003–1009. https://doi.org/10.1016/j.adolescence.2014.07.013 (In English)

Wolfers, L. N., Utz, S. (2022) Social media use, stress, and coping. *Current Opinion in Psychology*, vol. 45, article 101305. https://doi.org/10.1016/j.copsyc.2022.101305 (In English)

Wuyts, J., De Valck, E., Vandekerckhove, M. et al. (2012) The influence of pre-sleep cognitive arousal on sleep onset processes. *International Journal of Psychophysiology*, vol. 83, no. 1, pp. 8–15. https://doi.org/10.1016/j.ijpsycho.2011.09.016 (In English)

Yang, J., Fu, X., Liao, X., Li, Y. (2020) Association of problematic smartphone use with poor sleep quality, depression, and anxiety: A systematic review and meta-analysis. *Psychiatry Research*, vol. 284, article 112686. https://doi.org/10.1016/j.psychres.2019.112686 (In English)

Zhang, W., Gu, L. (2023) The role of computer game playing and reading attitudes in digital reading achievement: Evidence from Hong Kong 15-year-olds. *Research and Practice in Technology Enhanced Learning*, vol. 18, article 019. https://doi.org/10.58459/rptel.2023.18019 (In English)

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