

The Cognition-Impairing Effect of Video Games in Adolescents

Romina de Los Ángeles Virgilio*

Universidad Nacional del Sur (UNS)-Complejo Alem, Av. Leandro Niceforo Alem 1253, B8000 Bahía Blanca, Provincia de Buenos Aires, Argentina

*: All correspondence should be sent to: Romina de Los Ángeles Virgilio.

Author's Contact: Romina de Los Angeles Virgilio, MSc, MPH, E-mail: romina.virgilio@gmail.com

DOI: <https://doi.org/10.15354/si.24.re935>

Funding: No funding source declared.

COI: The author declares no competing interest.

AI Declaration: The author affirms that artificial intelligence did not contribute to the process of preparing the work.

The use of video games among adolescents has become a prevalent form of entertainment and leisure activity in today's digital age. However, the impact of extensive video game exposure on the cognitive development of young individuals is a topic of growing concern. Understanding how video games affect various aspects of cognition, such as attention, memory, problem-solving skills, and academic performance, is crucial for educators, parents, and healthcare professionals. This review delves into the cognition-impairing effects of video games in adolescents, exploring the research findings, challenges, and potential strategies to mitigate the negative consequences on cognitive function.

Keywords: Video Games; Adolescents; Cognition Dysfunction; Game Exposure; Performance

Science Insights, 2024 March 31; Vol. 44, No. 3, pp.1283-1289.

© 2024 Insights Publisher. All rights reserved.



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the [Creative Commons Attribution-NonCommercial 4.0 License](https://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed by the Insights Publisher.

Introduction

THE PREVALENCE of video game usage among adolescents has witnessed a notable surge in today's society. As gaming consoles, smartphones, and computers become more accessible to adolescents due to technological advancements, they spend an increasing amount of time playing video games. Approximately 97% of adolescents, according to a Pew Research Center survey, engage in video game activity; of these, 85% utilize gaming consoles, 72% employ smartphones, and 47% employ computers (1). Considering the interactive and immersive qualities of video games—which can offer amusement, social interaction, and cognitive stimulation—this development is not unexpected.

Concerns have been expressed, however, regarding the

potential negative effects of excessive video game use among adolescents. There is some evidence to suggest that excessive gaming is associated with adverse effects, including poor academic performance, social isolation, and health issues (2). Educators and parents must monitor and regulate the amount of time their children spend playing video games in order to promote a healthy balance between gaming and other pursuits. Promoting academic pursuits, social interactions, and physical activity among adolescents can assist in alleviating the potential adverse consequences associated with excessive gaming. Prolonged exposure to video games has been linked to cognitive impairments in memory, attention, decision-making, and problem-solving, according to a multitude of studies (3). Adolescents' academic performance and overall mental development may be

adversely affected in the long run.

A primary factor contributing to the cognitive impairment observed in adolescents is the addictive quality of video games. Numerous widely played video games are intentionally crafted to provide intense enjoyment and rewards, potentially resulting in the overindulgence of players and the disregard for other crucial responsibilities, including academic pursuits or social interactions (4). These difficulties may manifest as a reduction in attention span, subpar academic achievement, and challenges in executing judicious decisions. Moreover, the perpetual motion and rapidity of video game developments may induce cognitive fatigue and impair the capacity to concentrate and retain information by overstimulating the brain.

In addition, prolonged engagement in video game is linked to sedentary behavior, which may impair the cognitive functioning of adolescents. Insufficient engagement in outdoor exercise and physical activity may result in reduced cerebral blood flow, a vital factor detrimental to optimal cognitive functioning. Moreover, in addition to impairing cognitive function, the blue light emitted by displays can interfere with the synthesis of melatonin, a hormone responsible for regulating sleep patterns (5). This can result in suboptimal sleep quality. In general, it is critical that educators and parents monitor and restrict the amount of time adolescents spend playing video games in order to promote healthy cognitive development and prevent cognitive impairments.

The Impact of Video Games on Attention and Focus

Effects of Video Games on Attention Span

The term “attention span” pertains to an individual’s capacity to maintain focus on a particular endeavor or activity for an extended duration. Numerous individuals are concerned that, due to the fast-paced and extremely stimulating nature of video games, excessive gaming may impair attention span.

A primary issue pertaining to the influence of video games on attention span is the possibility that these games may encourage a fleeting and transient form of focus. Video games are intentionally engineered to be exceedingly captivating and thought-provoking, frequently necessitating swift reactions and decision-making (6). This may result in a tendency to prioritize immediate gratification and rewards over maintaining a sustained focus on a given task. Consequentially, those who engage in video game play for an extended period of time may find it difficult to concentrate on longer-term, more complex tasks that demand sustained effort and concentration.

A phenomenon known as “attentional blink” may also be exacerbated by the rapid-fire nature of numerous video games (7). This condition arises when the brain is inundated with stimuli that occur too quickly, resulting in the omission of critical information that occurs within a brief time span. This phenomenon may result in adverse consequences for activities that demand concurrent processing and retention of multiple pieces of information, as individuals may encounter difficulties in efficiently distinguishing irrelevant diversions and concentrating on what is genuinely critical.

Conversely, certain studies indicate that engaging in video

game play may potentially yield beneficial effects on one’s attention span. Specific categories of video games, including strategy and puzzle games, necessitate players to partake in critical thinking and problem-solving exercises, which have the potential to enhance cognitive capacities associated with concentration and attention (8, 9). By requiring players to engage in strategic thinking and premeditation, these games have the potential to improve attention abilities in a manner that is applicable to practical endeavors that demand constant focus.

An additional prospective advantage of video games in relation to attention span is the immersive quality of the gaming experience. Numerous video games provide players with intricate, multi-world environments to investigate, necessitating prolonged focus in order to navigate and achieve success. As individuals become immersed in the virtual world and endeavor to accomplish their objectives within the game, their capacity to concentrate on a single task for a prolonged duration may be enhanced (10).

Additionally, research has demonstrated that video games facilitate the growth of specific cognitive abilities, including visual processing and hand-eye coordination, which may contribute to an extended period of focus (11). Proficient and accurate reactions to visual stimuli are frequently attained through the iterative development and refinement of these abilities within the context of gameplay. This can be applied to practical situations that demand prompt processing and response to information, ultimately enhancing one’s capacity to concentrate and perform effectively across multiple domains.

Understanding the potential positive effects of video games on attention span, it is critical to recognize that overindulgence in gaming can result in adverse effects on cognitive functioning. Excessive time spent playing video games has been linked to attentional deficits, including decreased task focus and increased distractibility, according to research (12, 13). Young children and adolescents, whose minds are still developing and who may be more susceptible to the negative effects of prolonged screen time, may find this especially problematic. Additionally, the propensity for video games to be addictive may contribute to attentional difficulties. Numerous video games are developed with the intention of providing intense gratification and complete immersion, qualities that may hinder players from refocusing their attention to non-gaming pursuits. This may result in a recurring pattern of gaming addiction that worsens attentional difficulties, as people find it more difficult to regulate their emotions and give precedence to obligations other than gaming.

Factors Influencing Attention and Focus in Adolescent Gamers

Attention and concentration in adolescent gamers can be affected by a variety of factors, including gaming frequency, game genre, personal attributes, social influences, cognitive factors, and environmental conditions. In the first place, gaming duration can have a substantial effect on concentration and focus. Engagement in prolonged video game sessions among adolescents may result in impaired concentration and potential manifestation of attention deficit symptoms (14). Extended periods of gaming may also result in heightened impulsivity and challenges

in regulating impulses, thereby exacerbating disruptions to concentration and focus.

Furthermore, the category of games engaged in can have an impact on the concentration and focus of adolescent gamers. Constant stimuli and action-packed, fast-paced gameplay can cause the brain to become overwhelmed, making it difficult to concentrate on other duties (15). Conversely, engaging in puzzle or strategy games that demand critical thinking and problem-solving abilities may contribute to enhanced attention and focus.

Further, personality traits and cognitive abilities are examples of personal characteristics that may impact the attention and concentration of adolescent gamers. For instance, those who have attention deficits or higher levels of impulsivity may be more vulnerable to the detrimental effects of excessive gaming on their ability to concentrate and pay attention (16, 17). Moreover, executive function and working memory are cognitive abilities that may influence a gamer's capacity to concentrate and focus on tasks.

In addition, social factors, including peer pressure and social norms, can impact the concentration and attention of adolescent gamers. Adolescents may experience a sense of obligation to match the gaming prowess of their peers, which could result in an excessive amount of time spent on gaming and a disregard for other obligations (18). Additionally, a lack of social support or social isolation may contribute to attention and concentration difficulties among adolescent gamers.

Attentional control and cognitive flexibility are critical cognitive factors that significantly influence the level of focus and attention exhibited by adolescent gamers. Attention-challenged adolescents may find it difficult to concentrate on duties while playing video games, resulting in difficulties with attention and concentration (19). Likewise, those who lack cognitive flexibility may encounter difficulties transitioning between tasks or modifying their attention when necessary.

Moreover, environmental factors, including the availability of gaming devices and the prevalence of distractions, can impair the attention and concentration of adolescent gamers. While playing video games in a chaotic or cluttered environment, adolescents may experience attentional difficulties and find it difficult to concentrate. Furthermore, the constant availability of games and the ease of access to gaming devices can make it difficult for adolescents to limit their gaming time and maintain a healthy balance.

Video Games and Memory Function in Adolescents

Memory Impairment Associated with Video Game Use

Memory impairment can result from video game use, in part, due to the high levels of multitasking and consistent stimulation required to play the majority of modern video games. Constant exposure to visual and auditory stimuli can cause cognitive overload in participants, impeding their ability to effectively encode information into long-term memory (20). This can lead to challenges in remembering information and neglect in daily life.

Furthermore, memory impairment can be exacerbated by the rapid-fire design of numerous video games. Cognitive fatigue can occur when players are frequently required to make split-second decisions and respond swiftly to changing circumstances; this can impair the brain's ability to commit information to memory (21). This can have detrimental effects on participants' short-term and long-term memory, thereby impeding their ability to recall critical details or instructions. An additional factor that may contribute to memory impairment is the addictive quality of video games. Individuals who engage in prolonged video game usage may fail to attend to other cognitively beneficial activities, including engaging in social interactions, exercising, and obtaining sufficient rest (22). This may have long-term detrimental effects on memory function and result in cognitive impairment.

Excessive video game use is associated with alterations in brain structure and function, specifically in regions of the brain responsible for memory and cognitive control, according to research. Studies discovered that chronic video game players had gray matter reduction in the hippocampus, an essential brain region for memory and spatial navigation (23, 24). This implies that prolonged engagement in video game activities might impair memory function.

Plus, it has been demonstrated that the blue light released from electronic device displays, such as those found in video game consoles, disrupts the synthesis of melatonin, a hormone responsible for regulating the cycles of sleep and wakefulness (5, 25). Cognitive deficits can result from chronic sleep deprivation, which hinders the process of memory consolidation and ultimately affects an individual's ability to retain new information and retrieve previous memories. This may exacerbate the memory impairment that is commonly associated with playing video games.

Not every instance of video game use is detrimental to memory function. Cognitive abilities may be enhanced through the practice of moderate gaming, including attention, reaction time, and spatial awareness (26). Nevertheless, excessive gaming that disrupts various facets of an individual's life may result in adverse consequences for memory function and overall cognitive well-being.

Maintaining a healthy equilibrium between gaming and other cognitively beneficial activities—including physical exercise, social interactions, and sufficient sleep—is crucial for individuals to mitigate the potential adverse effects of video game usage on memory function (27). Additionally, implementing screen time restrictions and ensuring consistent pauses throughout gaming sessions can aid in mitigating cognitive overload and the potential for memory impairment.

Types of Memory Affected by Video Games

Procedural memory is one form of memory that can be affected by video game play. This category of memory pertains to the capacity to recollect the steps or procedures necessary to execute specific actions or tasks. Video games frequently necessitate players to execute a predetermined sequence of actions in order to advance through various levels. Engaging in this continuous repetition of actions may enhance a player's procedural memory and subsequently improve their capacity to recall and carry out

intricate tasks (28).

Spatial memory is another form of memory that may be impacted by video games. The capability of remembering and navigating through physical spaces constitutes spatial memory (29). To advance in a number of video games, particularly those in the adventure or puzzle genres, players must recall the layout of various environments they traverse. Through the completion of such activities, participants have the opportunity to enhance their spatial memory and awareness.

An additional form of memory that can be affected by video game play is working memory. Working memory is the capacity to temporarily retain and manipulate information in the mind. Players are frequently required to make split-second decisions and monitor multiple variables at once when playing video games (30). Through consistent working memory exercise, athletes can enhance their capacity to process and retain information efficiently and effectively.

A further kind of memory that can be influenced by video game play is episodic memory. This form of memory recalls particular occurrences or episodes that transpired in the past (31). A considerable number of video games feature intricate narratives and multifaceted characters that necessitate players to retain them in order to comprehend the game's plot and advance (32). By actively participating in these narratives, individuals can fortify their episodic memory and improve their capacity to recollect precise particulars from previous encounters.

Further, engaging in video game play can have an impact on visual memory. Visual memory pertains to the cognitive capacity to retain and retrieve visual stimuli, including patterns, hues, and shapes. A significant number of video games demand that players focus on visual details in order to complete objectives or solve puzzles. Through the practice of visual memory while playing, individuals can enhance their capacity to accurately recall and remember visual information (33).

Cognitive Impairment and Problem-Solving Skills in Adolescent Gamers

Challenges to Problem-Solving Abilities in Video Game Players

Every day, individuals employ their problem-solving capabilities to surmount challenges and obstacles in a multitude of spheres. Players are frequently required to employ strategic and critical thinking in order to advance through levels and accomplish objectives in video games. Nevertheless, several obstacles can impede an individual's capacity for problem-solving within the realm of video games.

One such difficulty is schedule constraints. Many video games require quick reasoning and reflexes to complete tasks or impose time constraints. Certain individuals may experience an inordinate amount of this, leading them to panic or hastily form decisions, thereby hindering their capacity for effective problem-solving. Furthermore, certain games feature intricate challenges or puzzles that demand meticulous attention to detail and strategic planning. However, players may find it difficult to strategize effectively due to time constraints.

Cognitive excess is an additional obstacle that problem-solving abilities in video games must overcome. Certain

games overwhelm players with an abundance of information, duties, and stimuli, thereby impeding their ability to concentrate and efficiently process information (34). Players may become inundated, which could impede their capacity to assess circumstances, formulate judgments, and devise resolutions for challenges present in the game. A cognitive excess may result in disarray, exasperation, and impaired problem-solving capabilities.

Moreover, the intricacy of certain video games may present a puzzle-solving obstacle for players. Complex video games that feature elaborate narratives, numerous objectives, and complex control schemes may potentially overwhelm players, impeding their ability to effectively navigate the environment and resolve challenges. Players may experience dizziness, perplexity, and difficulty identifying and implementing solutions to problems due to the overwhelming quantity of information and options at their disposal.

Frustration is an extra obstacle that may impede the problem-solving capabilities of video game players. Repeatedly failing to complete a level or challenge may result in player frustration and hinder their capacity to employ critical and creative thinking in order to devise solutions (35). Frustration has the potential to impair players' problem-solving capabilities, dull their motivation, cloud their judgment, and impede their ability to surmount obstacles and advance in the game.

Video game participants may find their problem-solving abilities hindered by distractions. Environmental factors, noise, and interruptions are examples of external distractions that can impair a player's concentration and focus, thereby impeding their ability to analyze circumstances, make decisions, and find solutions to problems within the game. Players' problem-solving capabilities may be hindered by internal distractions, including fatigue, tension, or emotional factors. These factors can negatively impact their ability to navigate and resolve challenges in the game in an effective manner.

Furthermore, inexperience or unfamiliarity with a specific game genre or its mechanics may present a hindrance to video game players' problem-solving capabilities (36). It may be difficult for novice players to comprehend the rules, mechanics, and strategies necessary to solve problems and advance in a game. Their limited knowledge and experience may impede their capacity for critical and creative thinking, thereby impeding their ability to employ problem-solving abilities to surmount challenges.

Cognitive Impairment in Adolescent Gamers

A significant contributor to cognitive impairment among adolescent gamers is the inordinate duration of video game engagement. A number of adolescents dedicate several hours daily to virtual world engagement, disregarding their academic obligations and social engagements. The continuous screen exposure and rapid-fire gameplay have the potential to tax the brain and result in cognitive fatigue (37). Furthermore, persistent video game stimulation can desensitize the brain, thereby impeding adolescents' ability to concentrate and focus on tasks that demand extended periods of attention.

An additional element that contributes to cognitive impairment among adolescent gamers is the absence of activity

variety. Adolescents who dedicate the majority of their leisure time to video game playing fail to participate in alternative activities that could potentially stimulate various cerebral regions (38). Illustratively, engaging in social activities such as reading, athletics, and friendships can yield significant cognitive advantages that are not commonly acquired through gaming in isolation. In the absence of a diverse range of activities, it can be difficult for adolescents to cultivate critical thinking, creativity, and problem-solving abilities, among others.

Cognitive impairment among adolescents who play video games may also be a consequence of the addictive qualities of these platforms. A significant number of adolescents struggle to disconnect from the screen when they are so absorbed in their preferred video games. This may result in compromised personal hygiene, inadequate nutrition, and sleep deprivation, all of which are detrimental to cognitive function (39, 40). Moreover, adolescents may develop a sense of entitlement and impatience due to the incessant pursuit of immediate gratification in video games, which can hinder their ability to persevere when confronted with difficult tasks in the real world.

During the initial stages, adolescents might encounter academic challenges, including subpar grades, diminished motivation, and a decline in overall academic achievement (41). Their gaming behaviors may also hinder their ability to form meaningful connections with others and isolate them from their peers, which may cause them to have difficulty with social interactions (42). Cognitive impairment can have a lasting impact on the future prospects of adolescents, impeding their ability to excel in

tertiary education and obtain lucrative employment.

In order to alleviate the consequences of cognitive impairment among adolescent gamers, proactive measures such as restricting screen time and promoting a more balanced lifestyle can be implemented by parents and educators (43). Implementing explicit restrictions on the duration and timing of video game usage among adolescents can effectively mitigate the risk of excessive gaming and foster the development of more health-conscious behaviors. In addition to reading, arts and crafts, and outdoor sports, parents may offer their children alternative activities, such as arts and crafts, that stimulate various regions of the brain. By integrating technology-free periods into the school schedule, instructors can foster student engagement in collaborative endeavors that demand critical thinking and cooperation.

Conclusion

Video game stimulation and rapidity can result in diminished attention span, impeded memory retention, and compromised decision-making abilities. The brain's cognitive processes may become inundated with visual and auditory stimuli on a continuous basis, posing challenges for adolescents in maintaining focus on tasks that demand such concentration. Moreover, video games have the potential to disturb sleep patterns, resulting in fatigue and exacerbating cognitive decline. Parents and educators must monitor and restrict the amount of time adolescents spend playing video games to promote healthy brain development and prevent long-term cognitive deficits. ■

References

1. Vidal C, Lhaksampa T, Miller L, Platt R. Social media use and depression in adolescents: A scoping review. *Int Rev Psychiatry* 2020; 32(3):235-253. DOI: <https://doi.org/10.1080/09540261.2020.1720623>
2. Kim YJ, Lee CS, Kang SW. Increased adolescent game usage and health-related risk behaviors during the COVID-19 pandemic. *Curr Psychol* 2023; 3:1-12. DOI: <https://doi.org/10.1007/s12144-023-04466-8>
3. Smirni D, Garufo E, Di Falco L, Lavanco G. The playing brain. The impact of video games on cognition and behavior in pediatric age at the time of lockdown: A systematic review. *Pediatr Rep* 2021; 13(3):401-415. DOI: <https://doi.org/10.3390/pediatric13030047>
4. Mohammad S, Jan RA, Alsaedi SL. Symptoms, mechanisms, and treatments of video game addiction. *Cureus* 2023; 15(3):e36957. DOI: <https://doi.org/10.7759/cureus.36957>
5. Silvani MI, Werder R, Perret C. The influence of blue light on sleep, performance and wellbeing in young adults: A systematic review. *Front Physiol* 2022; 13:943108. DOI: <https://doi.org/10.3389/fphys.2022.943108>
6. Dye MW, Green CS, Bavelier D. Increasing speed of processing with action video games. *Curr Dir Psychol Sci* 2009; 18(6):321-326. DOI: <https://doi.org/10.1111/j.1467-8721.2009.01660.x>
7. Holm SK, Häikiö T, Olli K, Kaakinen JK. Eye movements during dynamic scene viewing are affected by visual attention skills and events of the scene: Evidence from first-person shooter gameplay videos. *J Eye Mov Res* 2021; 14(2):10.16910/jemr.14.2.3. DOI: <https://doi.org/10.16910/jemr.14.2.3>
8. Emihovich B, Roque N, Mason J. Can video game-play improve undergraduates' problem-solving skills? *Int J Game Based Learn* 2020; 10(2):21-38. DOI: <https://doi.org/10.4018/ijgbl.2020040102>
9. Martinez L, Gimenes M, Lambert E. Video games and board games: Effects of playing practice on cognition. *PLoS One*. 2023; 18(3):e0283654. DOI: <https://doi.org/10.1371/journal.pone.0283654>
10. Bocci F, Ferrari A, Sarini M. Putting the gaming experience at the center of the therapy-The Video Game Therapy® approach. *Healthcare (Basel)* 2023; 11(12):1767. DOI: <https://doi.org/10.3390/healthcare11121767>

11. Latham AJ, Patston LL, Tippett LJ. The virtual brain: 30 years of video-game play and cognitive abilities. *Front Psychol* 2013; 4:629. DOI: <https://doi.org/10.3389/fpsyg.2013.00629>
12. Cardoso-Leite P, Buchard A, Tissieres I, Mussack D, Bavelier D. Media use, attention, mental health and academic performance among 8 to 12 year old children. *PLoS One* 2021; 16(11):e0259163. DOI: <https://doi.org/10.1371/journal.pone.0259163>
13. Alsaad F, Binkhamis L, Alsalman A, Alabdulqader N, Alamer M, Abualait T, Khalil MS, Al Ghamdi KS. Impact of action video gaming behavior on attention, anxiety, and sleep among university students. *Psychol Res Behav Manag* 2022; 15:151-160. DOI: <https://doi.org/10.2147/PRBM.S347694>
14. Chan PA, Rabinowitz T. A cross-sectional analysis of video games and attention deficit hyperactivity disorder symptoms in adolescents. *Ann Gen Psychiatry* 2006; 5:16. DOI: <https://doi.org/10.1186/1744-859X-5-16>
15. Aliyari H, Sahraei H, Daliri MR, Minaei-Bidgoli B, Kazemi M, Ageai H, Sahraei M, Hosseini SMAS, Hadipour MM, Mohammadi M, Dehghanimohammadabadi Z. The beneficial or harmful effects of computer game stress on cognitive functions of players. *Basic Clin Neurosci* 2018; 9(3):177-186. DOI: <https://doi.org/10.29252/nirp.bcn.9.3.177>
16. Masi L, Abadie P, Herba C, Emond M, Gingras MP, Amor LB. Video games in ADHD and non-ADHD children: Modalities of use and association with ADHD symptoms. *Front Pediatr* 2021; 9:632272. DOI: <https://doi.org/10.3389/fped.2021.632272>
17. Sújar A, Martín-Moratinos M, Rodrigo-Yanguas M, Bella-Fernández M, González-Tardón C, Delgado-Gómez D, Blasco-Fontecilla H. Developing serious video games to treat attention deficit hyperactivity disorder: Tutorial guide. *JMIR Serious Games* 2022; 10(3):e33884. DOI: <https://doi.org/10.2196/33884>
18. Doi S, Isumi A, Fujiwara T. Association between adverse childhood experiences and time spent playing video games in adolescents: Results from A-CHILD study. *Int J Environ Res Public Health* 2021; 18(19):10377. DOI: <https://doi.org/10.3390/ijerph181910377>
19. Alrahili N, Alreefi M, Alkhonain IM, Aldakhilallah M, Alothaim J, Alzahrani A, Alshargi A, Baabbad N. The prevalence of video game addiction and its relation to anxiety, depression, and attention deficit hyperactivity disorder (ADHD) in children and adolescents in Saudi Arabia: A cross-sectional study. *Cureus* 2023; 15(8):e42957. DOI: <https://doi.org/10.7759/cureus.42957>
20. Craik FI. Effects of distraction on memory and cognition: A commentary. *Front Psychol* 2014; 5:841. DOI: <https://doi.org/10.3389/fpsyg.2014.00841>
21. Jafari MJ, Khosrowabadi R, Khodakarim S, Mohammadian F. The effect of noise exposure on cognitive performance and brain activity patterns. *Open Access Maced J Med Sci* 2019; 7(17):2924-2931. DOI: <https://doi.org/10.3889/oamjms.2019.742>
22. Khorsandi A, Li L. A multi-analysis of children and adolescents' video gaming addiction with the AHP and TOPSIS methods. *Int J Environ Res Public Health* 2022; 19(15):9680. DOI: <https://doi.org/10.3390/ijerph19159680>
23. West GL, Zendel BR, Konishi K, Benady-Chorney J, Bohbot VD, Peretz I, Belleville S. Playing Super Mario 64 increases hippocampal grey matter in older adults. *PLoS One* 2017; 12(12):e0187779. DOI: <https://doi.org/10.1371/journal.pone.0187779>
24. West GL, Konishi K, Diarra M, Benady-Chorney J, Drisdelle BL, Dahmani L, Sodums DJ, Lepore F, Jolicoeur P, Bohbot VD. Impact of video games on plasticity of the hippocampus. *Mol Psychiatry* 2018; 23(7):1566-1574. DOI: <https://doi.org/10.1038/mp.2017.155>
25. Lawrenson JG, Hull CC, Downie LE. The effect of blue-light blocking spectacle lenses on visual performance, macular health and the sleep-wake cycle: A systematic review of the literature. *Ophthalmic Physiol Opt* 2017; 37(6):644-654. DOI: <https://doi.org/10.1111/opo.12406>
26. Green CS, Bavelier D. Effect of action video games on the spatial distribution of visuospatial attention. *J Exp Psychol Hum Percept Perform* 2006; 32(6):1465-1478. DOI: <https://doi.org/10.1037/0096-1523.32.6.1465>
27. Kühn S, Gallinat J, Mascherek A. Effects of computer gaming on cognition, brain structure, and function: A critical reflection on existing literature. *Dialogues Clin Neurosci* 2019; 21(3):319-330. DOI: <https://doi.org/10.31887/DCNS.2019.21.3/skuehn>
28. Matthews BR. Memory dysfunction. *Continuum (Minneapolis)* 2015; 21(3 Behavioral Neurology and Neuropsychiatry):613-626. DOI: <https://doi.org/10.1212/01.CON.0000466656.59413.29>
29. West R, Swing EL, Anderson CA, Prot S. The contrasting effects of an action video game on visuo-spatial processing and proactive cognitive control. *Int J Environ Res Public Health* 2020; 17(14):5160. DOI: <https://doi.org/10.3390/ijerph17145160>
30. Blacker KJ, Curby KM, Klobusicky E, Chein JM. Effects of action video game training on visual working memory. *J Exp Psychol Hum Percept Perform* 2014; 40(5):1992-2004. DOI: <https://doi.org/10.1037/a0037556>
31. Toril P, Reales JM, Mayas J, Ballesteros S. Video game training enhances visuospatial working memory and episodic memory in older adults. *Front Hum Neurosci* 2016; 10:206. DOI: <https://doi.org/10.3389/fnhum.2016.00206>
32. Kuss DJ. Internet gaming addiction: Current perspectives. *Psychol Res Behav Manag* 2013; 6:125-137. DOI: <https://doi.org/10.2147/PRBM.S39476>
33. Blacker KJ, Curby KM. Enhanced visual short-term memory in action video game players. *Atten Percept Psychophys* 2013; 75(6):1128-1136. DOI: <https://doi.org/10.3758/s13414-013-0487-0>

34. Shanmugasundaram M, Tamilarasu A. The impact of digital technology, social media, and artificial intelligence on cognitive functions: A review. *Front Cognit* 2023; 2:1203077. DOI: <https://doi.org/10.3389/fcogn.2023.1203077>
35. Ting ST, Ho KH, Pau K. Need frustration, gaming motives, and internet gaming disorder in mobile Multiplayer Online Battle Arena (MOBA) games: Through the lens of self-determination theory. *Int J Ment Health Addict*. 2022; 2022:1-21. DOI: <https://doi.org/10.1007/s11469-022-00825-x>
36. Ream GL, Elliott LC, Dunlap E. A genre-specific investigation of video game engagement and problem play in the early life course. *J Addict Res Ther* 2013; 6:8.
37. Faber LG, Maurits NM, Lorist MM. Mental fatigue affects visual selective attention. *PLoS One* 2012; 7(10):e48073. DOI: <https://doi.org/10.1371/journal.pone.0048073>
38. Uffholz KE, Flack KD, Roemmich JN. The influence of active video game play upon physical activity and screen-based activities in sedentary children. *PLoS One* 2022; 17(6):e0269057. DOI: <https://doi.org/10.1371/journal.pone.0269057>
39. Nagata JM, Singh G, Sajjad OM, Ganson KT, Testa A, Jackson DB, Assari S, Murray SB, Bibbins-Domingo K, Baker FC. Social epidemiology of early adolescent problematic screen use in the United States. *Pediatr Res* 2022; 92(5):1443-1449. DOI: <https://doi.org/10.1038/s41390-022-02176-8>
40. Peracchia S, Curcio G. Exposure to video games: Effects on sleep and on post-sleep cognitive abilities. A systematic review of experimental evidences. *Sleep Sci* 2018; 11(4):302-314. DOI: <https://doi.org/10.5935/1984-0063.20180046>
41. McLeod JD, Uemura R, Rohrman S. Adolescent mental health, behavior problems, and academic achievement. *J Health Soc Behav* 2012; 53(4):482-497. DOI: <https://doi.org/10.1177/0022146512462888>
42. Sun RQ, Sun GF, Ye JH. The effects of online game addiction on reduced academic achievement motivation among Chinese college students: The mediating role of learning engagement. *Front Psychol* 2023; 14:1185353. DOI: <https://doi.org/10.3389/fpsyg.2023.1185353>
43. Breslau J, Miller E, Breslau N, Bohnert K, Lucia V, Schweitzer J. The impact of early behavior disturbances on academic achievement in high school. *Pediatrics* 2009; 123(6):1472-1476. DOI: <https://doi.org/10.1542/peds.2008-1406>

Received: January 18, 2024 | Revised: February 12, 2024 | Accepted: February 17, 2024
