

Digital Dementia and Cognitive Decline in the Era of Smart Gadgets

Jasna Badžak¹, Filip Đerke^{1,2}, Silvio Bašić^{1,2,3}, Vida Demarin⁴

¹ Department of Neurology, Referral Centre for Preoperative Assessment of Patients with Pharmacoresistant epilepsy, University Hospital Dubrava, Zagreb, Croatia

² Department of Psychiatry and Neurology, Faculty of Dental Medicine and Health, JJ Strossmayer University of Osijek, Osijek, Croatia

³ School of Medicine, University of Zagreb, Zagreb, Croatia

⁴ Croatian Academy of Sciences and Arts, Zagreb, Croatia

ABSTRACT:

Digital dementia, a concept introduced by neuroscientist Manfred Spitzer, describes the cognitive decline linked to the overuse of smart gadgets like smartphones, tablets, and computers. This phenomenon is characterized by reduced memory, attention, and problem-solving abilities, especially among younger individuals. While not a formal medical diagnosis, digital dementia highlights the broader concern about the neurological impact of excessive reliance on technology. The “external memory” function of smart devices reduces the brain’s cognitive workload, freeing mental capacity for other tasks. However, this also limits the brain’s natural “mental exercise,” which is essential for maintaining cognitive health. Studies indicate that frequent reliance on digital devices for memory-related tasks impairs users’ ability to recall information independently. Cognitive offloading has been linked to “mental atrophy,” akin to muscle weakening from inactivity. Adolescents and children are especially vulnerable due to the plasticity of their developing brains. Excessive screen use among youth is associated with poor memory, fragmented attention, and disrupted sleep due to blue light exposure, all of which hinder cognitive development. Research highlights three primary pathways through which smart gadget usage impacts cognitive health: neurological changes, behavioral reinforcement, and emotional well-being. MRI studies reveal that heavy users of smartphones show reduced grey matter density in the prefrontal cortex and hippocampus, regions essential for decision-making and memory. Habitual use of digital devices fosters reliance on convenience, displacing cognitive challenges essential for mental resilience. Additionally, prolonged gadget use is linked to higher levels of stress and anxiety, which negatively affect memory consolidation. The situation in Croatia reflects broader European trends, with the COVID-19 pandemic amplifying screen usage among youth due to remote learning and restricted social activities. This shift has heightened concerns about cognitive health, social development, and mental well-being. Mitigation strategies emphasize mindful technology use, cognitive training exercises, and physical activity. Encouraging device-free periods, cognitive exercises, and physical activities like walking or swimming can promote neurogenesis, enhance hippocampal function, and strengthen memory. These preventive measures aim to counterbalance the cognitive decline associated with gadget overuse. In conclusion, while smart gadgets have improved daily convenience, their prolonged use poses significant risks to cognitive health. Addressing digital dementia requires a balanced approach that fosters mindful usage, cognitive engagement, and physical activity, particularly among youth. Proactive measures can help preserve cognitive health and reduce the long-term risks posed by digital overdependence.

OPEN ACCESS

Correspondence:

Filip Đerke
filip@mozak.hr

This article was submitted to RAD
CASA - Medical Sciences
as the original article

Conflict of Interest Statement:

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received: 11 November 2024

Accepted: 2 December 2024

Published: 20 December 2024

Citation:

Badžak J, Đerke F, Bašić S, Demarin V. Digital Dementia and Cognitive Decline in the Era of Smart Gadgets. *Medical Sciences* 68-69 (2024): 50-54
DOI: 10.21857/ygjwrc27ky

Copyright (C) 2024 Badžak J, Đerke F, Bašić S, Demarin V. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

KEYWORDS: Cognitive Decline; Memory Disorders; Screen Time; Technology Use Disorder

SAŽETAK:**DIGITALNA DEMENCIJA I KOGNITIVNI PAD U ERI PAMETNIH NAPRAVA**

Digitalna demencija, koncept koji je predstavio neuroznanstvenik Manfred Spitzer, opisuje kognitivni pad povezan s pretjeranom upotrebom pametnih naprava poput pametnih telefona, tableta i računala. Ovu pojavu karakterizira smanjeno pamćenje, pažnja i sposobnost rješavanja problema, osobito kod mlađih osoba. Iako nije službena medicinska dijagnoza, digitalna demencija naglašava širu zabrinutost o neurološkom učinku pretjeranog oslanjanja na tehnologiju. Funkcija "vanjske memorije" pametnih uređaja smanjuje kognitivno opterećenje mozga, oslobađajući mentalnu sposobnost za druge zadatke. Međutim, to također ograničava prirodnu "mentalnu vježbu" mozga, koja je neophodna za održavanje kognitivnog zdravlja. Studije pokazuju da često oslanjanje na digitalne uređaje za zadatke povezane s memorijom smanjuje sposobnost korisnika da se samostalno prisjete informacija. Kognitivno rasterećenje povezano je s "mentalnom atrofiom", sličnom slabljenju mišića uslijed neaktivnosti. Adolescenti i djeca posebno su ranjivi zbog plastičnosti svojih mozgova u razvoju. Pretjerano korištenje ekrana među mladima povezuje se sa slabim pamćenjem, fragmentiranom pažnjom i poremećenim snom zbog izlaganja plavom svjetlu, a sve to koči kognitivni razvoj. U preglednom radu ističemo tri primarna puta putem kojih korištenje pametnih gadgeta utječe na kognitivno zdravlje: neurološke promjene, jačanje ponašanja i emocionalno blagostanje. MRI studije otkrivaju da veliki korisnici pametnih telefona pokazuju smanjenu gustoću sive tvari u prefrontalnom korteksu i hipokampusu, regijama bitnim za donošenje odluka i pamćenje. Uobičajena uporaba digitalnih uređaja potiče oslanjanje na praktičnost, istiskujući kognitivne izazove ključne za mentalnu otpornost. Osim toga, dugotrajna uporaba gadgeta povezana je s višim razinama stresa i tjeskobe, što negativno utječe na konsolidaciju pamćenja. Situacija u Hrvatskoj odražava šire europske trendove, pri čemu je pandemija COVID-19 povećala korištenje zaslona među mladima zbog učenja na daljinu i ograničenih društvenih aktivnosti. Ova promjena povećala je zabrinutost za kognitivno zdravlje, društveni razvoj i mentalnu dobrobit. Strategije ublažavanja naglašavaju pažljivo korištenje tehnologije, vježbe kognitivnog treninga i tjelesnu aktivnost. Poticanje razdoblja bez uređaja, kognitivne vježbe i tjelesne aktivnosti poput hodanja ili plivanja mogu potaknuti neurogenezu, poboljšati funkciju hipokampusa i ojačati pamćenje. Ove preventivne mjere imaju za cilj uravnotežiti kognitivni pad povezan s prekomjernom upotrebom gadgeta. Zaključno, dok su pametni uređaji poboljšali svakodnevnu praktičnost, njihova produljena uporaba predstavlja značajan rizik za kognitivno zdravlje. Rješavanje digitalne demencije zahtijeva uravnotežen pristup koji potiče svjesno korištenje, kognitivni angažman i tjelesnu aktivnost, osobito među mladima. Proaktivne mjere mogu pomoći u očuvanju kognitivnog zdravlja i smanjiti dugoročne rizike uzrokovane pretjeranom digitalnom ovisnošću.

KLJUČNE RIJEČI: Kognitivni pad; Poremećaji pamćenja; vrijeme ekrana; Poremećaj korištenja tehnologije

Digital dementia refers to a decline in cognitive abilities, such as memory, attention, and critical thinking, often associated with the overuse of digital devices like smartphones, tablets, and computers. The term was first coined by neuroscientist Manfred Spitzer to describe the phenomenon where excessive reliance on technology for tasks like remembering phone numbers, navigation, and even everyday decisions may weaken cognitive function. While not a medically recognized disorder, digital dementia highlights a growing concern about the long-term effects of technology on brain health.

Studies reveal that digital devices act as "external memory," off-loading cognitive tasks from the brain to technology. While this can free up mental capacity for other tasks, it also reduces op-

portunities for mental exercise, which is crucial for maintaining cognitive health. This dependence is particularly concerning for younger individuals whose brains are still developing.

THE LINK BETWEEN SMART GADGETS AND MEMORY LOSS

Smart gadgets store vast amounts of information, eliminating the need for users to memorize. For example, GPS apps reduce the need to remember routes, while contact lists mean fewer people remember phone numbers. A study published in *Memory & Cognition* found that individuals who frequently used digital devices for memory tasks showed weaker recall of those tasks when required to remember manually¹. This suggests a direct trade-off between technology use and memory reliance. Cogni-

tive functions like memory, attention, and problem-solving benefit from regular mental exercise. Over-reliance on gadgets can lead to “mental atrophy,” much like muscles weaken when not exercised. A 2021 study from *Frontiers in Psychology* indicated that students who used smartphones excessively scored lower on memory retention tests compared to those who used traditional study methods². Continuous notifications, multitasking, and the instant gratification provided by digital devices promote fragmented attention. This impairs deep focus, essential for consolidating information into long-term memory. Researchers from the University of California, Irvine, demonstrated that frequent digital interruptions could significantly disrupt working memory, impacting long-term learning outcomes.

YOUNG PEOPLE AND THE RISKS OF DIGITAL DEMENTIA

The effects of digital dementia are particularly alarming in young people. Adolescents and children are at a developmental stage where their neural pathways are highly plastic. Overuse of digital devices during this critical period may have long-lasting consequences.

A study from the *Journal of Pediatrics* (2019) found that children who spent more than two hours daily on screens performed worse on memory and language tests^{3,4}. The findings align with concerns that excessive gadget use may hinder the development of critical cognitive skills. Young people often use their devices late into the night, exposing themselves to blue light, which suppresses melatonin production and disrupts sleep patterns. Poor sleep negatively affects memory consolidation, as the brain processes and stores information during deep sleep. Research published in *Sleep Medicine Reviews* (2020) linked increased screen time with shorter sleep duration and poorer memory in adolescents⁵.

Over-reliance on digital communication also limits opportunities for in-person social interactions, affecting the development of emotional intelligence and interpersonal skills. These are linked to cognitive flexibility and problem-solving abilities, critical for overall brain health⁶⁻¹⁰.

HOW SMART GADGET USE CAUSES COGNITIVE DECLINE

The pathways through which smart gadget use impacts memory and cognition are both direct and indirect:

1. **Neurological Changes:** Studies using MRI scans have shown that excessive screen time can lead to structural changes in the brain, particularly in areas like the prefrontal cortex, responsible for decision-making, and the hippocampus, critical for memory. For instance, a 2020 study in *NeuroImage* revealed reduced grey matter density in these regions among heavy smartphone users¹¹.
2. **Behavioral Patterns:** The habitual use of gadgets fosters reliance on convenience over effort, reducing opportunities

for cognitive challenges. This behavioral reinforcement loop discourages mental resilience, critical for memory retention and problem-solving.

3. **Stress and Anxiety:** Prolonged gadget use is associated with increased stress and anxiety levels, which negatively impact memory. Stress hormones like cortisol can interfere with the brain's ability to encode and retrieve information. A 2019 study in *Journal of Behavioral Addictions* found that heavy smartphone users experienced higher stress levels, correlating with weaker memory performance¹².

TIME ON SCREEN AMONG YOUNGS IN CROATIA

Screen time among young people in Croatia reflects broader trends observed in Europe, with increasing concerns about its impact on mental health, social behaviors, and digital dependence. Croatia has seen a rise in digital engagement, with young people extensively using devices for entertainment, socialization, and education. During the COVID-19 pandemic, screen time surged as schools adopted online learning, and social interactions shifted to digital platforms. Many adolescents reported increased stress, uncertainty, and changes in daily habits, compounded by extended hours on screens due to remote classes and restricted outdoor activities¹³⁻¹⁵.

The World Health Organization's recent findings align with trends in Croatia, highlighting that around 11% of European adolescents exhibit problematic social media use, while 12% show signs of problematic gaming. Such behaviors can contribute to issues like anxiety, poor sleep, and decreased face-to-face interaction, potentially impacting young Croatians similarly. Croatia ranks high in digital skills among youth within the European Union. About 80% of young Croatians aged 16-24 possess basic or advanced digital abilities, which support their capacity to adapt to digital environments. However, this also raises the question of whether high digital competency correlates with healthier screen usage or merely facilitates extended digital immersion¹⁶⁻²⁰.

MITIGATION AND PREVENTION STRATEGIES FOR DIGITAL OVERUSE

The rise in excessive gadget use has raised concerns about its impact on cognitive health, memory, and overall well-being. However, strategies for mitigation and prevention can effectively counter these effects. Here, we explore evidence-based approaches for healthier technology habits. Practicing mindful usage of technology encourages intentional and limited engagement with gadgets. Techniques include turning off non-essential notifications, scheduling device-free periods, and setting screen time limits. These steps can help break the cycle of constant connectivity, reducing cognitive overload. By fostering awareness of one's digital habits, individuals can prioritize meaningful interactions and focused tasks over passive scrolling. Such methods are

particularly beneficial in managing fragmented attention caused by multitasking on digital platforms. Engaging in cognitive exercises, popularly called "Brain Fitness" programs that challenge memory and learning abilities helps offset the negative impact of gadget overuse. Activities such as solving puzzles, reading, or acquiring new skills stimulate brain activity and improve cognitive performance. A 2021 study in *Neuropsychologia* highlighted that memory-intensive tasks significantly enhanced executive functions in individuals who had previously experienced excessive screen use. These exercises promote neuroplasticity which is essential for sustaining memory and attention in a digital age²¹. Physical exercise benefits cognitive health by increasing blood flow to the brain, which supports neurogenesis and enhances memory. A study from 2020 concluded that regular physical activity has significant positive effects on memory, attention, and executive functions, especially in young individuals²². Aerobic activities, such as walking, swimming, and cycling, have been shown to boost hippocampal function, the region responsible for memory processing. Encouraging youth to partake in regular physical activity can act as a counterbalance to the sedentary nature of prolonged gadget use, promoting better overall health and cognitive resilience.

To sum up, the harmful cognitive effects of excessive gadget use are not inevitable. By adopting mindful technology practices, engaging in cognitive exercises, encouraging parental and educational guidance, and promoting physical activity, individuals can build resilience against these effects. These strategies, grounded in scientific research, highlight the importance of balance and proactive habits in the digital era. Fostering healthier relationships with technology ensures that it serves as a tool for productivity and connection rather than a source of cognitive strain.

CONCLUSION

Digital dementia underscores the potential risks of excessive reliance on smart gadgets, especially among young people. While technology has undoubtedly improved our lives, its impact on memory and cognitive function warrants concern. Research highlights that externalizing memory tasks to devices, fragmented attention, and sleep disruption are key contributors to this phenomenon. By fostering mindful usage, promoting cognitive and physical activities, and educating the younger generation about these risks, we can counteract the adverse effects of digital overdependence and maintain cognitive health in the digital age.

REFERENCES:

1. Ali Z, Janarthanan J, Mohan P. Understanding Digital Dementia and Cognitive Impact in the Current Era of the Internet: A Review. *Cureus*. 2024 Sep 23;16(9):e70029. doi: 10.7759/cureus.70029. PMID: 39449887; PMCID: PMC11499077.
2. Dowson, B., Atkinson, R., Barnes, J., Barone, C., Cutts, N., Donnebaum, E., Hung Hsu, M., Lo Coco, I., John, G., Meadows, G., O'Neill, A., Noble, D., Norman, G., Pfende, F., Quinn, P., Warren, A., Watkins, C., & Schneider, J. (2021). Digital Approaches to Music-Making for People With Dementia in Response to the COVID-19 Pandemic: Current Practice and Recommendations. *Frontiers in psychology*, 12, 625258. <https://doi.org/10.3389/fpsyg.2021.625258>
3. Przybylski A. K. (2019). Digital Screen Time and Pediatric Sleep: Evidence from a Preregistered Cohort Study. *The Journal of pediatrics*, 205, 218–223.e1. <https://doi.org/10.1016/j.jpeds.2018.09.054>
4. Manwell, L. A., Tadros, M., Ciccarella, T. M., & Eikelboom, R. (2022). Digital dementia in the internet generation: excessive screen time during brain development will increase the risk of Alzheimer's disease and related dementias in adulthood. *Journal of integrative neuroscience*, 21(1), 28. <https://doi.org/10.31083/j.jin2101028>
5. Alshoabi Y, Bafil W, Rahim M. The effect of screen use on sleep quality among adolescents in Riyadh, Saudi Arabia. *J Family Med Prim Care*. 2023 Jul;12(7):1379-1388. doi: 10.4103/jfmpc.jfmpc_159_23. Epub 2023 Jul 14. PMID: 37649757; PMCID: PMC10465044.
6. Spitzer M. *Digital Dementia: What We and Our Children Are Doing to Our Minds*. Munich: Droemer; 2012.
7. Risko EF, Gilbert SJ. Cognitive offloading. *Trends Cogn Sci*. 2016;20(9):676–88.
8. Cain MS, Leonard JA, Gabrieli JD, Finn AS. Media multitasking in adolescence. *Psychon Bull Rev*. 2016;23(6):1932–41.
9. Montag C, Diefenbach S. Towards homo digitalis: Important research issues for psychology and the neurosciences at the dawn of the Internet of Things. *Front Psychol*. 2018;9:611.
10. Carter B, Rees P, Hale L, Bhattacharjee D, Paradkar MS. Association between portable screen-based media device access or use and sleep outcomes: A systematic review and meta-analysis. *JAMA Pediatr*. 2016;170(12):1202–8.
11. Montag C, Becker B. Neuroimaging the effects of smartphone (over-)use on brain function and structure—a review on the current state of MRI-based findings and a roadmap for future research. *Psychoradiology*. 2023 Feb 1;3:kkad001. doi: 10.1093/psyrad/kkad001. PMID: 38666109; PMCID: PMC10917376.
12. Nikolic A, Bukurov B, Kocic I, Vukovic M, Ladjevic N, Vrhovac M, Pavlović Z, Grujicic J, Kisic D, Si-

- petic S. Smartphone addiction, sleep quality, depression, anxiety, and stress among medical students. *Front Public Health*. 2023 Sep 6;11:1252371. doi: 10.3389/fpubh.2023.1252371. PMID: 37744504; PMCID: PMC10512032.
13. Chen Y, Bargh JA. Smartphone addiction and stress: The mediating roles of anxiety and sleep quality. *J Behav Addict*. 2019;8(3):456–67.
 14. Madigan S, Browne D, Racine N, Mori C, Tough S. Association between screen time and children's performance on a developmental screening test. *JAMA Pediatr*. 2019;173(3):244–50.
 15. Stern Y. Cognitive reserve in ageing and Alzheimer's disease. *Lancet Neurol*. 2012;11(11):1006–12.
 16. Musić Milanović S, Barić CT, Pavičić Žeželj S, Zambeli Jurjević T, Čorić T. Obesity and physical activity trends among Croatian schoolchildren: Results from the Childhood Obesity Surveillance Initiative (CroCOSI). *Croatian Institute of Public Health*; 2023 [cited 2024 Nov 17]. Available from: <https://hzjz.hr>
 17. Musić Milanović S. Croatian Childhood Obesity Surveillance Initiative – COSI. *Andrija Štampar School of Public Health*. 2023 [cited 2024 Nov 17]. Available from: <https://www.snz.hr>
 18. World Health Organization. Adolescent screen time and mental health concerns in Europe. *WHO Europe* [Internet]. 2024 [cited 2024 Nov 17]. Available from: <https://www.who.int/europe>
 19. Croatia Week. Croatia no.1 for digital skills among youth in EU. *Croatia Week* [Internet]. 2024 Apr 5 [cited 2024 Nov 17]. Available from: <https://www.croatiaweek.com>
 20. Statista. Screen time among young people in Europe 2023. *Statista* [Internet]. 2023 [cited 2024 Nov 17]. Available from: <https://www.statista.com>
 21. Drechsler R, Brem S, Brandeis D, Grünblatt E, Berger G, Walitza S. ADHD: Current Concepts and Treatments in Children and Adolescents. *Neuropediatrics*. 2020 Oct;51(5):315-335. doi: 10.1055/s-0040-1701658. Epub 2020 Jun 19. PMID: 32559806; PMCID: PMC7508636.
 22. Erickson KI, Hillman C, Stillman CM, Ballard RM, Bloodgood B, Conroy DE, Macko R, Marquez DX, Petruzzello SJ, Powell KE; FOR 2018 PHYSICAL ACTIVITY GUIDELINES ADVISORY COMMITTEE*. Physical Activity, Cognition, and Brain Outcomes: A Review of the 2018 Physical Activity Guidelines. *Med Sci Sports Exerc*. 2019 Jun;51(6):1242-1251. doi: 10.1249/MSS.0000000000001936. PMID: 31095081; PMCID: PMC6527141.

