



Digital multitasking and hyperactivity: unveiling the hidden costs to brain health

Md. Kamrul Hasan, MS, MPH^{a,b,*}

In a modern, fast-paced digital society, multitasking has become an everyday occurrence. We frequently find ourselves hopping between numerous jobs, such as responding to emails, perusing social media, and working on professional responsibilities, all within the same time window. While digital multitasking appears efficient, serious concerns exist about its long-term effects on brain hyperactivity and cognitive health^[1]. According to an American Psychological Association (APA) survey, roughly 40% of adults routinely multitask with digital devices, significantly increasing self-reported stress and lowering productivity^[2]. Despite its prominence, the long-term effects of digital multitasking on psychological well-being and cognitive performance are poorly understood. The increasing reliance on digital devices necessitates a closer examination of how these practices affect our brains and overall well-being^[3]. However, this editorial does not give new empirical evidence; rather, it integrates existing research to highlight important gaps and suggest future study options. This synthesis is critical for understanding the present level of research on the long-term effects of digital multitasking on brain health. In this regard, Wilmer *et al.*^[4] discovered that frequent digital multitasking is associated with decreased cognitive control and greater distractibility. Similarly, Ophir *et al.*^[5] found that heavy media multitaskers performed poorly on task-switching ability tests, indicating a lack of cognitive control. Furthermore, Uncapher *et al.*^[6] found that chronic multitaskers had inferior working memory performance and more difficulty filtering out irrelevant information, leading to increased mental fatigue and stress. Combining these findings, this editorial underlines the immediate cognitive repercussions of digital multitasking while emphasizing the critical need for additional rigorous longitudinal studies to investigate its long-term impacts. This summary attempts to direct future research efforts by identifying important gaps in knowledge and encouraging further exploration.

^aDepartment of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Canada and ^bDepartment of Public Health, North South University, Dhaka, Bangladesh

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*Corresponding author. Address: North South University, Dhaka, Bashundhara, Bangladesh. E-mail: kamrulhasanhriday205@gmail.com; hasanm57@mcmaster.ca (M.K. Hasan).

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Digital multitasking is the simultaneous administration of numerous digital tasks, such as texting while viewing a video or moving among apps on a smartphone^[5]. The rapid expansion of technology has enabled this tendency, making communication and data more accessible. Although digital multitasking is frequently viewed to increase productivity, it may incur considerable cognitive costs. Human brains are not designed to handle multiple things at once. Multitasking divides cognitive resources, leading to higher cognitive load and hyperactivity^[7]. Cognitive load refers to the amount of mental effort expended in working memory. When people multitask, the cognitive load increases because the brain has to move attention between tasks, which can overload working memory and reduce overall cognitive efficiency. Increased cognitive load can cause mental tiredness, decreased concentration, and poor decision-making^[4]. Executive function refers to a range of cognitive functions, including working memory, flexible thinking, and self-control. These mechanisms are critical for controlling and regulating thoughts and activities, especially goal-directed ones. Multitasking can have an adverse effect on executive function because it overloads the brain's ability to transition between activities quickly, hindering planning, problem-solving, and sustained attention^[8]. According to research, multitasking can impair cognitive abilities such as memory, focus, and decision-making. For example, Rubinstein, Meyer, and Evans discovered that task-switching might cost up to 40% of a person's productive time due to the cognitive load of moving between tasks^[8]. This suggests that while multitasking may appear effective, it might result in significant time loss and lower task performance. Switching between tasks causes the brain to reposition itself, consuming cognitive resources and causing mental tiredness.

Prolonged multitasking can result in brain hyperactivity, characterized by increased neuronal activity and arousal levels. Furthermore, the psychological consequences of digital multitasking are significant. Becker, Alzhabi, and Hopwood found that people who often multitask are more likely to experience symptoms of depression and anxiety^[9]. Heavy multitaskers had considerably greater levels of anxiety ($P < 0.01$) and depression ($P < 0.05$) than those who multitask less frequently^[9]. It indicates that the persistent cognitive load and mental strain associated with multitasking can have substantial consequences for mental health. This type of hyperactivity can impede the brain's ability to absorb information efficiently, adding to feelings of tension and anxiety. Recent neuroimaging research has revealed important insights into the effects of digital multitasking on brain function. For example, functional magnetic resonance imaging (fMRI) studies have shown that multitasking reduces activation in brain regions involved with cognitive control while increasing activation in areas associated with stress and arousal^[10]. Furthermore, electrophysiological investigations using electroencephalography (EEG) have revealed that multitasking is associated with

alterations in brain wave patterns, indicating increased cognitive load and decreased task performance efficiency^[11]. Understanding these neural pathways is critical to determining the long-term effects of chronic digital multitasking on brain health. This understanding can help to develop tailored strategies to reduce the negative consequences of multitasking.

Furthermore, digital multitasking can have a harmful long-term influence on cognitive health. Prolonged multitasking has been linked to decreased working memory capacity and poor executive function, which is essential for tasks requiring planning, problem-solving, and sustained focus^[6]. Cognitive impairments can have an impact on both academic and professional performance, as well as overall quality of life. While digital multitasking might have a negative impact on cognitive health, it also has several benefits. Multitasking can promote digital literacy, task-switching efficiency, and flexibility in some professional settings. Furthermore, some research indicates that managed multitasking might boost creativity and problem-solving abilities by fostering flexible thinking^[12]. To have a thorough knowledge of the influence of digital multitasking on cognitive and mental health, it is necessary to analyze both potential positives and negatives. Despite mounting evidence of the harmful effects of multitasking, there has been little research into the long-term implications of digital multitasking on brain hyperactivity and cognitive function. Most prior studies have focused on the immediate cognitive consequences of multitasking rather than its long-term implications. Furthermore, there are few longitudinal studies that track changes in brain function and mental health over time^[13].

To fill these gaps, future research should concentrate on long-term studies of changes in brain activity, cognitive performance, and mental health in those who frequently participate in digital multitasking. This research can provide helpful information about the cumulative impact of multitasking on brain health. Advanced neuroimaging techniques, including fMRI and EEG, can be used to examine the neurological correlates of digital multitasking, allowing researchers to pinpoint areas of the brain affected by multitasking and better understand the mechanisms underpinning brain hyperactivity^[10]. Furthermore, intervention studies aimed at reducing digital multitasking and its accompanying cognitive load, such as mindfulness training and digital detox programs, should be created and tested to determine their usefulness in alleviating the detrimental consequences of multitasking.

Understanding the consequences of digital multitasking on the brain has important practical implications. Adopting healthier digital habits, such as limiting multitasking and taking frequent breaks, may help people lower cognitive load and enhance their mental health. Implementing mindfulness training programs and digital detox campaigns are two practical techniques for mitigating the consequences of digital multitasking.

Mindfulness training: Mindfulness training programs that focus on improving attention and reducing stress have been demonstrated to be beneficial in improving cognitive control and alleviating anxiety and depression symptoms^[14]. These programs often include mindfulness meditation, which requires participants to focus on their breathing and present-moment awareness, and mindful movement exercises such as yoga. Mindfulness training can be delivered via workshops, online courses, and mobile applications. Zeidan *et al.*^[14] found that even brief mindfulness training improved visuospatial processing, working memory, and executive functioning. Participants in the study who

engaged in mindfulness activities reported lower stress levels and improved cognitive performance.

Digital detox programs: Digital detox programs involve taking regular breaks from digital gadgets to assist in recovering cognitive function and prevent mental tiredness^[15]. These programs may include activities like device-free intervals during the day, digital-free weekends, and getaways aimed at disconnecting from technology. Research has shown that digital detox programs increase well-being and concentration. For example, Kushlev *et al.*^[16] discovered that limiting smartphone notifications considerably improved participants' well-being and attention levels. Organizations can support digital detox programs by encouraging employees to take frequent screen breaks, holding device-free meetings, and providing tools for digital detox retreats.

Promoting environments that support focused work and minimizing digital distractions can also help. Employers can adopt policies that set aside defined hours for uninterrupted work and provide areas free of digital distractions. Educational institutions might include instruction on effective multitasking tactics and the need to take regular breaks in their curricula. Academic and professional organizations can create regulations to concentrate work while minimizing digital distractions. For policy-makers, increasing digital literacy and raising awareness about the potential cognitive and mental health risks of multitasking can contribute to a more educated population. Furthermore, technology developers can construct digital solutions that limit distractions and promote prolonged focus, reducing users' cognitive strain. By focusing on study in this area and applying evidence-based strategies, we can lessen the negative impacts of digital multitasking and promote a healthier, more focused lifestyle.

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