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Cognitive load and multitasking: Understanding the limits of mental processing.

Anna Petrova*

Department of Neurophysiology, Lomonosov Moscow State University, Russian federation.

***Correspondence to:** Anna Petrova, Department of Neurophysiology, Lomonosov Moscow State University, Russian federation, E-mail: a.petrova@lomonosov.edu

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Introduction

Cognitive load theory explores how the human brain processes information, particularly under conditions that stretch its limited capacity. Central to this theory is the idea that working memory, responsible for temporarily holding and manipulating information, can only handle a finite amount at any given time. When individuals engage in multiple tasks simultaneously, each requiring cognitive resources, the total demand may exceed the brain's processing limits. This leads to decreased efficiency, increased errors, and compromised performance. Understanding how cognitive load operates under multitasking conditions is critical not only in academic and occupational settings but also in environments that require sustained attention and rapid decision-making [1].

There are three types of cognitive load: intrinsic, extraneous, and germane. Intrinsic load relates to the inherent difficulty of the task, while extraneous load arises from the way information is presented, and germane load involves the mental effort used to create new schemas. Multitasking typically increases extraneous load, especially when tasks are unrelated or demand simultaneous attention to conflicting stimuli. For instance, driving while texting divides cognitive resources between spatial navigation and linguistic processing, heightening the chance of mistakes. Multitasking may feel efficient, but in reality, the cognitive cost is often high, particularly for complex or novel tasks that require deep processing [2].

Research using neuroimaging and behavioral experiments has provided empirical support for the limitations of cognitive load during multitasking. Functional MRI studies reveal that the prefrontal cortex, which is crucial for executive function and task-switching, becomes overburdened when individuals juggle multiple cognitive demands. This overload can result in "task-switching costs," where time and accuracy are compromised when moving from one task to another. Further, EEG studies show delayed neural responses and decreased amplitude in brainwave activity during multitasking, indicating a reduction in processing efficiency. These findings confirm that while the brain can switch between tasks, it does so with measurable declines in performance [3].

The impact of cognitive load is also influenced by individual differences such as age, expertise, and working memory capacity. Older adults generally exhibit greater difficulties with multitasking due to declines in executive function and reduced cognitive flexibility. Conversely, individuals with high working

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memory capacity can sometimes manage dual tasks more effectively, especially when the tasks are well-practiced. Expertise in a specific domain also plays a role; for example, experienced pilots or musicians can multitask better within their trained contexts because they have automated many of the underlying cognitive processes. Thus, task familiarity and skill development can mitigate some effects of high cognitive load [4].

Educational and professional environments must consider cognitive load when designing tasks and interfaces. Overloading students with complex materials or workers with multiple simultaneous demands can reduce comprehension, retention, and productivity. Effective strategies include breaking complex tasks into smaller units, minimizing irrelevant information, and using visual aids that align with auditory instructions. Technological solutions like adaptive learning systems and task management applications can also help distribute cognitive load more efficiently. As digital environments increasingly demand multitasking, understanding and managing cognitive load becomes crucial to sustaining attention, performance, and mental well-being [5].

Conclusion

Cognitive load and multitasking provide a window into the brain's limited but flexible capacity for handling information. While multitasking is a common feature of modern life, it often leads to cognitive strain and reduced effectiveness. By recognizing the boundaries of working memory and implementing strategies to manage mental load, individuals and organizations can foster more productive and cognitively sustainable practices. Continued research in this area remains vital to optimizing human performance in increasingly complex environments.

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