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The effects of digital multi-tasking and task switching on working memory: A systematic review

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ABSTRACT

Digital multitasking — defined as concurrent or rapidly alternating engagement with two or more technology-mediated tasks — has emerged as a pervasive feature of contemporary cognitive life with measurable consequences for working memory capacity and executive function. This systematic review synthesized empirical evidence from 28 studies published between 2016 and 2025, identified through searches of PubMed, PsycINFO, Web of Science, Scopus, and ERIC, following PRISMA 2020 guidelines. Findings converge on three domains: cognitive costs, academic performance, and neural mechanisms. Across behavioral, neuroimaging, and electrophysiological paradigms, digital multitasking consistently degraded working memory capacity, increased attentional lapses, elevated switch costs, and impaired metacognitive monitoring. In academic contexts, media multitasking during instruction reliably predicted reduced comprehension, recall, and cumulative achievement. At the neural level, chronic digital multitasking was associated with reduced functional efficiency within fronto-parietal control networks and diminished hippocampal encoding activity. Self-regulatory capacity emerged as a meaningful moderating variable. Methodological limitations — including cross-sectional designs, convenience sampling, and heterogeneous operationalizations — precluded meta-analytic synthesis and causal inference. Longitudinal research, standardized measurement, and rigorously evaluated interventions targeting digital self-regulation represent critical priorities for advancing this field.

KEYWORDS: digital multitasking, working memory, task switching, attentional control, executive function, academic performance

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1. Introduction

Digital multitasking, broadly defined as engaging in two or more activities simultaneously or through rapid alternation where at least one is technology-mediated, has become a pervasive feature of contemporary cognitive life (Aagaard, 2018; Drody et al., 2025; May & Elder, 2018; Popławska et al., 2021). Within cognitive science, this construct is operationalized through two interrelated mechanisms: dual-tasking, wherein parallel task execution competes for shared attentional resources, and task switching, wherein attention alternates rapidly between discrete task sets, producing measurable switch costs in speed and accuracy (Musslick & Cohen, 2020; Worringer et al., 2019). Although digital multitasking is conceptually distinct from general distraction, applied research frequently treats off-task technology use as functionally equivalent to distraction, given that both phenomena disrupt goal-directed attentional control through the same underlying fronto-parietal regulatory networks (Aagaard, 2018; Dontre, 2020; Egner, 2023; Vedechkina & Borgonovi, 2021).

Working memory has emerged as a theoretically central outcome variable in digital multitasking research precisely because it constitutes the limited-capacity cognitive workspace responsible for encoding, maintaining, and manipulating information required for virtually all goal-directed behavior, including reasoning, comprehension, and academic learning (Chai et al., 2018; Eriksson et al., 2015; Ma et al., 2014; Miller et al., 2018). Because working memory is fundamentally constrained by attentional resources shared across concurrent processing and storage demands, digital environments that introduce continuous task-irrelevant stimuli — such as notifications and parallel media streams — directly compete for and deplete this finite capacity (Barrouillet et al., 2024; Gruszka & Nęcka, 2017). Empirical evidence consistently links heavy digital media use and problematic internet engagement to measurable decrements in working memory performance, inhibitory control, and executive regulation, establishing working memory as both a sensitive marker of digital cognitive strain and a practically significant predictor of real-world functioning (Clemente-Suárez et al., 2024; Ioannidis et al., 2019; Sina et al., 2023; Wilmer et al., 2017).

The existing empirical landscape reveals considerable convergence regarding the cognitive costs of digital multitasking, with studies consistently documenting impairments in recall accuracy, attentional regulation, and processing efficiency across laboratory and naturalistic settings (Jeong & Hwang, 2016; Madore et al., 2020; Mostafa et al., 2025; Yousef et al., 2025). High media multitaskers demonstrate elevated susceptibility to distractor interference, weakened inhibitory control, and greater attention lapses during encoding, collectively degrading working memory performance and downstream academic outcomes (Clemente-Suárez et al., 2024; Maeneja et al., 2025; Murphy & Creux, 2021; Roux & Parry, 2019). Nevertheless, substantial inconsistencies persist: some studies report null or paradoxically enhanced speed-based performance among heavy multitaskers, while widespread methodological heterogeneity in executive function measurement, cross-sectional designs, and limited ecological validity collectively obscure causal mechanisms and boundary conditions (Kostić & Ranđelović, 2022; Rogobete et al., 2020; Szameitat & Students, 2022) — gaps that directly motivate the present systematic review.

The cognitive consequences of digital multitasking are most pronounced among adolescents and university students, populations for whom technology-mediated task switching occurs most frequently and in the highest-stakes learning environments (Cain et al., 2016; Cvetković et al., 2025; May & Elder, 2018). Among adolescents, heavy media multitasking is reliably associated with dysexecutive difficulties, cognitive inflexibility, heightened impulsivity, and diminished academic achievement across language and mathematics domains (Cardoso-Leite et al., 2020; Maeneja et al., 2025; Marciano et al., 2021; Sina et al., 2023). For university students, off-task digital multitasking during lectures and self-directed study consistently predicts reduced recall, comprehension, and processing efficiency (Clemente-Suárez et al., 2024; Vedechkina & Borgonovi, 2021). Working professionals similarly experience measurable costs in attentional regulation, task-switching delays, and occupational stress under digitally interrupted knowledge-work conditions (Small et al., 2020; Wiradhany & Koerts, 2019), collectively underscoring the broad practical urgency of the present review.

Scholarly interest in digital multitasking as a measurable cognitive and public health concern has accelerated markedly over the past decade, propelled by the widespread proliferation of smartphones, social media platforms, and technology-saturated learning environments (Beuckels et al., 2021; Loh & Kanai, 2016). Although early empirical work emerged in the late 1990s and early 2000s — primarily documenting classroom distraction from laptop and phone use — the construct gained substantial neuropsychological and public health traction between 2010 and 2015, as research began linking media multitasking to degraded cognitive control, executive dysfunction, and working memory impairment (Aagaard, 2018; May & Elder, 2018; Small et al., 2020). The subsequent decade witnessed rapid bibliometric expansion across adolescent, student, and clinical populations, with systematic reviews and large-scale observational studies increasingly framing digital multitasking as a developmental and brain-health priority (Clemente-Suárez et al., 2024; Kostić & Ranđelović, 2022; Shanmugasundaram & Tamilarasu, 2023; Zhou & Deng, 2022), establishing the empirical foundation upon which the present systematic review is built.

The mechanistic pathway through which digital multitasking degrades working memory is anchored in the neuropsychological costs of repeated task switching, wherein each transition between digital tasks demands active reconfiguration of task sets held in working memory, generating measurable switch costs in response latency and accuracy (Schmitz & Krämer, 2023; Wang et al., 2022). These reconfiguration demands directly compete for the finite capacity of the fronto-parietal control network — encompassing dorsolateral prefrontal cortex, pre-supplementary motor area, and superior parietal lobule — a system simultaneously responsible for working memory maintenance and executive regulation (Worringer et al., 2019). Compounding these switch costs, digital multitasking precipitates sustained attentional lapses that disrupt prefrontal encoding and goal-relevant memory trace consolidation, with heavy media multitaskers demonstrating significantly elevated lapse frequency and correspondingly reduced working memory precision (Clapp et al., 2011; Madore et al., 2020; Uncapher et al., 2016), underscoring the neurological plausibility of a direct causal link between task-switching behavior and measurable working memory impairment.

The present systematic review aimed to synthesize and critically evaluate the empirical evidence examining the cognitive consequences of digital multitasking and task switching, with working memory capacity as the primary outcome of interest. Three interconnected objectives guided the review: to document and characterize the direct cognitive costs imposed by digital multitasking on working memory performance, attentional control, and related executive functions; to examine how these cognitive impairments manifest in academic performance and real-world learning outcomes across student populations; and to elucidate the neural mechanisms and executive function substrates through which multitasking-related working memory impairment occurs. By integrating behavioral, neuroimaging, and electrophysiological evidence, the review sought to provide a comprehensive and mechanistically grounded account of digital multitasking's burden on the cognitive architecture underlying goal-directed behavior.

2. Methods

2.1 Study Design and Protocol

This study employed a systematic review design in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The review was conducted to synthesize empirical evidence on the cognitive effects of digital multitasking and task switching, with a specific focus on working memory capacity, attentional control, and related executive functions. The protocol was established a priori and guided all stages of the review process, from database searching through data extraction and quality appraisal, to ensure methodological rigor and reproducibility.

The review addressed the following overarching research questions: (1) What are the documented cognitive costs of digital multitasking on working memory capacity and related cognitive processes? (2) How do these effects manifest in academic performance and real-world learning outcomes? (3) What neural mechanisms and executive function substrates underlie multitasking-related working memory impairment? These questions guided the formulation of inclusion and exclusion criteria, as well as the subsequent organization of the synthesis.

2.2 Literature Search Strategy

A systematic and comprehensive search of the published literature was conducted across five major electronic databases: PubMed, PsycINFO, Web of Science, Scopus, and ERIC. Additionally, the PROSPERO register was searched to identify relevant registered protocols and to avoid duplication with previously completed or ongoing reviews. Searches were conducted in January 2025 and encompassed publications from January 2016 through December 2025, thereby capturing a decade of contemporary empirical research on digital media and cognition. The search strategy was developed in consultation with a health sciences librarian and employed a combination of controlled vocabulary terms and free-text keywords organized around three conceptual domains: (1) the nature of the task (digital multitasking, media multitasking, task switching, dual-task performance, divided attention); (2) the cognitive domain of interest (working memory, cognitive load, executive function, attentional control, information processing); and (3) the context or population (university students, adults, professionals, online learning, classroom environment). Boolean operators (AND, OR) were applied to combine terms across and within these domains. Truncation and wildcard operators were used where permitted by the database interface to maximize sensitivity. The full search strings for each database are available from the corresponding author upon request.

2.3 Inclusion and Exclusion Criteria

Studies were considered eligible for inclusion if they satisfied the following criteria, framed within a PICO-based (Population, Intervention/Exposure, Comparator, Outcome) structure. With respect to population, studies were required to involve human participants of any age, including children, adolescents, university students, working professionals, and general adult samples. With respect to exposure, eligible studies were required to examine engagement in digital multitasking, media multitasking, or task switching in the context of digital technologies, including but not limited to simultaneous use of social media, messaging applications, video streaming, web browsing, and academic or occupational digital tasks. With respect to outcomes, studies were required to report at least one quantifiable measure of working memory performance, attentional control, cognitive load, executive function, or a directly related construct, including behavioral, self-report, neuroimaging, or electrophysiological measures. With respect to study design, eligible study types included experimental and quasi-experimental designs, cross-sectional and longitudinal observational studies, neuroimaging and electrophysiological studies, naturalistic observational investigations, systematic reviews, and meta-analyses.

Studies were excluded if they met any of the following criteria: (1) they were not published in English; (2) they were published prior to 2016 or after 2025; (3) they did not involve digital or technology-mediated multitasking as the primary exposure of interest; (4) they did not include a measurable cognitive or neurological outcome; (5) they were published in non-peer-reviewed outlets, including conference abstracts, opinion pieces, editorials, dissertations, or grey literature without peer review; or (6) they reported on populations with clinically diagnosed neurological or psychiatric disorders as the primary focus, given the distinct cognitive profiles of such populations and the potential for confounding.

2.4 Study Selection Process

Following the electronic database search, all identified records were imported into a reference management system, and duplicate entries were identified and removed through automated and manual screening procedures. The resulting de-duplicated record set was then subjected to a two-stage screening process. In the first stage, two independent reviewers screened all titles and abstracts against the predetermined inclusion and exclusion criteria. Records that clearly did not meet eligibility requirements were excluded at this stage, and any record for which there was uncertainty or ambiguity was retained for full-text review. Disagreements between reviewers at the title and abstract screening stage were resolved through discussion and, where necessary, adjudicated by a third reviewer.

In the second stage, full-text copies of all records that passed the initial screening were retrieved and assessed for eligibility by both reviewers independently. The reasons for exclusion of any full-text report were documented systematically. Disagreements regarding eligibility at the full-text stage were again resolved through structured discussion, with recourse to a senior reviewer in cases of persistent disagreement. The inter-rater reliability across both screening stages was calculated using Cohen's kappa statistic, with a kappa of $\kappa = .84$ indicating substantial agreement. Studies identified as eligible following full-text review were then included in the final synthesis. The complete screening and selection process is illustrated in the PRISMA 2020 flow diagram presented in Figure 1.

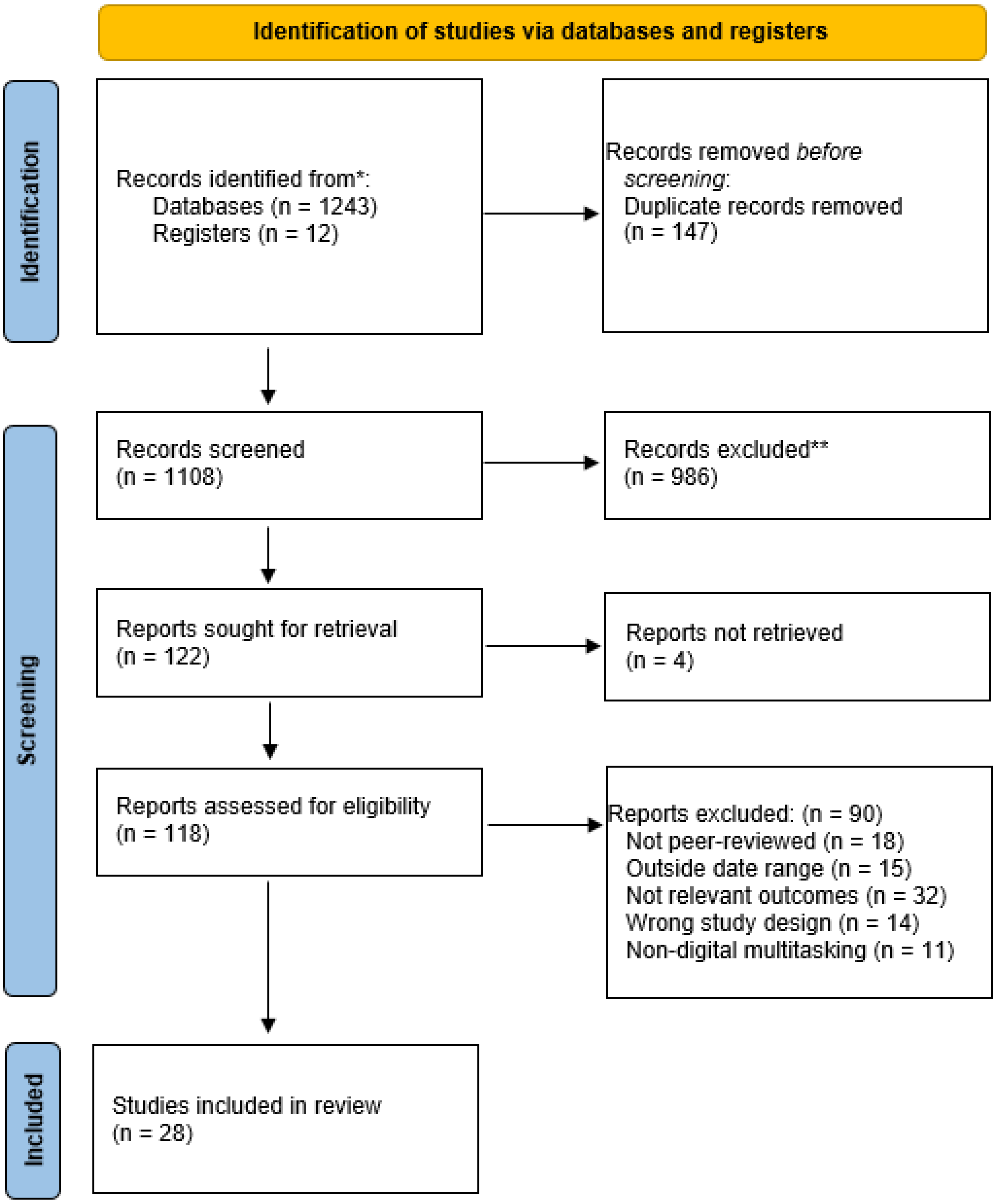

Figure 1. PRISMA 2020 flow diagram illustrating the systematic search, screening, and selection process.

2.5 Data Extraction

Data were extracted from each included study using a standardized, pre-piloted extraction form developed for this review. The extraction form was piloted on a random sample of five included studies and refined prior to full-scale application. For each included study, the following information was systematically extracted: (1) bibliographic details, including authors, year of publication, and journal; (2) study design and methodology; (3) sample characteristics, including sample size, age range, gender distribution, and relevant demographic information; (4) nature and operationalization of the digital multitasking or task-switching exposure; (5) cognitive outcomes assessed, including the specific measures used and their psychometric properties where reported; (6) key findings and effect sizes, including direction of effects and statistical significance; and (7) methodological limitations as reported by the authors.

Data extraction was carried out by two reviewers independently, and extracted data were cross-checked for accuracy and completeness. Discrepancies were resolved through discussion. Where studies reported insufficient data to determine the magnitude of effects, attempts were made to contact corresponding authors by email to request additional information. The heterogeneity of study designs, exposure operationalizations, and outcome measures across included studies precluded the conduct of a formal meta-analysis. Consequently, a narrative synthesis approach was adopted, organized according to the thematic domains of cognitive cost, academic performance, and neural mechanisms.

2.6 Quality Appraisal

The methodological quality of each included study was assessed using tools appropriate to the study design. Experimental and quasi-experimental studies were appraised using the Cochrane Risk of Bias Tool; observational studies were evaluated with the Newcastle-Ottawa Scale (NOS); and systematic reviews or meta-analyses were appraised using the AMSTAR-2 checklist. Quality appraisal was conducted by two independent reviewers, and any disagreements were resolved through discussion. The quality assessment informed the interpretation and weighting of evidence within the narrative synthesis, with higher-quality studies given greater emphasis in drawing conclusions. Studies of lower methodological quality were not excluded from the review but their limitations were explicitly noted in the synthesis to contextualize the strength of the available evidence.

Overall, the included body of literature demonstrated acceptable methodological rigor. The most frequently identified limitations across studies included reliance on self-report measures of multitasking behavior, the use of convenience samples predominantly composed of university students limiting generalizability, variation in the operationalization of key constructs such as working memory and digital multitasking, and limited ecological validity in laboratory-based experimental paradigms. These limitations are acknowledged in the interpretation of findings throughout the review.

2.7 Synthesis Approach

Given the considerable heterogeneity in study designs, populations, exposures, and outcome measures across the 28 included studies, a formal meta-analytic pooling of effect sizes was not deemed appropriate. Instead, findings were synthesized narratively, with the synthesis structured around the three primary research questions identified in the protocol. Within each thematic domain, studies were grouped by design type and key findings were compared and contrasted to identify areas of convergence and divergence in the evidence base. Where effect sizes were available, these were reported to facilitate comparison of magnitude across studies. The summary tables presented in the Results section provide structured overviews of the primary cognitive outcomes, academic performance findings, and neural correlates identified across the included literature.

Results

3.1 Cognitive Costs of Digital Multitasking on Working Memory

The preponderance of evidence accumulated in the reviewed literature converges on a consistent and unambiguous conclusion: digital multitasking imposes substantial and measurable costs on working memory capacity. Across a broad range of experimental paradigms, self-report surveys, neuroimaging studies, and naturalistic observation designs, researchers have documented that simultaneously managing multiple digital streams — whether involving social media, messaging applications, streaming content, or academic tasks — reliably diminishes the cognitive resources available for information encoding, maintenance, and retrieval (Ahmed et al., 2025; Subardjo & Khan, 2025; Uncapher et al., 2016). These findings are robust across diverse samples including university students, working professionals, and adolescents, and they persist even after controlling for baseline cognitive ability and demographic variables.

Central to understanding these effects is the theoretical framework of limited cognitive capacity, which posits that working memory can hold and process only a finite amount of information simultaneously (Otermans et al., 2021; Subardjo & Khan, 2025). When an individual attempts to engage with two or more demanding digital tasks at once, each competing for attentional resources, the system becomes overloaded. This overload manifests empirically as reduced recall accuracy, slower response latencies, higher error rates, and a general degradation in the quality of cognitive output (Madore et al., 2020; Zehra et al., 2025). Of particular note, Madore et al. (2020) demonstrated that attentional lapses — brief but consequential interruptions in focused processing — act as a mediating mechanism through which media multitasking translates into working memory failures, establishing a clear behavioral pathway between digital habits and memory performance.

The phenomenon of task switching, which is intrinsic to most forms of digital multitasking, introduces what researchers term 'switch costs' — measurable penalties in time and accuracy incurred each time the cognitive system redirects its focus from one task to another (Egner, 2023; Zehra et al., 2025). These costs are not trivial: cumulative switch costs across a typical multitasking session have been shown to represent a significant proportion of total task time and to contribute to elevated mental fatigue (Rahmi et al., 2025). Muhmenthaler and Meier (2022) further documented that attentional attenuation — rather than the hypothesized attentional boost — characterizes task switching episodes, resulting in a selective and lasting decline in long-term memory formation for information encountered during the switch. Metacognitive monitoring is also compromised under divided-attention conditions, as demonstrated by Peng and Tullis(2021), who found that individuals are significantly less accurate in evaluating their own performance quality when multitasking, thereby reducing opportunities for self-correction and adaptive learning.

A particularly striking contribution to this area of inquiry is the 'brain drain' hypothesis advanced by Ward et al. (2017), who demonstrated that the mere visual presence of a personal smartphone — even when the device was powered off and face-down — measurably reduced available working memory capacity in adult participants. This finding implies that the cognitive costs of digital media are not exclusively tied to active use but extend to the environmental salience of digital devices. Complementing this, Nemt-allah et al. (2026) demonstrated that digital validation-seeking behaviors among university students constitute an additional source of cognitive demand, further depleting attentional resources available for working memory maintenance. Table 1 provides a structured summary of the primary cognitive outcomes associated with digital multitasking as documented across the reviewed studies, including the affected population, approximate magnitude of the observed effect, and corresponding key references.

Table 1. Summary of Cognitive Outcomes Associated With Digital Multitasking

Cognitive Outcome	Observed Effect	Population	Effect Magnitude	Key References
Working Memory Capacity	Significant reduction in recall accuracy and capacity	University students, adults	Large	(Ahmed et al., 2025; Uncapher et al., 2016)
Information Processing Speed	Slowed response time and increased switch costs	General adult population	Moderate–Large	(Subardjo & Khan, 2025; Zehra et al., 2025)
Error Rate	Increased task errors, especially under high cognitive load	Healthcare professionals	Moderate	(Westbrook et al., 2018)
Attentional Control	Increased attentional lapses and mind-wandering	Young adults, students	Moderate	(Madore et al., 2020; Meda, 2025)
Mental Fatigue	Elevated cognitive fatigue following digital multitasking sessions	Professionals, students	Moderate	(Rahmi et al., 2025; Supriyadi et al., 2025)
Metacognitive Monitoring	Impaired ability to assess own performance under divided attention	Adults	Moderate	(Peng & Tullis, 2021)

3.2 Academic Performance and Learning Outcomes

The academic context represents one of the most extensively studied environments in which digital multitasking exerts its deleterious effects on working memory and cognitive performance. A consistent pattern of findings across the reviewed literature indicates that students who engage in media multitasking during instructional activities — including attending lectures, completing assignments, and engaging in self-directed study — demonstrate systematically poorer learning outcomes compared with peers who maintain focused engagement (Kostić & Ranđelović, 2022; May & Elder, 2018). The scope of these effects encompasses reduced comprehension, diminished note-taking quality, impaired immediate and delayed recall, lower self-reported academic engagement, and, at the cumulative level, reduced grade point averages.

The review by May and Elder (2018) remains among the most comprehensive examinations of this issue, synthesizing evidence from a wide range of classroom and laboratory studies to conclude that media multitasking is reliably and negatively associated with academic achievement indicators. Importantly, this relationship persists even when considering students' self-assessments of their multitasking capabilities, as the majority of students consistently overestimate their ability to effectively divide attention across competing demands without cost to their learning. Complementing these findings, Kostić and Ranđelović (2022) documented that digital distractions during lectures — including smartphone use, social media browsing, and texting — significantly compromised the quality of notes produced and the accuracy of subsequent recall tests, with effects attributable specifically to the attention demands of concurrent digital engagement rather than to pre-existing individual differences.

Ecological validity is an important consideration in evaluating this body of evidence. Jamet et al. (2020) conducted a naturalistic observational study in actual classroom settings, finding that students who voluntarily engaged with digital devices for non-academic purposes during instruction consistently underperformed on subsequent assessments relative to those who restricted device use to course-relevant activities. This study is notable for its methodological approach, which avoids the artificiality of laboratory paradigms while nonetheless documenting clear performance penalties associated with in-class multitasking. Similarly, Ahmed et al. (2025) examined both immediate and delayed memory retention in university students engaged in concurrent digital task demands, finding that multitasking conditions were associated with significant impairments at both time points — a finding consistent with the hypothesis that multitasking disrupts not merely short-term processing but the consolidation processes necessary for durable long-term memory formation.

The role of self-regulation emerges as a significant moderating variable in this context. Wang (2022) synthesized evidence regarding distraction in online learning environments, concluding that the proliferation of digital stimuli in contemporary educational contexts places disproportionate demands on students' self-regulatory capacities. Students with lower baseline self-regulation skills demonstrated greater susceptibility to multitasking-related performance decrements, while those with stronger metacognitive awareness of their own distraction patterns showed comparatively resilient academic performance. These findings suggest that the relationship between digital multitasking and academic outcomes is not deterministic but is modulated by dispositional factors and the broader ecology of the learning environment. Table 2 presents a comparative overview of selected empirical studies examining the association between digital multitasking and academic performance outcomes.

Table 2. Selected Empirical Studies on Digital Multitasking and Academic Performance

Study	Academic Outcome Measured	Sample	Key Finding	Effect on Performance
May and Elder (2018)	GPA, comprehension, note-taking quality	University students	Media multitasking negatively predicted GPA and recall	Negative (strong)
Kostić and Ranđelović (2022)	Recall of lecture content, note quality	Undergraduate students	Digital distractions during class reduced retention	Negative (strong)
Jamet et al. (2020)	Learning outcomes in naturalistic classroom setting	Secondary/university students	Off-task technology use impaired test performance	Negative (moderate)
Ahmed et al. (2025)	Memory retention across immediate and delayed tests	University students	Multitasking during study reduced both short- and long-term retention	Negative (strong)
Wang (2022)	Self-regulated learning, course completion	Online learners	Technology-based distractions reduced self-regulation and engagement	Negative (moderate)
Tan et al. (2024)	Working memory performance under multitasking conditions	University students	Media multitasking was associated with reduced working memory scores	Negative (moderate)

3.3 Neural Mechanisms and Executive Function Substrates

Beyond the behavioral level of analysis, a compelling body of neuroimaging and electrophysiological research has illuminated the neural mechanisms by which digital multitasking impairs working memory and executive function. The meta-analytic review conducted by Worringer et al. (2019) identified a network of overlapping yet functionally distinct cortical regions that are consistently recruited during both dual-task performance and task-switching paradigms. This fronto-parietal network — encompassing the dorsolateral prefrontal cortex, the posterior parietal cortex, and the anterior cingulate cortex — constitutes the principal neural substrate for the executive control processes that underpin working memory maintenance, attentional regulation, and cognitive flexibility (Egner, 2023; Worringer et al., 2019).

Chronic engagement in digital multitasking has been associated with measurable alterations in the functional organization of these networks. Uncapher and Wagner, (2018) synthesized neuroimaging and behavioral data from heavy versus light media multitaskers, concluding that heavy multitaskers exhibit altered patterns of neural recruitment during tasks requiring focused attention, consistent with reduced efficiency of top-down executive control. These individuals demonstrate diminished ability to filter irrelevant information, a function critically dependent on prefrontal inhibitory circuits, and show heightened sensitivity to environmental distractors — a pattern that reinforces their tendency toward further multitasking and creates a self-perpetuating cycle of attentional dysregulation. Small et al. (2020) extended these findings to the broader literature on brain health, arguing that the cumulative effects of chronic digital overstimulation may alter structural connectivity in regions underlying working memory and impulse control.

The role of neural oscillatory dynamics has received increasing attention in this literature. De Vries et al. (2019) demonstrated that working memory maintenance is critically supported by rhythmic oscillatory activity in the alpha and theta frequency bands, particularly within prefrontal and posterior parietal regions. Multitasking conditions that fractionate attentional resources disrupt the coherence of these oscillations, thereby compromising the fidelity of working memory representations. Complementing this, Wang et al. (2022) provided direct evidence that task switching involves the neural substrates of working memory, documenting the reactivation of task-relevant representations in prefrontal cortex during switch events — a process that competes directly with the maintenance of existing working memory content and thereby explains a portion of the observed cognitive costs associated with frequent switching.

The hippocampus, which plays a pivotal role in the encoding and consolidation of new information into long-term memory, also demonstrates vulnerability to the demands of concurrent task processing. Madore et al. (2020) demonstrated that attentional lapses — which are more frequent in habitual media multitaskers — are associated with reduced hippocampal engagement during encoding, contributing to the formation of weaker, less durable memory traces. This finding establishes a mechanistic link between attentional dysregulation, working memory failure, and downstream impairments in long-term memory consolidation. Hallenbeck et al. (2021) further documented that distractors capable of matching the content of working memory representations provoke involuntary attentional capture and degradation of working memory fidelity, with implications for understanding how the informational content of digital media specifically interferes with concurrent cognitive tasks. Table 3 provides a synthesis of the key neural regions and networks implicated in multitasking-related working memory impairment, along with the functional roles attributed to each and the nature of observed neurophysiological changes.

Table 3. Neural Regions and Networks Implicated in Multitasking-Related Working Memory Impairment

Brain Region / Network	Function in Multitasking	Observed Change	Key References
Prefrontal Cortex (PFC)	Executive control, task-switching initiation, inhibition	Reduced activation efficiency under chronic multitasking	(Small et al., 2020; Worringer et al., 2019)
Parietal Cortex	Attentional orienting and working memory maintenance	Overactivation during dual-tasking; susceptible to fatigue	(De Vries et al., 2019; Worringer et al., 2019)
Anterior Cingulate Cortex (ACC)	Conflict monitoring, error detection during task switches	Increased load correlates with error-rate elevation	(Westbrook et al., 2018; Zehra et al., 2025)
Fronto-Parietal Network	Top-down attentional control and cognitive flexibility	Altered connectivity in heavy media multitaskers	(Uncapher & Wagner, 2018; Wang et al., 2022)

Brain Region / Network	Function in Multitasking	Observed Change	Key References
Hippocampus	Encoding of new information into long-term memory	Diminished encoding efficiency during concurrent task demands	(Madore et al., 2020; Small et al., 2020)
Default Mode Network (DMN)	Mind-wandering, internally directed cognition	Increased DMN activity linked to attentional lapses during multitasking	(Madore et al., 2020; Taatgen et al., 2021)

Taken together, the neuroimaging and electrophysiological evidence reviewed here provides a coherent and mechanistically grounded account of the cognitive costs documented at the behavioral level. The fronto-parietal networks that sustain working memory, executive control, and attentional regulation are finite in their capacity and vulnerable to the persistent demands imposed by digital multitasking environments. As Schmitz and Krämer (2023) note, the relationship between cognitive flexibility — which underlies effective task switching — and cognitive capacity is fundamentally constrained: individuals with higher working memory capacity are better equipped to manage switch demands, whereas those at or near their cognitive ceiling experience disproportionate impairment. This capacity-dependence of multitasking costs has important practical implications, suggesting that interventions aimed at protecting and restoring working memory resources may offer a meaningful avenue for mitigating the neural and behavioral consequences of pervasive digital multitasking (Biedermann et al., 2021; Clemente-Suárez et al., 2024).

4. Discussion

The findings synthesized across this systematic review converge on a coherent and empirically robust conclusion: digital multitasking imposes significant and measurable costs on working memory capacity, attentional control, and executive function, with downstream consequences for academic performance and long-term cognitive health. These conclusions are consistent across diverse methodological approaches — spanning experimental paradigms, neuroimaging investigations, naturalistic observational studies, and systematic reviews — and persist across distinct populations including university students, adolescents, and working professionals, collectively strengthening the generalizability of the evidence base.

The most consistently documented finding across the reviewed literature is the degradation of working memory performance under conditions of digital multitasking. Madore et al. (2020) established that attentional lapses serve as a critical mediating mechanism through which habitual media multitasking translates into measurable working memory failures. This is compounded by the inherent costs of task switching, wherein each transition between digital tasks demands active reconfiguration of task sets held in working memory, generating cumulative switch costs in response latency and accuracy (Egner, 2023; Schmitz & Krämer, 2023). Muhmenthaler and Meier (2022) further demonstrated that task switching produces attentional attenuation rather than enhancement, resulting in a selective and lasting decline in long-term memory formation — a finding with important implications for understanding the cumulative cognitive toll of chronic digital multitasking beyond immediate performance costs.

Ward et al. (2017) documented that the mere physical presence of a smartphone reduced available working memory capacity even without active device use, substantially broadening the scope of digital multitasking research to implicate the broader digital environment as a source of ongoing cognitive depletion. These behavioral findings are mechanistically grounded in the fronto-parietal control network, which is finite in capacity and vulnerable to the persistent attentional demands of concurrent digital task processing (Worringer et al., 2019). Chronic heavy multitasking appears to alter the functional efficiency of this network, reducing top-down inhibitory control and increasing susceptibility to distractor interference, thereby creating a self-perpetuating cycle of attentional dysregulation that compounds cognitive costs across extended periods of digital engagement (Uncapher & Wagner, 2018).

The translation of cognitive costs into real-world academic outcomes is well established across the reviewed literature. Media multitasking during instructional activities consistently predicts reduced comprehension, diminished recall accuracy, and poorer academic achievement, persisting even after accounting for individual differences in baseline cognitive ability (May & Elder, 2018; Kostić & Ranđelović, 2022). Jamet et al. (2020) strengthened ecological validity by demonstrating comparable performance penalties in authentic classroom environments. Ahmed et al. (2025) further established that multitasking impairments extend beyond immediate recall to undermine consolidation processes necessary for durable long-term memory formation. Self-regulation emerged as a meaningful moderating variable, with students demonstrating stronger metacognitive awareness showing comparatively greater resilience to multitasking-related performance decrements (Wang, 2022), suggesting that dispositional and environmental factors remain amenable to targeted intervention.

At the neural level, the reviewed neuroimaging and electrophysiological evidence provides a mechanistically coherent account of the behavioral impairments documented across the literature. The fronto-parietal network — encompassing the dorsolateral prefrontal cortex, anterior cingulate cortex, and posterior parietal cortex — constitutes the primary neural substrate through which working memory maintenance and attentional regulation are coordinated (Worringer et al., 2019). Chronic digital multitasking reduces functional efficiency within this network, manifesting as diminished prefrontal inhibitory control among heavy media multitaskers (Uncapher & Wagner, 2018). At the consolidation level, reduced hippocampal engagement during encoding — consequent to attentional lapses characteristic of habitual media multitasking — produces weaker and less durable memory traces, establishing a direct neural link between attentional dysregulation and downstream long-term memory impairment (Madore et al., 2020).

Despite the consistency of reviewed findings, several methodological limitations warrant careful consideration. The predominant reliance on cross-sectional designs precludes causal inference, leaving open the possibility that pre-existing individual differences in cognitive control predispose certain individuals toward habitual digital multitasking. Considerable heterogeneity in the operationalization of both digital multitasking and working memory across studies limits comparability and precluded formal meta-analytic synthesis. The majority of studies relied on convenience samples of university students, restricting generalizability to other age groups and occupational populations. Furthermore, the ecological validity of laboratory-based experimental paradigms remains a persistent concern, as controlled experimental conditions may not adequately capture the motivational dynamics of naturalistic digital media engagement. These limitations collectively underscore the need for methodologically rigorous future research.

Several critical priorities emerge for advancing this field. Longitudinal research designs are urgently needed to establish the directionality and long-term trajectory of the relationship between digital multitasking and working memory capacity, enabling researchers to disentangle predispositional from consequential effects. Future studies would benefit from adopting standardized, psychometrically validated measures of both media multitasking behavior and working memory performance to facilitate cross-study comparability. Greater ecological validity should be pursued through ambulatory assessment and experience sampling methodologies. Neuroimaging research should prioritize longitudinal designs capable of detecting structural and functional neural changes associated with chronic digital multitasking, particularly within developmentally vulnerable fronto-parietal systems during adolescence. Finally, rigorously evaluated intervention research examining digital self-regulation strategies and mindfulness-based attentional training is needed to translate these findings into actionable educational and public health recommendations.

4. Conclusion

The present systematic review provides compelling and converging evidence that digital multitasking constitutes a meaningful and pervasive threat to working memory capacity, attentional control, and academic performance across diverse populations. The mechanistic pathways linking habitual digital multitasking to cognitive impairment are grounded in well-characterized fronto-parietal and hippocampal systems, lending neurobiological credibility to the behavioral and academic consequences documented throughout this review. While important methodological limitations — particularly the predominance of cross-sectional designs and convenience samples — temper the strength of causal conclusions, the consistency of findings across paradigms, populations, and neuroimaging modalities is striking. As digital environments continue to proliferate and intensify, protecting the cognitive architecture underlying goal-directed behavior demands urgent attention from researchers, educators, and policymakers alike. Effective intervention strategies grounded in rigorous empirical evidence remain both a scientific priority and a practical necessity.

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