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The Devastation Wrought by Neurocognitive Offloading on Reading Skills in Education: The Bi-Literate Brain in The Light of Neuroimaging Findings and Pedagogical Recommendations for Constructing Adaptive Neural Circuits

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Abstract

The rapid proliferation of artificial intelligence (AI) tools in education and the increase in digital screen usage structurally transform students' reading skills whilst generating negative neurocognitive effects. This digitisation introduces the threat of neurocognitive offloading as a result of delegating information processing in the brain to external systems; whilst neural networks are constructed through cognitive strain along the natural pathway of learning, the delegation of this process to AI tools by the student damages the brain's comprehension and synthesis capacities. This study is a neurocognitive review examining the neural underpinnings of deep reading skills under cognitive threat. Recent EEG, fNIRS, and fMRI findings are synthesised based on Stanislas Dehaene's Neuronal Recycling Hypothesis and Maryanne Wolf's Bi-literate Brain model. Lee et al. (2024) prove with fNIRS data that reading printed text reduces the workload of the prefrontal cortex—the most advanced brain region responsible for executive functions—thereby providing higher cognitive efficiency during information encoding. In the research conducted by Froud et al. (2024), where brainwaves were measured using an EEG device, it is shown that the N400 wave, which serves as the biological indicator of semantic processing depth, remains passive and semantic network activity does not occur during digital reading. The research conducted by Kosmyna et al. (2025) at the MIT Media Lab reports that when students outsource writing tasks to AI, it reduces neural connectivity by 55% and, in the long term, accumulates cognitive debt in the brain. The study argues that mental tasks outsourced to AI render the cognitive load required for schema construction—the conceptual networks—ineffective. Consequently, to mitigate these negative effects by constructing adaptive and flexible neural circuits, three pedagogical strategies are proposed: cognitive patience protocols, Socratic AI design, and academic code-switching pedagogy. This strategy aims to develop a bi-literate neural architecture to restore cognitive agency in education.

Keywords: Adaptive Neural Circuits, Bi-Literate Brain, Deep Reading, Generative Artificial Intelligence, Neurocognitive Offloading