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Original Article

Review of the Impact of Chat GPT on Human Memory: A Neuronal Perspective

Shital Tanaji Alhat
Department of Computer Science, RJSPM's Arts, Commerce & Science College Landewadi, Bhosari, Pune

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Correspondence Address:
Shital Tanaji Alhat
Department of Computer Science, RJSPM's Arts, Commerce & Science College Landewadi,Bhosari, Pune
Email: salhat82@gmail.com

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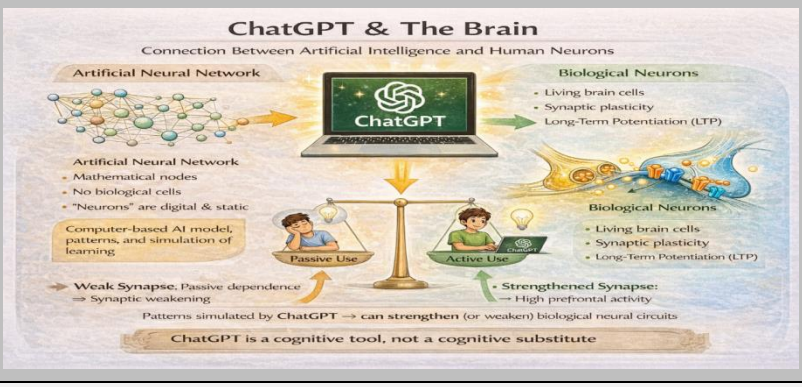
The rapid integration of generative Artificial Intelligence (AI), particularly Chat GPT, has significantly transformed how humans access, process, and internalize information. This paper examines the impact of Chat GPT on human memory from a neuronal and neuroscience-based perspective. Drawing on principles of synaptic plasticity, Hebbian learning, hippocampal–cortical interactions, and cognitive offloading, the study analyzes how different modes of Chat GPT usage influence memory encoding, consolidation, and retrieval. The paper conceptually differentiates between passive reliance on AI-generated outputs and active, reflective engagement with AI tools. Passive use may reduce hippocampal activation and weaken long-term memory consolidation due to decreased cognitive effort and limited synaptic reinforcement. In contrast, active interaction—such as questioning, reasoning, and self-explanation—stimulates prefrontal cortex engagement and supports deeper conceptual encoding. The study further integrates classical Sanskrit insights on repetition and memory strengthening with modern neurobiological theories, highlighting parallels between traditional wisdom and Hebbian learning mechanisms. Visual illustrations of neurons, synapses, and memory reinforcement are used to demonstrate how repetition and effort shape neural networks. The paper argues that while Chat GPT does not directly modify neuronal structures, it significantly modulates neural activation patterns that influence memory outcomes. When used in a balanced and guided manner, Chat GPT can enhance conceptual understanding and metacognitive skills without undermining core memory systems. The findings underscore the importance of intentional AI usage in educational and cognitive contexts to preserve and strengthen human memory processes.

Keywords: *Chat GPT, Human Memory, Neurons, Synaptic Plasticity, Hebbian Memory, Cognitive Offloading, Artificial Intelligence,prefrontal cortex, hippocampus*

Introduction

Generative AI systems are increasingly reshaping cognitive engagement and memory processes (Oakley et al., 2025; Hoskins, 2024).Human memory is a biological process rooted in neural activity, synaptic connections, and brain network dynamics. Traditionally, memory development required repeated attention, rehearsal, and emotional engagement. With the emergence of generative AI tools such as Chat GPT, humans increasingly rely on external systems for information retrieval and problem-solving. This shift raises an important question: How does frequent interaction with Chat GPT influence human memory at the neuronal level?



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This paper explores the neurological mechanisms of memory and examines how Chat GPT-mediated learning alters neural engagement, synaptic strengthening, and long-term retention. It also bridges classical Sanskrit insights with modern Hebbian learning theory.

Biological Basis of Human Memory

1. **Neurons and Synapses**

Memory in the human brain is encoded primarily through synapses, the functional junctions between neurons. A synapse allows a presynaptic neuron to transmit signals to a postsynaptic neuron using electrical and chemical mechanisms. Information is stored in patterns of synaptic connectivity across neural networks.

At the synaptic level, learning alters:

- Synaptic strength
- Neurotransmitter release probability
- Postsynaptic receptor density
- Dendritic spine morphology

2. **Types of Synapses Relevant to Memory**

- **Chemical synapses:** Dominant in memory formation; rely on neurotransmitters such as glutamate
- **Electrical synapses:** Enable rapid synchronization but play a limited role in long-term memory

Excitatory synapses (mainly glutamatergic) are especially important for learning and memory processes.

3. **Synaptic Plasticity**

Synaptic plasticity refers to the ability of synapses to strengthen or weaken over time in response to activity. It is the cellular foundation of memory.

- **Long-Term Potentiation (LTP):** Persistent strengthening of synapses following repeated stimulation
- **Long-Term Depression (LTD):** Weakening of synapses due to low activity or disuse

These mechanisms regulate memory formation and forgetting.

4. **Key Brain Regions Involved in Synaptic Memory Processing**

- **Hippocampus:** High synaptic plasticity; crucial for memory encoding
- **Prefrontal Cortex:** Maintains synaptic activity for working memory
- **Neocortex:** Long-term storage via distributed synaptic networks
- **Amygdala:** Enhances synaptic strength for emotionally significant memories

Hebbian Memory

Memory consolidation occurs through repeated co-activation of neurons, a principle known as Hebbian learning (Hebb, 1949; Kandel et al., 2021). Hebbian memory is based on the principle: "Neurons that fire together, wire together."

- Memory is strengthened through repetition and co-activation of neurons.
- Synaptic connections grow stronger with repeated activation (Long-Term Potentiation).
- Daily-life examples include:
  - Learning to ride a bicycle
  - Memorizing a phone number

Sanskrit Perspective

स्मरणं पुनरावृत्त्या दृढं भवति, यस्माद् तस्यानुरूपानि स्नायुजालानि दृढानि भवन्ति।

Meaning: "Memory is strengthened by repetition, so that the corresponding networks of muscles are strengthened."

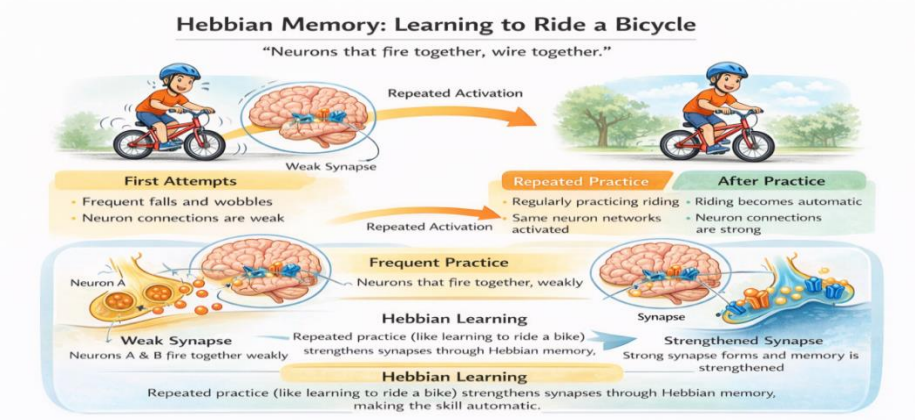

Figure 1: Hebbian Memory in Daily Life

Figure 1: An educational info graphic showing Hebbian muscle memory. Includes a person regularly practicing cycling, neurons firing, strengthened synapses through Hebbian memory making the skill automatic.

Chat GPT as an External Cognitive System

Chat GPT functions as an external memory aid, providing immediate access to information and structured explanations. The reliance on external tools for memory tasks is described as cognitive offloading, which can alter neural engagement patterns (Risko & Gilbert, 2016). Unlike the human brain, Chat GPT does not store episodic or emotional memories and does not undergo synaptic modification. However, its use changes how often and how deeply human neural circuits are activated. This phenomenon is known as cognitive offloading, where cognitive tasks are shifted from internal neural processing to external tools.

Neuronal Impact of Chat GPT Usage

The prefrontal cortex is responsible for executive functions and working memory, while the hippocampus plays a central role in memory formation and consolidation.

Excessive automation may reduce hippocampal involvement in long-term memory formation (Chan et al., 2024).

Consequently, the nature of interaction with AI systems—passive or active—determines the extent of neural engagement and synaptic reinforcement.

Impact of Chat GPT on These Neurons

Passive Use

- Reduced hippocampal activation
- Less synaptic strengthening
- Weaker long-term memory formation

Active Use

- Strong prefrontal engagement
- Conceptual hippocampal encoding
- Enhanced understanding and retention

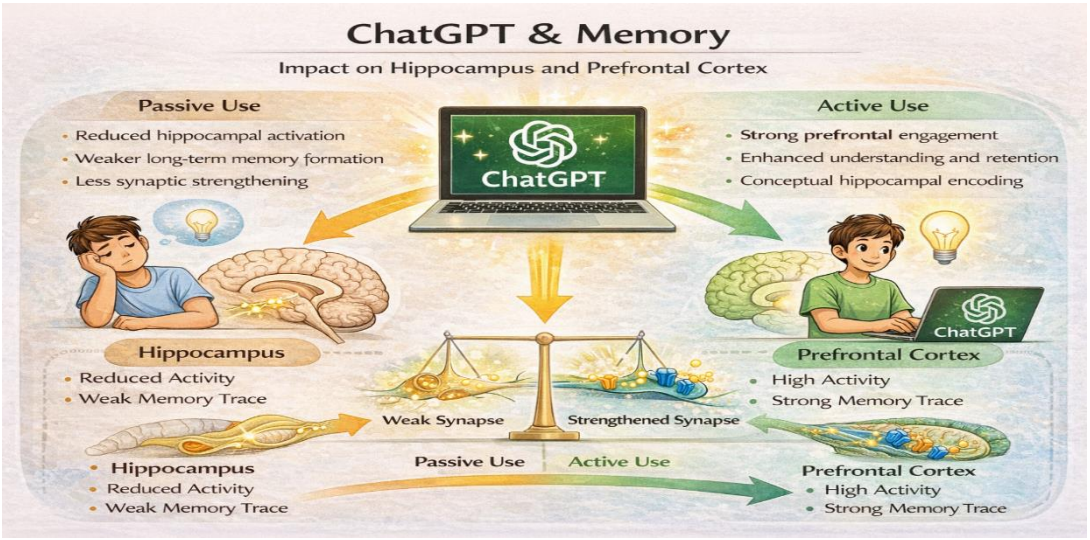

Figure 2: Chat GPT impact on Memory

Effects on Different Types of Memory

Memory Type	Neuronal Effect of Chat GPT
Working Memory	Reduced load but less neural exercise
Semantic Memory	Strengthened through concept clarification
Episodic Memory	Weak if learning is passive
Procedural Memory	Minimal impact
Emotional Memory	Limited influence

Dopamine, Reward, and Learning Effort

Instant answers activate dopamine-based reward circuits, increasing motivation but potentially reducing effortful learning, which is crucial for strong synaptic modification.

Long-Term Neuroplastic Effects

Risks of Overdependence

- Underuse of memory-related neural pathways

- Reduced hippocampal engagement
- Decline in recall-based neural strength

Benefits of Balanced Use

- Preservation of neuroplasticity
- Stronger meta-cognitive networks
- Enhanced conceptual understanding

Educational and Cognitive Implications

The integration of Chat GPT into educational contexts has the potential to significantly reshape learning processes. Rather than emphasizing rote memorization, Chat GPT encourages a shift toward **higher-order cognitive skills** such as analysis, synthesis, critical thinking, and problem-solving. By providing instant access to explanations and examples, AI tools can reduce cognitive load and allow learners to focus on conceptual understanding. However, excessive reliance on Chat GPT for direct answers may weaken **active memory retrieval,** a process essential for long-term memory consolidation at the hippocampal and cortical levels. To counteract this risk, educators should design learning activities that promote **retrieval practice**, reflection, and self-explanation alongside AI usage. Encouraging students to recall information before consulting Chat GPT and to critically evaluate AI-generated responses can enhance synaptic reinforcement and deepen understanding. Balanced AI use can enhance metacognition without replacing effortful learning (Huff & Ulakçı, 2024).When used as a **supportive cognitive tool rather than a replacement for thinking,** Chat GPT can complement traditional pedagogy by fostering metacognition, personalized learning, and meaningful engagement with content. Thus, balanced and guided use of AI is crucial to preserve and strengthen human memory systems while benefiting from technological advancement.

Conclusion

Chat GPT modulates neural activation patterns that underlie learning and memory processes. Prolonged passive reliance on AI-generated information can reduce cognitive effort, leading to diminished synaptic reinforcement and weaker long-term memory consolidation. In contrast, active and reflective interaction with Chat GPT stimulates neural circuits associated with attention, reasoning, and memory, thereby enhancing synaptic plasticity. Accordingly, the educational effectiveness of Chat GPT depends on its balanced and guided use, which can promote resilient, adaptive, and efficient human memory systems without undermining core cognitive functions.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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