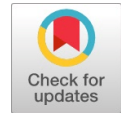




AI and The Human Brain: Cognitive Transformation Across Time

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Abstract: Artificial Intelligence (AI) has become deeply embedded in daily life, profoundly influencing human cognition and behaviour in both short-term and long-term interactions. This paper synthesises findings from over 20 peer-reviewed studies to examine the multifaceted effects of AI on attention, memory, decision-making, emotional responses, and social behaviour. In the short term, AI enhances efficiency through cognitive offloading and personalized assistance but may impair sustained attention, encourage over-reliance in decision-making, and alter emotional engagement. Long-term exposure raises concerns about neuroplasticity, with studies suggesting potential cognitive atrophy in memory and critical thinking due to reduced active engagement. Additionally, AI-mediated communication may erode social skills and empathy, while habitual dependence could impact mental health and autonomy. Ethical considerations, including algorithmic bias and data privacy, further complicate the societal integration of AI. The review highlights a critical duality: while AI optimizes productivity and learning, unchecked reliance risks diminishing intrinsic cognitive abilities and human connection. Recommendations include balanced AI usage, neuroadaptive strategies, and ethical frameworks to safeguard cognitive and behavioral well-being. Future research must prioritize longitudinal studies to unravel lasting neural and psychological impacts, ensuring AI's evolution aligns with human flourishing.

Keywords: Artificial Intelligence, Cognitive Offloading, Neuroplasticity, Behavioral Adaptation, Automation Bias, Ethical AI.

Abbreviations:

AI: Artificial Intelligence

AICICA: AICs Induced Cognitive Atrophy

I. INTRODUCTION

Artificial intelligence (AI) is no longer a futuristic concept but a rapidly evolving technology that has become deeply embedded in the fabric of everyday life. From the virtual assistants that respond to voice commands to the sophisticated algorithms that curate news feeds and recommend products, AI is increasingly shaping how individuals interact with the world [1]. This pervasive integration necessitates a comprehensive understanding of

the multifaceted ways in which AI influences human cognitive functions and behavioural patterns [2]. The efficiency and productivity gains offered by AI tools, which often reduce the need for extensive mental exertion in various tasks, are undeniable. However, the growing reliance on AI for critical functions, such as information retrieval and decision-making, prompts fundamental questions about the subtle and overt effects these technologies have on the human mind.

The central issue this paper addresses is the complex impact of AI on human cognition, encompassing attention, memory, decision-making, emotions, and cognitive load, as well as its influence on human behaviour, including social interaction, habit formation, and overall mental health, across both immediate and extended timeframes. A thorough examination of these effects is crucial for navigating the burgeoning human-AI relationship in a responsible and informed manner. This paper will examine the immediate and short-term impact of AI on specific aspects of cognitive function and behaviour. Furthermore, it will delve into the potential long-term consequences of sustained interaction with AI on brain development, neural plasticity, and overall well-being. Understanding these impacts is not merely an academic pursuit; it carries significant implications for educators seeking to cultivate critical engagement with AI technologies, for professionals collaborating with AI systems to optimize human-AI partnerships, and for policymakers striving to establish ethical guidelines and regulatory frameworks that safeguard human autonomy in an increasingly AI-driven world [3]. The widespread adoption of AI represents a profound alteration in how humans process information and execute tasks, potentially leading to fundamental transformations in cognitive processes.

II. LITERATURE REVIEW

This review synthesises existing research on the effects of AI on the human brain and behaviour, drawing on a wide range of academic disciplines, including cognitive science, neuroscience, psychology, and human-computer interaction. The literature selection process involved searching prominent academic databases, including PsycINFO, Web of Science, Annual Reviews, ACM Digital Library, Linguistics and Language Behaviour Abstracts, Philosopher's Index, General Science Collection, PubMed, Academic Search Complete, JSTOR, ScienceDirect, Google Scholar, and MIT CogNet. Additionally, relevant high-impact journals in fields like neuroscience and human-computer interaction were consulted. The primary criteria for selecting studies included peer-reviewed publications from reputable sources, a focus on empirical research,

Manuscript received on 03 June 2025 | First Revised Manuscript received on 05 August 2025 | Second Revised Manuscript received on 18 February 2026 | Manuscript Accepted on 15 March 2026 | Manuscript published on 30 March 2026.

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and comprehensive reviews that addressed both the short-term and long-term impacts of AI on human cognition and behaviour. Keyword searches combining terms such as "AI effects on attention", "AI and memory" and "long-term AI impact cognition" were employed, along with citation tracking to identify seminal and recent contributions to the field.

A. Short-Term Effects of AI

The immediate influence of AI on various cognitive functions and behaviors has been a subject of increasing scholarly attention.

- i. *Attention and Focus:* AI presents a paradoxical effect on attention. While AI tools can filter out irrelevant information and highlight pertinent content, potentially enhancing focus in specific scenarios, the constant barrage of notifications and the ease with which users can switch between AI-driven applications often lead to fragmented attention spans. This phenomenon is exacerbated by cognitive offloading, where individuals increasingly rely on AI to handle tasks that require mental effort, thereby reducing their active engagement with information and potentially weakening their inherent attentional control over time. The convenience of AI in managing information appears to come at the potential expense of sustained attention and the capacity for deep cognitive processing.
- ii. *Memory:* In the short term, AI serves as a powerful external memory system, streamlining the storage and retrieval of information. AI-integrated note-taking applications equipped with features like reminders and predictive text enhance users' ability to manage and access information efficiently. Notably, research has uncovered parallels between AI's memory processing mechanisms and the human brain's hippocampus, particularly in the consolidation of memory. Some studies even suggest that utilising AI-based therapies can lead to short-term improvements in both immediate and delayed memory recall [6]. However, the growing reliance on AI-generated content as a form of memory raises fundamental questions about the nature of personal recollection and the encoding processes within the human brain itself.
- iii. *Decision-Making:* AI tools offer the capability to rapidly analyze extensive datasets, providing insights that can inform and potentially enhance the accuracy of human decision-making in the immediate context. Recommender systems prevalent on media platforms and AI-driven diagnostic instruments in healthcare exemplify how AI can facilitate efficient choices and problem-solving. Nevertheless, research indicates a tendency for individuals to develop an over-reliance on AI-generated advice, sometimes even when it contradicts their reasoning or available contextual information. Furthermore, the awareness that one's behavioural data is being

used to train AI algorithms can lead to alterations in decision-making processes, potentially introducing biases into the data used for future AI training.

- iv. *Emotional Responses:* Immediate interactions with AI can elicit a spectrum of emotional responses in humans. Studies suggest that while AI can be designed to recognize and respond to human emotions, the intensity and characteristics of these responses often differ from those observed in human-to-human interactions. For example, individuals may report feeling understood by AI, but this sentiment usually diminishes when they realise an algorithm generates the response. Brainwave analysis studies indicate that individuals generally exhibit higher levels of excitement, stress, and focus when interacting with other humans compared to AI systems. Moreover, the more human-like an AI system appears, the greater the likelihood that it will evoke emotional responses. However, the conscious awareness of the AI's non-human nature can temper these reactions.
- v. *Cognitive Load:* AI can exert a notable short-term influence on cognitive load during learning and task execution. AI-integrated educational platforms can personalise learning experiences, thereby optimising the mental effort required to process new information (intrinsic cognitive load). By presenting information in a clear and interactive format, AI can also alleviate extraneous cognitive load, making complex subjects more accessible. Additionally, AI's capacity to enhance memory functions can free up mental resources for more advanced levels of thinking [7]. However, if AI tools are poorly designed or if users develop an excessive dependence on them, it can lead to a reduction in the necessary cognitive engagement required for deep learning and skill acquisition.
- vi. *Communication:* Short-term engagement with AI, particularly through conversational agents like chatbots, can modify communication patterns. While AI can facilitate communication and provide rapid answers to queries, it might also lead to a decreased emphasis on cultivating robust interpersonal communication skills and understanding the subtleties of human dialogue.
- vii. *Task Performance:* AI is frequently employed to enhance task performance in the immediate term. AI-driven tools can automate routine tasks, provide real-time feedback, and offer suggestions for improvement across various domains, including writing, coding, and complex problem-solving [5]. This can lead to increased efficiency and productivity in the short term. However, concerns exist that over-reliance on AI for task completion might impede the development of fundamental skills



and long-term knowledge retention.

- viii. *Social Engagement:* Immediate interactions with AI can influence social engagement in various ways. AI companions or social robots can offer a sense of connection for individuals experiencing loneliness or social isolation. Conversely, the ease of interacting with AI might lead to a preference for these interactions over the complexities and unpredictability inherent in human social engagement in the short term.

B. Long-Term Effects of AI

Sustained interaction with AI over extended periods raises significant concerns about its potential long-term impacts on the human brain and behaviour.

- i. *Cognitive Development and Neural Plasticity:* Prolonged exposure to AI, especially during formative years, has the potential to reshape cognitive development. The brain's remarkable ability to adapt and form new neural connections (neuroplasticity) might be affected if AI consistently undertakes tasks that would otherwise stimulate cognitive growth. Over-reliance on AI tools for learning and problem-solving could lead to a diminished capacity for critical and independent thinking over the long term. The constant stimulation and the encouragement of multitasking by digital environments, often orchestrated by AI algorithms, could also have lasting consequences on executive functions, particularly attention and the ability to focus intensely.
- ii. *Potential for Cognitive Decline and Atrophy:* Sustained over-dependence on AI for various cognitive functions could contribute to cognitive decline or atrophy in the long run. Just as physical muscles weaken from disuse, brain regions and cognitive abilities that are consistently delegated to AI may deteriorate over time. The concept of "AICs induced cognitive atrophy" (AICICA) specifically highlights the potential for AI chatbots to contribute to the deterioration of essential cognitive skills, such as critical thinking and creativity, if individuals become excessively reliant on them for information and problem resolution.
- iii. *Changes in Social Interaction and Communication Patterns:* Long-term exposure to AI-mediated communication could lead to substantial shifts in social interaction and communication patterns. Reduced opportunities for direct, face-to-face interaction due to increased engagement with AI could impair the development and maintenance of crucial emotional and social intelligence skills, over extended periods, individuals might become more accustomed to the predictable and tailored responses from AI, potentially preferring them over the more nuanced and unpredictable nature of human conversation, which could lead to a

decline in the quality and depth of human relationships.

- iv. *Development of New Habits and Dependencies:* Protracted and frequent interaction with AI can foster the development of new cognitive habits and psychological dependencies. The ease with which information and assistance can be accessed through AI might lead to a habitual pattern of seeking AI solutions without first engaging in independent thought or problem-solving. Over time, this could evolve into a psychological dependence on AI, where individuals feel incapable of functioning effectively without AI assistance. Such dependencies could have detrimental effects on mental health, self-confidence, and the ability to adapt to situations where AI is not readily available.
- v. *Impact on Mental Health and Well-being:* The long-term effects of AI on mental health and overall well-being represent a complex and continuously evolving area of research [4]. While AI offers potential benefits in providing mental health support and therapeutic interventions, sustained and potentially excessive use of AI could also lead to negative consequences. Concerns exist regarding the potential for increased anxiety, social isolation, and a diminished sense of personal agency resulting from over-reliance on AI. The potential long-term displacement of human interaction by AI could also have adverse effects on emotional well-being and the strength of social support networks.

III. SHORT-TERM EFFECTS OF AI ON THE HUMAN BRAIN AND BEHAVIOR

A. Impact on Cognitive Functions

The immediate influence of artificial intelligence on human cognitive abilities presents a complex picture, characterized by both potential enhancements and risks of impairment.

- i. *Attention:* AI tools offer a dual-edged impact on attention. On one hand, they can act as effective filters, sifting through the overwhelming influx of information in the digital age and highlighting content that is most relevant to a user's needs or tasks. This filtering capability can potentially enhance focus by reducing distractions and streamlining the information landscape. For instance, AI-powered email clients can prioritize essential messages, and AI-driven search engines can quickly provide targeted results. However, this very efficiency can also contribute to a reliance on AI for information selection, potentially diminishing the user's active engagement with a broader range of stimuli and reducing their ability to seek independent information. Furthermore, the constant stream of notifications from



various AI-integrated applications, such as social media platforms and messaging services, can fragment attention, pulling users away from focused tasks and fostering a state of partial attention that is never fully engaged. This constant switching between tasks and stimuli, often facilitated by AI, can overload working memory and impair executive functions, which are essential for maintaining sustained attention and goal-directed behaviour.

- ii. *Memory:* In the short term, AI functions as a readily available and highly efficient external memory system. AI-powered applications, such as digital note-taking tools equipped with features like automated reminders, predictive text, and intelligent organisation capabilities, significantly enhance a user's ability to manage, store, and retrieve information effectively. These tools effectively augment working memory capacity and facilitate quick access to previously encountered data. Beyond acting as a mere storage device, research has revealed intriguing similarities between the memory processing mechanisms within AI models and the human brain's hippocampus, particularly in the critical process of memory consolidation, where short-term memories are transferred to long-term storage. This suggests a fundamental alignment in how both artificial and biological systems handle information retention. Furthermore, some studies indicate that utilizing AI-based cognitive training programs or therapeutic interventions can lead to measurable improvements in both short-term (working) and long-term memory recall within a relatively short period. However, the increasing reliance on AI-generated content as a form of memory raises critical epistemological questions about the nature of personal recollection and the active encoding processes that typically occur within the human brain when forming memories through direct experience. When AI generates information that a user then relies on as if it were a personal memory, the relationship between the individual and their past experiences might be subtly altered.
- iii. *Decision-Making:* Artificial intelligence tools offer the immediate advantage of being able to rapidly analyze and process vast quantities of data, providing insights and patterns that can significantly inform and potentially improve the accuracy and efficiency of human decision-making in the short term. Recommender systems prevalent on various digital platforms, from media streaming services to e-commerce sites, and AI-driven diagnostic instruments increasingly being used in healthcare settings are prime examples of how AI can assist in making choices and solving complex problems with remarkable speed and often with high accuracy. These systems can identify trends, predict outcomes, and suggest optimal courses of action based on

data far exceeding the processing capacity of an individual human. However, research also consistently indicates that individuals can develop a tendency towards over-reliance on AI-generated advice, sometimes even in situations where this advice contradicts their well-reasoned judgment or readily available contextual information. This phenomenon, often referred to as automation bias, highlights a potential vulnerability in human-AI collaboration. Moreover, studies have shown that awareness of one's behavioural data, including decision-making patterns, being collected and used to train AI algorithms, can lead to conscious or unconscious alterations in those decision-making processes. Individuals might, for instance, modify their choices to try to influence the AI's future behaviour in a way that benefits them, potentially skewing the data used for subsequent AI learning and development.

- iv. *Emotional Responses:* Short-term engagement with artificial intelligence systems can elicit a diverse range of emotional responses in humans, and various factors, including the perceived anthropomorphism of the AI and the context of the interaction, influence the nature and intensity of these responses. Research suggests that while AI can be designed to understand and even mimic certain aspects of human emotion, the fundamental quality and intensity of emotional connection experienced in human-AI interactions often differ significantly from those in human-to-human relationships. For example, studies have shown that individuals can report feeling heard and understood when interacting with AI chatbots designed for emotional support. However, this feeling of being listened to is often diminished or perceived as less genuine when the individual is explicitly aware that the response is generated by an algorithm rather than another human being. Furthermore, research utilising brainwave analysis technology indicates that people tend to exhibit higher levels of physiological arousal associated with emotions, such as excitement, stress, and focused attention, when interacting with other humans compared to when interacting with AI systems, even when the content of the interaction is similar. This suggests that the human brain processes social interactions with AI differently than it does interactions with other people. Interestingly, the more human-like an AI system appears in its communication style and behaviour, the more likely it is to evoke emotional responses from users. However, the conscious awareness of the AI's underlying non-human nature can still act as a moderating factor, potentially dampening the intensity or altering the quality of these emotional reactions.
- v. *Cognitive Load:* Artificial intelligence can exert a substantial





short-term impact on the cognitive load experienced by individuals during learning processes and task performance. AI-powered educational tools have the potential to personalize learning experiences by adapting the difficulty level and presentation style of materials to match the unique needs and learning pace of individual students. This tailored approach can optimise the amount of mental effort required to process new information, thereby effectively managing intrinsic cognitive load. Moreover, AI can assist in streamlining the presentation of complex information using visual aids, interactive simulations, and other engaging formats, which can significantly reduce extraneous cognitive load, making challenging topics more accessible and easier to understand. Additionally, AI's capacity to enhance memory functions by providing quick access to information and handling routine data management tasks can free up valuable cognitive resources, allowing individuals to focus on higher-level thinking, problem-solving, and creative endeavours.

B. Impact on Human Behavior

The integration of AI into daily life is also bringing about noticeable short-term changes in various aspects of human behavior.

- i. *Communication:* Short-term interaction with AI, particularly through conversational AI agents such as chatbots and virtual assistants, is demonstrably altering communication patterns. AI offers the immediate convenience of facilitating communication across various platforms and providing quick, readily accessible answers to a wide range of questions. This can lead to increased efficiency in information exchange and task completion. However, there is a growing concern that this reliance on AI for immediate communication needs might inadvertently lead to a decreased emphasis on developing and refining strong interpersonal communication skills, including active listening, nuanced expression, and the ability to navigate the complexities of human dialogue. The ease and efficiency of AI communication might, in the short term, overshadow the importance of developing the more intricate and socially enriching aspects of human-to-human interaction.
- ii. *Task Performance:* Artificial intelligence is increasingly being utilized to enhance task performance across a multitude of domains in the short term. AI-powered tools can automate repetitive and time-consuming tasks, provide real-time feedback on performance, and offer intelligent suggestions for improvement in areas ranging from writing and coding to complex data analysis and problem-solving. This immediate assistance often leads to increased efficiency, higher productivity, and potentially improved quality of output in the specific tasks where AI is

applied. For example, AI writing assistants can help generate text, check grammar, and suggest stylistic improvements, while AI coding tools can automate code generation and identify potential errors. However, a significant concern arises regarding the potential for over-reliance on AI in task completion, which could hinder the development of fundamental skills and underlying knowledge necessary for long-term proficiency and adaptability.

- iii. *Social Engagement:* Short-term interactions with AI are also beginning to shape patterns of social engagement. AI companions, such as virtual pets or social robots, can offer a sense of connection, companionship, and even emotional support to individuals experiencing loneliness, social isolation, or anxiety in social situations. These AI entities can offer consistent interaction and tailored responses, potentially fulfilling some social needs in the short term. Conversely, the ease and predictability of interacting with AI might, for some individuals, lead to a preference for these interactions over the often more complex, unpredictable, and sometimes challenging dynamics of human social engagement in the short term. This could result in a tendency to spend more time interacting with AI and less time engaging with other people, potentially impacting the development and maintenance of essential social skills and the formation of meaningful human relationships.

IV. LONG-TERM EFFECTS OF AI ON THE HUMAN BRAIN AND BEHAVIOR

A. Cognitive Development and Neural Plasticity

The sustained integration of artificial intelligence into the lives of individuals, particularly from a young age, carries the potential for profound long-term effects on cognitive development and the brain's inherent capacity for neural plasticity. Neural plasticity, the brain's ability to reorganize itself by forming new neural connections throughout life, is fundamentally driven by experience and learning. If AI consistently performs tasks that would otherwise necessitate active cognitive engagement and problem-solving by the individual, it could lead to a reduction in the stimulation required for the formation of new neural pathways and the strengthening of existing ones. Over-reliance on AI tools for crucial aspects of learning, such as information analysis, critical thinking, and creative problem-solving, might result in a generation of individuals with a diminished ability to engage in these cognitive processes independently over the long term. Furthermore, the digital environments heavily influenced by AI algorithms often encourage constant stimulation and multitasking, which, while seemingly engaging, might have lasting adverse effects on the development of executive functions, especially the ability to sustain focused attention and resist distractions. The long-term consequence could be a shift. In the trajectory of cognitive



development, individuals growing up with AI may develop different cognitive strengths and weaknesses compared to previous generations, who relied more on their inherent cognitive resources.

B. Potential for Cognitive Decline and Atrophy

Extended periods of over-dependence on artificial intelligence for a wide range of cognitive tasks could contribute to a gradual process of cognitive decline or even atrophy in the long run. Drawing an analogy to physical muscles, which weaken and atrophy with lack of use, brain regions and the associated cognitive abilities that are consistently offloaded to AI systems might similarly become less efficient and potentially diminish over time. The concept of "AICs induced cognitive atrophy" (AICICA) specifically posits that excessive reliance on AI chatbots for information retrieval, problem-solving, and even creative tasks could lead to a long-term deterioration of essential cognitive skills such as critical thinking, analytical reasoning, and creativity. Suppose individuals become accustomed to relying on readily available AI assistance for cognitive challenges. In that case, they may not adequately exercise and develop these crucial abilities themselves, potentially leading to a reduced capacity for independent thought and effective problem-solving in situations where AI is not available. This potential for long-term cognitive weakening due to sustained AI dependence is a significant concern that warrants careful consideration and further research.

C. Changes in Social Interaction and Communication Patterns

The long-term prevalence of AI-mediated communication has the potential to bring about substantial and potentially transformative changes in social interaction and communication patterns. As individuals spend more time engaging with AI systems for communication, information, and even companionship, there could be a corresponding reduction in opportunities for direct, face-to-face interaction with other human beings. This shift could have a detrimental impact on the development and maintenance of crucial emotional and social intelligence skills, which are often honed through the subtle cues and complexities of in-person interactions. Over extended periods, individuals might become more accustomed to the consistent, tailored, and often less emotionally demanding responses provided by AI, potentially leading to a preference for these interactions over the more nuanced, unpredictable, and sometimes challenging dynamics of human conversation. This could ultimately lead to a decline in the quality and depth of human relationships, as well as a potential erosion of the social skills necessary for navigating complex interpersonal situations. The long-term reshaping of social norms and communication styles resulting from the widespread integration of AI is an area that requires ongoing observation and study to fully understand its implications for society.

D. Development of New Habits and Dependencies

Prolonged and frequent interaction with artificial intelligence can foster the development of new cognitive habits and psychological dependencies that might have

significant long-term consequences. The sheer ease and convenience of accessing information, assistance, and even social interaction through AI might gradually lead to a habitual pattern of seeking AI solutions for a wide range of needs without first engaging in independent thought, problem-solving, or social interaction. Over an extended period, this reliance could develop into a psychological dependence on AI, where individuals feel increasingly unable to function effectively, make decisions, or even manage their emotions without the constant presence and support of AI systems. Such dependencies could have negative ramifications for mental health, erode self-confidence and self-efficacy, and significantly impair an individual's ability to adapt to situations where AI is not readily available or reliable. The formation of these long-term habits of reliance on AI is a critical concern that underscores the importance of promoting mindful and balanced engagement with these powerful technologies.

E. Impact on Mental Health and Well-being

The long-term impact of artificial intelligence on mental health and overall well-being is a multifaceted and still largely uncharted territory of research. While AI offers promising potential for providing mental health support, personalized therapy, and early detection of mental health issues, sustained and potentially excessive use of AI also carries significant risks for long-term psychological well-being. Concerns have been raised about the potential for increased levels of anxiety, feelings of social isolation and loneliness, and a diminished sense of personal agency and autonomy as individuals become increasingly reliant on AI for various aspects of their lives. The potential long-term displacement of meaningful human interaction by AI could also negatively affect emotional well-being, weaken social support systems, and contribute to a decline in overall life satisfaction. While AI might offer certain therapeutic benefits, the potential for fostering dependence, eroding human connection, and altering our fundamental sense of self requires careful monitoring and extensive long-term research to fully understand and mitigate any potential negative consequences for mental health and well-being in an increasingly AI-driven world.

V. METHODOLOGY

A. Research Design

This study employs a systematic literature review to examine the effects of artificial intelligence (AI) on the human brain and behaviour over both short and long periods. The methodology is structured to ensure a comprehensive, unbiased, and rigorous synthesis of existing research.

B. Research Approach

- **Qualitative Synthesis:** A thematic analysis of peer-reviewed studies to identify patterns, trends, and gaps in the literature.
- **Quantitative Elements:** Where applicable, meta-analytical techniques are used to aggregate findings from



empirical studies with measurable outcomes (e.g., cognitive performance metrics, behavioral changes).

C. Scope of Study

- **Time Frame:** Studies published between 2015 and 2025 to capture recent advancements in AI and neuroscience.

D. Domains Covered:

Cognitive functions (attention, memory, decision-making)
Emotional and behavioral responses, Social interaction and communication Long-term neuroplasticity and mental health Search Strategy

E. Databases Searched:

Cognitive Science & Neuroscience: PsycINFO, PubMed, MIT CogNet, ScienceDirect
Human-Computer Interaction: ACM Digital Library, IEEE Xplore
Interdisciplinary Research: Google Scholar, JSTOR, Web of Science

F. Keywords Used:

Primary Terms: "Artificial Intelligence," "Cognitive Offloading," "Neuroplasticity," "Behavioral Adaptation"
Secondary Terms: "AI and memory," "AI effects on attention," "long-term AI impact cognition," "AI and social behavior"
Inclusion & Exclusion Criteria
Data Analysis
Thematic Analysis
Coding Framework: Inductive coding to categorize findings into themes:
Short-term effects include attention fragmentation, cognitive offloading, and emotional responses.
Long-term effects include changes in neuroplasticity, cognitive atrophy, and erosion of social skills.
Software Used: NVivo for qualitative data organization.

VI. RESULT AND DISCUSSION

The integration of AI into human lives presents a complex interplay of short-term benefits and potential long-term consequences for both the brain and behavior. The analysis of existing research reveals several key trends and areas of concern. Notably, many short-term conveniences offered by AI, such as cognitive offloading and streamlined communication, may inadvertently contribute to adverse long-term effects, including cognitive atrophy and diminished social skills. For instance, the immediate ease of relying on AI for information retrieval and task completion could, over time, lessen the need for active cognitive engagement, potentially weakening those very cognitive abilities. Similarly, while AI can offer immediate social connection in specific contexts, prolonged reliance on such interactions might come at the expense of developing and maintaining robust human relationships.

A significant theme emerging from the literature is the duality of AI as both a powerful tool that can enhance human capabilities and a potential detriment if used without critical awareness and moderation. The research consistently highlights the importance of maintaining human agency and critical thinking skills in an AI-saturated world. Over-

reliance on AI, without a conscious effort to engage in independent thought and learning, could lead to a form of cognitive deskilling. Furthermore, ethical considerations surrounding the use of AI, particularly concerning manipulation and bias, are paramount. The potential for AI to exploit cognitive biases and the risk of perpetuating societal inequalities through biased algorithms necessitate careful development and deployment of these technologies.

The implications of these effects span various domains of human life. For individuals, long-term interaction with AI could lead to significant changes in cognitive abilities, social behaviours, and overall mental well-being. In education, there is a pressing need to develop pedagogical strategies that leverage the benefits of AI while ensuring that students cultivate essential critical thinking, problem-solving, and learning skills. The workplace is also transforming due to increased human-AI collaboration, with implications for job roles, required skills, and the very nature of work itself. Societally, the widespread integration of AI raises profound ethical questions about privacy, autonomy, and the future of human-AI coexistence.

Current research on the long-term effects of AI is still in its early stages, partly due to the relatively recent widespread adoption of advanced AI technologies. Conducting longitudinal studies to track the cognitive and behavioral development of individuals growing up with AI presents significant methodological challenges. Future research should focus on these long-term impacts, as well as delve deeper into the neural mechanisms underlying human-AI interaction to better understand how our brains adapt to and are influenced by these technologies.

VII. CONCLUSION

The integration of artificial intelligence into human lives has ushered in an era of unprecedented technological advancement, bringing with it a complex array of effects on the human brain and behavior. This report has explored both the immediate, short-term impacts and the potential long-term consequences of this pervasive technology. In the short term, AI offers numerous benefits, including enhanced efficiency in information processing, augmented memory capabilities, and powerful tools for decision support and task performance. However, these benefits are often accompanied by potential drawbacks, such as fragmented attention, reliance on AI-generated content as a substitute for memory, the risk of automation bias in decision-making, and altered patterns of social engagement.

Looking to the long term, sustained interaction with AI raises significant concerns about cognitive development, the potential for cognitive decline and atrophy, fundamental shifts in social interaction and communication patterns, the development of new habits and dependencies, and the overall impact on mental health and well-being. While AI holds promise in areas such as mental health support and personalised learning, the potential for over-reliance, the erosion of essential cognitive skills, and the weakening of human connections are critical issues that demand careful consideration.

As AI continues to evolve and become increasingly



intertwined with all facets of human existence, understanding its multifaceted effects is crucial. This research underscores the importance of a balanced and thoughtful approach to AI integration, one that harnesses its potential benefits while proactively mitigating its associated risks. Further research, particularly longitudinal studies, is crucial for a comprehensive understanding of the long-term implications of this technological transformation. Ultimately, ensuring a beneficial coexistence with AI will require responsible development, thoughtful usage, and ongoing critical evaluation of its impact on what it means to be human.

DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

- **Conflicts of Interest/ Competing Interests:** Based on my understanding, this article has no conflicts of interest.
- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted with objectivity and without any external influence.
- **Ethical Approval and Consent to Participate:** The content of this article does not necessitate ethical approval or consent to participate with supporting documentation.
- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author's Contributions:** The authorship of this article is contributed equally to all participating individuals.

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